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Contents

Contents	iii
Figures.....	vi
Tables.....	xiv
Abstract	1
Introduction.....	1
Background and Key Functions of PRISM.....	2
Installation of Software	4
Module 1. ViewSPECPR	5
Function 1.1 – Listing the contents of a SPECPR file	5
Function 1.2 – Navigating through the record list.....	8
Function 1.3 – Saving the list of records in the SPECPR file	8
Function 1.4 – Plotting the data in a selected record	8
Step 1. Setting the data record.....	8
Step 2. Setting the wavelength record.....	9
Step 3. Plotting the data	11
Step 4. Overplotting data.....	11
Function 1.5 – Viewing the header, text, or DESCRIPT information in a record	13
Viewing the header information of a data record	14
Viewing the text stored in a text record	14
Viewing the description stored in a DESCRIPT record.....	14
Function 1.6 – Exporting a selected record to ASCII text.....	15
Function 1.7 – Performing continuum removal on a record.....	16
User Selection 1 – setting the plot title.	20
User Selection 2 – setting the output PostScript filename.	20
User Selection 3 – setting the continuum start wavelength.	20
User Selection 4 – setting the continuum stop wavelength.	20
User Selection 5 – Adjust continuum endpoints.	20
User Selection 6 – Set continuum endpoints by channel or by wavelength.....	20
Function 1.7.1 – Spectral Feature Comparison	29
Function 1.8 – Running MICA analysis on the selected record.....	42
Prompt 1: Select the MICA command file.....	44
Prompt 2: Set the output directory.....	44
Prompt 3: Set the verbose level	45
Prompt 4: Set the scale factor for reference spectra, if not set in the command file	46
Prompt 5: Enter the scale factor for reference spectra	46
Prompt 6: Set the scale factor for observed spectra, if not set in the command file	47
Prompt 7: Enter the scale factor for observed spectra	47
Prompt 8: Change the scale factor for observed spectra, if set in the command file	48
Prompt 9: Enter the scale factor for observed spectra, if changing the value from the command file	48
Prompt 10: Confirm the successful completion of MICA.....	49
Function 1.9 – ViewSPECPR spectral analysis functions	50
Function 1.9.1 – Write text record	51
Function 1.9.2 – Write a separator record	53
Function 1.9.2.1 – Write separator record of asterisks *****	53
Function 1.9.2.2 – Write separator record of dashes ----	55
Function 1.9.3 – Import ASD spectra	55

Function 1.9.4 – Transfer SPECPR record(s) into this file.....	61
Function 1.9.4.1 – Transfer SPECPR record(s) no changes	62
Function 1.9.4.2 – Transfer SPECPR record(s) set wave/FWHM.....	65
Function 1.9.4.3 – Transfer SPECPR record(s) set wave/FWHM and change title	69
Function 1.9.5 – Transfer SPECPR record(s) from this file	72
Function 1.9.5.1 – Transfer SPECPR record(s) no changes	72
Function 1.9.5.2 – Transfer SPECPR record(s) set wave/FWHM.....	72
Function 1.9.5.3 – Transfer SPECPR record(s) set wave/FWHM and change title	72
Function 1.9.6 – Average ASD spectra	72
Function 1.9.6.1 – Average ASD spectra.....	74
Function 1.9.6.2 – Average and AbsRef ASD spectra	83
Function 1.9.7 – Interpolate spectra	93
Function 1.9.8 – Convolve spectra	100
Function 1.9.8.1 – Convolve spectra with user-set output titles	101
Function 1.9.8.2 – Convolve spectra with automatic output titles	109
Function 1.9.8.3 – Convolve spectra with automatic output titles – ALL RECORDS	119
Function 1.9.9 – Spectral arithmetic.....	127
Function 1.9.9.1 – Add two spectra (spec1 + spec2).....	128
Function 1.9.9.2 – Subtract two spectra (spec1 - spec2).....	132
Function 1.9.9.3 – Multiply two spectra (spec1 * spec2).....	132
Function 1.9.9.4 – Divide two spectra (spec1 / spec2)	132
Function 1.9.9.5 – Average spectra	132
Function 1.9.10 – Constant arithmetic.....	136
Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)	136
Function 1.9.10.2 – Subtract a constant from a spectrum (spec1 - constant).....	139
Function 1.9.10.3 – Multiply a spectrum by a constant (spec1 * constant)	139
Function 1.9.10.4 – Divide a spectrum by a constant (spec1 / constant).....	139
Function 1.9.10.5 – Subtract a spectrum from a constant (constant - spec1).....	139
Function 1.9.11 – Line segment of constant value	140
Function 1.9.12 – Edit a SPECPR record header.....	143
Function 1.9.12.1 – Change record title	144
Function 1.9.12.2 – Change record title to "DO NOT USE THIS RECORD".....	146
Function 1.9.12.3 – Change pointer to wavelength record	148
Function 1.9.12.4 – Change pointer to FWHM record	151
Function 1.9.13 – Export SPECPR Records to ENVI Spectral Library	154
Function 1.9.14 – Import ENVI Spectral Library	161
Function 1.10 – Viewing the “Help file”.....	163
Function 1.11 – Quitting the ViewSPECPR program	164
iPlot Functions	164
Export plot to encapsulated PostScript and other image formats	164
Module 2. Spectral Analysis Functions	166
Function 2.1 – Create a new SPECPR file.....	167
Function 2.2 – Create a new SPECPR file for ASD spectra.....	170
Function 2.3 – Write text record	174
Function 2.4 – Write separator record.....	175
Function 2.4.1 – Separator of asterisks *****	175
Function 2.4.2 – Separator of dashes ----	175
Function 2.5 – Import ASD binary files into a SPECPR file.....	176

Function 2.6 – Transfer SPECPR record(s)	182
Function 2.6.1 – Transfer SPECPR record(s) no changes	182
Function 2.6.2 – Transfer SPECPR record(s) set wave/FWHM	182
Function 2.6.3 – Transfer SPECPR record(s) set wave/FWHM and change title	183
Function 2.7 – Average ASD spectra	183
Function 2.7.1 – Average and AbsRef ASD spectra	184
Function 2.7.2 – Average ASD spectra	184
Function 2.8 – Interpolate spectra	184
Function 2.9 – Convolve spectra	184
Function 2.9.1 – Convolve spectra with user-set output titles	185
Function 2.9.2 – Convolve spectra with automatic output titles	185
Function 2.9.3 – Convolve spectra with automatic output titles – ALL RECORDS	185
Function 2.9.4 – Convolve USGS Spectral Library splib06b	186
Function 2.10 – Spectral arithmetic	190
Function 2.10.1 – Add two spectra (spec1 + spec2)	190
Function 2.10.2 – Subtract two spectra (spec1 - spec2)	191
Function 2.10.3 – Multiply two spectra (spec1 * spec2)	191
Function 2.10.4 – Divide two spectra (spec1 / spec2)	191
Function 2.10.5 – Average spectra	191
Function 2.11 – Constant arithmetic	191
Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)	191
Function 2.11.2 – Subtract a constant from a spectrum (spec1 - constant)	192
Function 2.11.3 – Multiply a spectrum by a constant (spec1 * constant)	192
Function 2.11.4 – Divide a spectrum by a constant (spec1 / constant)	192
Function 2.11.5 – Subtract a spectrum from a constant (constant - spec1)	192
Function 2.12 – Create a line segment	192
Function 2.12.1 – Line segment of constant value	192
Function 2.13 – Edit a SPECPR record header	192
Function 2.13.1 – Change record title	193
Function 2.13.2 – Change record title to "DO NOT USE THIS RECORD"	193
Function 2.13.3 – Change pointer to wavelength record	193
Function 2.13.4 – Change pointer to FWHM record	193
Function 2.14 – Export SPECPR to ENVI Spectral Library	194
Function 2.15 – Import ENVI Spectral Library	194
Function 2.16 – Export SPECPR record to ASCII	194
Function 2.16.1 Export to ASCII Floating Point	195
Function 2.16.2 – Export to ASCII Scientific Notation	198
Function 2.17 – Wavelength/FWHM evaluation of ASD	199
Function 2.17.1 – Compare reference to ASD measurements for Mylar	205
Function 2.17.2 – Compare reference to ASD measurements for CG5121	216
Function 2.17.3 – Compare reference to ASD measurements for SRM2035 VNIR	216
Function 2.17.4 – Compare reference to ASD measurements for SRM2035 SWIR	217
Function 2.17.5 – Create ASD wavelength, bandpass (FWHM), spectralon records	217
Module 3. Image Processing Functions	225
Function 3.1 – Apply RTGC multiplier correction to image cube	226
Function 3.2 – Apply RTGC offset and multiplier corrections to image cube	231
Module 4. MICA – Material Identification and Characterization Algorithm	232
Function 4.1 – Run MICA for Image Cubes	245

Function 4.2 – Run MICA for Spectral Records	264
Function 4.3 – Run internal check of a MICA command file	272
Release Notes	276
Acknowledgments	276
References Cited	276
Appendix A. The MICA Command File	279
Appendix B. MICA output reports	328
Appendix C. DESCRIPT pages of example spectra	412
Appendix D. ASD detector corrections and example asd.txt entries	428
Appendix E. Format description and examples of FILE_DN_COLORS	431

Figures

1. ENVI menu bar with PRISM menu items.	4
2. The main ViewSPECPR control window.	5
3. Selecting a SPECPR file.	6
4. An example listing of the contents of a SPECPR file.	7
5. Setting the data record.	9
6. Setting the wavelength record.	10
7. Warning message following an error in wavelength record selection.	10
8. Plotting data records.	11
9. Selecting new wavelength and data records.	12
10. Overplotting data records.	13
11. Header information from a data record.	14
12. Text information from a text record.	14
13. Example of information in a DESCRIPT record.	15
14. Setting the filename for the output text file.	16
15. The iPlot window for continuum removal.	17
16. The iPlot window after drawing the continuum line.	18
17. The continuum-removal GUI.	19
18. Continuum refinement with Adjust Continuum Endpoints turned on.	22
19. Setting the JPEG file for the continuum-removed plot.	23
20. Setting the csv file for the continuum-removed plot.	24
21. Setting the title for the SPECPR record that will contain the continuum-removed feature.	25
22. Warning that title exceeds 40 characters.	25
23. Header information for a data record containing a continuum-removed feature.	26
24. Using the plot range tool.	27
25. The iPlot window after using the plot range tool.	27
26. The continuum line in the iPlot window after using the plot range tool.	28
27. The undo tool in the iPlot window.	29
28. Selecting the SPECPR file containing the new spectrum for comparison.	30
29. Selecting the SPECPR data record containing the new spectrum for comparison.	31
30. The spectral feature comparison plot, including fit value and other parameters.	32
31. The regression plot for continuum-removed features.	33
32. The spectral feature comparison plot with equalized depths.	35
33. Setting the JPEG file for the comparison plot.	36
34. Setting the csv file for the comparison plot.	37
35. Setting the title for the SPECPR record that will contain the continuum-removed feature from the observed spectrum.	39

36.	Setting the title for the SPECPR record that will contain the continuum-removed feature from the reference spectrum.....	40
37.	Setting the title for the SPECPR record that will contain the scaled continuum-removed feature from the reference spectrum.....	40
38.	Example text and data records written “Save Features to SPECPR”; the records written are 33861 to 33884.	41
39.	Spectral feature comparison parameters and continuum-removed feature parameters stored in the text record.....	41
40.	Parameters describing the continuum-removed feature of the observed spectrum stored in the header of the data record.....	42
41.	Running MICA on a selected record.	43
42.	Selecting a MICA command file.	44
43.	Selecting an output directory for MICA.....	45
44.	Setting the verbose level for MICA.....	45
45.	Prompt to set the scale factor for the reference spectra.....	46
46.	Setting the scale factor for the reference spectra.....	47
47.	Prompt to set the scale factor for the observed spectra.....	47
48.	Setting the scale factor for the observed spectra.....	48
49.	Prompt to change the scale factor for the observed spectra.....	48
50.	Setting the scale factor for the observed spectra.....	48
51.	Confirming the successful completion of the MICA routine.....	49
52.	Text report of the MICA results.....	50
53.	Spectral functions available within the ViewSPECPR module.....	51
54.	Entering the title for a text record.....	51
55.	Warning that title exceeds 40 characters.....	52
56.	The title truncated to 40 characters.....	52
57.	A title with only 40 characters.....	52
58.	Text to store in a SPECPR text record.....	53
59.	Separator record functions available within the ViewSPECPR module.....	54
60.	Separator record written to SPECPR file.....	55
61.	Selecting ASD binary files for import into a SPECPR file.....	55
62.	Selecting ASD binary files for import into a SPECPR file.....	57
63.	SPECPR file listing after importing ASD spectra with default wavelength and bandpass (FWHM) records.....	58
64.	Header information in an imported ASD spectrum using default wavelength and bandpass (FWHM) values.....	59
65.	Choosing the wavelength record in the SPECPR file into which ASD spectra will be imported.....	60
66.	Choosing the bandpass (FWHM) record in the SPECPR file into which ASD spectra will be imported.....	61
67.	Functions for transferring records into the SPECPR file being viewed.....	62
68.	Choosing the SPECPR file from which records will be transferred using the “no changes” function.....	63
69.	Choosing the records that will be transferred using the “no changes” function.....	64
70.	Records transferred using the “no changes” function, listed at the end of the SPECPR file being viewed.....	65
71.	Choosing the records that will be transferred.....	66
72.	Choosing the wavelength record for the records that will be transferred.....	67
73.	Choosing the bandpass (FWHM) record for the records that will be transferred.....	68
74.	Prompt to use the selected wavelength and bandpass (FWHM) records for all the data records that will be transferred.....	68
75.	Refreshed SPECPR file contents list showing the records transferred with the set wave/FWHM option.....	69
76.	Choosing the records that will be transferred.....	70
77.	Setting the title for the record that will be transferred.....	71

78.	Refreshed SPECPR file contents list showing the transferred records.	71
79.	Averaging functions for ASD spectra.	73
80.	Listing showing ASD records to be averaged.	75
81.	Choosing the wavelength record for the records that will be averaged.	76
82.	Selecting the bandpass (FWHM) record for the records that will be averaged.	77
83.	Selecting the data records to be averaged.	78
84.	Prompt for detector offset correction.	79
85.	Setting the output title for the record that will contain the average of ASD spectra.	79
86.	File listing after averaging of ASD spectra.	80
87.	Header information for the average spectrum.	81
88.	Selecting the option for detector offset correction.	81
89.	Message warning that the asd.txt file was not found.	82
90.	Offset options when asd.txt file is not found.	82
91.	Options for program execution when detector splice information is not found.	83
92.	Listing showing ASD records to be averaged and converted to absolute reflectance.	84
93.	Choosing the wavelength record for the records that will be averaged.	85
94.	Selecting the bandpass (FWHM) record for the records that will be averaged.	86
95.	Selecting the Spectralon panel reflectance record for the ASD spectra that will be averaged.	87
96.	Selecting the data records to be averaged and corrected to absolute reflectance.	88
97.	Prompt for detector offset correction.	89
98.	File listing after averaging and conversion to absolute reflectance of ASD spectra.	90
99.	Header information for the spectrum of the average, converted to absolute reflectance.	91
100.	Selecting the option for detector offset correction.	91
101.	Message warning that the asd.txt file was not found.	92
102.	Offset options when asd.txt file is not found.	92
103.	Options for program execution when detector splice information is not found.	92
104.	Default listing of file contents for the selection of the input wavelength record of the spectrum to be interpolated.	94
105.	Listing of new file containing the input wavelength record and the spectrum to be interpolated.	95
106.	Selecting the spectrum to be interpolated.	96
107.	Selecting the output wavelength record.	97
108.	Setting the title for the record that will be interpolated.	97
109.	Selecting the bandpass (FWHM) record for the interpolated spectrum.	98
110.	Selecting the bandpass (FWHM) record for the interpolated spectrum.	99
111.	Header information for the interpolated spectrum.	100
112.	Initiating the convolution with user-set output titles.	101
113.	Setting the wavelength record for the spectrum to be convolved with user-set output titles.	102
114.	Setting the bandpass (FWHM) record for the spectrum to be convolved with user-set output titles.	103
115.	Setting the spectrum to be convolved with user-set output titles.	104
116.	Setting the output wavelength record for the spectrometer to which the input data will be convolved, with user-set output titles.	105
117.	Setting the output bandpass (FWHM) record for the spectrometer to which the input data will be convolved, with user-set output titles.	106
118.	Plot window showing the input data being convolved, with user-set output titles.	107
119.	Setting the output title for the record that will contain the convolved spectrum.	107
120.	Records written after convolving a spectrum with user-set output titles.	108
121.	Record header information for the convolved spectrum.	109
122.	The contents of the text record containing the processing log information for the convolved spectrum.	109

123.	Initiating the convolution with automatic output titles.....	110
124.	The default file listing that appears when convolving spectra with automatic output titles.	111
125.	Selecting the input spectrometer wavelength record from the new file listing during the convolution of spectra with automatic output titles.	112
126.	Selecting the input spectrometer bandpass (FWHM) record from the new file listing during the convolution of spectra with automatic output titles.	113
127.	Selecting the input records from the new file listing during the convolution of spectra with automatic output titles.	114
128.	Setting the output wavelength record for the spectrometer to which the input data will be convolved, with automatic output titles.	115
129.	Setting the output bandpass (FWHM) record for the spectrometer to which the input data will be convolved, with automatic output titles.	116
130.	Plot window showing the input data being convolved, with automatic output titles.	117
131.	Records written after convolving a spectrum with automatic output titles.	118
132.	Record header information for a spectrum convolved with automatic output titles.	119
133.	Processing log information for a spectrum convolved with automatic output titles.	119
134.	Initiating the convolution with automatic output titles – ALL RECORDS.	120
135.	The default file listing that appears when convolving spectra with automatic output titles – ALL RECORDS.	121
136.	Selecting the input spectrometer wavelength record from the new file listing during the convolution of spectra with automatic output titles – ALL RECORDS.	122
137.	Selecting the input spectrometer bandpass (FWHM) record from the new file listing during the convolution of spectra with automatic output titles – ALL RECORDS.	123
138.	Setting the output wavelength record for the spectrometer to which the input data will be convolved, with automatic output titles – ALL RECORDS.	124
139.	Setting the output bandpass (FWHM) record for the spectrometer to which the input data will be convolved, with automatic output titles – ALL RECORDS.	125
140.	Records written after convolving spectra with automatic output titles – ALL RECORDS.	126
141.	Record header information for a spectrum convolved with automatic output titles – ALL RECORDS.	127
142.	Arithmetic functions for spectra.	128
143.	Selecting the first spectrum for the “Add two spectra (spec1 + spec2)” function.	129
144.	Selecting the second spectrum for the “Add two spectra (spec1 + spec2)” function.	130
145.	Selecting the wavelength record for the output spectrum of the “Add two spectra (spec1 + spec2)” function.	130
146.	Selecting the bandpass (FWHM) record for the output spectrum of the “Add two spectra (spec1 + spec2)” function.	131
147.	Setting the title for the output spectrum of the “Add two spectra (spec1 + spec2)” function.	131
148.	Completion message of the “Add two spectra (spec1 + spec2)” function.	132
149.	Choosing the wavelength record for the spectra to be averaged.	133
150.	Selecting the bandpass (FWHM) record for the spectra to be averaged.	134
151.	Selecting the records for the spectra to be averaged.	135
152.	Setting the title for the record that will contain the average spectrum.	135
153.	Arithmetic functions for spectra and constant values	136
154.	Selecting the spectrum for the “Add a constant to a spectrum (spec1 + constant)” function.	137
155.	Setting the constant value for the “Add a constant to a spectrum (spec1 + constant)” function, default value of 1 is shown.	137
156.	Edited constant value for the “Add a constant to a spectrum (spec1 + constant)” function.	138

157.	Selecting the wavelength record for the output spectrum of the “Add a constant to a spectrum (spec1 + constant)” function.....	138
158.	Selecting the bandpass (FWHM) record for the output spectrum of the “Add a constant to a spectrum (spec1 + constant)” function.....	138
159.	Setting the title for the output spectrum of the “Add a constant to a spectrum (spec1 + constant)” function.	139
160.	Setting the constant value for the “Add Line segment of constant value” function, default value of 1 is shown.	140
161.	Edited constant value for the “Line segment of constant value” function.	140
162.	Choosing the wavelength record for the line segment to be generated.	141
163.	Selecting the bandpass (FWHM) record for the spectra to be averaged.....	142
164.	Setting the title for the output spectrum of the “Line segment of constant value” function.	142
165.	Functions for editing the header information of a SPECPR record.	143
166.	Selecting the record to edit	144
167.	Information message that the record title is being changed.	145
168.	Prompt to edit the title.	145
169.	The edited title.	145
170.	Confirmation message that the user wishes to change the record title.	146
171.	Message advising the user that the title has been changed.....	146
172.	Selecting the record to edit, changing the title to “DO NOT USE THIS RECORD”.	147
173.	Information message that the record title is being changed.	147
174.	Confirmation message that the user wishes to change the record title to “DO NOT USE THIS RECORD”.	148
175.	Message advising the user that the title has been changed.....	148
176.	Selecting the record to edit, changing the pointer to the wavelength record.	149
177.	Selecting the wavelength record to associate with the edited record.	150
178.	Confirmation message that the user wishes to change the pointer to the wavelength record.	150
179.	Message advising the user that the wavelength pointer has been changed.	151
180.	Selecting the record to edit, changing the pointer to the FWHM record.	152
181.	Selecting the bandpass (FWHM) record to associate with the edited record.	153
182.	Confirmation message that the user wishes to change the pointer to the bandpass (FWHM) record.	153
183.	Message advising the user that the bandpass (FWHM) pointer has been changed.	154
184.	Selecting the wavelength record that is associated with the spectra to export to an ENVI spectral library	155
185.	Selecting the bandpass (FWHM) record that is associated with the spectra to export to an ENVI spectral library	156
186.	Selecting the spectra to export to an ENVI spectral library	157
187.	Setting the filename for the ENVI spectral library.....	157
188.	Setting the wavelength units for the ENVI spectral library file.	158
189.	Setting the reflectance scale factor for the ENVI spectral library file.	158
190.	Message advising the user that the ENVI spectral library file has been created.....	158
191.	The newly created ENVI spectral library file listed in the ENVI available bands list.	159
192.	The contents of the newly created ENVI spectral library listed using the “Spectral Library Viewer” function of ENVI.	160
193.	Spectra from the newly created ENVI spectral library.	160
194.	Selecting the ENVI spectral library file to be imported into the SPECPR file being viewed.....	161
195.	Message advising the user that the ENVI spectral library file has been imported.....	161
196.	Records written after importing an ENVI spectral library.....	162

197.	Header information in the wavelength record written when importing an ENVI spectral library.	163
198.	Exporting the plot to an encapsulated PostScript file.	165
199.	Exporting the plot to an encapsulated PostScript file – step 1.	166
200.	Spectral analysis functions available under the PRISM menu item.....	167
201.	Setting the name of the SPECPR file to create.	168
202.	Default information to store in the text record when creating a SPECPR file.	168
203.	Adding information to the text record when creating a SPECPR file.	169
204.	Listing the contents of the newly created SPECPR file.	170
205.	Setting the name of the SPECPR file to create for ASD spectra.	171
206.	Default information to store in the text record when creating a SPECPR file for ASD spectra.	171
207.	Adding information to the text record when creating a SPECPR file for ASD spectra.	172
208.	Selecting the SPECPR file containing the ASD wavelength, bandpass (FWHM), and Spectralon reflectance records to transfer into the new SPECPR file.....	172
209.	Selecting the ASD wavelength, bandpass (FWHM), and Spectralon reflectance records to transfer into the new SPECPR file.	173
210.	Message advising the user that the SPECPR file for ASD spectra was created.	173
211.	Listing the contents of the newly created SPECPR file for ASD spectra.	174
212.	Selecting a SPECPR file for adding a text record.	175
213.	Selecting ASD binary files for import into an existing SPECPR file for ASD spectra.....	177
214.	Selecting the SPECPR file into which the ASD spectra will be imported.	177
215.	Selecting ASD binary files for import into a SPECPR file.	178
216.	Selecting the wavelength record in the SPECPR file into which ASD spectra will be imported.	179
217.	Selecting the bandpass (FWHM) record in the SPECPR file into which ASD spectra will be imported.....	180
218.	Message advising the user that the ASD spectra were imported into the SPECPR file.	180
219.	Listing of the SPECPR file after importing ASD spectra.....	181
220.	Header information for a record containing an imported ASD spectrum.	182
221.	Convolution functions available under the PRISM menu item.....	185
222.	Setting a string describing the output spectrometer.	186
223.	Selecting the SPECPR file with the wavelength and bandpass (FWHM) records for the output spectrometer.....	187
224.	Selecting the wavelength record for the output spectrometer.	188
225.	Selecting the bandpass (FWHM) record for the output spectrometer.	189
226.	Setting the output SPECPR that will be created to contain the convolved library spectra.....	190
227.	Functions for exporting spectra to an ASCII text file.	195
228.	Selecting the SPECPR file containing the record to export to an ASCII text file in floating point format.	195
229.	Selecting the SPECPR record to export to an ASCII text file in floating point format.....	196
230.	Selecting the output ASCII text file to hold the exported spectrum in floating point format.	197
231.	Values from a text file containing a record exported in floating point format.	198
232.	Values from a text file containing a record exported in scientific notation format.	199
233.	Mylar single pass transmission spectrum measured with an ASD spectrometer.	202
234.	CG5121 single pass transmission spectrum measured with an ASD spectrometer.....	203
235.	NIST SRM2035 single pass transmission spectrum measured with an ASD spectrometer.	204
236.	NIST SRM2035 single pass transmission spectrum measured with an ASD spectrometer.	205
237.	Functions for evaluating ASD spectrometer characteristics.	206
238.	Setting the filename for the output report.	207
239.	Message indicating the SPECPR file, containing spectra of reference materials measured on the reference laboratory spectrometers, was found.....	207

240.	Selecting the SPECPR file that contains the spectrum of Mylar that was measured using the ASD spectrometer that the user is evaluating.	208
241.	Selecting the record that contains the one-way transmission spectrum of Mylar that was measured using the ASD spectrometer that the user is evaluating.	209
242.	Message indicating the successful completion of the ASD evaluation using spectra of Mylar.	209
243.	Report on the ASD evaluation using spectra of Mylar; the beginning of the file is shown	210
244.	Plots from the ASD evaluation using spectra of Mylar, for the 1.6601 μm feature.	212
245.	The bandpass estimate part of the spreadsheet for evaluating ASD spectral characteristics.	214
246.	The wavelength position part of the spreadsheet for evaluating ASD spectral characteristics.	215
247.	Entering the splice 1 wavelength value (in micrometers).	218
248.	Entering the splice 2 wavelength value (in micrometers).	218
249.	Entering the wavelength adjustment, in micrometers, for detector 1.	218
250.	Entering the wavelength adjustment, in micrometers, for detector 2.	219
251.	Entering the wavelength adjustment, in micrometers, for detector 3.	219
252.	Entering the bandpass (FWHM) estimate, in micrometers, for detector 1.	219
253.	Entering the bandpass (FWHM) estimate, in micrometers, for detector 2.	220
254.	Entering the bandpass (FWHM) estimate, in micrometers, for detector 3.	220
255.	Setting the output SPECPR file for the ASD wavelength and bandpass (FWHM) records and Spectralon reflectance.	221
256.	Entering the ASD spectrometer number.	221
257.	Entering the spectrometer's calibration number.	221
258.	Message indicating the successful creation of the ASD wavelength and bandpass (FWHM) records and Spectralon reflectance spectrum.	222
259.	Listing of the records written to the end of the output SPECPR file.	223
260.	Header information in the ASD wavelength record.	224
261.	Header information in the ASD bandpass (FWHM) record.	224
262.	Header information in the Spectralon reflectance record.	225
263.	Image processing functions in PRISM.	226
264.	Selecting the image cube to which the multiplier correction will be applied.	226
265.	Setting the input cube's scale factor.	227
266.	Selecting the SPECPR file that contains the multiplier record.	227
267.	Selecting the record that contains the wavelengths of the imaging spectrometer.	228
268.	Selecting the record that contains the bandpass (FWHM) of the imaging spectrometer.	229
269.	Selecting the record that contains the multiplier correction.	230
270.	Setting the filename for the output image cube.	230
271.	Setting the scale factor for the output image cube.	231
272.	Message indicating the completion of the processing of the image cube.	231
273.	Processing flow and key elements of MICA, image cube analysis.	232
274.	Reflectance spectrum and photo of an area of rangeland primarily covered by dry grass.	234
275.	Spectral feature comparison of a rangeland spectrum to the principal spectral features of two reference materials.	235
276.	Spectral feature comparison of a rangeland spectrum to the diagnostic spectral features of two reference materials.	236
277.	Absolute NOT feature.	240
278.	Relative NOT feature.	241
279.	Diagnostic features of muscovite.	242
280.	MICA routines.	245
281.	Selecting a MICA command file.	246

282.	Selecting an output directory for MICA.....	247
283.	Setting the verbose level for MICA, image mode.	247
284.	Selecting the spectra to analyze.	248
285.	Prompt to set the scale factor for the reference spectra.....	248
286.	Setting the scale factor for the reference spectra.....	249
287.	Prompt to set the scale factor for the observed spectra.	249
288.	Setting the scale factor for the observed spectra.	249
289.	Prompt to change the scale factor for the observed spectrum.	250
290.	Setting the scale factor for the observed spectrum.	250
291.	Confirming the successful completion of the MICA routine.	251
292.	Available bands list following completion of MICA image cube mode.	252
293.	Calcite fit, depth, and fit*depth image from MICA image cube mode.	253
294.	Fit images for calcite, green vegetation, and muscovite from MICA image cube mode.	254
295.	Image spectra in comparison to reference spectra.	255
296.	Example of header information stored in the ENVI header of a fit image.	256
297.	MICA summary image "mica_class_allmaterials_defaultindex" from MICA image cube mode.	258
298.	ENVI header information for MICA summary image "mica_class_allmaterials_defaultindex_withnondataclass"	259
299.	MICA summary image "mica_class_mappedmaterials_rankedbypixelcount" from MICA image cube mode.	260
300.	MICA summary image "mica_class_allmaterials_userindex" from MICA image cube mode.....	262
301.	Overlaying the classification image on the MICA image cube, with linked fit image for calcite and Z-profile window showing the reflectance spectrum of the selected pixel.....	263
302.	Selecting a MICA command file.	264
303.	Selecting an output directory for MICA.....	265
304.	Setting the verbose level for MICA spectral records mode.	266
305.	Selecting the spectra to analyze.	266
306.	Selecting the SPECPR file.	267
307.	Listing the contents of a SPECPR file for selecting records to analyze with MICA.	268
308.	Prompt to set the scale factor for the reference spectra.....	269
309.	Setting the scale factor for the reference spectra.....	269
310.	Prompt to set the scale factor for the observed spectra.	269
311.	Setting the scale factor for the observed spectra.	270
312.	Prompt to change the scale factor for the observed spectrum.	270
313.	Setting the scale factor for the observed spectra.	270
314.	Confirming the successful completion of the MICA routine.	271
315.	Text report of the MICA results.	272
316.	Selecting a MICA command file.	273
317.	Selecting an output directory for MICA.....	274
B1.	Photo and reflectance spectrum of example spectrum 1, field measurement of reflectance from an area of rangeland, primarily covered by shrub and tree species.	329
B2.	Photo and reflectance spectrum of example spectrum 2, field measurement of reflectance from an area of rangeland, primarily covered by dry grass.	329
B3.	Photo and reflectance spectrum of example spectrum 3, field measurement of reflectance from an area of rangeland, primarily exposed soil.	330
B4.	Photo and reflectance spectrum of example spectrum 4, field measurement of reflectance from an area of rangeland, primarily green grass.	330

B5. Plots of reference features for “Dry Golden Grass”, A and B, and “Illite”, C and D, compared to the observed spectrum.	372
D1. Correction factor for the first ASD detector.	429
D2. Correction factor for the third ASD detector.	430

Tables

1. Parameters describing the continuum-removed feature, exported in comma-separated value format.	24
2. Parameters describing the continuum-removed features and their comparison using linear regression, exported in comma-separated value format.	37
3. Feature and continuum constraints.	237
A1. Optional setup keywords and values in the MICA command file.	280
A2. Keywords and values required to define NOT features in the MICA command file.	285
A3. Keywords and values required to set up a spectrum of a reference material.	286
A4. Keywords and values required to define diagnostic features in the MICA command file.	288
A5. Keywords and values required to invoke NOT features in the MICA command file.	291
A6. Values for the WEIGHTED_FIT_DEPTH_CONSTRAINTS keyword in the MICA command file.	294

PRISM: Processing Routines in IDL for Spectroscopic Measurements (Installation Manual and User's Guide, Version 1.0)

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Abstract

This document describes procedures for installing and using the U.S. Geological Survey Processing Routines in IDL for Spectroscopic Measurements (PRISM) software. PRISM provides a framework to conduct spectroscopic analysis of measurements made using laboratory, field, airborne, and space-based spectrometers. Using PRISM functions, the user can compare the spectra of materials of unknown composition with reference spectra of known materials. This spectroscopic analysis allows the composition of the material to be identified and characterized. Among its other functions, PRISM contains routines for the storage of spectra in database files, import/export of ENVI spectral libraries, importation of field spectra, correction of spectra to absolute reflectance, arithmetic operations on spectra, interactive continuum removal and comparison of spectral features, correction of imaging spectrometer data to ground-calibrated reflectance, and identification and mapping of materials using spectral feature-based analysis of reflectance data. This report provides step-by-step instructions for installing the PRISM software and running its functions.

Introduction

Processing Routines in IDL for Spectroscopic Measurements (PRISM) is a software system that provides for storage and analysis of spectra collected using laboratory, field, airborne and space-borne spectrometers. The PRISM routines are grouped into four categories: (1) the ViewSPECPR module, (2) spectral analysis functions, (3) image processing functions, and (4) the Material Identification and Characterization Algorithm (MICA). PRISM is composed of programs written in IDL (Interactive Data Language) that run within the ENVI (ENvironment for Visualizing Images) image processing system.

PRISM uses database files of SPECPR (SPECtrum Processing Routines) format (Clark, 1993). SPECPR files have been used in terrestrial remote sensing and planetary studies for storing spectra collected by laboratory, field, and remote sensing instruments. A widely used SPECPR file is the U.S. Geological Survey (USGS) spectral library that contains thousands of spectra of minerals, vegetation, and manmade materials (Clark and others, 2007). SPECPR files can store reflectance spectra and associated wavelength and spectral resolution data, as well as metadata on the time and date of collection and spectrometer settings. PRISM has been written to use the headers of SPECPR records to track changes to stored spectra, allowing the user to

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understand the history and find the original source data for any spectrum stored in a SPECPR file. For additional details on the format and content of SPECPR files, see Clark (1993).

PRISM version 1.0 was compiled using a full ENVI 4.8+IDL 8.0 license running on a computer with a 64-bit version of the Windows 7 operating system. PRISM requires a licensed version of ENVI 4.8. Full functionality requires the iTools component of IDL. PRISM was tested on computers with full ENVI+IDL versions installed on 32-bit Windows XP, 64-bit Red Hat Linux, and Apple OSX 10.6 systems. PRISM operated correctly in runtime versions of ENVI 4.8 on these systems. For details on ENVI, see ITT Visual Information Solutions (2009).

Background and Key Functions of PRISM

PRISM provides a framework to conduct spectroscopic analysis. This spectroscopic analysis allows the composition of the material to be identified and characterized. At its core, PRISM relies on comparisons of user-defined diagnostic absorption features in reflectance spectra of reference materials, collected in a spectral library, to the spectrum of an unknown material. In these comparisons, the term “best match” is applied to the reference spectrum with the highest measure of similarity, in the wavelength positions and shapes of absorption features, between it and the spectrum of the material of unknown composition. This concept has been used for decades in the fields of analytical chemistry, geology, and astronomy. With technological advances that have produced airborne and space-based spectrometers, spectroscopic remote sensing using these same principles has been successfully applied to identifying and detecting the distribution of materials over large areas, including minerals (Clark and others, 2003), vegetation (Kokaly and others, 2003), and microbial life (Karnieli and others, 2001; Kokaly and others, 2007a).

PRISM draws on the legacies of a variety of USGS computer programs that have been created to advance spectroscopy and spectroscopic remote sensing, including SPECPR (Clark, 1993) and Tetracorder (Clark and others, 2003). Many capabilities of these programs are available in PRISM routines. Written in the IDL programming language, PRISM further allows easy integration of these methods with the image processing and GIS (Geographic Information Systems) capabilities of ENVI.

PRISM routines are generally applicable to spectra of all types (reflectance, transmission, emission, and others) spanning all wavelengths. The user has the flexibility to define the wavelengths of spectral data in whatever units they desire, for example, micrometers (μm), nanometers, wavenumbers, and so on. However, some PRISM routines have default settings to label plots or print results in terms of wavelengths in micrometers. Primarily, PRISM routines have been tested on and applied to reflectance spectra spanning the reflected solar wavelength region (0.35 to 2.50 μm).

For successful spectroscopic analysis and identification of materials, accurate reflectance measurements and robust spectral comparison methods are needed. To help ensure spectral quality, PRISM tracks spectra in spectral database files. The fixed length records of SPECPR files include header information on the data that are stored in the record (for details on the format of SPECPR files and records, see Clark, 1993). PRISM utilizes history fields in the record headers to trace a stored spectrum back to its source data (see *Function 1.5*). In PRISM, each stored spectrum contains metadata about its collection or creation. If derived through transformation of other spectra, for example, through arithmetic functions, the history fields in the header of a spectral record allow a user to determine the mathematical functions applied and input spectra used to generate it. In addition, PRISM allows the user to write text records, which

can be used to further explain the contents and histories of data records (see *Function 2.3*). A special type of text record, DESCRIPT records, can be used to store HTML-formatted descriptions to which photos can be linked. When viewed in PRISM, these DESCRIPT records can be selected and easily viewed in a Web browser (*Function 1.5*).

An important part of the SPECPR database is the association of spectra with their wavelength records. In the header of each stored spectrum is a pointer to the data record that contains the wavelength positions of each channel of the spectrometer that was used to measure the spectrum. Similarly, there is a pointer to the bandpass (FWHM, or Full-Width at Half Maximum) record that describes the width of the spectral window, around each channel's wavelength position, over which the instrument is sensitive. In PRISM, records are only added by appending them to the end of SPECPR files. Therefore, no data are overwritten and the ability to trace a spectrum back to its source records is preserved.

To help ensure spectral measurements are accurate, PRISM provides programs to evaluate the wavelength and bandpass (FWHM) characteristics of ASD (Analytical Spectral Devices, Boulder, Colorado) field spectrometers by analyzing measurements of reference materials (*Function 2.17*). By routinely evaluating the performance of an ASD spectrometer, significant changes over time, revealed by shifts in wavelength positions of absorption features, can be detected. Such shifts can arise during a field season.

PRISM includes additional routines for spectra measured with ASD spectrometers, including importing spectra in ASD binary files into SPECPR files (*Function 1.9.3*), converting spectra measured relative to a Spectralon reference panel to absolute reflectance, and correcting for offsets between detectors in ASD spectrometers (see *Functions 2.5* and *2.7*). Spectra measured using other spectrometers may be imported into SPECPR files via an ENVI spectral library (*Function 2.15*). Spectra stored in SPECPR files may likewise be exported to an ENVI spectral library file (*Function 2.14*). A spectrum may also be exported from a SPECPR file to a simple text file (*Function 2.16*). Through the ENVI spectral library files, spectra stored in SPECPR files and processed using PRISM functions may be linked to ENVI spectral functions or other spectral analysis programs which utilize ENVI spectral libraries to store data or have the capability to import/export spectra in ENVI spectral library files.

The accuracy of any mapping method applied to imaging spectrometer data is dependent, in part, on having well-calibrated reflectance data for analysis. Thus, PRISM includes methods to use field measurements of a calibration site to develop and apply empirical correction factors to generate well-calibrated imaging spectrometer data cubes (see *Functions 3.1* and *3.2*). PRISM's method of identifying and mapping materials relies on comparing well-calibrated data to spectra of known materials. Therefore, PRISM includes routines for spectral interpolation (*Function 2.8*) and convolution (*Function 2.9*) in order to convert spectra stored in USGS spectral libraries from their native spectroscopic characteristics to those of imaging spectrometers such as AVIRIS (Green and others, 1998) and HyMap (Cocks and others, 1998).

The Material Identification and Characterization Algorithm (MICA) is the module of PRISM that gives the user the ability to identify and map materials by comparing a spectrum, multiple spectra, or even an entire image cube to reference spectra of known materials (see *Functions 4.1* and *4.2*). A core function of MICA and PRISM is the continuum removal of absorption features in order to study their wavelength positions and shapes. *Function 1.7* creates a spectral viewer that lets the user interactively define individual continuum lines for spectral features and to plot continuum-removed spectral features. With a continuum-removed feature defined in this viewer, the user can select another spectrum in order to compare the shapes of the

continuum-removed features of these two spectra (see *Function 1.7.1*). The spectral feature comparison function calculates a measure of agreement between the two spectral features; this measure is termed the “fit” value. The continuum removal and comparison plot tools let the user become familiar with the shapes of absorption features and how they differ between materials. The MICA command file (see *appendix A*), is a user-created/edited document in which users list the spectra of materials they wish to use in a reference library against which to compare the spectrum of a material of unknown composition. In the MICA command file, the continuum endpoints of diagnostic absorption features and user-defined constraints on feature fits, depths, and continuum levels are defined. The values in the MICA command can be fine-tuned by the user to optimize material identification, improve discrimination between similar materials, and perform detailed chemical characterizations of mineral and vegetation composition. When used to analyze imaging spectrometer data (*Function 4.2*), MICA creates fit images for each reference material, showing the distribution of pixels which were found to be the best match to each material, and a summary image of detected materials.

Installation of Software

1. ENVI 4.8 must be installed.
2. Download the PRISM software files from <http://pubs.usgs.gov/of/2011/1155/> or insert the PRISM software disk.
3. On Windows systems, copy the “usgsprism” folder from the PRISM software disk to the top level of your C drive (C:\) on Windows systems or to “/var/local/” on Linux systems. If installing from the web address, uncompress the “usgsprism.zip” compressed archive file, containing the PRISM software and support files, to the top level of the C drive (C:\); this should create a new folder “C:\usgsprism\”. On Linux systems, uncompress the “usgsprism.zip” file to “/var/local/”; this should create a new folder “/var/local/usgsprism/”.
4. Copy the “usgsprism_v1_envi48.sav” file from the PRISM software disk or download it from the web address to your ENVI “save_add” directory. For installations of ENVI 4.8 on Windows computers, the save_add directory is commonly in the following location: “C:\ Program Files\ITT\IDL\IDL80\products\ENVI48\save_add\”. On Linux systems, the save_add directory is commonly located at: “/usr/local/itt/idl/idl80/products/envi48/save_add/”.
5. Start the ENVI program. The ENVI menu bar should now look like figure 1, with six items listed under the “PRISM” item when you click on it.

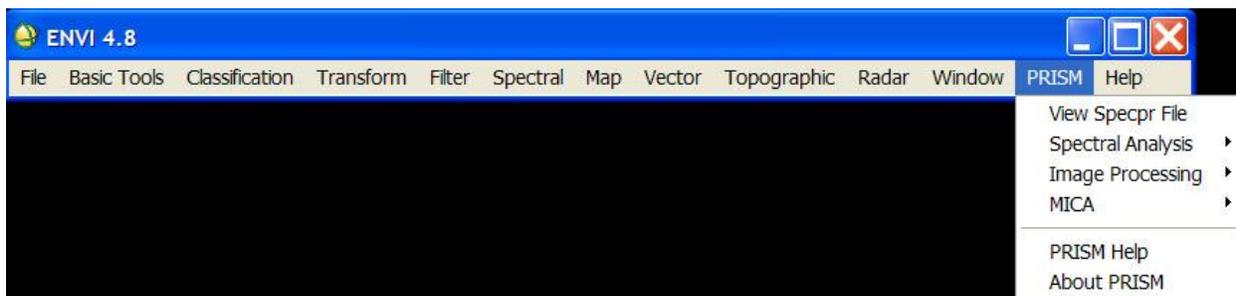


Figure 1. ENVI menu bar with PRISM menu items.

Module 1. ViewSPECPR

To start the program, click the “View SPECPR File” item under the “PRISM” entry on the ENVI menu bar. Figure 2 shows the main program control window that will appear.

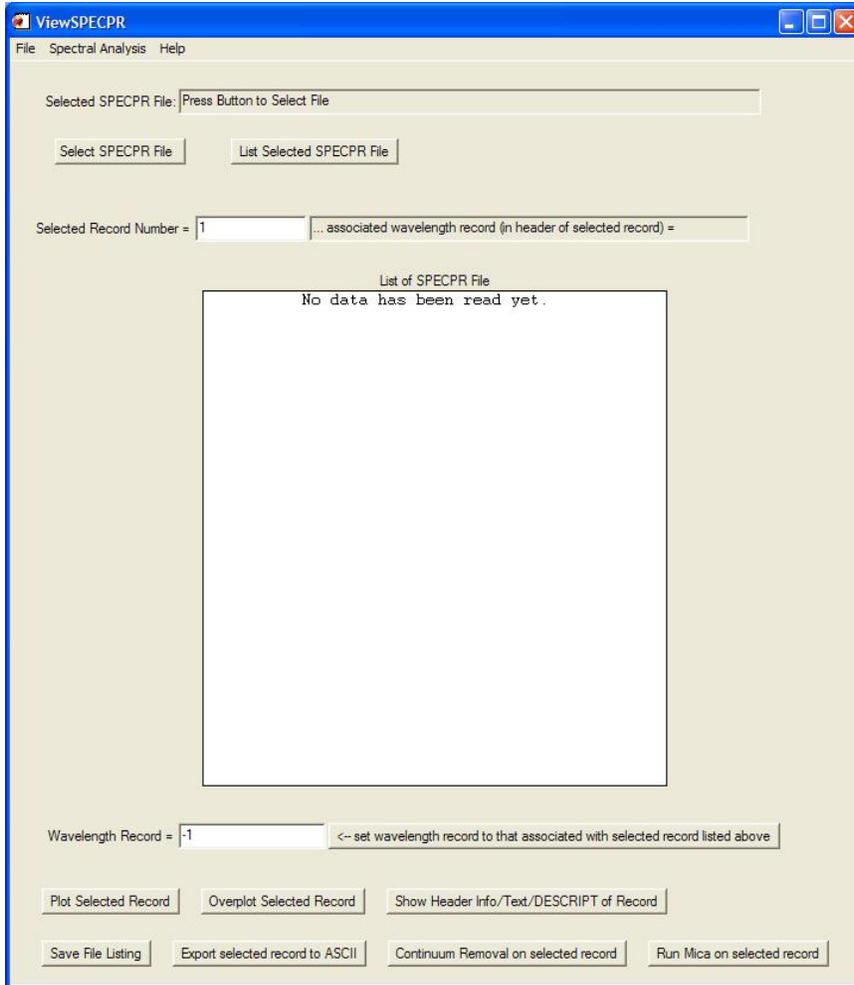


Figure 2. The main ViewSPECPR control window.

Function 1.1 – Listing the contents of a SPECPR file

Select the input SPECPR file by clicking on the “Select SPECPR File” button at the top left corner of the widget. A dialog widget (fig. 3) appears, in which the SPECPR file can be selected. Select the file and press the “Open” button. This example (fig. 3) shows the selection of a spectral library file, splib06a, which is a SPECPR file containing the USGS Spectral Library Version 6 (Clark and others, 2007). This file is included with the PRISM software distribution. If step 3 of the installation instructions was followed, the file will be located at “C:\usgsprism\spectra\splib06\splib06a” on Windows computers and at “/var/local/usgsprism/spectra/splib06/splib06a” on Linux computers.

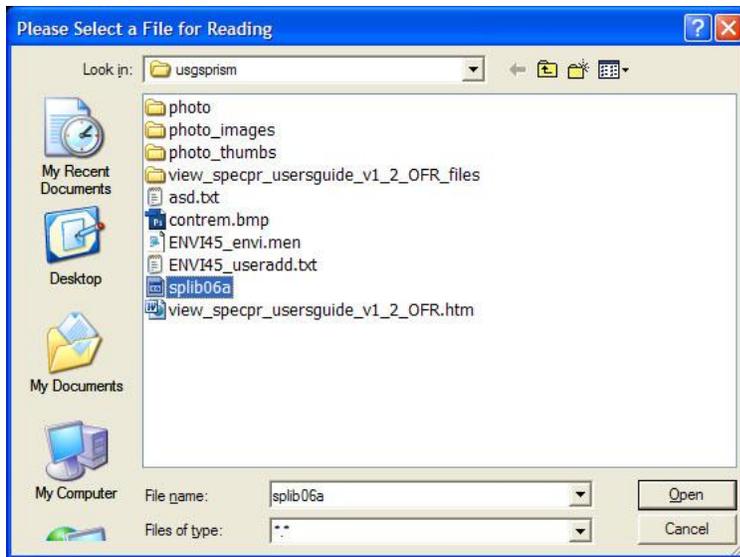


Figure 3. Selecting a SPECPR file.

To display the selected file, click the “List Selected SPECPR File” button, shown in the ViewSPECPR control window in figure 2. Figure 4 shows an example of the file listing that appears after following these two steps.

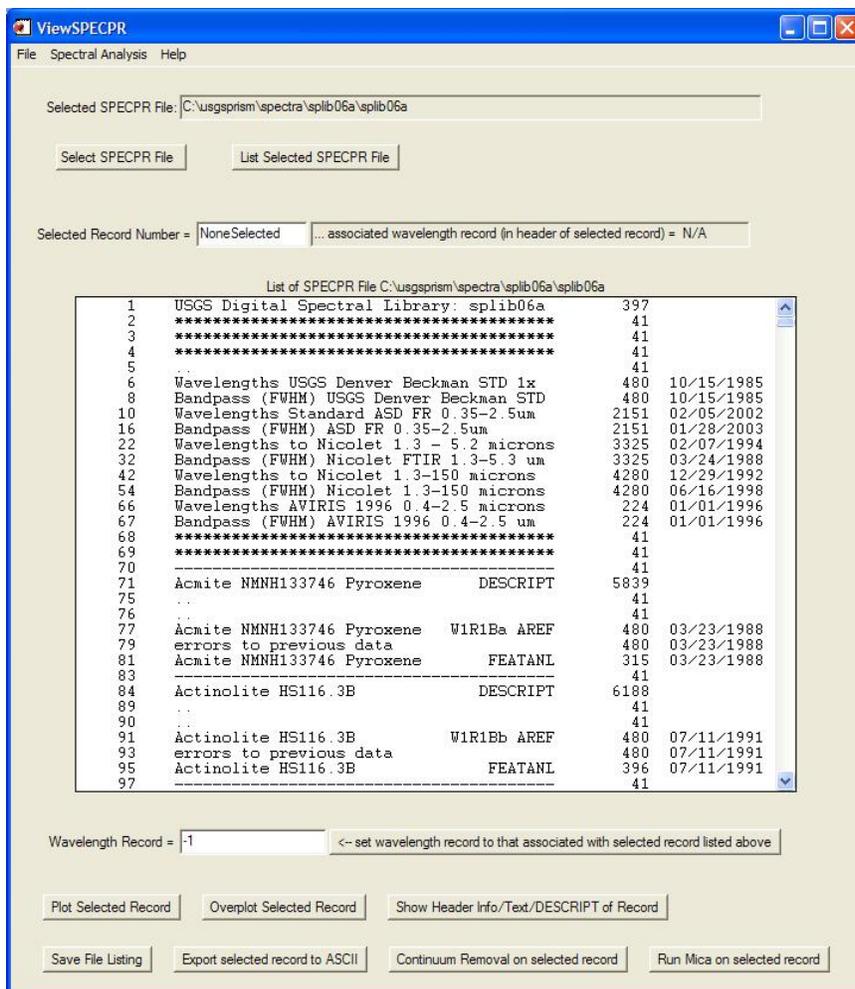


Figure 4. An example listing of the contents of a SPECPR file.

Each line in the list shows the record number in the left column, the record title in the second column, and the number of data channels or text characters in the third column. For data records, the date the data were collected is shown in the column on the right; otherwise, for text records, which do not have an associated collection date, this column is blank. If the spectrum's data collection date was not set in the header of the SPECPR data record when it was added to the SPECPR file, the column shows the text "no date set". Note: not all record numbers are listed. The file listing shows only the beginning record of the set of fixed-length records in which a spectrum is stored; the listing does not show "continuation records" that are used when the data length exceeds the size of the first record. For more details on SPECPR record lengths and continuation records, see Clark (1993). For example, records 1 to 6 are listed in figure 4. However, the next record listed is record 8. This is because the spectrum stored in record 6 has 480 channels and requires two records for storage. The listing does not show record 7, which is a continuation record; instead, the next spectrum stored in the SPECPR file is listed, in this case record 8.

Function 1.2 – Navigating through the record list

The scroll bar on the right-hand side of the list in figure 4 can be used to scroll through the listing of records in the SPECPR file. The user also can type a record number in the box to the right of the “Selected Record Number =” label. After entering the number and pressing the “enter” key or moving the cursor out of the box, the view in the list box will jump to the area of the SPECPR file that contains the closest record to the value entered in the box.

Function 1.3 – Saving the list of records in the SPECPR file

To output a text listing of the contents of a SPECPR file, the user can click the “Save File Listing” button in the bottom left corner of the widget. This will open a file selection widget so the user can set the name of a file that will hold a plain text listing of the records in the displayed SPECPR file.

Function 1.4 – Plotting the data in a selected record

Step 1. Setting the data record

The user can click on the data record for which the spectral plot is desired. Alternatively, the user may enter the record number in the text box next to the “Selected Record Number =” label. Figure 5 shows an example of clicking on record number 77. Once a data record is selected, it will appear “highlighted” in the record list. The text box to the right of the “Selected Record Number =” label shows the associated wavelength record that is encoded in its header information. Note: in some SPECPR records the wavelength record may not be set, in which case, the number 0 (zero) will be displayed.

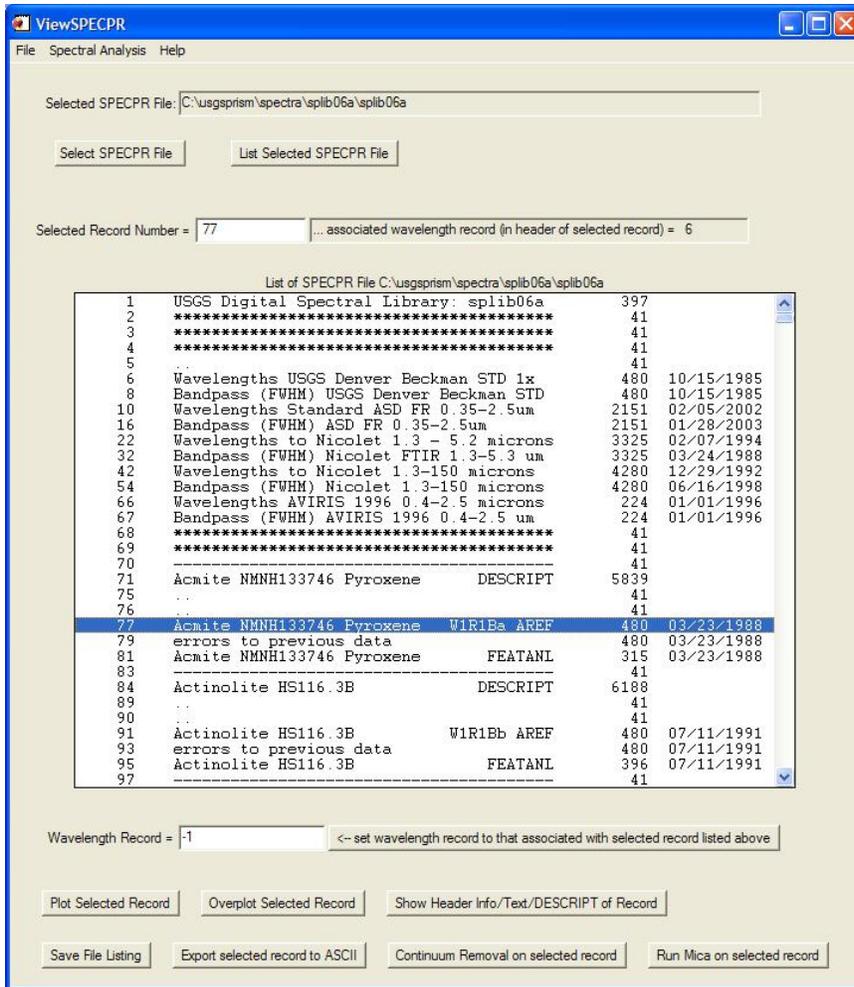


Figure 5. Setting the data record.

Step 2. Setting the wavelength record

Before plotting the spectrum, the user must set the wavelength record. The wavelength record contains the central wavelength positions of the channels of the spectrometer used to measure the spectrum. The user can type this record number in the box to the right of the "Wavelength Record =" label. Using the example in figure 5, the number "6" could be entered into the box in order to select record-6. The listing of the SPECPR file shows the title of this record to be "Wavelengths USGS Denver Beckman STD 1x". After the user presses the "enter" key or moves the cursor out of the text box, the record number entered will be accepted if it corresponds to a record number in the listing of the SPECPR file. Alternatively, the wavelength record can be set using the wavelength pointer encoded in the header information of the data record by clicking the button labeled "<-- set wavelength record to that associated with selected record listed above". Figure 6 shows an example of the wavelength record set to record 6.

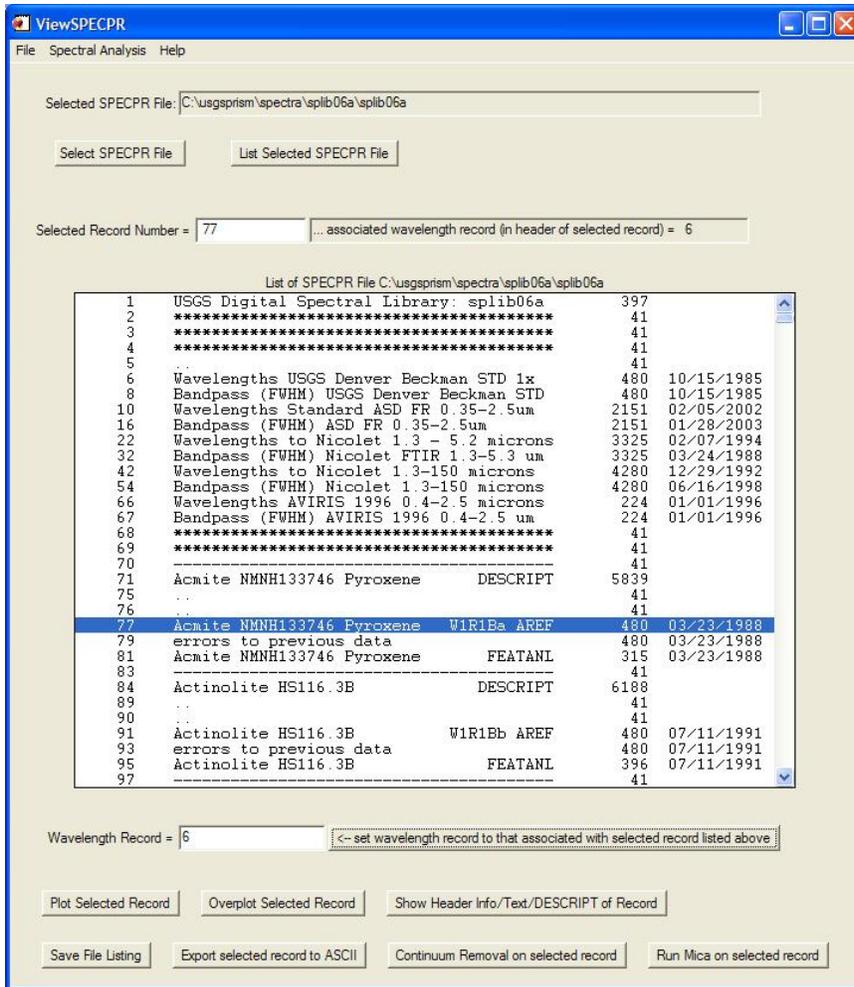


Figure 6. Setting the wavelength record.

If the user enters a number that does not correspond to a listed record number, then the message shown in figure 7 appears, and the value in the wavelength record field is set to a default value of 1. This message could appear if the record number is mistyped by the user or if the wavelength record value in the header is not set correctly.



Figure 7. Warning message following an error in wavelength record selection.

Step 3. Plotting the data

The user must click the “Plot Selected Record” button in order to make the plot appear. If the number of channels in the wavelength record, set in step 2, does not match the number of channels in the data record, set in step 1, then a warning box will appear, and no spectrum will be plotted. Figure 8 shows an example of plotting record 77 of the example SPECPR file using record 6 as the wavelength record. The plotted spectrum contains all valid data in the wavelength and data records. Channels that contain the SPECPR deleted point value ($-1.23e^{+34}$) are not plotted. A text line describing the SPECPR file and record that correspond to the plotted spectrum appears beneath the plot. Excluding the deleted points, the plot ranges for the x and y axes are set to encompass the values stored in the wavelength and data records, respectively. Note: The plotting function requires the “iTools” routines distributed by IDL/ENVI; the iTools routines usually are installed by default. Using the built-in functions of the iPlot routine of the iTools toolbox, the user may change axes limits, change axes labels, annotate the plot, and so on. Consult the IDL documentation on iTools and iPlot for more information (ITT Visual Information Solutions, 2009). Other spectra can be plotted in new windows by repeating steps 1-3 for different data and wavelength records.

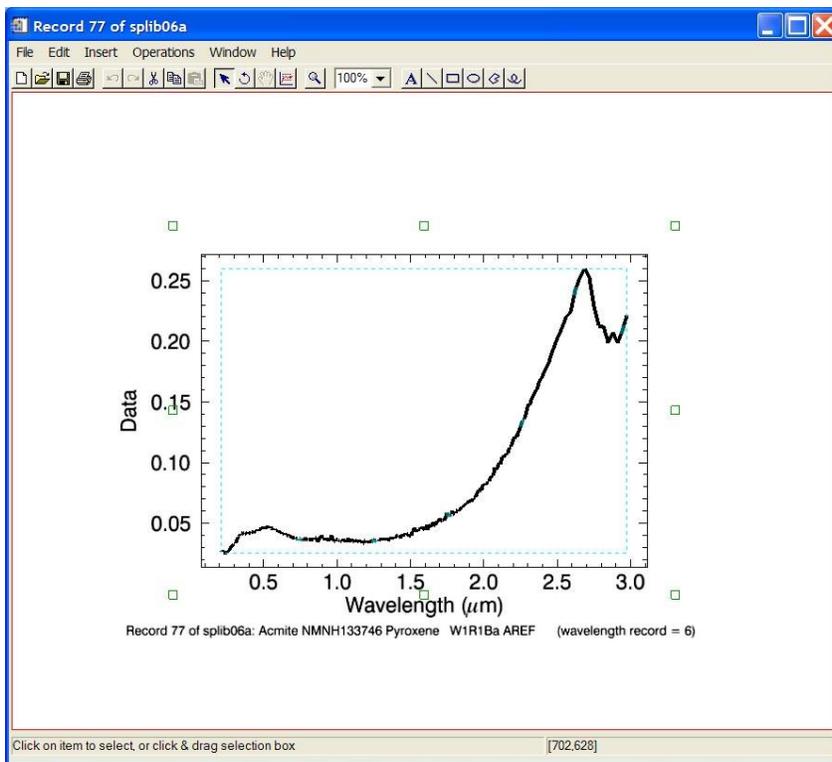


Figure 8. Plotting data records.

Step 4. Overplotting data

To overlay additional spectra with the same wavelengths, the user may repeat step 1, selecting a new data record, and click the “Overplot Selected Record” button. The user may also

overplot spectra collected with a different spectrometer by both selecting a new data record and a new wavelength record (repeating steps 1 and 2) and clicking the “Overplot Selected Record” button. This can be repeated for as many records as desired. For example, figure 9 shows the ViewSPECPR control window after selecting a new data record (29634) and its corresponding wavelength record (10).

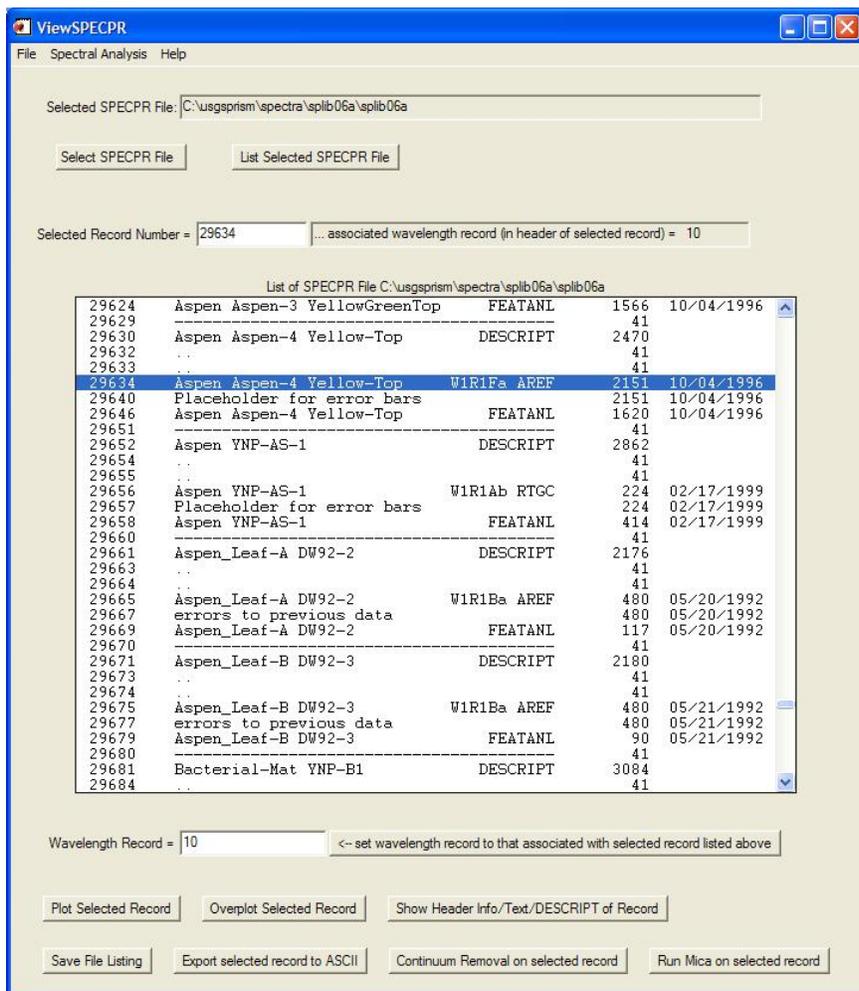


Figure 9. Selecting new wavelength and data records.

Figure 10 shows the result of overplotting this spectrum on the previously created plot. These spectra were measured with different spectrometers. The new spectrum is shown in a different color, and text describing the SPECPR file, record, and title of this overplotted spectrum is put below the text describing the previously plotted spectrum. The first eight spectra plotted are given different colors and their titles are placed below the plot in the lower left. The next eight spectra are given the same colors, but adjusted to appear darker, and their titles are placed below the plot in the lower right. While any number of spectra can be overplotted, after sixteen spectra are plotted, there will not be enough room below the plot for the descriptive text, and that text will not appear in the iPlot widget.

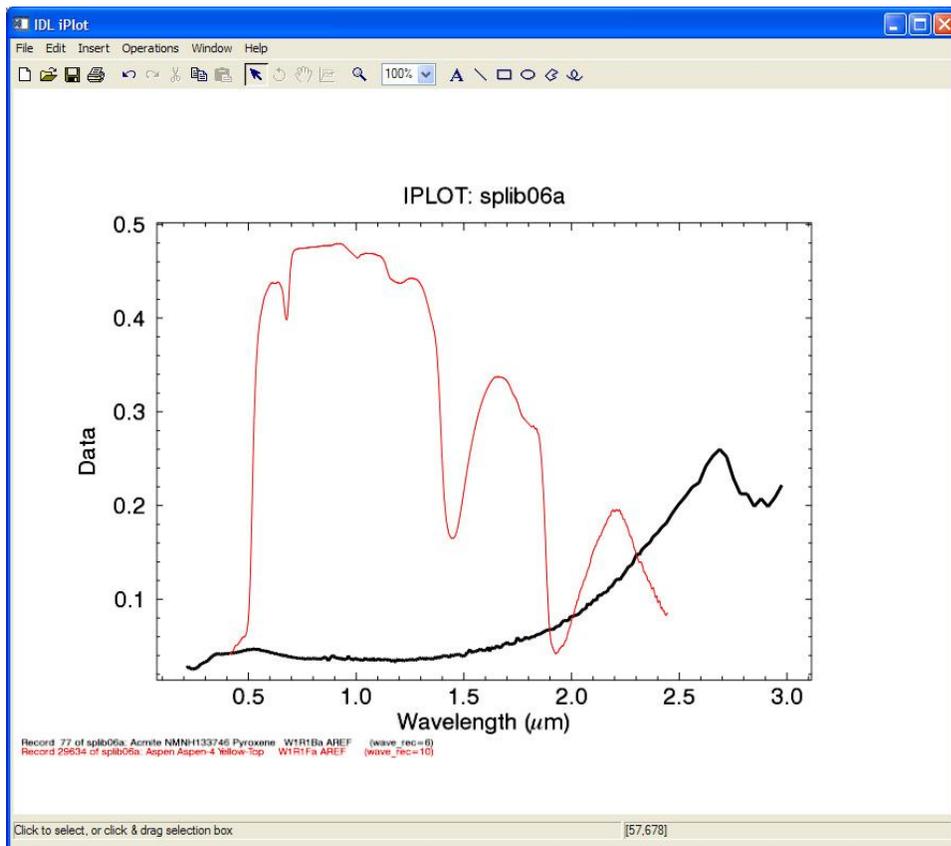


Figure 10. Overplotting data records.

Overplotted spectra will be added to the last plot window that the user has created or interacted with. For example, if the user has created two plot windows and wishes to overplot a spectrum in the first window that was created, the user can “left-click” the first plot window to activate it and then click the “Overplot Selected Record” button in the main program widget. Note: The user may also select and list the contents of a different SPECPR file (following the steps in *Function 1.1*) and overplot a data record from it. However, if the user has two ViewSPECPR sessions running, one ViewSPECPR control window cannot plot to the windows opened by another session.

Function 1.5 – Viewing the header, text, or DESCRIP information in a record

For a selected record, information about it may be obtained by clicking on the “Show Header Info/Text/DESCRIP of Record” button in the right corner of the main program widget (see fig. 2). There are three different responses, dependent on the type of record selected:

Viewing the header information of a data record

If the selected record is a data record, for example, record 29634 in figure 9, information from the data record header will be displayed as shown in figure 11.

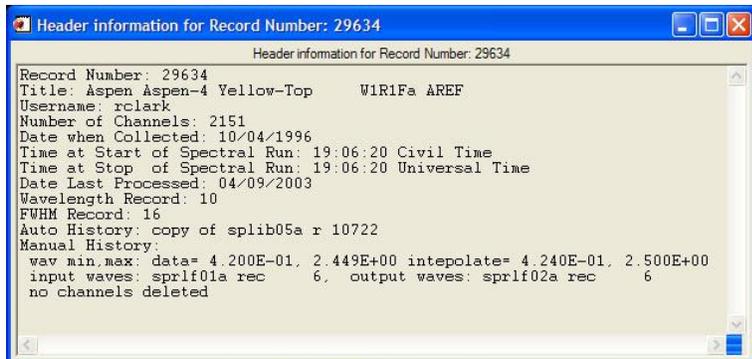


Figure 11. Header information from a data record.

Viewing the text stored in a text record

If the selected record is a text record, for example, record 1 in figure 4, the text information stored in it will be displayed, as shown in figure 12.

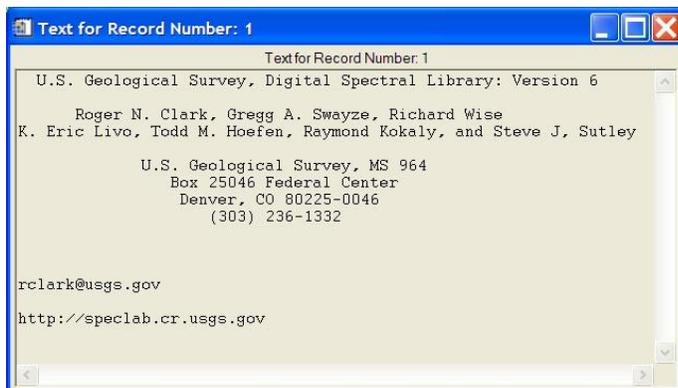


Figure 12. Text information from a text record.

Viewing the description stored in a DESCRIPT record

If the selected record contains a description of a spectrum in a published USGS spectral library file, an internet browser window should open and show information that characterizes the spectral library entry. These descriptions are called DESCRIPT records and are text information in HTML format stored in a text record. They are identified in PRISM by the word “DESCRIPT”, in all capital letters, in the title of the text record. An example of the information in DESCRIPT record 71 is shown in figure 13. For more information on DESCRIPT records and the USGS Spectral Library, see Clark and others (2007). Note: photos referred to in the HTML

DESCRIPT records may not appear, since the locations of these photos on a user's computer may be different. Placing the folders containing photos of samples in the spectral library in the same directory as the spectral library's SPECPR file should result in the photos appearing correctly in the browser window. If the contents of the "usgsprism" folder are installed according to the instructions in the "Installation of Software" section of this report, then the photos in the DESCRIPT records of splib06a should appear correctly. If a Web browser fails to launch when attempting to view a DESCRIPT record, the user should consult the ENVI/IDL User's Guide. Additional examples of DESCRIPT records are given in *appendix C*.

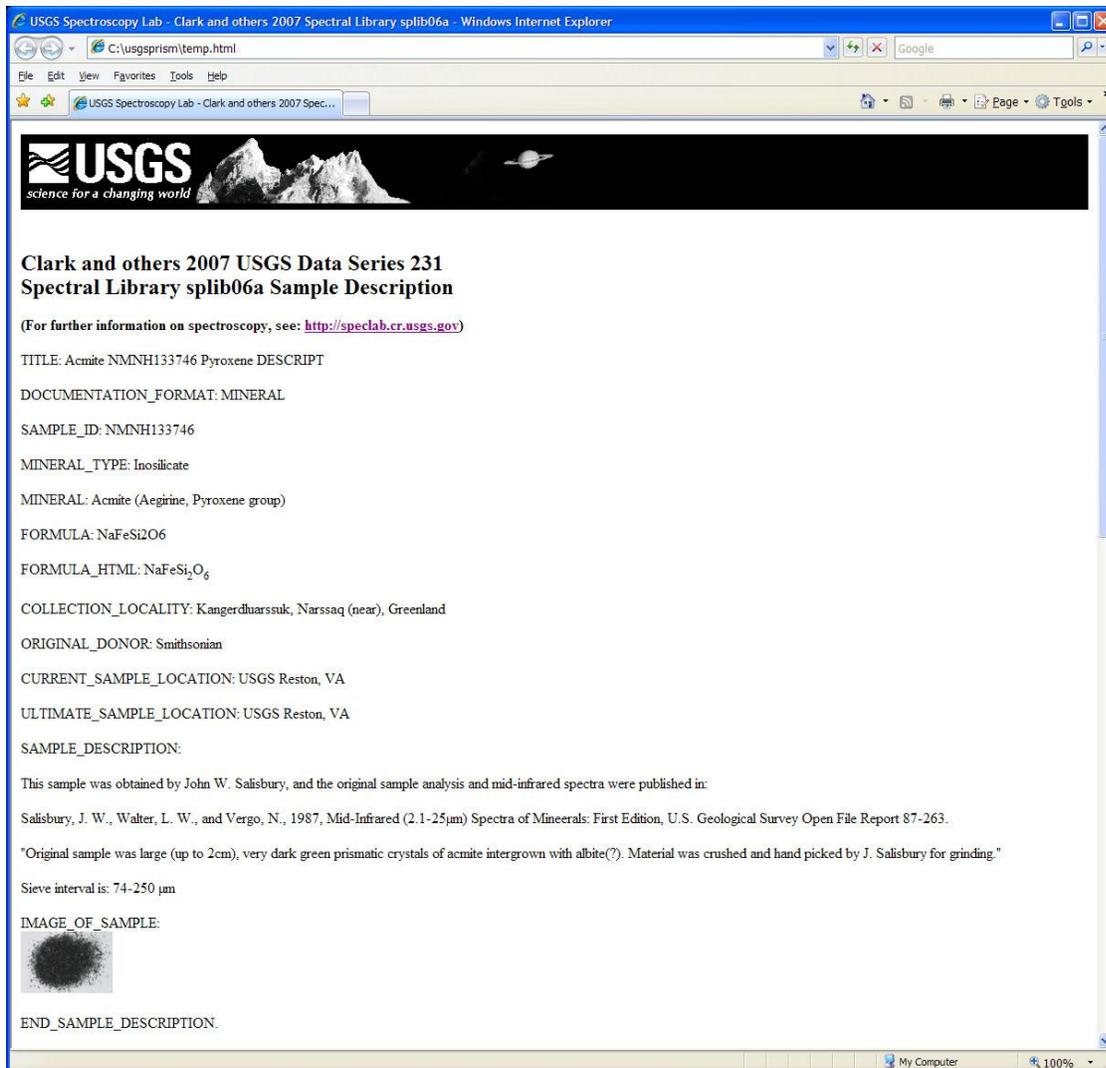


Figure 13. Example of information in a DESCRIPT record.

Function 1.6 – Exporting a selected record to ASCII text

The data within a selected record can be exported to an ASCII text file using the "Export selected record to ASCII" button at the bottom of the ViewSPECPR control window (see fig. 2).

A dialog box appears, prompting the user to set the output filename of the ASCII text file (fig. 14). A default filename is pre-set in the filename box; the pre-set name includes the record number and SPECPR filename. The user may change the output directory and (or) the filename, if desired. The file will be created and the spectrum exported to the text file when the user presses the “Save” button. Note: This function allows for exporting all the channels of the data stored in the selected record of the SPECPR file. It exports any “deleted points”, also referred to as “deleted channels”, in the spectrum as values of $-1.23e^{+34}$ (see the SPECPR documentation of Clark, 1993). In some cases, for example the USGS Spectral Library splib06a, deleted channels are set because the spectrometer was configured to collect data over only a subset of its full wavelength range capability (see Clark and others, 2007). In other cases, the deleted channel value is assigned to channels which contain invalid or corrupted data, for example channels within wavelength regions of strong atmospheric absorption in field spectra. See “*Function 2.16 – Export SPECPR record to ASCII*” for additional details on exporting spectra to ASCII text in both floating point and scientific notation. Note: existing files will be overwritten without notification.

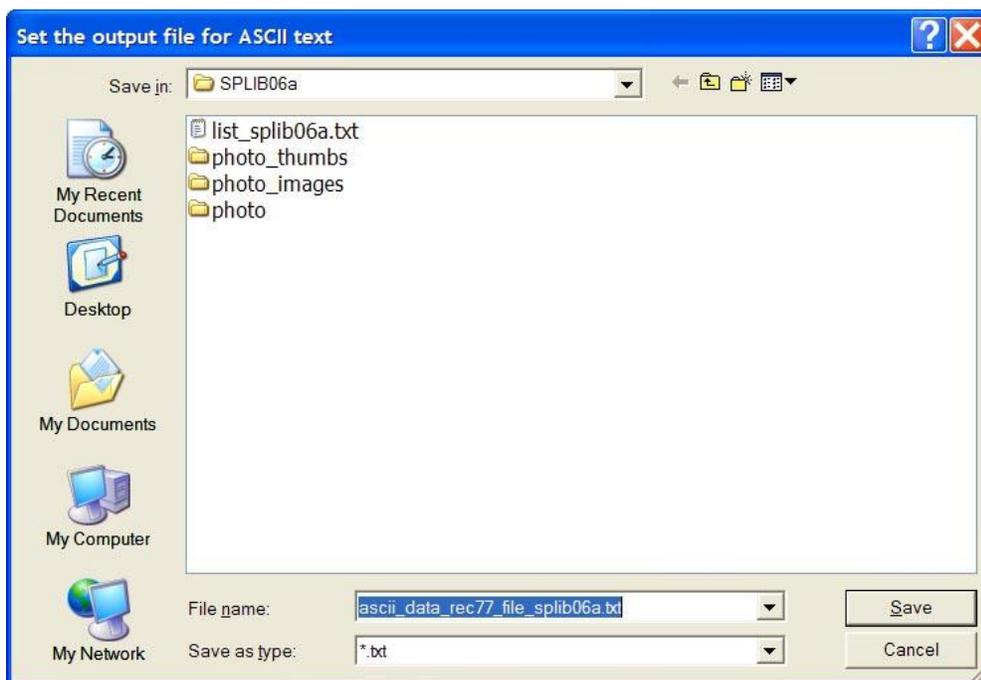


Figure 14. Setting the filename for the output text file.

Function 1.7 – Performing continuum removal on a record

Linear continuum removal of a spectral feature can be performed on the data in a selected record by pressing the “Continuum Removal on selected record” button at the bottom right of the main program widget (see fig. 2). Continuum removal is used to isolate and analyze features in reflectance spectra (see Clark and Roush, 1984; Clark and others, 2003; and Kokaly and others, 2003). Continuum removal, or baseline normalization, is a method that has been commonly used

in laboratory infrared spectroscopy (Ingle, 1988). This technique has been applied to terrestrial imaging spectrometer data as part of analyses to map the distribution of minerals and vegetation by comparing remotely sensed absorption band shapes to those in a reference spectral library (Clark and others, 1990; Mustard and Sunshine, 1999; Kokaly and others, 2003; and Kokaly and others, 2007b). The continuum is an estimate of the other absorptions present in the spectrum, not including the one of interest (Clark, 1999; Clark and Roush, 1984). In that sense, continuum removal is most often performed on absorption features. However, PRISM allows continuum removal to be applied to emission features as well.

To perform continuum removal in PRISM, the user must have already set data and wavelength records as described in steps 1-2 of “*Function 1.4*”. After clicking on the “Continuum Removal on selected record” button, a plot window will appear with the spectrum of the selected record (fig. 15). Note: this plot window looks similar to the standard iPlot window, except that a “continuum removal” tool is added to the tool bar (see the tool indicated with the red arrow in fig. 15).

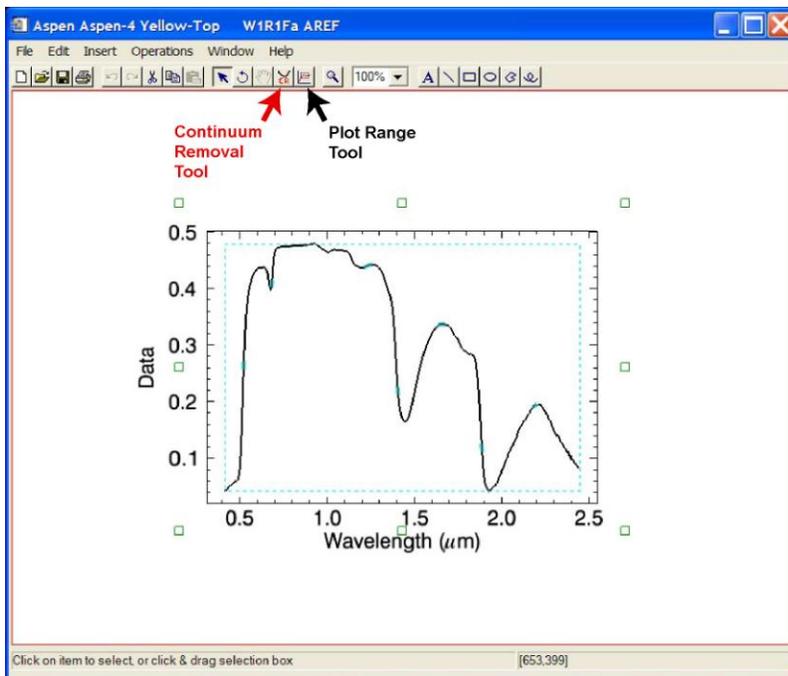


Figure 15. The iPlot window for continuum removal.

The first step in continuum removal is selection of the continuum endpoints (λ_1 and λ_2), which may be established at the points of minimum absorption surrounding the absorption feature. Following the selection of endpoints, the continuum is modeled using a linear function fit to the endpoints. To define the continuum line in PRISM, click on the continuum-removal tool and draw the continuum line over the feature of interest. The line can be drawn by left-clicking at the desired position of the first endpoint of the line, holding the button down, dragging the mouse to the second endpoint of the line, and releasing the button. The iPlot window will update to show the line and its endpoints (fig. 16), where the continuum endpoints are the channels closest to the endpoints of the line that was drawn. Usually, the line should be

drawn at the highest points on either side of the absorption feature of interest. Alternatively, for emission features, the line is usually drawn from the lowest points on either side of the peak of interest.

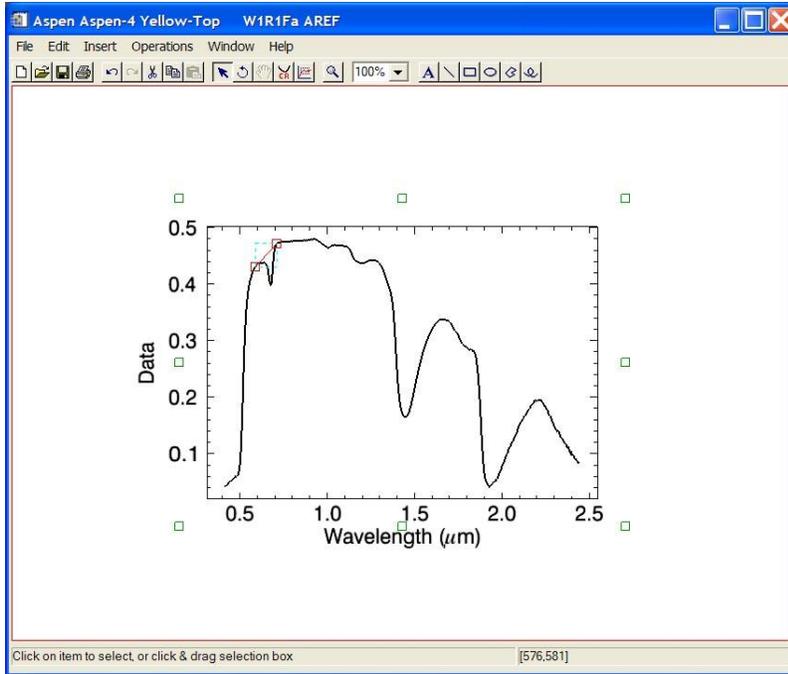


Figure 16. The iPlot window after drawing the continuum line.

Following the drawing of the continuum line, the continuum removal interface GUI (graphical user interface) will appear with a plot of the continuum-removed feature (fig. 17). The values of the continuum-removed spectrum (R_C) are calculated by dividing the original reflectance values (R_O) by the corresponding values of the continuum line (R_L) for all the channels in the wavelength region (λ_1 to λ_2) of the absorption feature:

$$R_C(\lambda) = R_O(\lambda) / R_L(\lambda) \quad \text{eq. 1}$$

The depth (D) of the absorption feature at each channel is calculated by

$$D(\lambda) = 1 - R_C(\lambda) \quad \text{eq. 2}$$

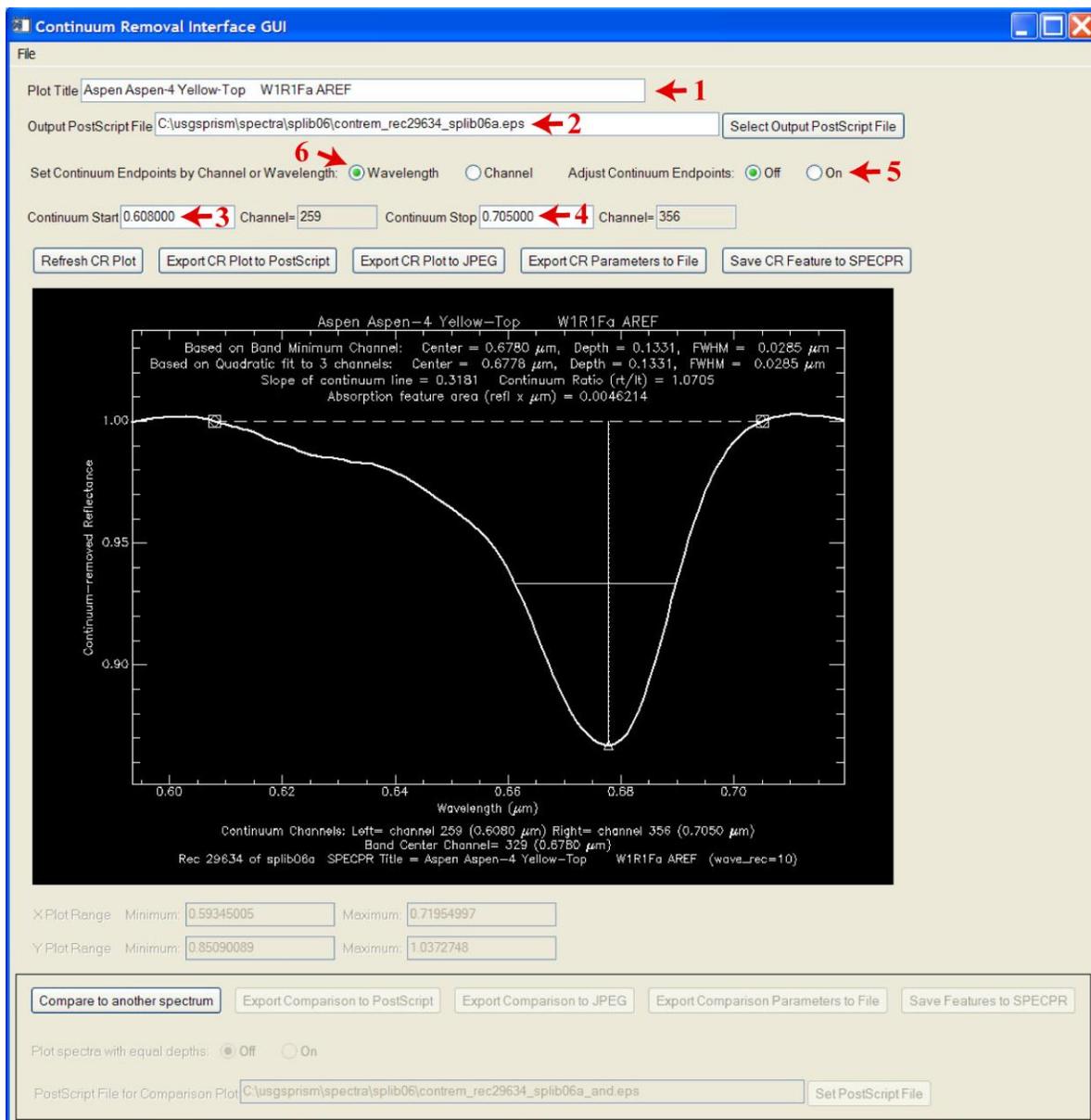


Figure 17. The continuum-removal GUI.

Annotations on the plot of the continuum-removed feature (fig. 17) include descriptors of the feature, including the band center, band depth, and width (defined as the full-width at half maximum, or FWHM) of the feature. Two sets of these values are computed, one set based on the band center channel (that is, the channel with the minimum value in the continuum-removed feature) and one set based on the central wavelength of a quadratic function fitted to the band center and one channel on each side (that is, a quadratic function fitted to the three center channels). The band center from the quadratic function (λ_{Cquad}) and the wavelength position of the band center channel (λ_{Cchan}) may be very close in value when the feature is resolved by a large number of channels. The quadratic function is less subject to noise in the spectrum since it uses more than one channel.

The band depth and width (FWHM) associated with the fitted quadratic function (referred to as D_Q and W_Q , respectively) are shown as solid lines on the plot of the continuum-removed feature (fig. 17). The depth and width (FWHM) associated with the band center channel, D_C and W_C , respectively, are shown as dotted lines. Also shown in the plot of the continuum-removed feature are descriptors of the continuum line, specifically the slope of the continuum line and the ratio of the continuum endpoint reflectance values. The feature area is calculated and displayed for absorption features if all values in the continuum reflectance are below 1.0, that is, if all channels in the input spectrum between λ_1 and λ_2 fall below the continuum line.

Using the controls in the continuum removal interface GUI, the user can control aspects of the plot. These aspects are described below and their corresponding widgets are labeled in figure 17. To change the plot using any of the altered settings, click on the “Refresh CR Plot” button.

- User Selection 1 – setting the plot title. The GUI appears with the default title set to the SPECPR title of the data record. The user may edit this title.
- User Selection 2 – setting the output PostScript filename. The GUI appears with a suggested output filename containing the record number and SPECPR filename. The default directory is set as the directory that contains the SPECPR file. The user may edit this file directly or use the “Select Output PostScript File” button to use a dialog window to set the output PostScript file. PostScript filenames traditionally are appended with “.eps”; add this extension if it is not present. Note: existing files will be overwritten without notification.
- User Selection 3 – setting the continuum start wavelength. The GUI appears with the start point of the continuum line set as the wavelength of the channel closest to the endpoint of the line drawn by the user. This wavelength may be changed by the user by editing the value in the text box. The channel with the wavelength closest to the value in this text box will be used as the start point of the continuum line.
- User Selection 4 – setting the continuum stop wavelength. The GUI appears with the stop point of the continuum line set as the wavelength of the channel closest to the endpoint of the line drawn by the user. This wavelength may be changed by the user by editing the value in the text box. The channel with the wavelength closest to the value in this text box will be used as the stop point of the continuum line.
- User Selection 5 – Adjust continuum endpoints. By default, when the GUI starts, this option is turned off. The user may turn this option on in order to refine the continuum endpoint selection. Turning this option on will cause the continuum-removal program to search around the specified endpoints to find channels above the continuum line. The highest channels above the continuum line will be used to recalculate the continuum-removed feature when the user presses either the “Refresh CR Plot” or “Create Continuum Removal PostScript File” buttons. Note: when this option is “on”, the plot will be annotated with the adjusted continuum endpoints (shown with diamond shapes) as well as the original endpoints (shown with square shapes). Currently, this adjustment only functions for absorption features.
- User Selection 6 – Set continuum endpoints by channel or by wavelength. By default, when the GUI starts, this option is set to “wavelength”. The user may turn this option to “channel” in order to refine the continuum endpoint selections by specifying

channel numbers, in which case the inactive boxes containing the channel numbers will become active (the background color of the active box is a different color than inactive boxes on Windows computers), and the user may edit the continuum start and stop values. When the channel boxes are active, the wavelength boxes become inactive.

The user selections will be applied when the “Refresh CR Plot”, “Export CR Plot to PostScript”, “Export CR Plot to JPEG”, or “Export CR Parameters to File” button is pressed. Pressing the “Refresh CR Plot” button will update the plot to show changes made to any of the user selections described above. For example, figure 18 shows the refreshed plot resulting from turning on the automatic selection of continuum endpoints.

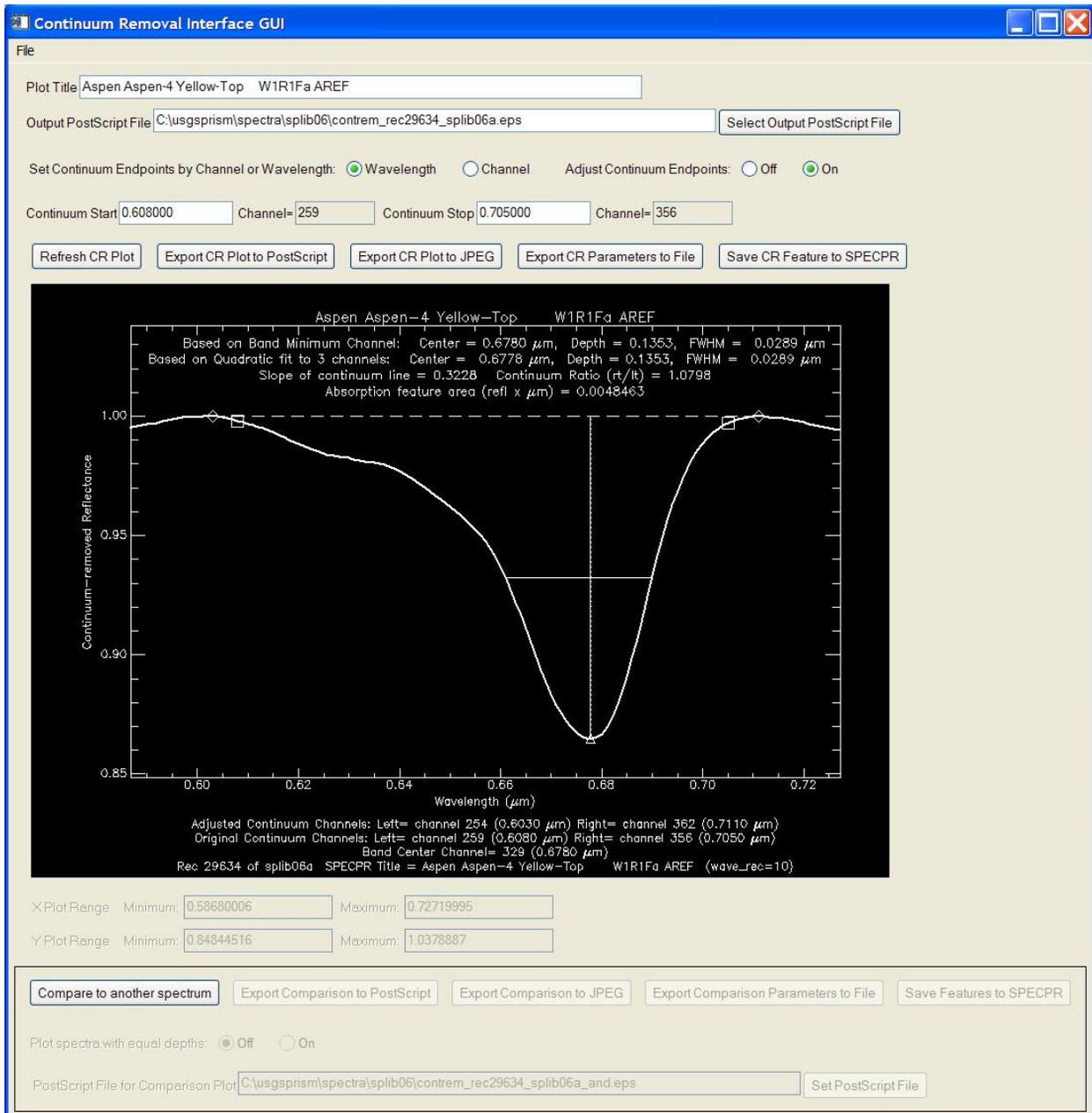


Figure 18. Continuum refinement with Adjust Continuum Endpoints turned on. Squares indicate the original continuum start and stop points and diamonds indicate continuum endpoints after automatic adjustment.

To create a PostScript version of the plot, press the “Export CR Plot to PostScript” button (fig. 18). The plot will be saved to the file set in the text box described above in the User Selection 2 section. To create a JPEG version of the plot, press the “Export CR Plot to JPEG” button (fig. 18). After pressing the button, a file selection window appears (fig. 19) prompting the user to set the output JPEG file. Initially, the file selection window will contain a suggestion for the output JPEG file; this suggested file is equivalent to the file set for the PostScript file, set

in the User Selection 2 section of this function, but with a “.jpg” extension in place of the “.eps” extension. After setting the file, press “Open” to continue the program and create a JPEG plot of the continuum-removed feature.

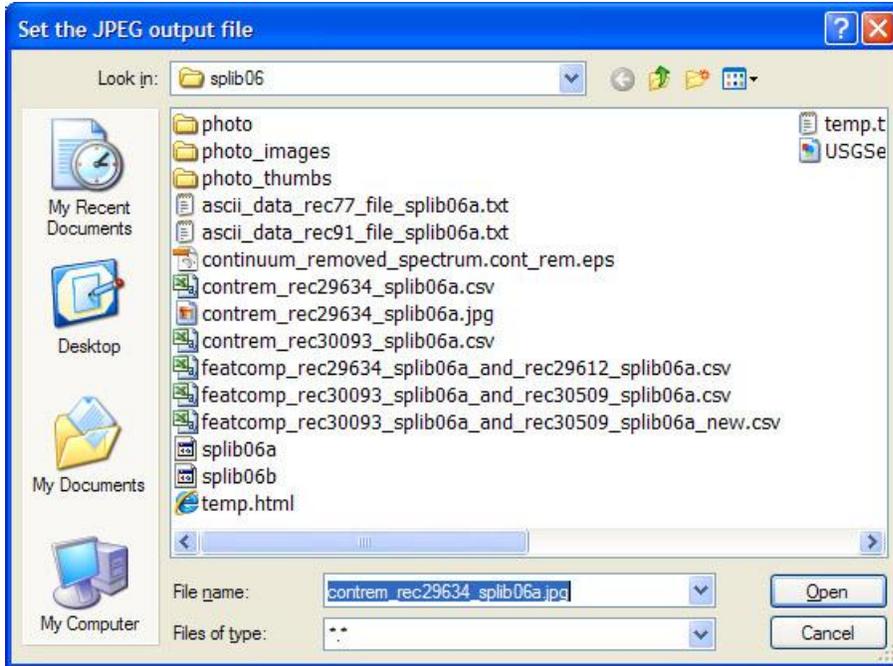


Figure 19. Setting the JPEG file for the continuum-removed plot.

To export the parameters describing the continuum-removed feature to a text file, press the “Export CR Parameters to File” button (see fig. 18). The output file will contain parameters, describing the continuum-removed feature, written as ASCII values in a comma-separated value (csv) format. By convention, a “.csv” extension is used to denote such files, and the user should add this extension to any output filenames. After pressing the button, a file selection window appears, prompting the user to set the output file (fig. 20). Initially, the file selection window will contain a suggestion for the output file; this suggested file is equivalent to the file set for the PostScript file but with a “.csv” extension in place of the “.eps” extension (see the User Selection 2 section of this function).

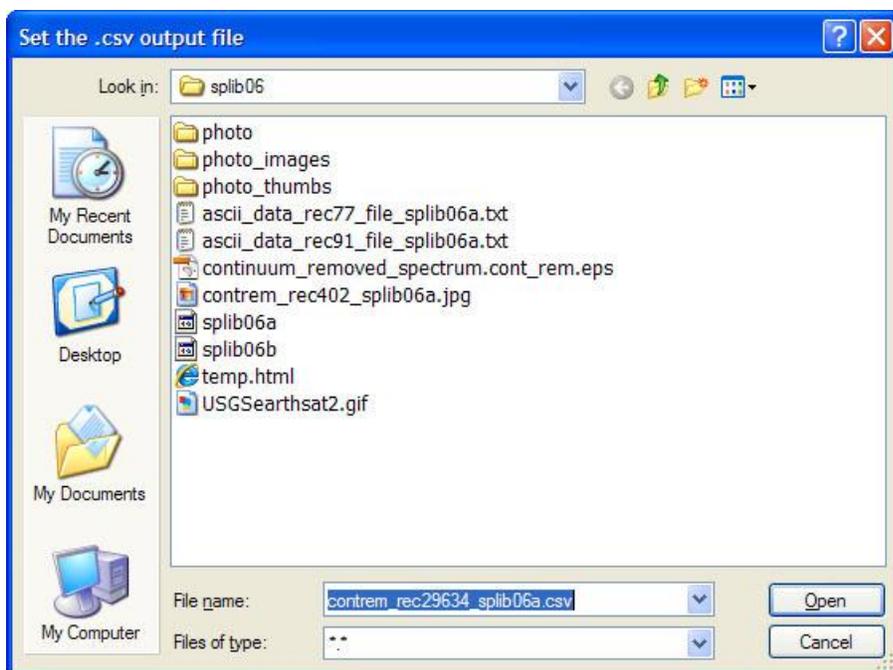


Figure 20. Setting the csv file for the continuum-removed plot.

After setting the output file, press “Open” to continue the program and create the csv file. The first line of the csv file will contain the names of the parameters. The second line will contain the values of these parameters, in the order shown in table 1. Note: if the file already exists, the user will be prompted to append the parameters to the end of the existing file. If the user responds positively, a single line, containing the comma-separated values for the feature, will be written to the end of the existing file. If the user responds negatively, the parameters will not be exported.

Table 1. Parameters describing the continuum-removed feature, exported in comma-separated value format.

Parameter name	Description
spectrum_specpr_title	title of the record containing the spectrum being analyzed
spectrum_specpr_record	record number of the spectrum being analyzed
spectrum_specpr_file	filename of the SPECPR file containing the spectrum being analyzed
continuum_left_wave	wavelength of the left continuum endpoint (λ_1)
continuum_right_wave	wavelength of the right continuum endpoint (λ_2)
continuum_left_channel	channel number of the left continuum endpoint
continuum_right_channel	channel number of the right continuum endpoint
feature_center_wave	wavelength position of the center of the feature, calculated using a quadratic fit to the values of the band minimum channel and a channel on each side (λ_{Cquad})
feature_depth	depth of the feature based on the band minimum channel (D_C)
feature_FWHM	width of the feature, calculated as the full-width at half-maximum based on the depth of the band minimum channel (W_C)
feature_area	area of the continuum-removed feature. Note: this value will be set to -999 if all values in the continuum reflectance are not below 1.0, that is, if any channel in the input spectrum falls above the continuum line
continuum_level_left	reflectance value of the left continuum endpoint

Table 1. Parameters describing the continuum-removed feature, exported in comma-separated value format.—Continued

Parameter name	Description
continuum_level_mid	calculated value of the continuum line at the wavelength midpoint
continuum_level_right	reflectance value of the right continuum endpoint
continuum_rtdivbylt	reflectance value of the right continuum endpoint divided by the reflectance value of the left continuum endpoint
wavelength_specpr_title	title of the record containing the wavelengths
wavelength_specpr_record	record number containing the wavelengths
wavelength_specpr_file	SPECPR file containing the wavelength record

To save the continuum-removed feature as a data record in the SPECPR file that contains the data being viewed, press the “Save CR Feature to SPECPR” button (see fig. 18). The user is prompted to set the title for the record that will contain the data for the continuum-removed feature (fig. 21). By default, the string “CRfeat”, followed by a space, and then the title of the data record being viewed is suggested as the title, truncated to character limit for SPECPR titles (40 characters). This suggested title appears in the output title window. Note: the full title of the data record being viewed is also shown in the window (fig. 21). The user can edit the displayed title, if desired. Accept the title by pressing “OK”. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered (fig. 22). After pressing “OK”, the user is again prompted to enter the title for the text record; however, the previously entered title, truncated to 40 characters, will be present in the text field.

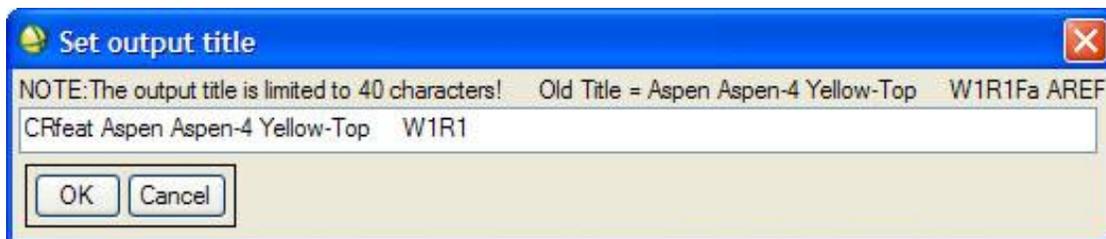


Figure 21. Setting the title for the SPECPR record that will contain the continuum-removed feature.

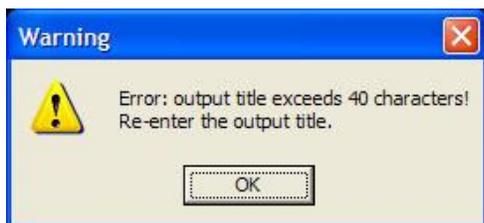


Figure 22. Warning that title exceeds 40 characters.

Once the title is accepted, the continuum-removed feature is written to the SPECPR file of the data record being viewed. The channels outside the continuum endpoints are set to the SPECPR deleted point value ($-1.23e^{+34}$). To see the newly created record, the user can refresh the listing of the SPECPR file containing the data record being viewed by pressing the “List Selected SPECPR File” button in the ViewSPECPR control window. The data record containing the continuum-removed feature will be at the bottom of the listing. Parameters describing the continuum-removed feature are written to the header of the newly created record. Figure 23 shows an example of the information stored in the data record of a continuum-removed feature, which includes the values in table 1.

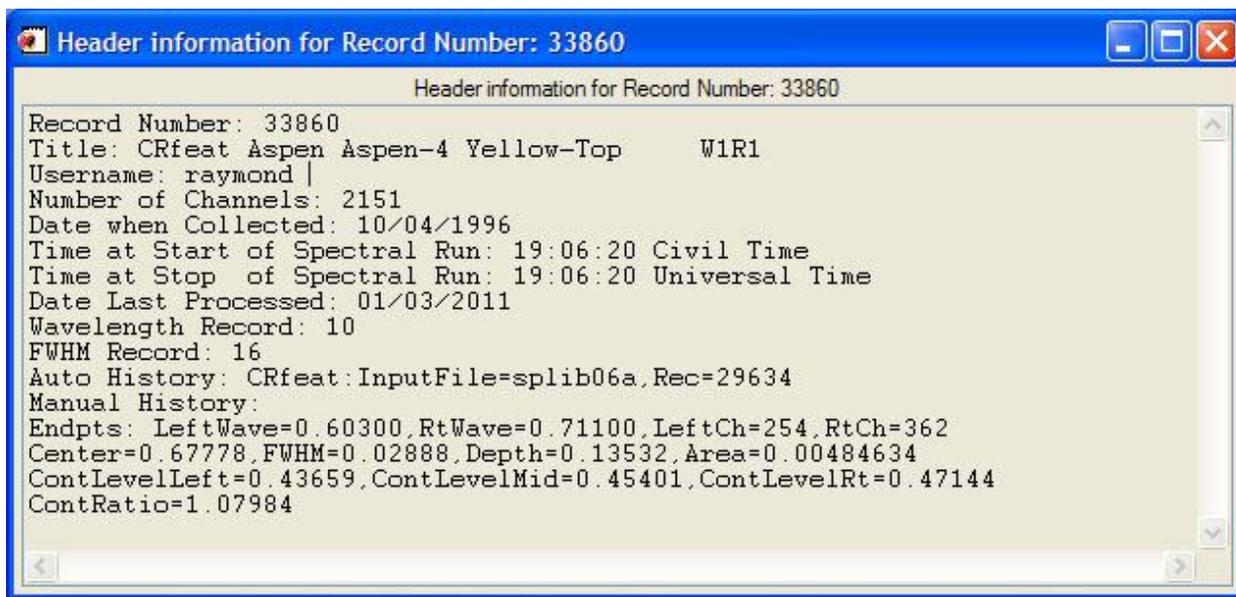


Figure 23. Header information for a data record containing a continuum-removed feature.

Pressing the “Exit continuum removal” button will cause the continuum-removal interface GUI window to disappear. The GUI may also be closed by selecting the “Exit” option under the “File” item on the GUI’s menu bar. Note: the continuum-removal interface GUI (fig. 17) must be closed before closing the iPlot window that contains the interactive continuum-removal tool (fig. 15), otherwise the program may encounter an error, the PRISM program might be halted, and the ENVI session may stop working. If this situation is encountered, quit and then restart the ENVI program.

For narrow features, drawing the continuum line on the initial plot window may be difficult. As a result, the user may want to use the iPlot “plot range” tool (marked with the black arrow in figure 15) to zoom into a specific region of the spectrum before drawing the continuum line. To use this tool, click on the tool’s icon and then left-click and hold down the left mouse button and drag the cursor to draw a box around a plot region to see it in more detail. Figure 24 shows an example box.

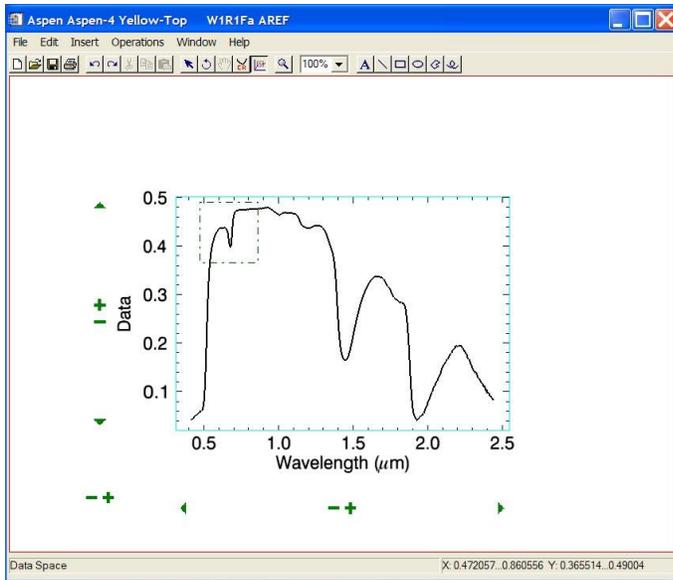


Figure 24. Using the plot range tool.

When releasing the mouse button after drawing the box, the iPlot window will update to show the selected area in greater detail (fig. 25).

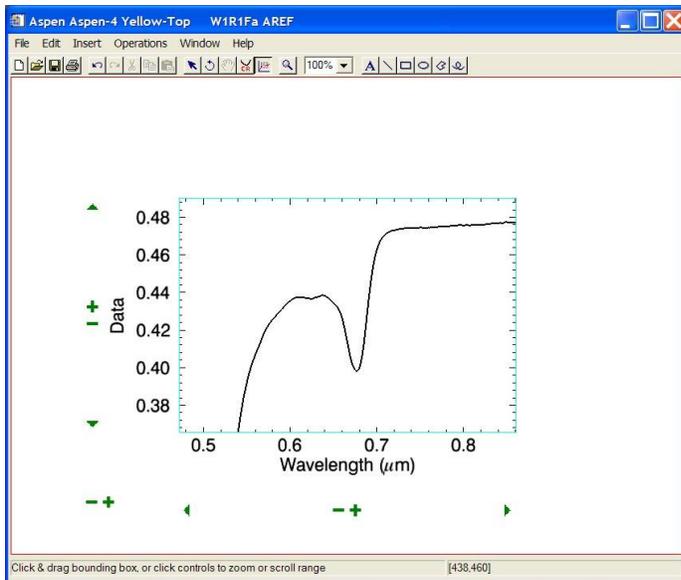


Figure 25. The iPlot window after using the plot range tool.

The user may then select the continuum-removal tool and draw the continuum line (fig. 26). As described previously, the continuum-removal interface GUI will launch after the continuum line is drawn.

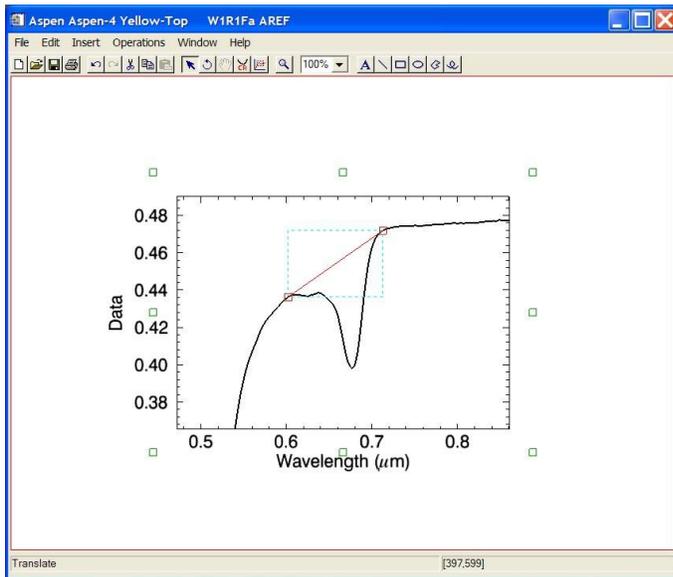


Figure 26. The continuum line in the iPlot window after using the plot range tool.

NOTE: the user should NOT launch more than one continuum-removal interface GUI at a time, as the plot windows in the two GUIs may interfere with one another and not function properly. If the user makes a mistake in drawing the continuum or wants to examine another feature of the spectrum, it is easiest to close the continuum-removal interface GUI that has appeared and then use the “undo” button (as shown on fig. 27) in the continuum-removal iPlot window to remove the continuum line. The user may continue to press the “undo” button again in order to undo any changes to the plot range, if desired, and choose the continuum-removal button to draw a new continuum line on a different feature as shown in figure 27.

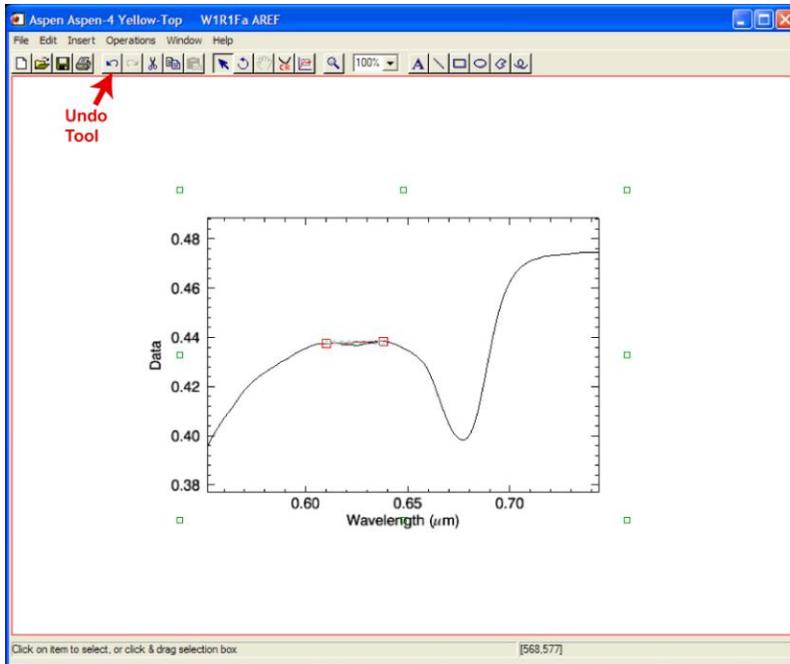


Figure 27. The undo tool in the iPlot window.

Function 1.7.1 – Spectral Feature Comparison

Once a feature has been continuum-removed, it can be compared to the continuum-removed feature of another spectrum. PRISM quantifies the similarity between two continuum-removed spectral features by using linear regression. PRISM uses the resultant coefficient of determination (r^2) as the “fit” value, that is, the measure of the agreement between the spectra. In contrast, Tetracorder uses the linear correlation coefficient (r) as the fit value (Clark and others, 2003). The r^2 fit value ranges from 0 to 1, with better matches indicated by high fit numbers and perfect agreement indicated by a value of 1.

Start the spectral feature comparison function by clicking on the “Compare to another spectrum” button in the lower left corner of the Continuum Removal Interface GUI (see fig. 18). The user will be prompted to select the SPECPR file containing the second spectrum (fig. 28).

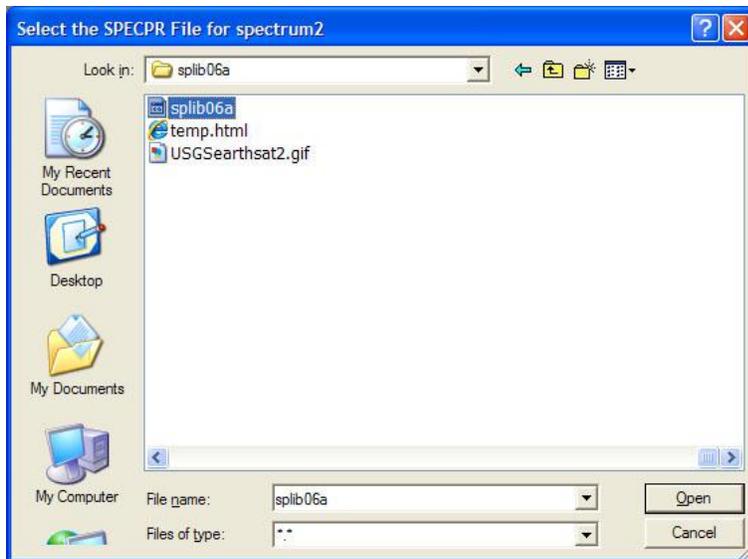


Figure 28. Selecting the SPECPR file containing the new spectrum for comparison.

Then, the user is prompted to select the data record containing the spectrum for comparison (fig. 29). The selected data record must have the same number of channels as the original spectrum plotted in the continuum-removal process and should have the same wavelengths.

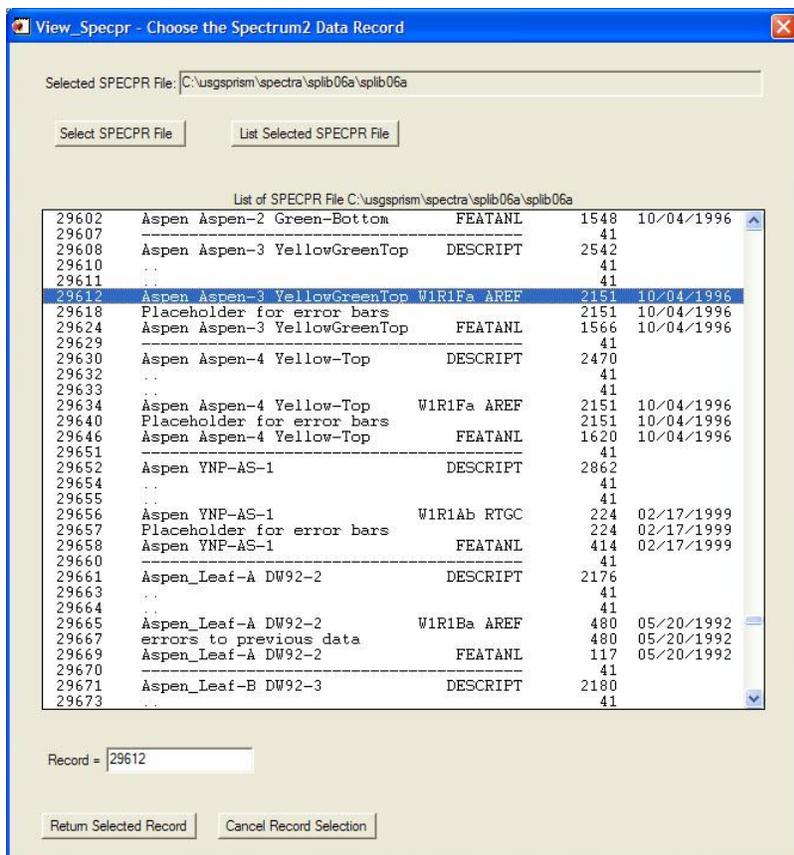


Figure 29. Selecting the SPECPR data record containing the new spectrum for comparison.

After selecting the record for comparison and pressing the “Return Selected Record” button, the plot in the Continuum Removal Interface GUI will show the results of the feature comparison (fig. 30).

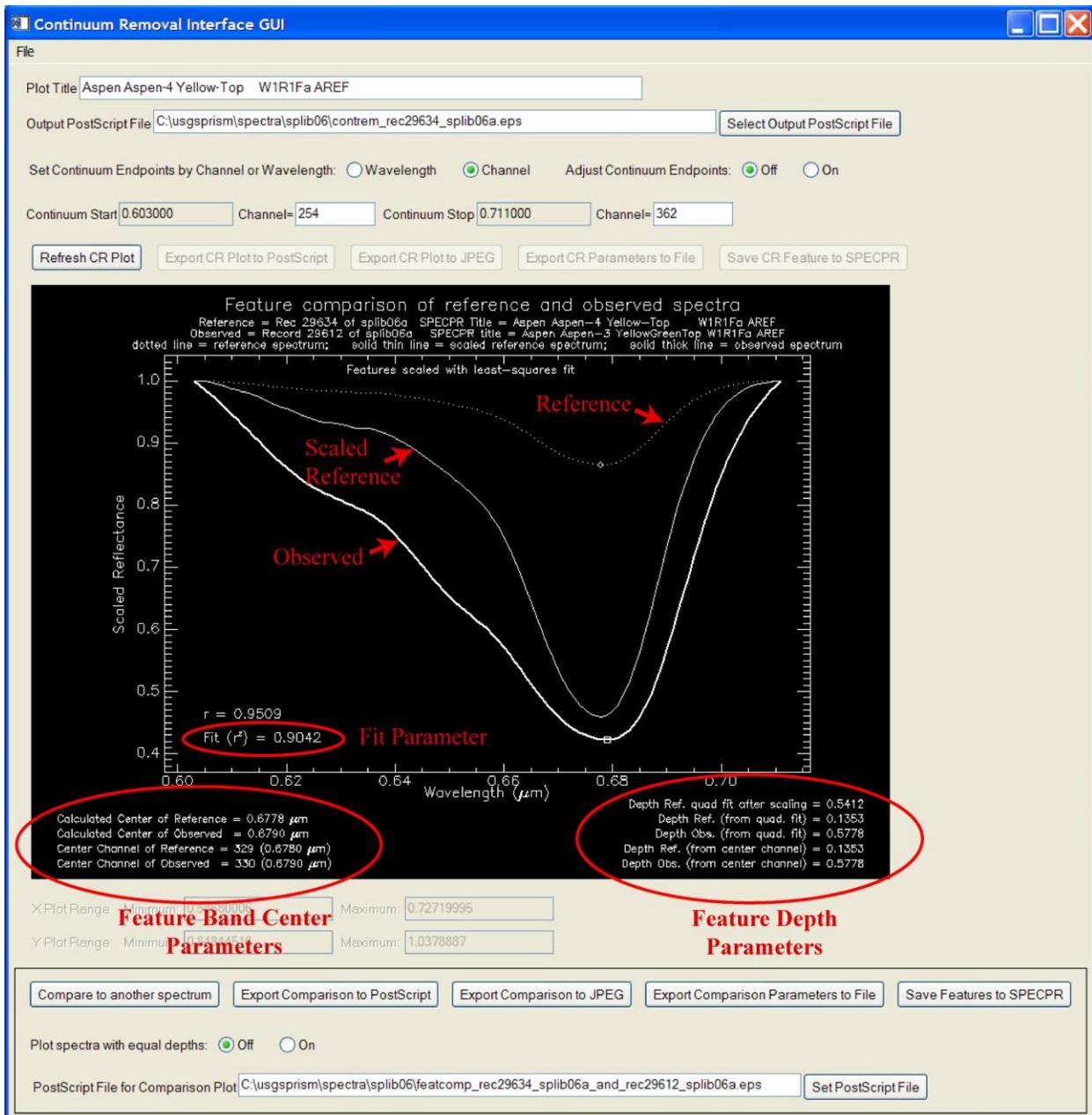


Figure 30. The spectral feature comparison plot, including fit value and other parameters.

PRISM quantifies the similarity between two continuum-removed spectral features by linear regression, using the resultant coefficient of determination (r^2) as the “fit” value, that is, the measure of the agreement between the spectra. The r^2 fit value ranges from 0 to 1, with better matches indicated by high fit numbers and perfect agreement, or similarity between spectral features, indicated by a value of 1. Figure 31 shows the regression plot of the continuum-removed values, with the linear relationship established by the regression shown as a dashed line.

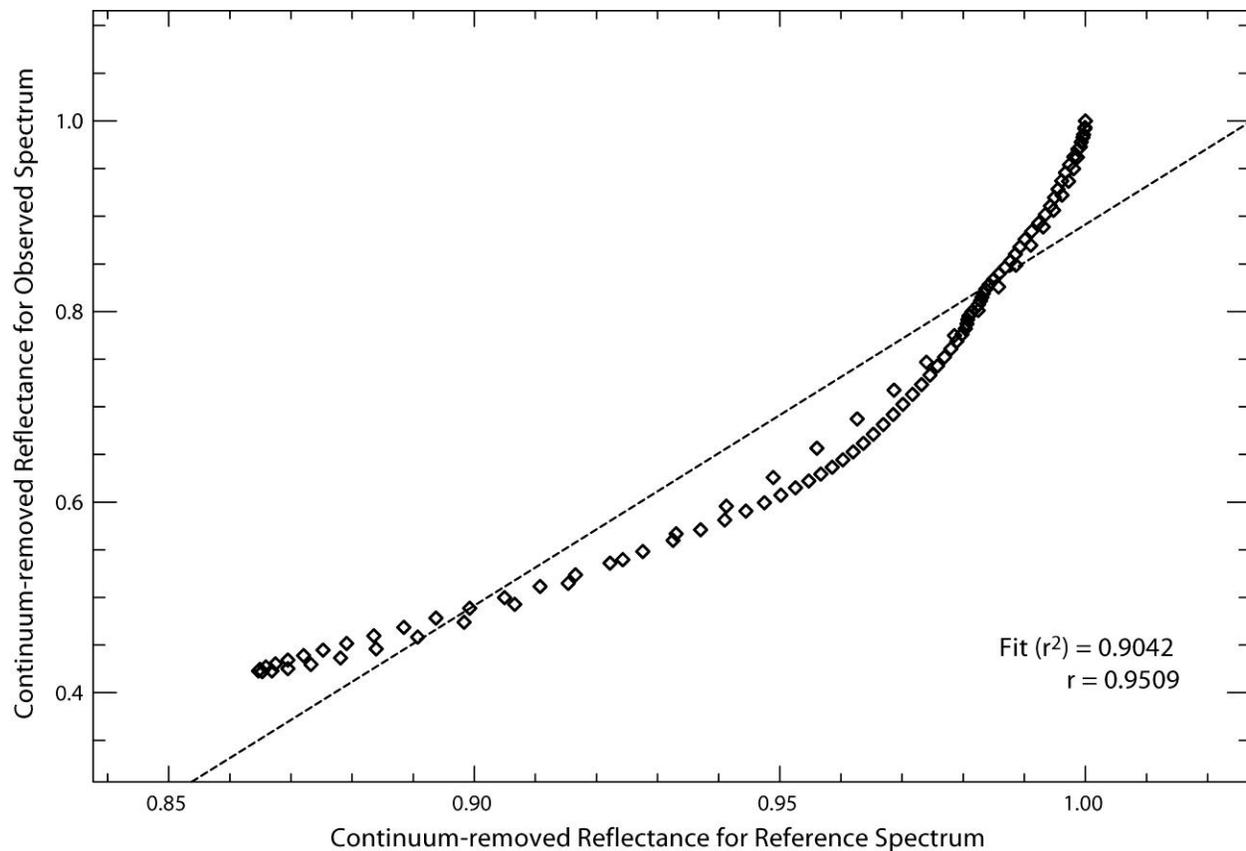


Figure 31. The regression plot for continuum-removed features.

The spectra being compared are termed the reference spectrum and the observed spectrum. In the case of spectral comparisons made in the continuum-removal interface GUI, the reference spectrum is the one originally displayed in the GUI (for example, record 29634 of splib06a in fig. 30). The spectrum that was selected for comparison is termed the observed spectrum (for example, record 29612 of splib06a in fig. 30). The continuum parameters in the Continuum Removal Interface GUI are applied to both the reference and observed spectra. The continuum-removed spectral feature of the reference spectrum is plotted with a **dotted** line and the continuum-removed spectral feature of the observed spectrum is plotted with a **thick solid** line (fig. 30). The coefficient of determination from PRISM’s linear regression calculation, the fit parameter, is reported in the lower left corner of the plot as the “Fit (r^2)” value (fig. 30). Also shown on the plot is the linear correlation coefficient (r). As part of a linear regression calculation using least-squares, a scaling factor can be computed and used to scale the continuum-removed reference spectral feature to the observed spectral feature (for details see Clark and others, 2003). The scaled reference spectrum is plotted with a **thin solid** line (fig. 30). For additional discussion on spectral feature comparison, see *Module 4. MICA – Material Identification and Characterization Algorithm*.

In addition to the fit value, other parameters describing the continuum-removed features are reported on the plot. These parameters include the band centers of the reference and observed spectral features, which are reported in the lower left corner below the plot. The reported band center positions include:

- the central wavelength position of a quadratic function fit to the three channels at the center of the reference spectral feature ($\lambda_{C_{quadRef}}$), that is, the band minimum channel and one channel on either side
- the central wavelength position of a quadratic function fit to the three channels at the center of the observed spectral feature ($\lambda_{C_{quadObs}}$), that is, the band minimum channel and one channel on either side
- the wavelength position of the channel at the center of the reference spectral feature ($\lambda_{C_{chanRef}}$), that is, the band minimum channel of the reference feature
- the wavelength position of the channel at the center of the observed spectral feature ($\lambda_{C_{chanObs}}$), that is, the band minimum channel of the observed feature

The band depths of the features are also reported. These are printed in the lower right corner below the plot. The reported depths include:

- the depth of the scaled reference spectral feature ($D_{S_{Qref}}$) based on the quadratic function fitted to the three channels at the center of the feature, that is, the band minimum channel and one channel on either side
- the depth of the reference spectral feature based on the quadratic function fitted to the three channels at the center of the feature (D_{Qref})
- the depth of the observed spectral feature based on the quadratic function fitted to the three channels at the center of the feature (D_{Qobs})
- the depth of the reference spectral feature calculated using the channel at the center of the feature (D_{Cref})
- the depth of the observed spectral feature calculated using the channel at the center of the feature (D_{Cobs})

On a feature comparison plot, if the user wants to plot the features with equal band depths, the user may turn that option “on” in the lower left of the Continuum Removal Interface GUI (see fig. 30). The buttons and other fields in the bottom portion of the continuum-removal interface GUI become active when the comparison plot is created. In some cases it is easier to see the shift in band center position between two spectra when they are plotted with equalized depths. Figure 32 shows an example comparison plot with equalized band depths for two dry vegetation spectra from splib06a, dry grass in record 30093 as the reference spectrum and dry pine needles in record 30509 as the observed spectrum.

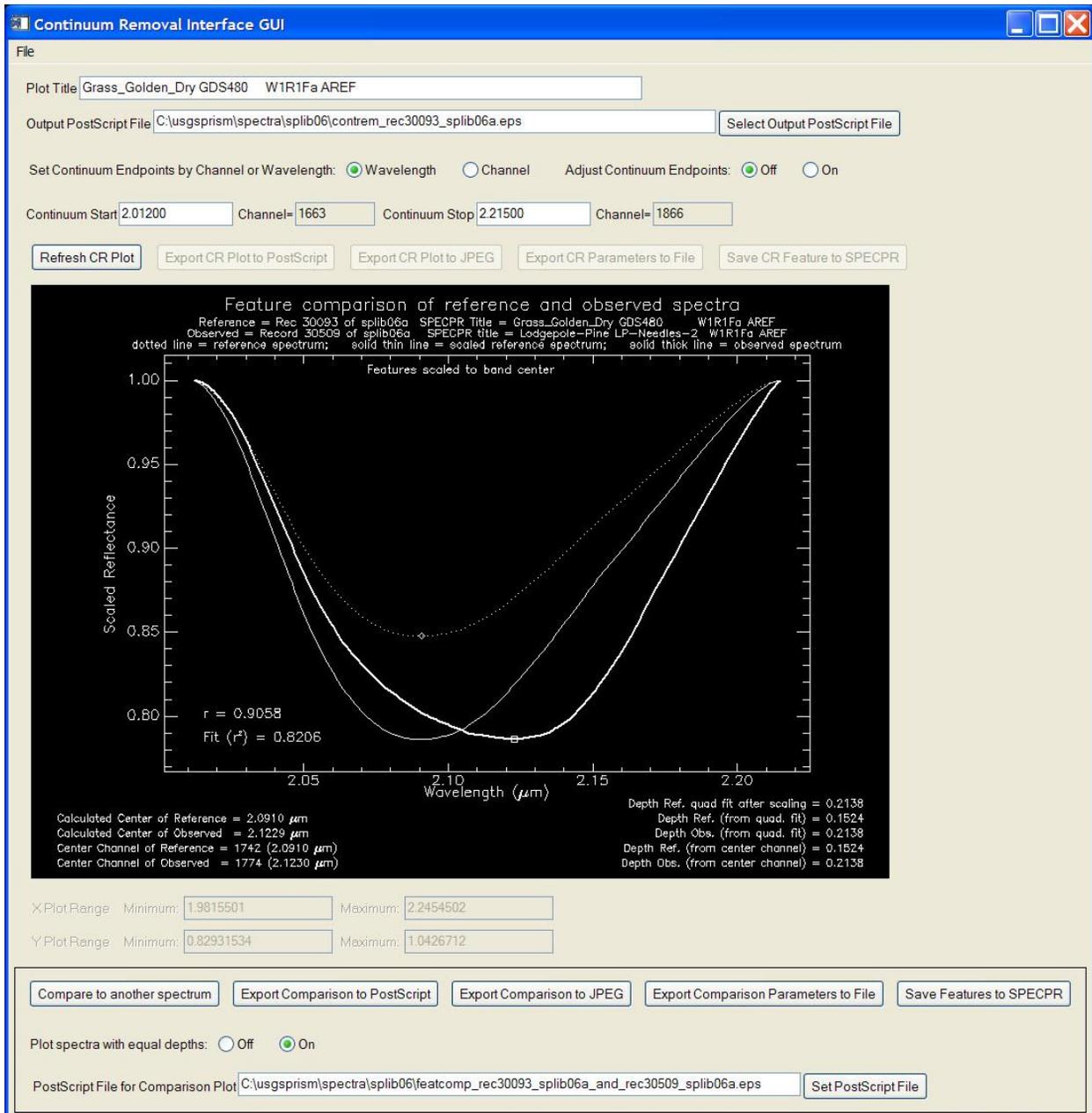


Figure 32. The spectral feature comparison plot with equalized depths.

When comparing spectra, the Continuum Removal Interface GUI displays an output PostScript filename, which by default contains the record numbers and SPECPR filenames of the reference and observed spectra. The directory for this output is set, by default, as the directory that contains the input SPECPR file. The user may edit the filename in the text box directly or use the “Set PostScript File” button to use a dialog window to set the output PostScript file. That PostScript file is created when the user presses the “Export Comparison to PostScript” button in the bottom left of the Continuum Removal Interface GUI.

To create a JPEG version of the plot, press the “Export Comparison to JPEG” button (fig. 32). After pressing the button, a file selection window appears (fig. 33) prompting the user to set the output JPEG file. Initially, the file selection window will contain a suggestion for the output JPEG file; this suggested file is equivalent to the file set for the PostScript file, but with a “.jpg” extension in place of the “.eps” extension. After setting the file, press “Open” to continue the program and create a JPEG plot of the continuum-removed feature.

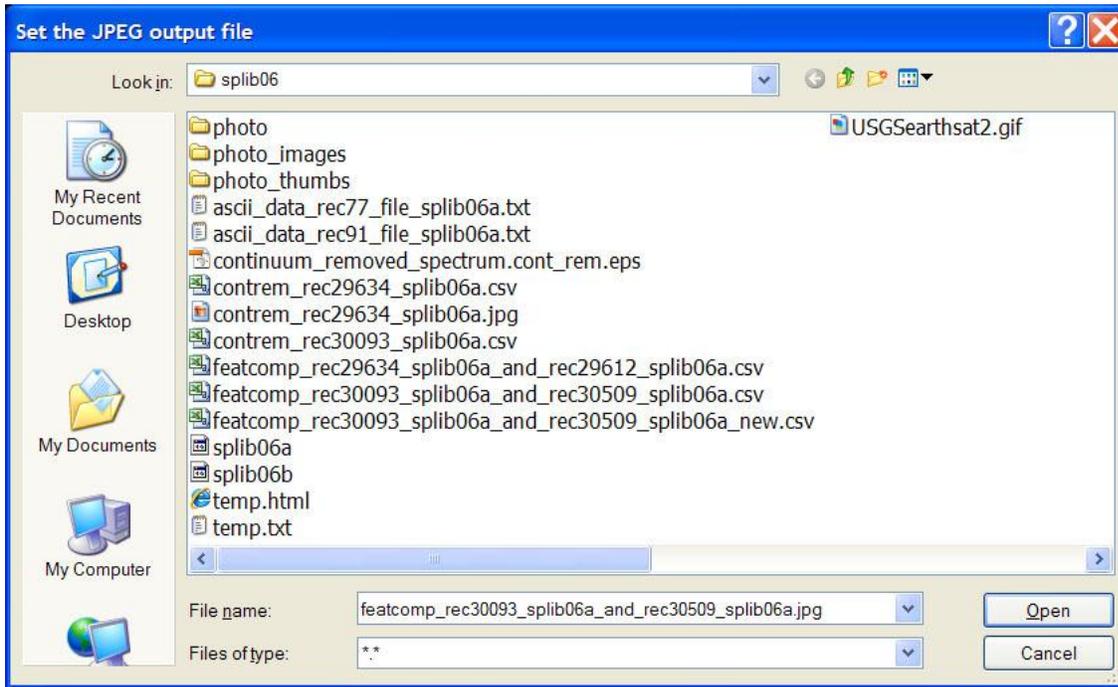


Figure 33. Setting the JPEG file for the comparison plot.

To export the parameters describing the continuum-removed features and their comparison to a text file, press the “Export Comparison Parameters to File” button (see fig. 32). The output file will contain parameters, describing the continuum-removed features and their comparison measures, written as ASCII values in a comma-separated value (csv) format. By convention, a “.csv” extension is used to denote such files, and the user should add this extension to any output filenames. After pressing the button, a file selection window appears, prompting the user to set the output file (fig. 34). Initially, the file selection window will contain a suggestion for the output file; this suggested file is equivalent to the file set for the PostScript file, but with a “.csv” extension in place of the “.eps” extension.

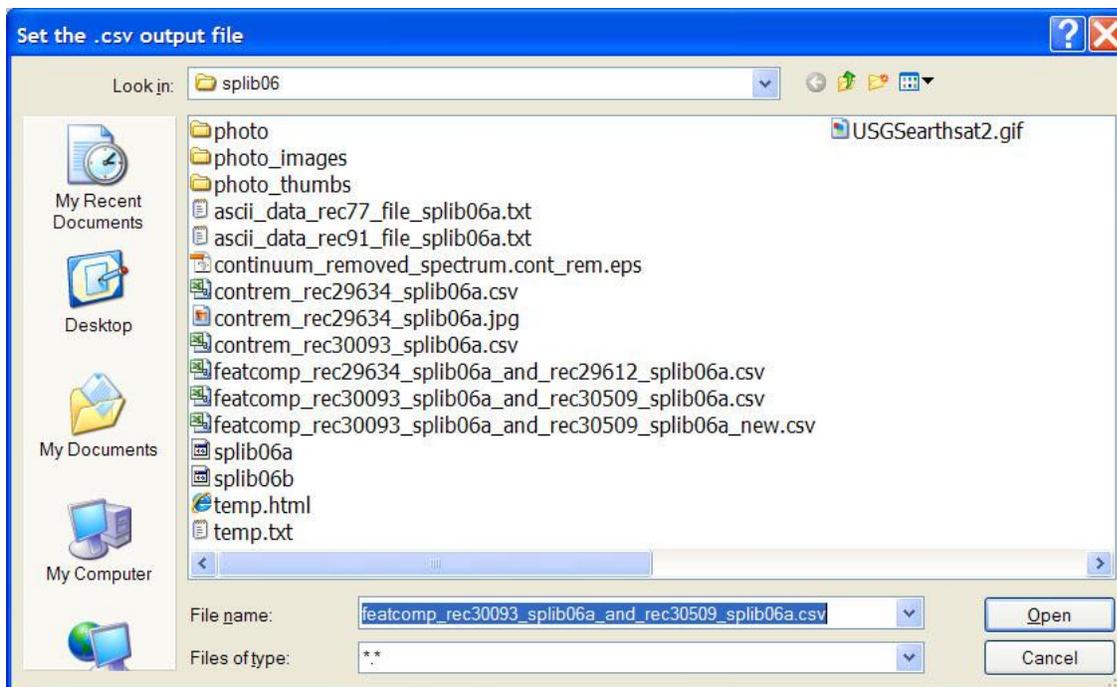


Figure 34. Setting the csv file for the comparison plot.

After setting the output file, press “Open” to continue the program and create the csv file. The first line of the csv file will contain the names of the parameters. The second line will contain the values of these parameters, in the order shown in table 2. Note: if the file already exists, the user is prompted in regard to appending the parameters to the end of the existing file. If the user responds positively, a single line, containing the comma-separated values for the feature, is written to the end of the existing file. If the user responds negatively, the parameters are not exported.

Table 2. Parameters describing the continuum-removed features and their comparison using linear regression, exported in comma-separated value format.

Parameter name	Description
ref_spectrum_specpr_title	title of the record containing the reference spectrum
ref_spectrum_specpr_record	record number of the reference spectrum
ref_spectrum_specpr_file	filename of the SPECPR file containing the reference spectrum
continuum_left_wave	wavelength of the left continuum endpoint (λ_1)
continuum_right_wave	wavelength of the right continuum endpoint (λ_2)
continuum_left_channel	channel number of the left continuum endpoint
continuum_right_channel	channel number of the right continuum endpoint
obs_spectrum_specpr_title	title of the record containing the observed spectrum
obs_spectrum_specpr_record	record number of the observed spectrum

Table 2. Parameters describing the continuum-removed features and their comparison using linear regression, exported in comma-separated value format.—Continued

Parameter name	Description
obs_spectrum_specpr_file	filename of the SPECPR file containing the observed spectrum
comparison_fit_value	value describing the measure of “fit”, or level of agreement, between the continuum-removed spectra; it is the coefficient of determination (r^2) that results from a linear regression between the continuum-removed reflectance values of the reference spectrum and the continuum-removed reflectance values of the observed spectrum
comparison_r_value	the linear correlation coefficient (r) that results from a linear regression between the continuum-removed reflectance values of the reference spectrum and the continuum-removed reflectance values of the observed spectrum; the USGS Tetracorder algorithm uses this value as the measure of fit (see Clark and other, 2003)
comparison_depth_value	depth of the scaled reference spectrum (D_{SQref}), based on the band minimum channel; for details on the scaling calculations, see Clark and others (2003)
scaling_type	a text description of the type of scaling used in the comparison plot, either “least-squares” or “equalized-to-observed”
ref_feature_center_wave	wavelength position of the center of a reference feature ($\lambda_{CquadRef}$), calculated using a quadratic fit to the values of the band minimum channel and a channel on each side
ref_feature_depth	depth of the reference feature based on the band minimum channel (D_{Cref})
ref_feature_FWHM	width of the reference feature, calculated as the full-width at half-maximum based on the depth of the band minimum channel (W_{Cref})
ref_feature_area	area of the continuum-removed reference feature; note: this value will be set to -999 if all values in the continuum reflectance are not below 1.0, that is, if any channel in the input spectrum falls above the continuum line
ref_continuum_level_left	reflectance value of the left continuum endpoint of the reference feature
ref_continuum_level_mid	calculated value of the continuum line at the wavelength midpoint of the reference feature
ref_continuum_level_right	reflectance value of the right continuum endpoint of the reference feature
ref_continuum_rtdivbylt	reflectance value of the right continuum endpoint of the reference feature divided by the reflectance value of the left continuum endpoint of the reference feature
obs_feature_center_wave	wavelength position of the center of the feature in the observed spectrum ($\lambda_{CquadObs}$), calculated using a quadratic fit to the values of the band minimum channel and a channel on each side
obs_feature_depth	depth of the feature in the observed spectrum, based on the band minimum channel (D_{Cobs})
obs_feature_FWHM	width of the feature in the observed spectrum, calculated as the full-width at half-maximum based on the depth of the band minimum channel (W_{Cobs})
obs_feature_area	area of the continuum-removed feature in the observed spectrum; note: this value will be set to -999 if all values in the continuum reflectance are not below 1.0, that is, if any channel in the input spectrum falls above the continuum line
obs_continuum_level_left	reflectance value of the left continuum endpoint in the observed spectrum
obs_continuum_level_mid	calculated value of the continuum line at the wavelength midpoint in the observed spectrum
obs_continuum_level_right	reflectance value of the right continuum endpoint in the observed spectrum
obs_continuum_rtdivbylt	reflectance value of the right continuum endpoint divided by the reflectance value of the left continuum endpoint for the observed spectrum
wavelength_specpr_title	title of the record containing the wavelengths

Table 2. Parameters describing the continuum-removed features and their comparison using linear regression, exported in comma-separated value format.—Continued

Parameter name	Description
wavelength_specpr_record	record number containing the wavelengths
wavelength_specpr_file	SPECPR file containing the wavelength record

To save the continuum-removed features and the spectral feature comparison results as records in the SPECPR file of the reference spectrum, press the “Save Features to SPECPR” button (see fig. 32). The user is prompted to set the titles for the continuum-removed features. First, a window appears in which the user can set the title for the record that will contain the data for the continuum-removed feature from the observed spectrum (fig. 35). By default, the string “CR-OBS” followed by a space and the title of the record of the observed spectrum is suggested as the title, truncated to character limit for SPECPR titles (40 characters). This suggested title appears in the output title window. Note: the full title of the record of the observed spectrum is also shown in the window (see fig. 21). The user can edit the displayed title, if desired. Accept the title by pressing “OK”. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered (see fig. 22). After setting the title for the observed feature, the user is prompted to set the title for the record that will contain the data for the continuum-removed feature from the reference spectrum (fig. 36). By default, the string “CR-REF” followed by a space and the title of the record of the reference spectrum is suggested as the title, truncated to character limit for SPECPR titles (40 characters). After setting the title for the reference feature, the user is prompted to set the title for the record that will contain the data for the scaled continuum-removed reference feature (fig. 37). By default, the string “CR-ScaledREF” followed by a space and the title of the record of the reference spectrum is suggested as the title, truncated to the character limit for SPECPR titles (40 characters).

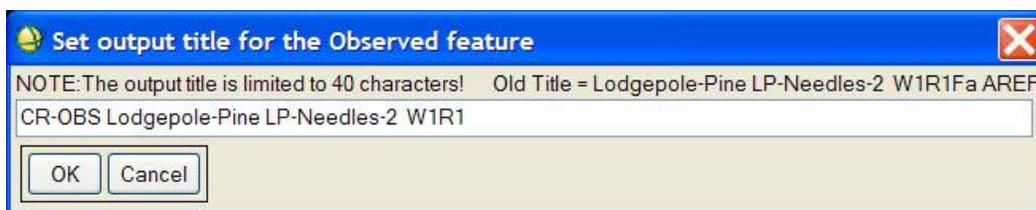


Figure 35. Setting the title for the SPECPR record that will contain the continuum-removed feature from the observed spectrum.

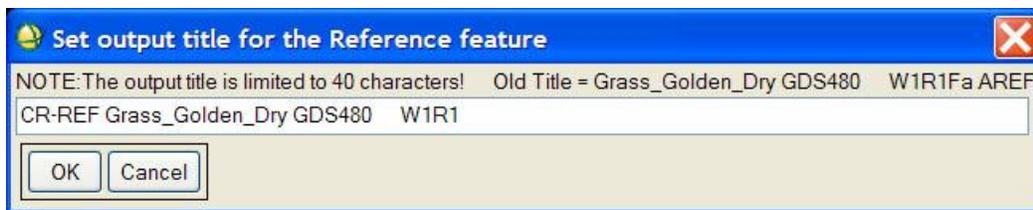


Figure 36. Setting the title for the SPECPR record that will contain the continuum-removed feature from the reference spectrum.

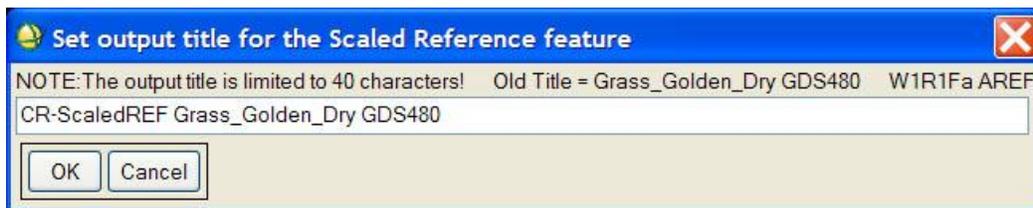


Figure 37. Setting the title for the SPECPR record that will contain the scaled continuum-removed feature from the reference spectrum.

Once the titles are accepted, the continuum-removed features are written to the SPECPR file of the data record being viewed (the SPECPR file of the reference spectrum). The channels beyond the continuum endpoints are set to the SPECPR deleted point value ($-1.23e^{+34}$). The user can refresh the listing of the SPECPR file containing the data record being viewed by pressing the “List Selected SPECPR File” button, shown in the ViewSPECPR control window in figure 2. The text records and data records containing the spectral feature comparison parameters and the continuum-removed features will be at the bottom of the listing (fig. 38). To distinguish the block of records with the comparison results and the continuum-removed features from the preceding records, the function first writes a separator record of asterisks (see *Function 1.9.2*), record 33860 in figure 38. Next, two text records identify the block of records as pertaining to spectral comparison, records 33861 and 33862 in figure 38. The next text record (record 33863 in fig. 38), titled “text rec w/ fit info on ref&obs features”, contains the spectral feature comparison results and continuum-removed feature parameters. By viewing the text in the record (see *Function 1.5*), the user can display the spectral feature comparison parameters (fig. 39); these are the same parameters described in table 2. Before the data records containing the spectra of the continuum-removed features, a text record of dashes is written (record 33864 in fig. 38). The next three records contain the continuum-removed features for the observed spectrum, the reference spectrum, and the scaled reference, respectively (see records 33865, 33871, and 33877). The header of each of these records contains information on the continuum-removed features and the fit value of the spectral feature comparison (fig. 40). The end of the block of records is another separator record of asterisks (record 33883 in fig. 38).

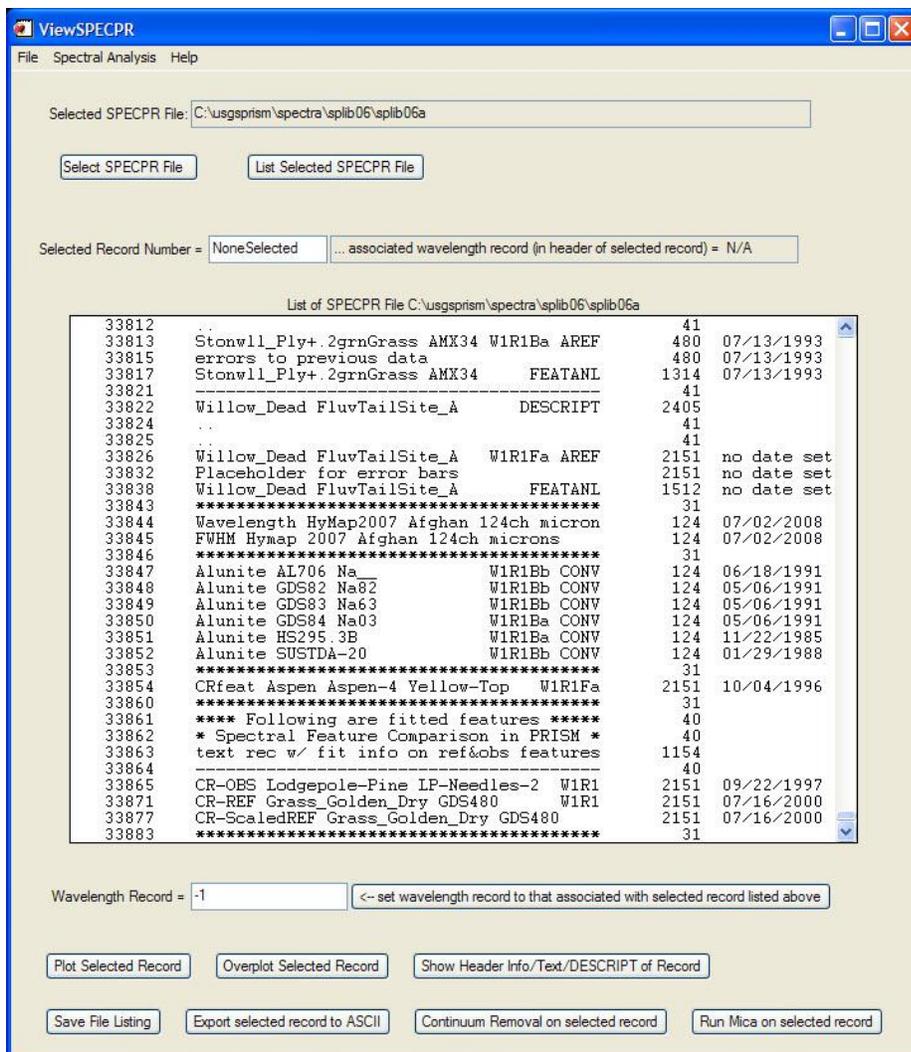


Figure 38. Example text and data records written “Save Features to SPECPR”; the records written are 33861 to 33884.

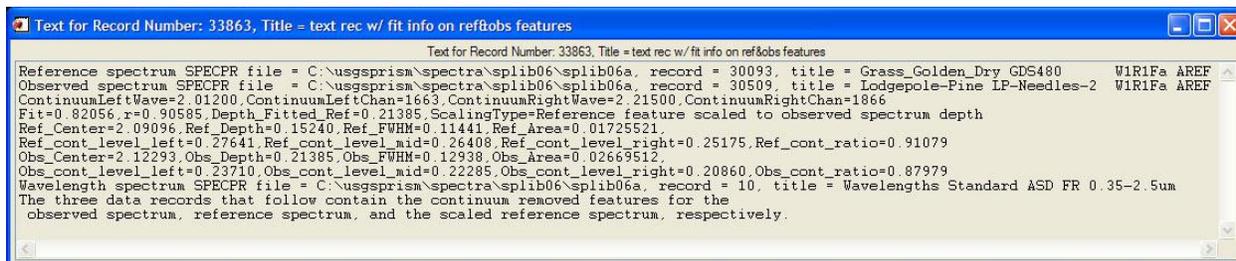


Figure 39. Spectral feature comparison parameters and continuum-removed feature parameters stored in the text record.

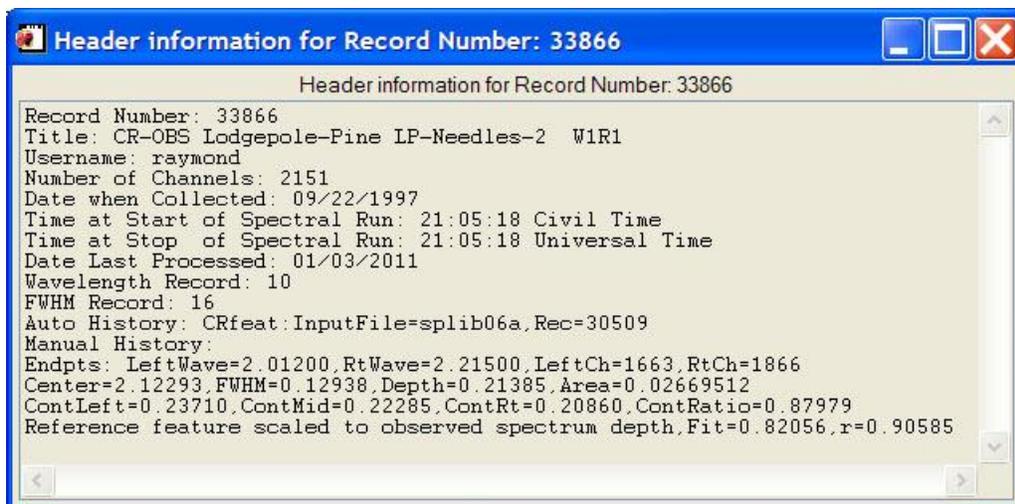


Figure 40. Parameters describing the continuum-removed feature of the observed spectrum stored in the header of the data record.

After creating a comparison plot, the user can return to the plot of the continuum-removed feature by pressing the “Refresh CR Plot” button.

Function 1.8 – Running MICA analysis on the selected record

The shape of the reflectance spectrum of a material derives, in large part, from its chemical composition and physical structure (see Clark, 1999). Differences in the chemical compositions of materials lead to differences in spectral shapes. MICA analyzes an input spectrum in comparison to a set of spectral features in reference spectra and identifies the best match to the reference spectra; in this manner a material can be identified by spectral characteristics. Details on the algorithms in MICA can be found in the “*Module 4. MICA – Material Identification and Characterization Algorithm*” section of this report. The reference spectra, their diagnostic absorption features, continuum constraints, and other controls on the MICA analysis are defined in a MICA command file. *Appendix A* describes the format and syntax of the MICA command file and shows a sample command file with helpful annotations explaining the file structure and parameter values. Spectra to be analyzed with a MICA command file must have been either measured on the same spectrometer as the reference spectra, or the spectra to be analyzed and the reference spectra must have been reconciled to the same spectral parameters, that is, converted to a consistent set of channels with the same wavelength and bandpass (FWHM) values. The spectra with the finer resolution, that is, smaller bandpass (FWHM), overall, should be resampled, either interpolated (*Function 2.8*) or convolved (*Function 2.9*) to the spectral characteristics of the coarser resolution spectra. For example, AVIRIS spectra cannot be compared directly to a set of reference spectra measured on a high-resolution laboratory spectrometer. First, the laboratory spectra must be convolved to the sampling and bandpass (FWHM) characteristics of the AVIRIS data being analyzed. Subsequently, a MICA command file referencing the convolved laboratory spectra can be used to analyze the AVIRIS spectra.

From the ViewSPECPR interface, MICA analysis of a selected record can be performed by clicking on the “Run MICA on selected record” button at the bottom right of the ViewSPECPR control window (fig. 41). In order to run MICA on a spectrum, the user must have a valid MICA command file and the SPECPR file(s) containing the spectra listed in the MICA command file. A sample MICA command file “mica_cmds_group2_hymap2007.mcf” and the associated SPECPR file “splib06b_cvhymap07_124ch” are included with this distribution of PRISM. This command file was developed to detect the occurrences of a set of materials in the pixels of HyMap imaging spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press). Here, it is used to illustrate the steps taken when running MICA on a selected spectral record, in this case, record 945 of the example SPECPR file (fig. 41). The example files are included with the PRISM software distribution. If step 3 of the installation instructions was followed (see the “Installation of Software” section of this report), the files will be in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers.

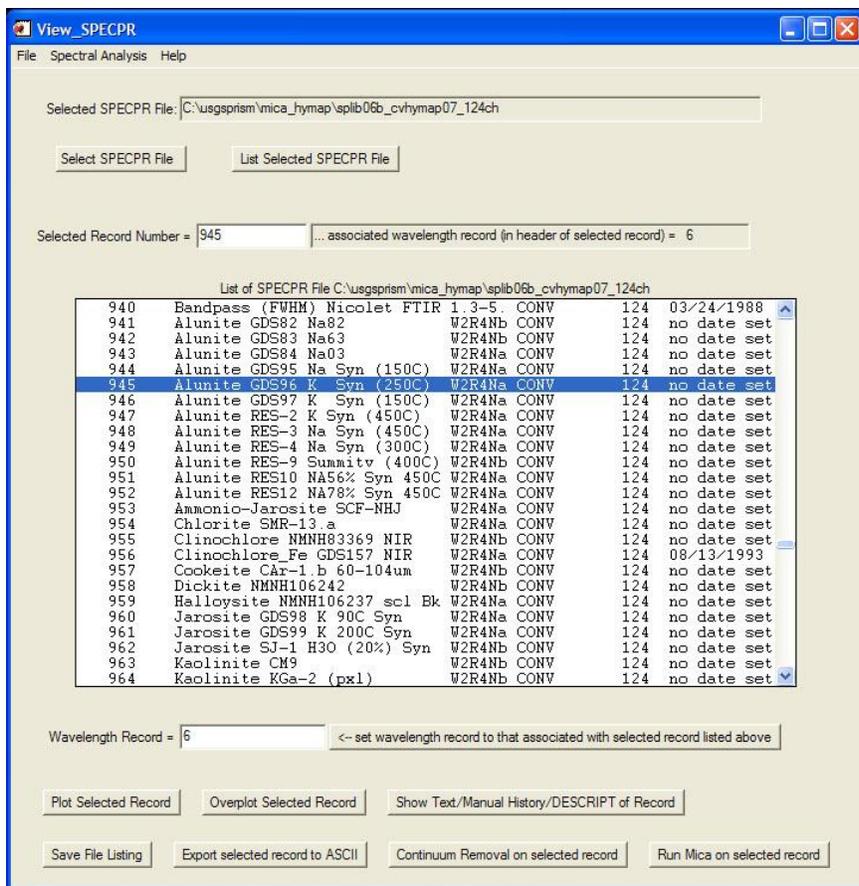


Figure 41. Running MICA on a selected record.

During program execution, the following prompts are made by MICA.

Prompt 1: Select the MICA command file

The user is prompted to select the MICA command file to use in the analysis of the selected record (fig. 42). In this example, the sample MICA command file included with the PRISM software distribution is used.

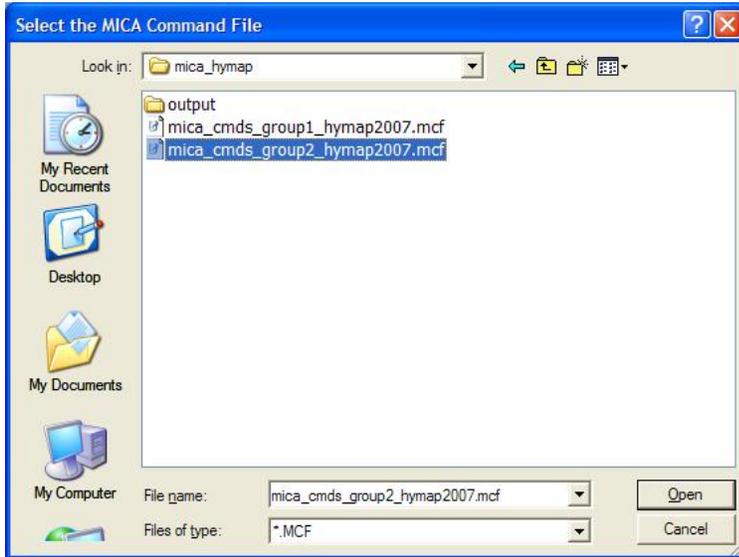


Figure 42. Selecting a MICA command file.

Prompt 2: Set the output directory

The user is prompted to set the output directory (fig. 43). This is the directory where a results file of the MICA analysis for the selected record will be created in text format. The user must have write permission to this directory. This output file is formed according to the following pattern, in which the term “log” is shorthand notation for logbook and indicates the file contains results from the MICA analysis as well as important information on events that occur during the program execution:

Results file = Output directory + “mica_log_spectrummode_” + command file + “.txt”

Thus, for the example given here, the results file will be

“C:\usgsprism\mica_hymap\output\mica_log_spectrummode_mica_cmds_group2_hymap2007.txt”

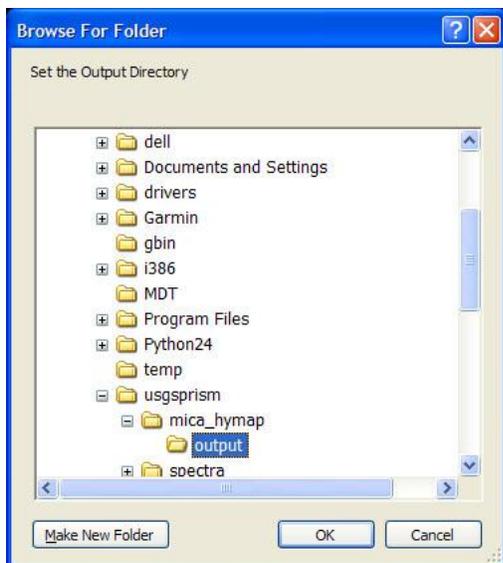


Figure 43. Selecting an output directory for MICA.

Prompt 3: Set the verbose level

The user is prompted to set the verbose level of the program output (fig. 44). The verbose level refers to the amount of information reported to the user as the spectrum is processed. A higher number verbose level means more information is reported to the user. See *appendix B* for samples and interpretation of MICA output at different verbose levels.

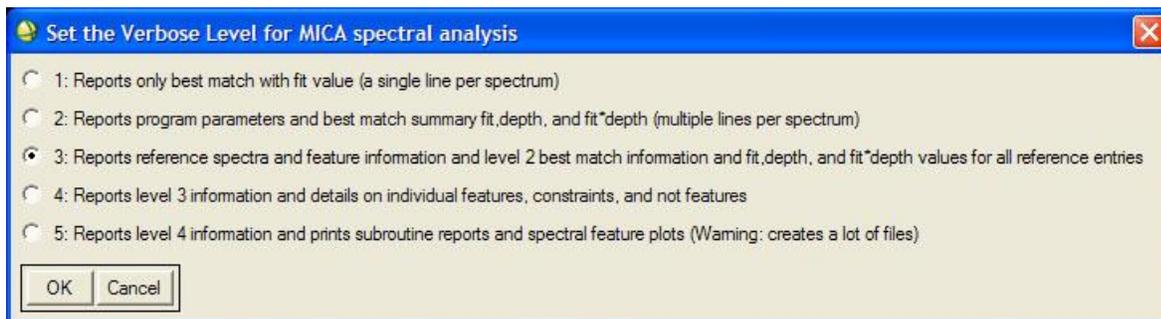


Figure 44. Setting the verbose level for MICA.

At verbose level 1, a single line of text is printed that indicates which one, if any, of the reference spectra was found to be the best match to the selected record. The weighted fit value of this best match is reported, where the weighted fit value is the overall fit calculated by summing the fit values of the observed spectrum to each feature in the “best match” reference spectrum, weighted by the user-supplied weights set in the command file. See *Module 4* for additional details on MICA calculations. At the next level, verbose level 2, the results file also contains some information on the parameters used to run MICA and, in addition to the weighted fit value

of the best match, the weighted band depth and the fit*depth values of the match are reported. Additional information on the record selected for analysis (observed) and the record of the best match (reference) is reported, including the SPECPR file, record number, and title of the observed spectrum and the same information for the best match to the reference spectra.

At verbose level 3, MICA also reports information about the contents of the MICA command file, including a list of the reference spectra and the continuum endpoints that define the spectral features to be analyzed. Also at verbose level 3, the output file reports the weighted fit results for all reference spectra, not just the “best match” spectrum. In addition, the reference spectra with the top 5 weighted fit values are ranked and reported.

At verbose level 4, the output file contains detailed information on the fit and depth values for each spectral feature of each reference spectrum, in contrast to the reporting of just the summary values for each reference spectrum. Also, the calculated values of feature and continuum parameters are reported along with the threshold values for these parameters that were set in the MICA command file (see *appendix A*). If a threshold was not set in the command file, the output file will show a value of -99.99 for that constraint. Summary reports for whether the features passed or failed constraints are also given. A table reporting the weighted fit, depth, and fit*depth values is created along with threshold values for these parameters that were set in the MICA command file. If a threshold was not set in the command file, the output file will show a value of -99.99 for that constraint. Verbose level 5 adds reporting from the subroutines of MICA and, therefore, can generate a large output text file, depending on the number of spectra listed in the command file. In addition, PostScript plots are created which show the comparison of the spectrum of the selected record to all diagnostic and NOT features of reference spectra listed in the command file.

Prompt 4: Set the scale factor for reference spectra, if not set in the command file

If the MICA command file does not specify the scaling factor for the reference spectra, the user is asked if he or she wishes to set this value (fig. 45). The reference spectra will be divided by the scale factor to convert the spectrum to reflectance values ranging from 0 to 1. If the user selects “No” then the program execution will halt. Note: if the scale factor for the reference spectra is set in the MICA command file, then this and the next prompt (Prompt 5) will not appear.

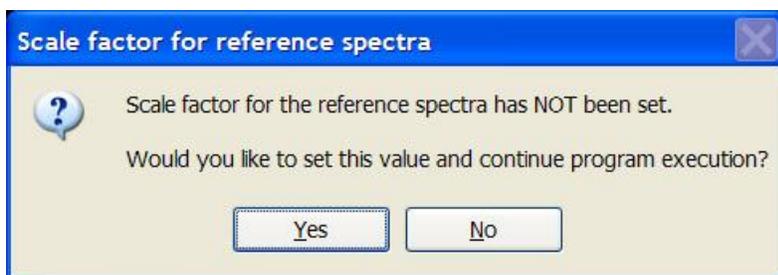


Figure 45. Prompt to set the scale factor for the reference spectra.

Prompt 5: Enter the scale factor for reference spectra

If the user selected “Yes” in answer to the previous prompt, setting the scale factor for the reference spectra, then the user is prompted to enter the scale factor (fig. 46). Note: if the

scale factor for the reference spectra is set in the MICA command file then this and the previous prompt (Prompt 4) will not appear.

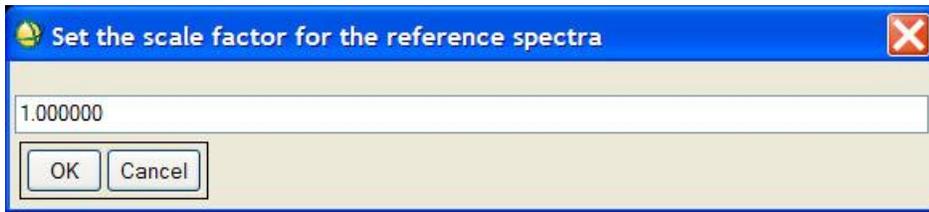


Figure 46. Setting the scale factor for the reference spectra.

Prompt 6: Set the scale factor for observed spectra, if not set in the command file

If the MICA command file does not specify the scaling factor for the observed spectra, that is, the spectra being analyzed, then the user is asked to set this value (fig. 47). The observed spectra will be divided by the scale factor to convert them to reflectance values ranging from 0 to 1. Typically, laboratory and field spectra are collected and stored with values ranging from 0 to 1, in which case, the scale factor should be set to 1. Spectra from cubes of imaging spectrometer data are typically stored with a scaling factor of 10,000 or 20,000. If the user selects “No” in response to Prompt 6 then the program execution will halt. Note: if the scale factor for the observed spectra is set in the MICA command file then this and the next prompt (Prompt 7) will not appear.



Figure 47. Prompt to set the scale factor for the observed spectra.

Prompt 7: Enter the scale factor for observed spectra

In selecting “Yes” in answer to the previous prompt, that the user wishes to set the scale factor for the observed spectra, then the user is prompted to enter that value (fig. 48). Note: if the scale factor for the observed spectra is set in the MICA command file then this and the previous prompt (Prompt 6) will not appear.

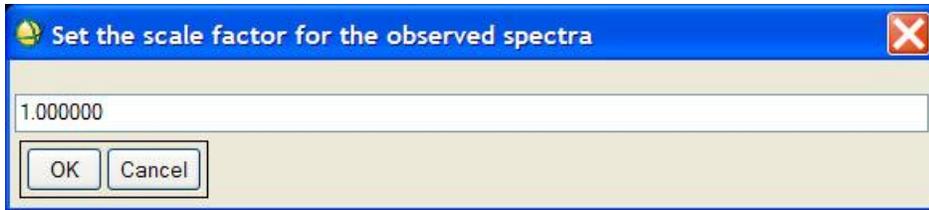


Figure 48. Setting the scale factor for the observed spectra.

Prompt 8: Change the scale factor for observed spectra, if set in the command file

If the MICA command file specifies the scaling factor for the observed spectra, the user is prompted to accept or change this value (fig. 49). If the user presses “No” then the program execution will continue using the scale factor value set in the command file. Note: if the scale factor for the observed spectra is not set in the MICA command file then this and the next prompt (Prompt 9) will not appear.

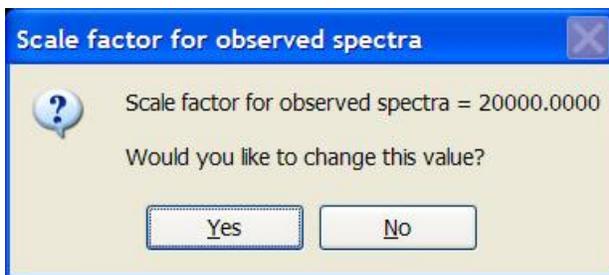


Figure 49. Prompt to change the scale factor for the observed spectra.

Prompt 9: Enter the scale factor for observed spectra, if changing the value from the command file

If the user selected “Yes” in answer to the previous prompt, that is, that the user wishes to change the scale factor for the observed spectra, the user is prompted to enter that value (fig. 50). Note: if the scale factor for the observed spectra is not set in the MICA command file then this and the previous prompt (Prompt 8) will not appear.

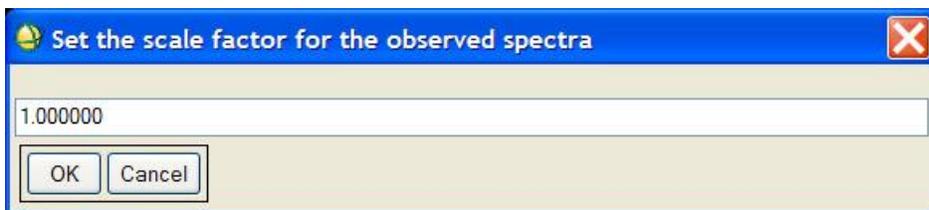


Figure 50. Setting the scale factor for the observed spectra.

Prompt 10: Confirm the successful completion of MICA

If the program completes successfully, a message reporting this is displayed (fig. 51). Press “OK” to dismiss the message.

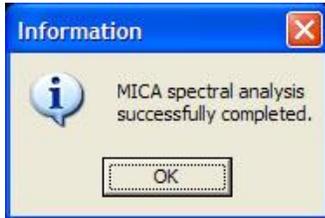


Figure 51. Confirming the successful completion of the MICA routine.

A window containing the text report of the MICA results is also displayed (the bottom of the text report is shown in fig. 52). The reference spectrum that had the best match to the analyzed spectrum (observed spectrum) is shown at the bottom of the report. If a verbose level greater than three was selected, as described above, the reference materials with the five highest fit values are listed before the reporting of the best match. These are shown under the heading “TOP 5 FITS” and are ranked in descending order of fit value. If the observed spectrum does not meet all constraints in the MICA command file for any of the reference spectra, a “no match” result is reported (see the feature and continuum constraints described in *Module 4*). Depending on the verbose level, as described above, additional reporting is done. The text report is also written to the output directory, in this example, the output file is “C:\usgsprism\mica_hymap\output\mica_log_spectrummode_mica_cmds_group2_hymap2007.txt”. Further information on MICA can be found in the “*Module 4. MICA – Material Identification and Characterization Algorithm*” section of this report. *Appendix A* explains the format and syntax of MICA command files and includes the sample command file with explanatory comments. Additional details on the output from MICA are given in *appendix B*.

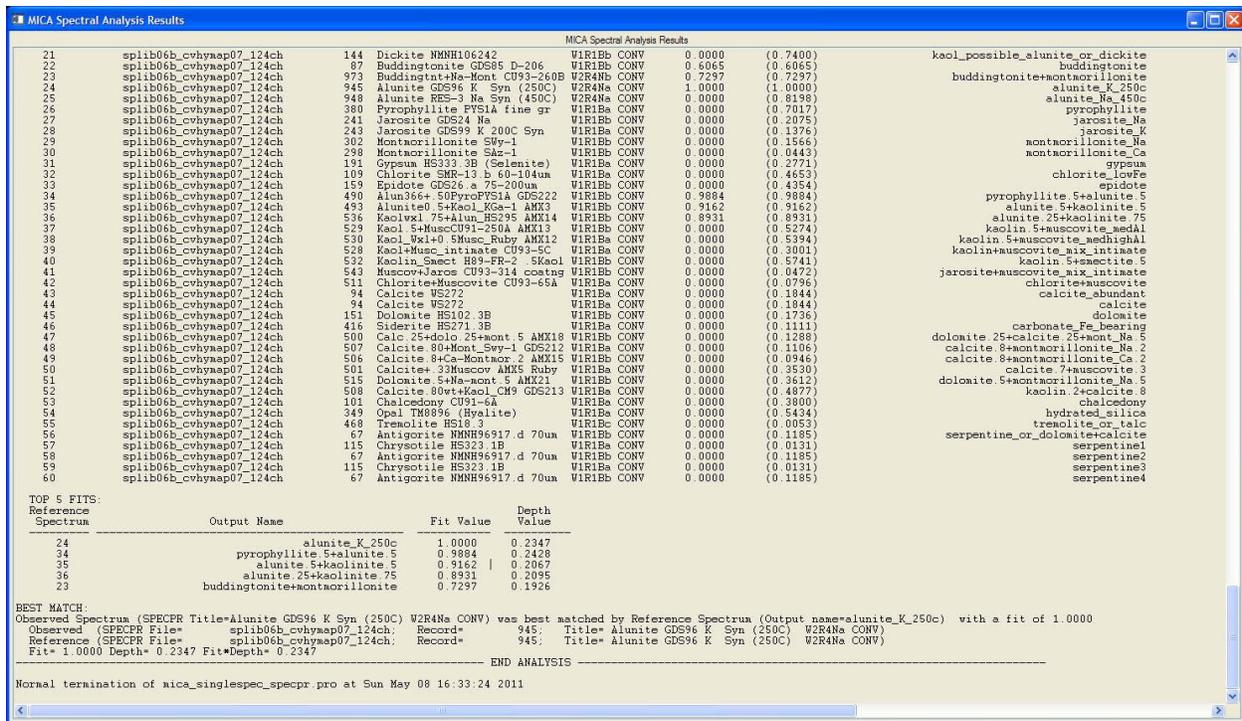


Figure 52. Text report of the MICA results.

Function 1.9 – ViewSPECPR spectral analysis functions

A variety of functions, among them routines for importing/exporting data to/from a SPECPR file, managing and editing SPECPR records, and applying arithmetic, convolution, and interpolation functions to spectra, can be accessed using the “Spectral Analysis” menu entry on the ViewSPECPR control window’s menu bar. When selected, a list of the available routines drops down from the menu entry (fig. 53). The routines listed are intended for use with the displayed SPECPR file. All of these same functions are accessible from the drop-down list that appears when the user clicks on the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see the *Module 2. Spectral Analysis Functions*” section of this report). However, when these functions are invoked from the PRISM menu instead of from the ViewSPECPR menu, the user must select the input/output SPECPR. Therefore, initiating the functions from the ViewSPECPR menu offers a shortcut to work with records in the SPECPR file being viewed.

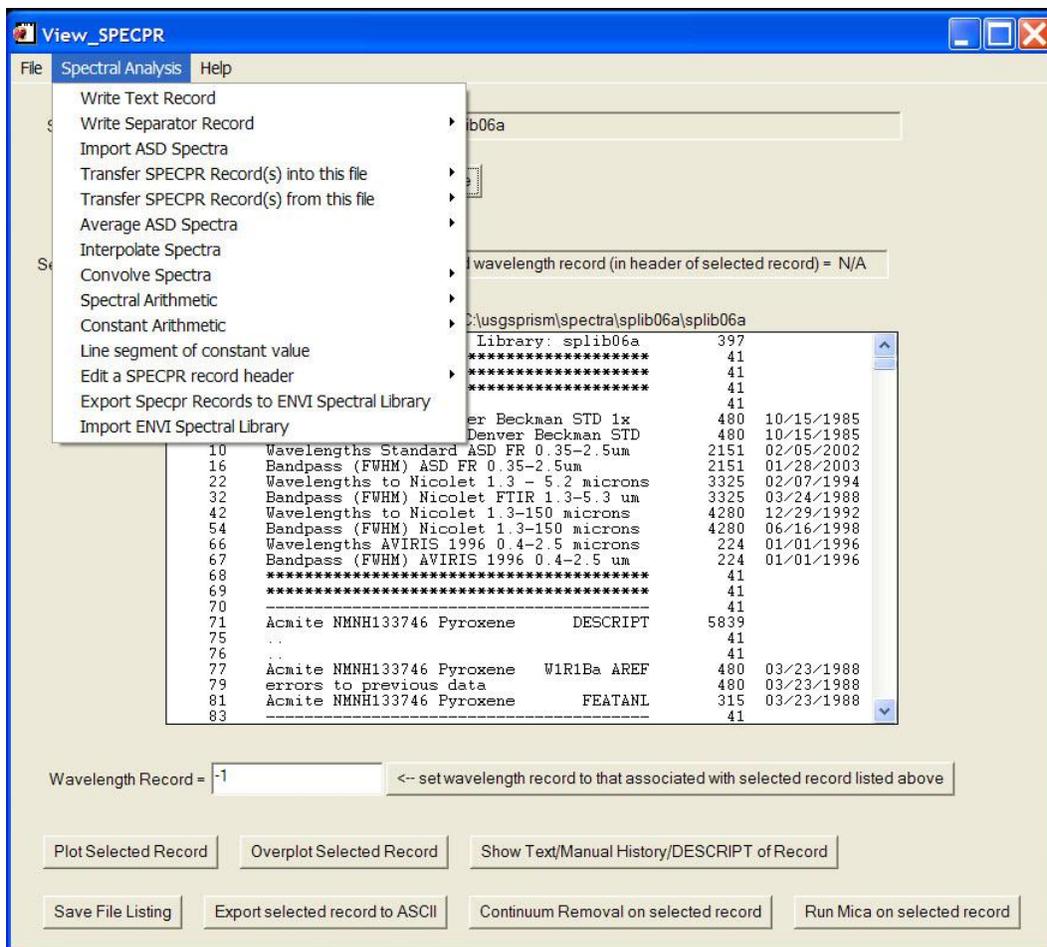


Figure 53. Spectral functions available within the ViewSPECPR module.

Function 1.9.1 – Write text record

This function can be used to add a text record to the end of the SPECPR file being viewed. To start the function, click on the “Write Text Record” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar (fig. 53). When creating a text record the user is first prompted to enter the title of the text record (fig. 54). Within SPECPR database files, titles are limited to 40 characters.

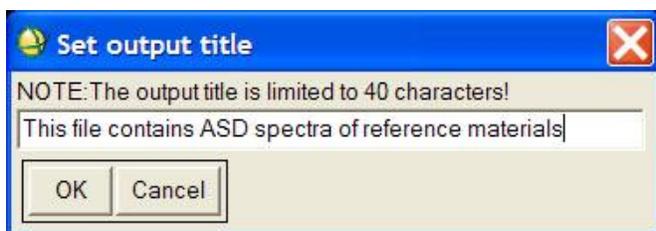


Figure 54. Entering the title for a text record.

If the title exceeds 40 characters the user will be warned that an error occurred and the output title should be re-entered (fig. 55).



Figure 55. Warning that title exceeds 40 characters.

After pressing “OK”, the user is again prompted to enter the title for the text record; however, the previously entered title, truncated to 40 characters, will be present in the text field (fig. 56). The user may edit that title, making sure to use at most 40 characters (fig. 57).

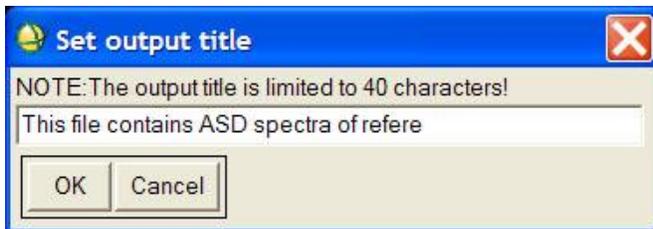


Figure 56. The title truncated to 40 characters.

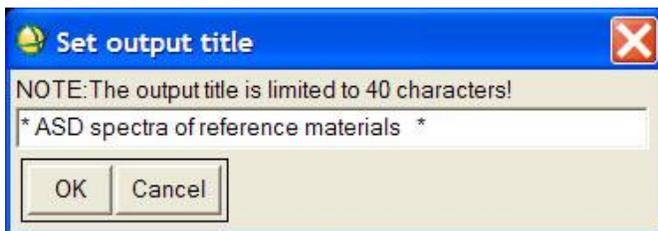


Figure 57. A title with only 40 characters.

After the title has been accepted, the user is prompted to enter the text to be stored in the new record. Figure 58 shows an example of text written to a SPECPR example file “spd_example1”. This example file is included with the PRISM software distribution. If the user followed step 3 of the installation instructions (see section “*Installation of Software*” of this report), the file will be located in “C:\usgsprism\spectra\” on Windows computers and at “/var/local/usgsprism/spectra/” on Linux computers.

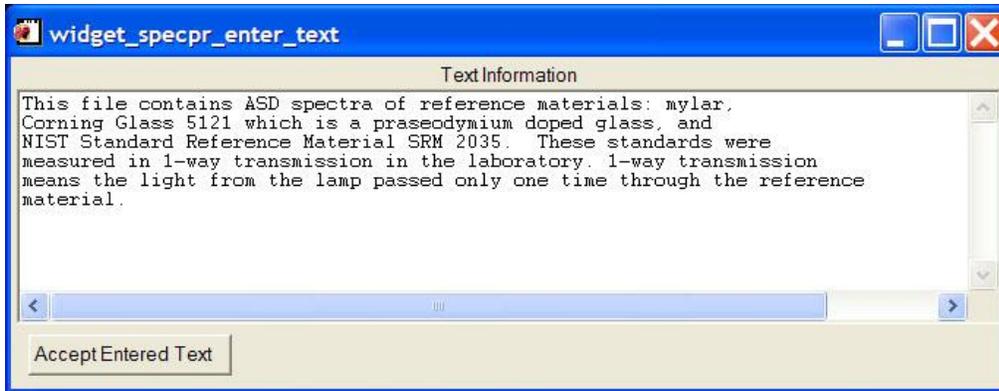


Figure 58. Text to store in a SPECPR text record.

Function 1.9.2 – Write a separator record

These functions provide a convenient way to add text records that have titles of all asterisks (*) or all dashes (-). These are used to mark divisions between blocks of spectra or data. For example, figure 6 shows three such records before and after the data records that contain the wavelengths and bandpass (FWHM) of the spectrometers in the USGS splib06a spectral library (Clark and others, 2007). Also, between the records of each sample material in that library, separator records of dashes are used for visual separation.

Function 1.9.2.1 – Write separator record of asterisks *****

When this function is selected, a text record with a title of 40 asterisks (*) is written to the end of the SPECPR file being viewed. To start the function, click on the “Write Separator Record” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Write separator record of asterisks *****” item that appears (fig. 59). After the record is written, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new record appearing at the bottom of the listing. Figure 60 shows the file listing that results after writing this type of separator to a SPECPR example file “spd_example1”. This example file is included with the PRISM software distribution. If the user followed step 3 of the installation instructions (see section “*Installation of Software*” of this report), the file will be located in “C:\usgsprism\spectra\” on Windows computers and at “/var/local/usgsprism/spectra/” on Linux computers.

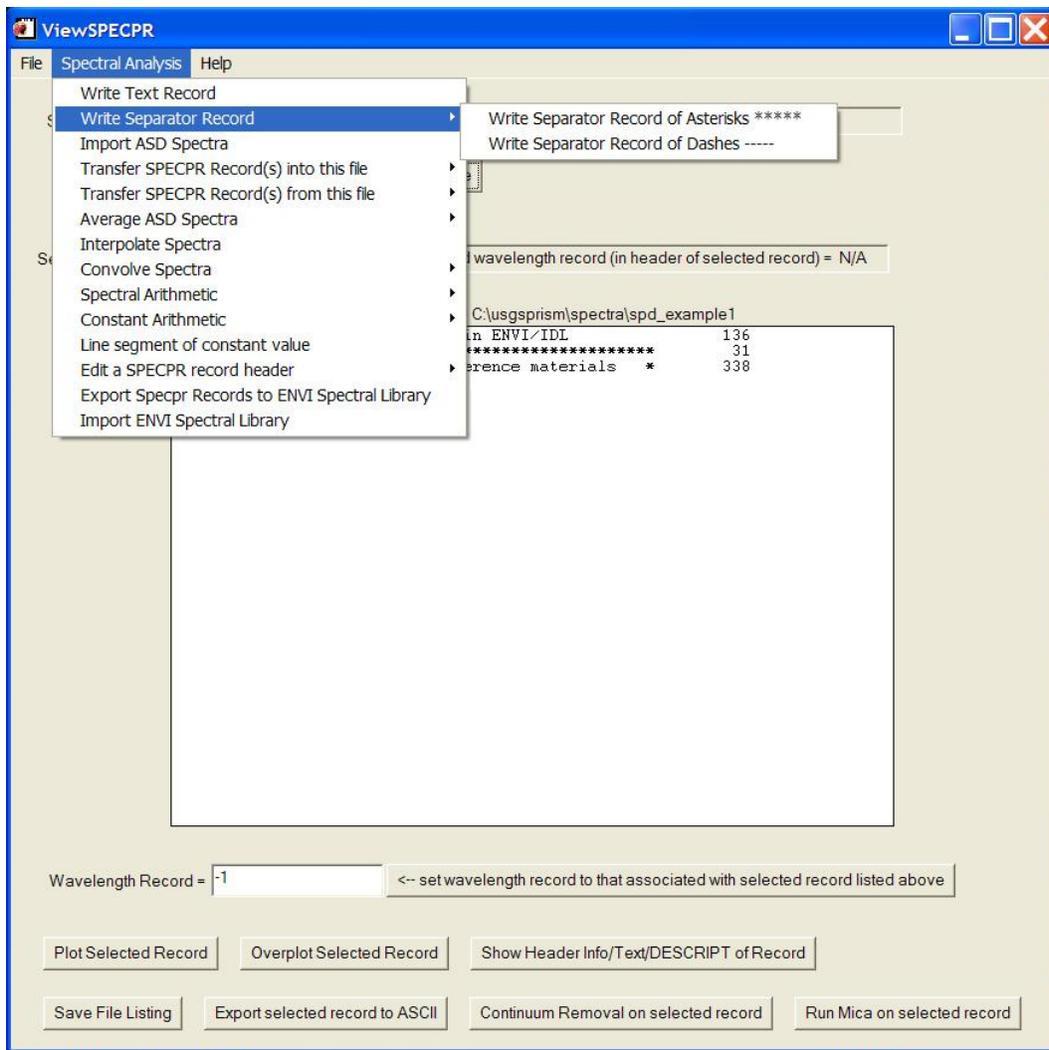


Figure 59. Separator record functions available within the ViewSPECPR module.

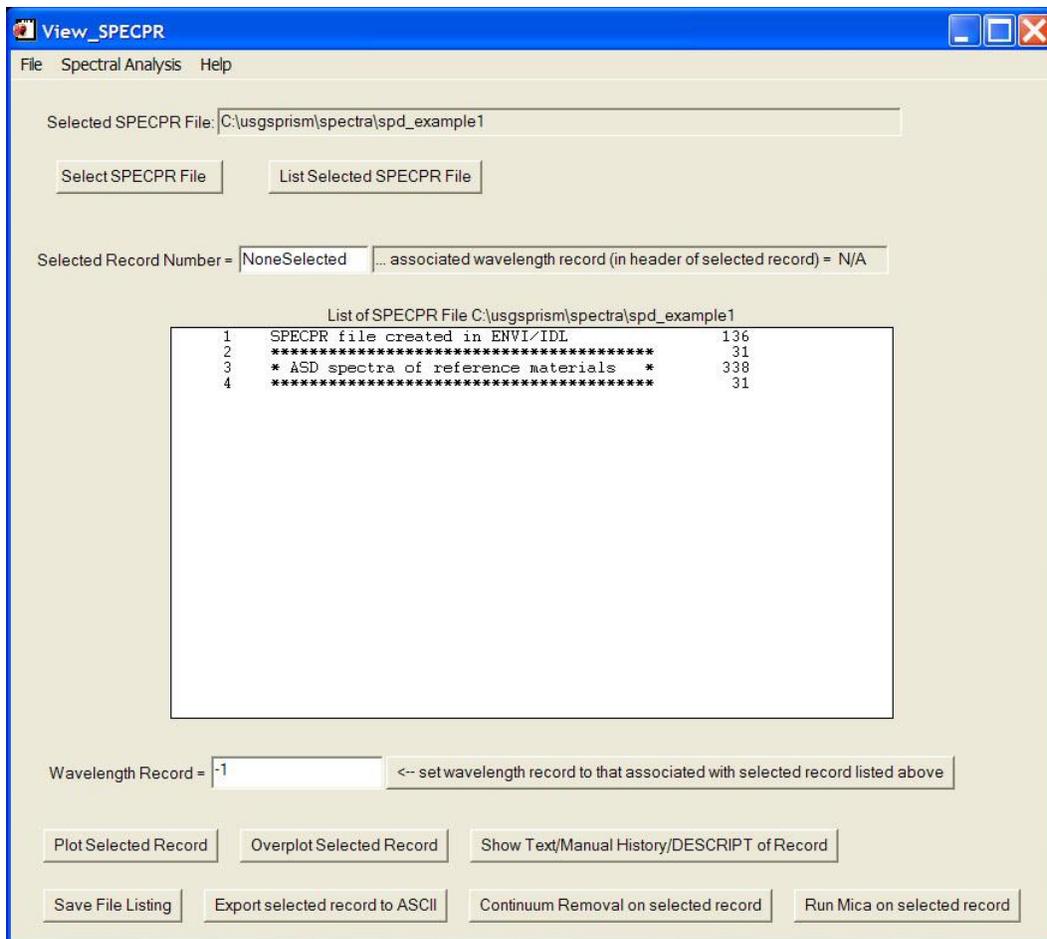


Figure 60. Separator record written to SPECPR file.

Function 1.9.2.2 – Write separator record of dashes ----

When this function is selected, a text record with a title of 40 dashes (-) is written to the end of the SPECPR file being viewed. To start the function, click on the “Write Separator Record” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Write separator record of dashes ----” item that appears (see fig. 59). After the record is written, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new record appearing at the bottom of the listing.

Function 1.9.3 – Import ASD spectra

This function allows the user to import spectra collected using ASD full range spectrometers. Full range refers to spectrometers that produce spectra with 2151 channels with 1 nanometer (nm, 0.001 μm) sampling increments, starting at the wavelength of 350 nm (0.35 μm) and ending at 2500 nm (2.5 μm). In PRISM, these are considered to be the default wavelengths of ASD spectra. Thus, this function is designed to work with ASD spectrometers with three detectors, a visible/near-infrared detector (VNIR), a shortwave infrared 1 (SWIR1) detector, and

a shortwave infrared 2 (SWIR2) detector. Drawing on over 15 years of experience with five ASD spectrometers maintained by the USGS Spectroscopy Laboratory in Denver, Colorado, PRISM uses default bandpass (FWHM) characteristics of these detectors as 5 nm (0.005 μm) for the VNIR, 11 nm (0.011 μm) for the SWIR1, and 11 nm (0.011 μm) for the SWIR2. However, PRISM also contains routines for the users to evaluate the wavelength and bandpass (FWHM) characteristics of their ASD spectrometers (see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*” for details) and to create custom wavelength and bandpass (FWHM) records. These custom characteristics may or may not differ from the nominal characteristics. The user may then link imported ASD spectra to these custom wavelength and bandpass (FWHM) records. Alternatively, the user may use the default wavelength and bandpass (FWHM) records. Currently, PRISM works only with ASD files in the older binary format, so the user should consult the documentation of ASD software to see how to record data in this format and how to convert data collected in the newer format back to the old format.

When using this function, the user is first prompted to choose the ASD binary files. Example ASD binary files are provided with the PRISM software distribution. If step 3 of the installation instructions was followed (see section “*Installation of Software*” of this report), these files will be located in “C:\usgsprism\spectra\asd\raw_binaries\” on Windows computers and at “/var/local/usgsprism/spectra/asd/raw_binaries/” on Linux computers. Figure 61 shows an example of selecting the ASD files with the name of “mylar” using multiple file selection by left-clicking the file at one end of the desired block and then pressing and holding the Shift button and left-clicking the file at the other end of the desired block of files. The user can then click “Open” after selecting the ASD files.

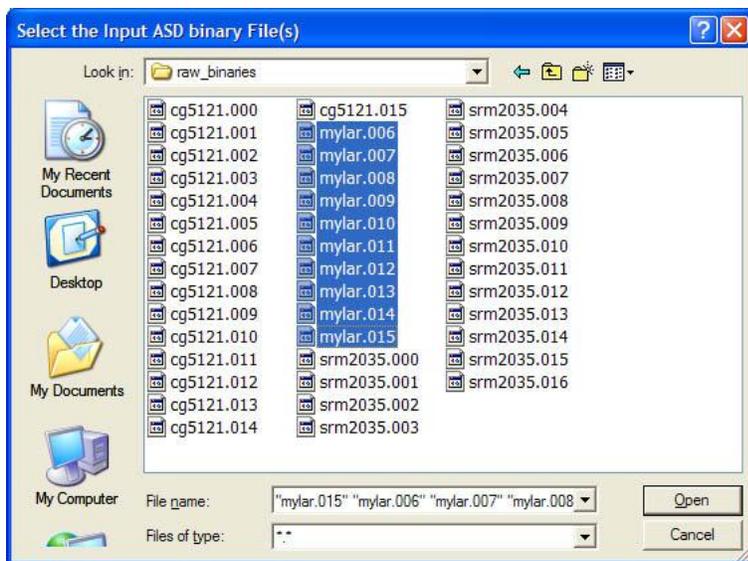


Figure 61. Selecting ASD binary files for import into a SPECPR file.

The user is then asked whether the SPECPR file into which the spectra are being imported (that is, the SPECPR file being viewed) contains the wavelength and bandpass (FWHM) records that correspond to the ASD spectra being imported (fig. 62).

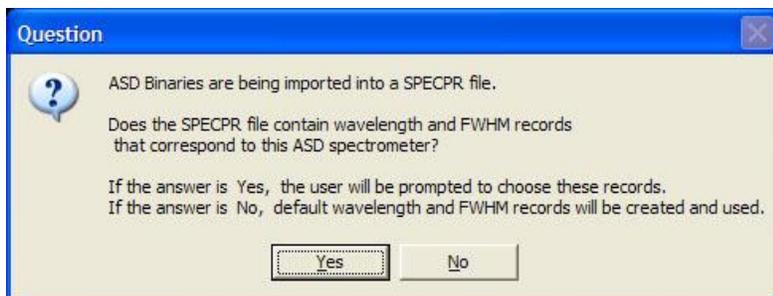


Figure 62. Selecting ASD binary files for import into a SPECPR file.

If the wavelength and bandpass (FWHM) records are not present in the SPECPR file being viewed, but are present in another SPECPR file, the user should first transfer those records (see *Function 1.9.4*) into the SPECPR file being viewed before importing ASD spectra. PRISM works best when each spectrum is linked to the wavelength and bandpass (FWHM) records that characterize the spectrometer on which it was collected. In the case of ASD spectra, the user may have customized wavelength and bandpass (FWHM) records using “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”. If the user does not have a custom set of wavelength and bandpass (FWHM) records for the ASD spectra, then the user may choose to continue importing spectra using a set of default wavelengths and bandpass (FWHM) values for ASD full range spectrometers by clicking “No” in answer to the prompt shown in figure 62. The user may select “No” and later use the custom PRISM routines to establish wavelengths and bandpass (FWHM) records for the ASD spectrometer (see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”). If the user has established the spectrometer’s wavelength and bandpass (FWHM) characteristics through another means, the user may import the wavelength and bandpass (FWHM) records by importing them from an ENVI spectral library and then using “*Function 1.9.14 – Import ENVI Spectral Library*” to bring them into the SPECPR file being viewed.

If “No” is selected in answer to the question, default records for ASD wavelength and bandpass (FWHM) will be created (for details on these default values see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”) and the ASD spectra imported. After the records are imported, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. Figure 63 shows the resulting file listing after pressing “No” and importing the selected ASD binaries. Text, wavelength, and bandpass (FWHM) records are written before the imported spectra to describe the subsequent data records as imported ASD spectra (records 5-20 in fig. 63). First, a text separator record of asterisks is written (record 5). Then, a text record containing the ASD spectrometer number and calibration number is written (record 6), as extracted from the first ASD binary file. Next, a text separator record of dashes is written (record 7). Since the user opted to use the default ASD wavelength and bandpass (FWHM) values, the next two records will contain those data (records 8 and 14 in fig. 63). After these records, another text separator record of dashes is written (record 20). Next, the imported ASD spectra are written (records 21-75 in fig. 63). Finally, a text separator record of asterisks is written to demarcate the end of the block of imported ASD spectra.

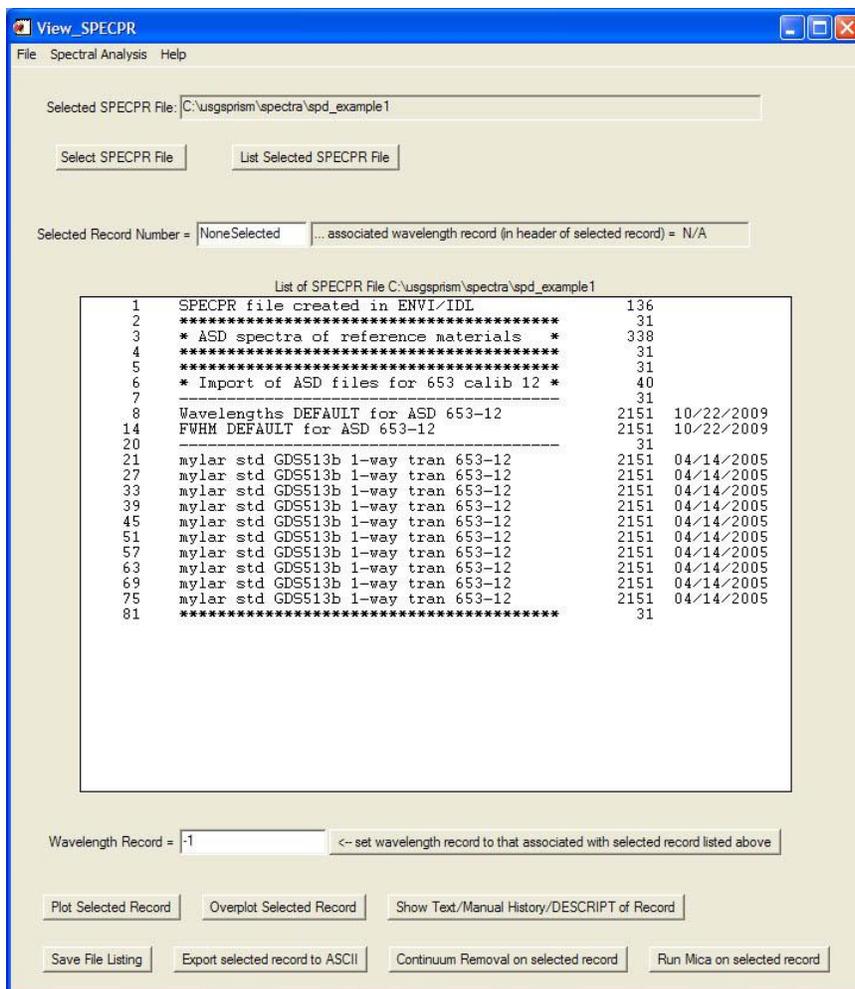


Figure 63. SPECPR file listing after importing ASD spectra with default wavelength and bandpass (FWHM) records.

Each record containing one of the imported ASD spectra, for example, record 21, has pointers to the wavelength record (record 8) and bandpass (FWHM) record (record 14) set in its header. By clicking on an imported ASD spectrum, in this case, record 21, and then pressing the “Show Header Info/Text/DESCRIP Record” button, you can examine the information stored in the header of an imported ASD record (fig. 64). If a GPS was connected to the ASD while collecting the spectra, the manual history will contain the latitude and longitude coordinates stored in the ASD binary file, along with the GPS datum. If the GPS was not connected or not communicating with the ASD during spectral measurements, the datum value will be set to “No GPS data” and the latitude and longitude values will be set to zero.

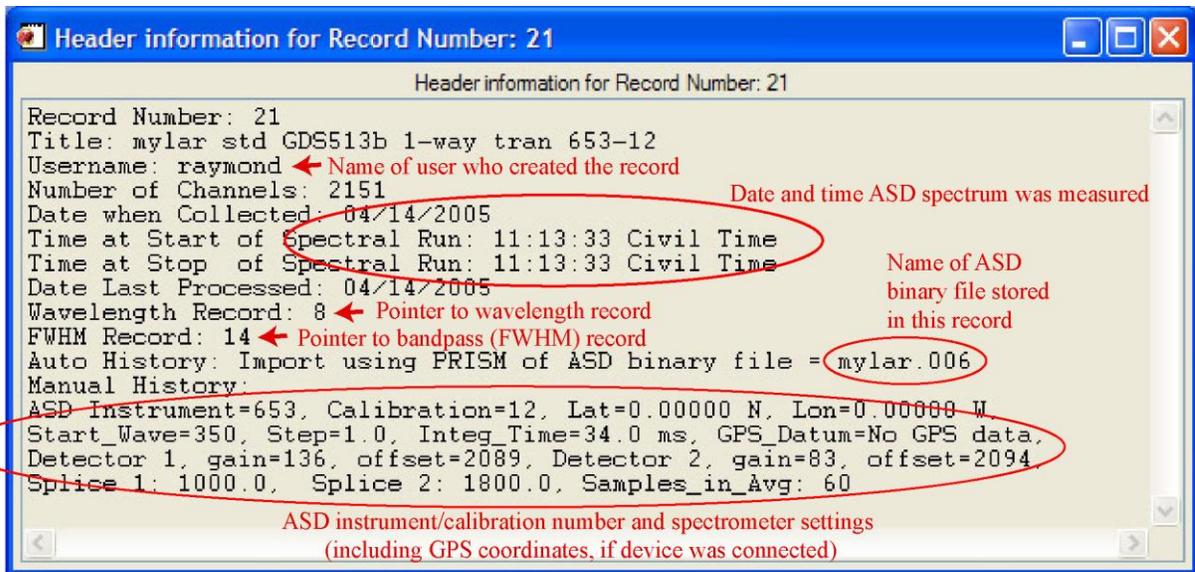


Figure 64. Header information in an imported ASD spectrum using default wavelength and bandpass (FWHM) values.

If the user pressed “Yes” when prompted whether the SPECPR file contains wavelength and bandpass (FWHM) records (see fig. 62), a window will appear with a listing of the SPECPR file being viewed (fig. 65). In this window, the user should select the wavelength record and press “Return Selected Wavelength Record”. Figure 65 shows an example of this step when importing “cg5121” and “srm2035” files. These example ASD binary files are provided with the PRISM software distribution. If step 3 of the installation instructions was followed (see section “*Installation of Software*” of this report), these files will be located in “C:\usgsprism\spectra\asd\raw_binaries\” on Windows computers and at “/var/local/usgsprism/spectra/asd/raw_binaries/” on Linux computers.

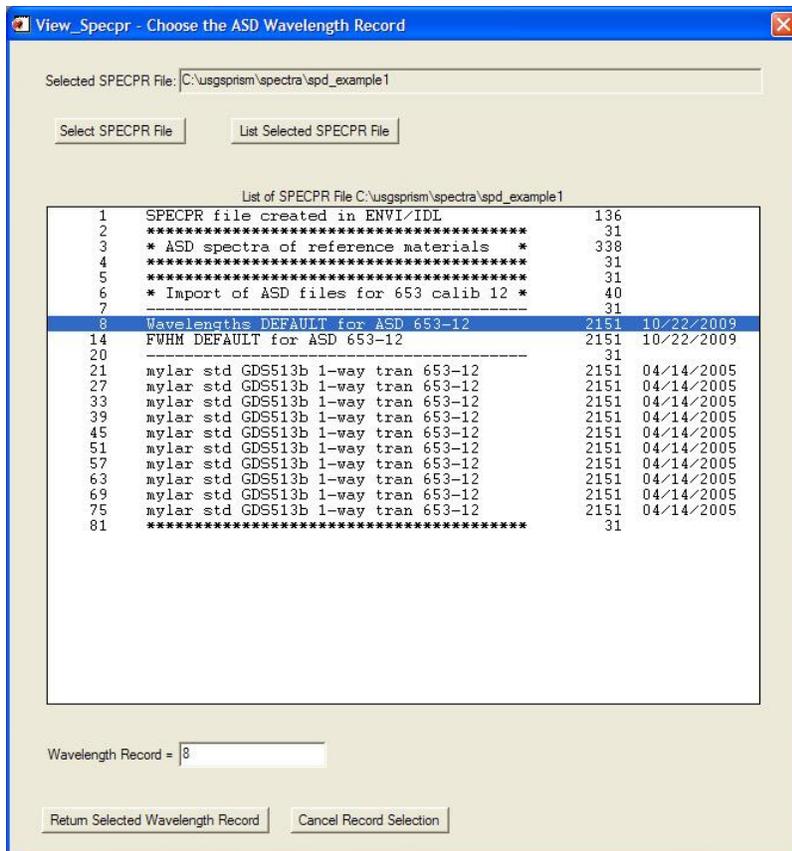


Figure 65. Choosing the wavelength record in the SPECPR file into which ASD spectra will be imported.

Next, the user is prompted to select the bandpass (FWHM) record. After selecting the record, the user should press “Return Selected FWHM Record” (fig. 66).

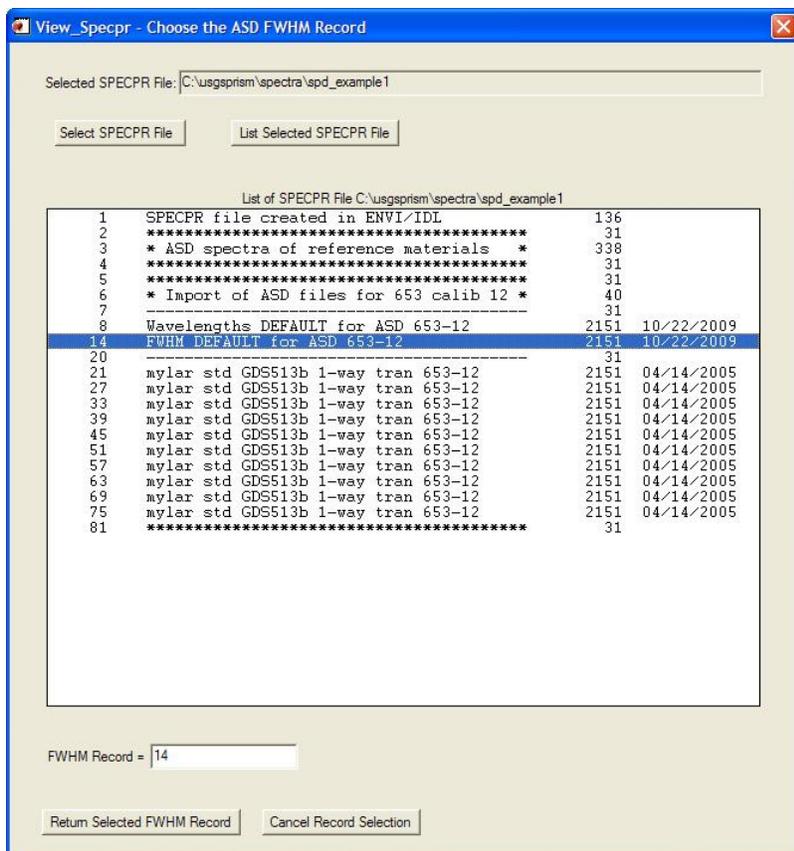


Figure 66. Choosing the bandpass (FWHM) record in the SPECPR file into which ASD spectra will be imported.

After the records are imported, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. Before the imported spectra are written, text records are written to describe the subsequent spectra as imported ASD spectra. First, a text separator record of asterisks is written. Then, a text record containing the ASD spectrometer number and calibration number is written. Next, a text separator record of dashes is written. Next, the imported ASD spectra are written. Finally, a text separator record of asterisks is written to demarcate the end of the block of imported ASD spectra.

Function 1.9.4 – Transfer SPECPR record(s) into this file

These functions (fig. 67) provide a means to transfer records stored in other SPECPR files into the SPECPR file that is being viewed. “*Function 1.9.4.1 – Transfer SPECPR record(s) no changes*” transfers records without altering any of the header information, including without changing the pointers to the wavelength and bandpass (FWHM) records that are associated with the transferred data records. This function should only be used when transferring text records or data records that have pointers to wavelength and bandpass (FWHM) records that are the same and exist in both the SPECPR file from which records are being transferred and the SPECPR file into which they are being transferred. “*Function 1.9.4.2 – Transfer SPECPR record(s) set wave/FWHM*” allows the user to set the pointers to the wavelength and bandpass (FWHM)

records in the SPECPR file into which the data record(s) are being transferred. “Function 1.9.4.3 – Transfer SPECPR record(s) set wave/FWHM and change title” allows the titles of transferred records to be changed.

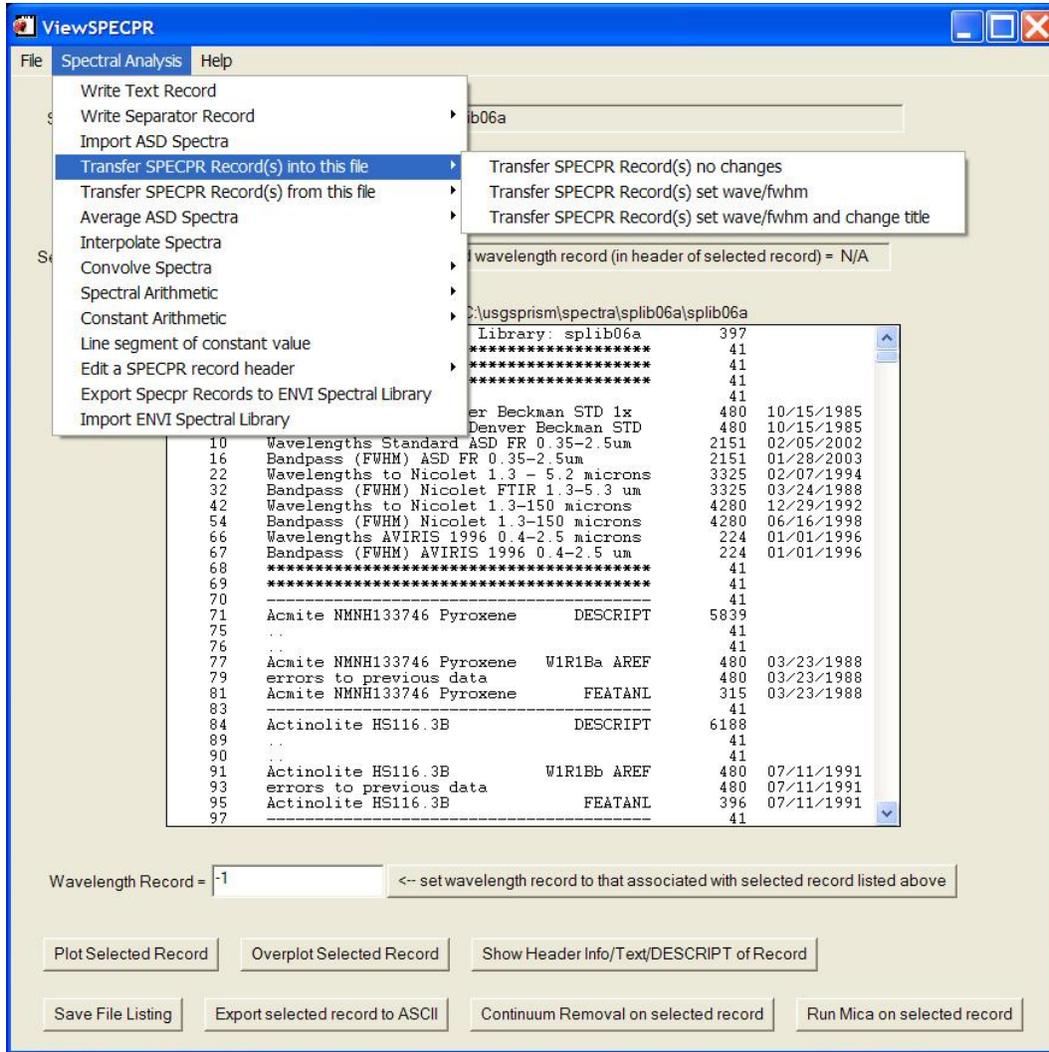


Figure 67. Functions for transferring records into the SPECPR file being viewed.

Function 1.9.4.1 – Transfer SPECPR record(s) no changes

To start the function, click on the “Transfer SPECPR record(s) into this file” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Transfer SPECPR record(s) no changes” item that appears (fig. 67). This example shows records being transferred into the “splib06a” SPECPR file. The file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “Installation of Software” section of this report), this file will be located in

“C:\usgsprism\spectra\splib06\” on Windows computers and in “/var/local/usgsprism/spectra/splib06/” on Linux computers.

First, the user is prompted to choose the SPECPR file from which records will be transferred (fig. 68). In this example, a SPECPR file containing the spectra that have been convolved to HyMap 2007 wavelength and bandpass (FWHM) characteristics is used. This SPECPR file “splib06b_cvhymap07_124ch” is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers.

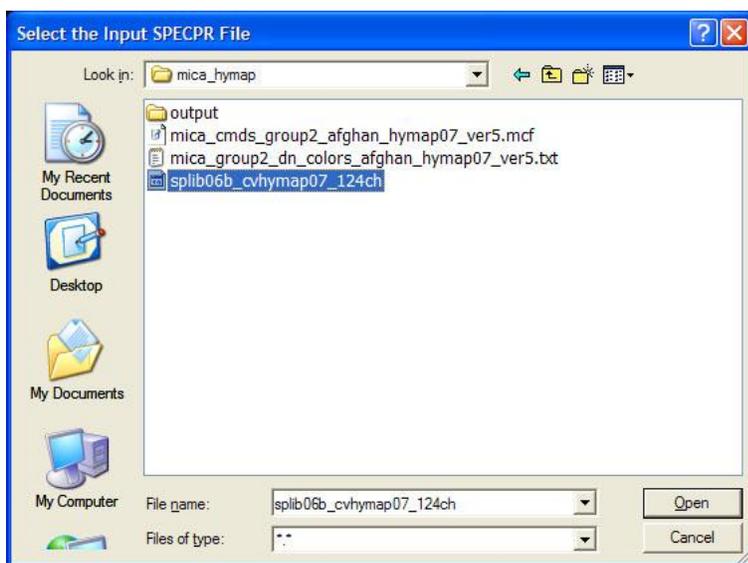


Figure 68. Choosing the SPECPR file from which records will be transferred using the “no changes” function.

Next, the user is prompted to select the records to transfer (fig. 69). Data records and text records can be transferred. A single record can be transferred by left-clicking on the record and then clicking on the “Return Selected Record Numbers” button. Additional records can be selected by pressing and holding down the “Ctrl” (control) button on the keyboard and left-clicking on other records that the user wishes to transfer. A block of records may be selected by first left-clicking on either the record at the top or bottom of the desired block and then pressing and holding the Shift button while left-clicking on the record at the other end of the desired block. The user may scroll up or down before selecting the end record of the desired block. Figure 69 shows the selection of records 5 through 8, a block which contains both text and data records.

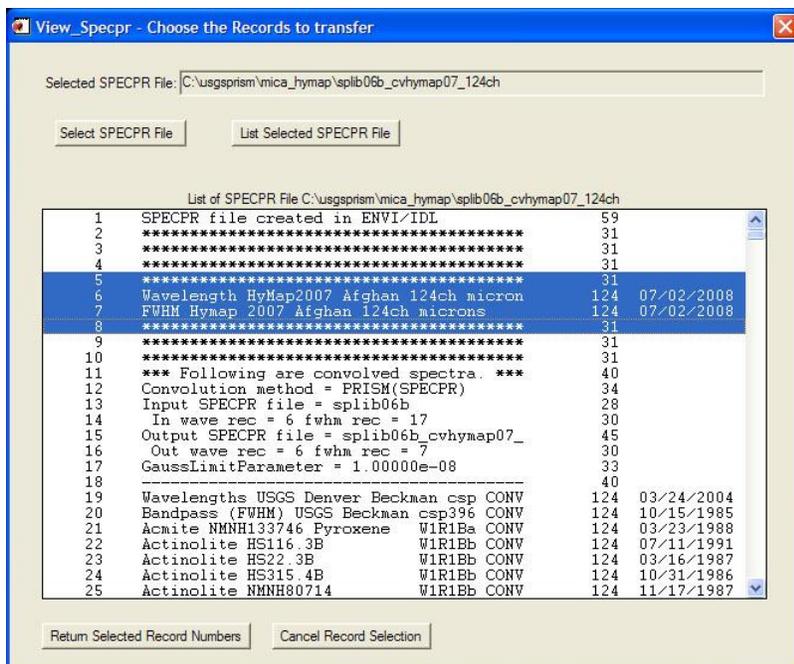


Figure 69. Choosing the records that will be transferred using the “no changes” function.

After pressing the “Return Selected Record Numbers” button, the records are transferred into the SPECPR file being viewed. After the records are transferred, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. By scrolling down to the bottom of the SPECPR file listing, the user will see these transferred records listed (fig. 70).

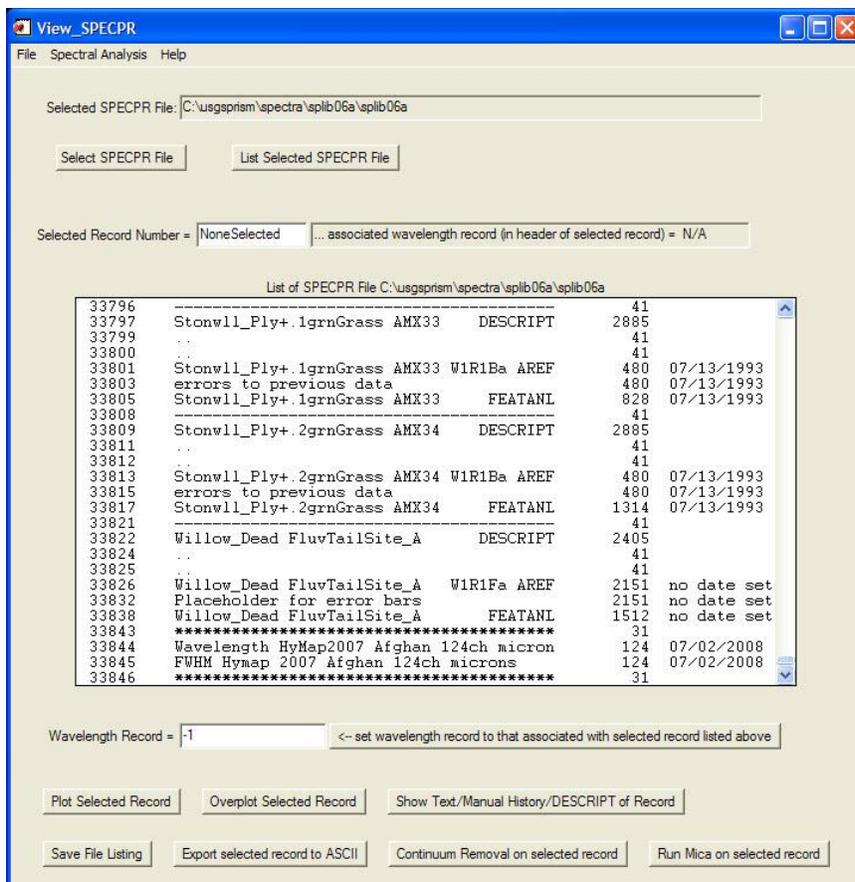


Figure 70. Records transferred using the “no changes” function, listed at the end of the SPECPR file being viewed.

Function 1.9.4.2 – Transfer SPECPR record(s) set wave/FWHM

To start the function, click on the “Transfer SPECPR record(s) into this file” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Transfer SPECPR record(s) set wave/FWHM” item that appears (see fig. 67). This example shows records being transferred into the “splib06a” SPECPR file. The file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\spectra\splib06\” on Windows computers and in “/var/local/usgsprism/spectra/splib06/” on Linux computers.

First, the user is prompted to choose the SPECPR file from which records will be transferred (see fig. 68). In this example, a SPECPR file is used which contains spectra that have been convolved to HyMap 2007 wavelength and bandpass (FWHM) characteristics. This SPECPR file “splib06b_cvhymap07_124ch” is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers.

Next, the user is prompted to select the records to transfer (fig. 71). Data records and text records can be transferred. A single record can be transferred by left-clicking on the record and then clicking on the “Return Selected Record Numbers” button. Additional records can be selected by pressing and holding down the “Ctrl” (control) button on the keyboard and left-clicking on other records that the user wishes to transfer. A block of records may be selected by first left-clicking on either the record at the top or bottom of the desired block and then pressing and holding the Shift button while left-clicking on the record at the other end of the desired block. The user may scroll up or down the record list before selecting the end record of the desired block. Figure 71 shows the selection of records 39 through 44, data records containing spectra of alunite samples.

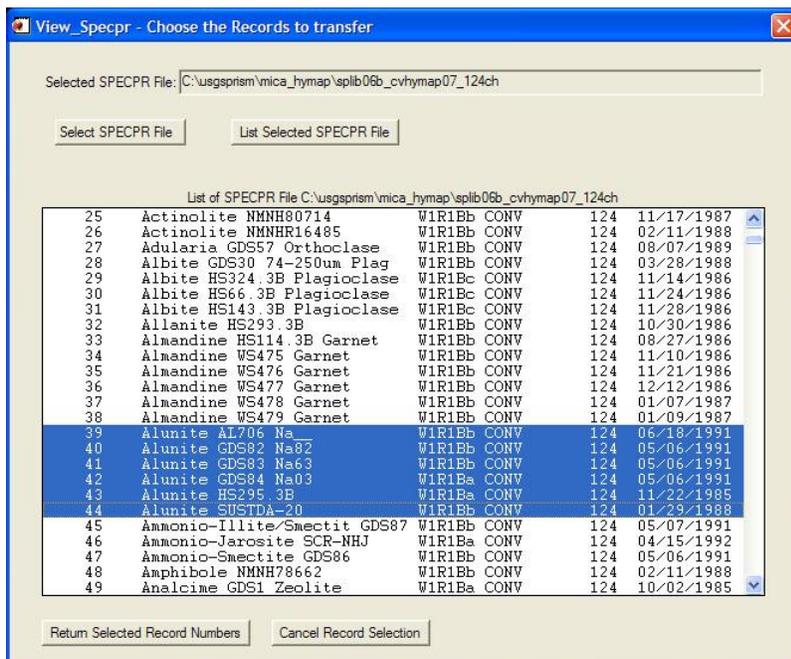


Figure 71. Choosing the records that will be transferred.

Next, the user is prompted to choose the wavelength record corresponding to the transferred records from a listing of the SPECPR file being viewed (the SPECPR file into which the records will be transferred). Figure 72 shows the selection of record 33844. Press the “Return Selected Wavelength Record” after choosing the record.

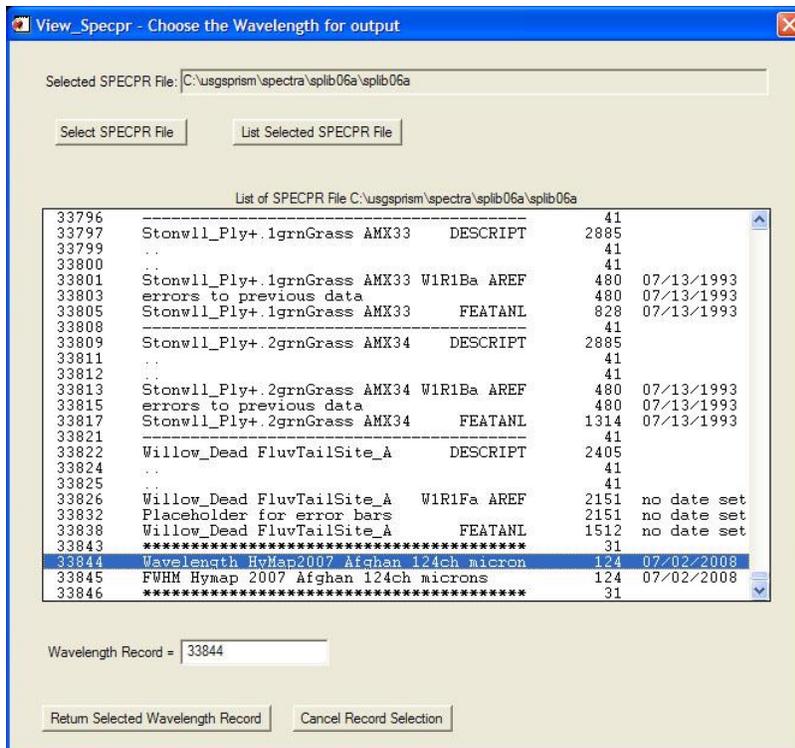


Figure 72. Choosing the wavelength record for the records that will be transferred.

Next, the user is prompted to choose the bandpass (FWHM) record corresponding to the transferred records from a listing of the SPECPR file being viewed (the SPECPR file into which the records will be transferred). Figure 73 shows the selection of record 33845. Press the “Return Selected FWHM Record” after choosing the record.

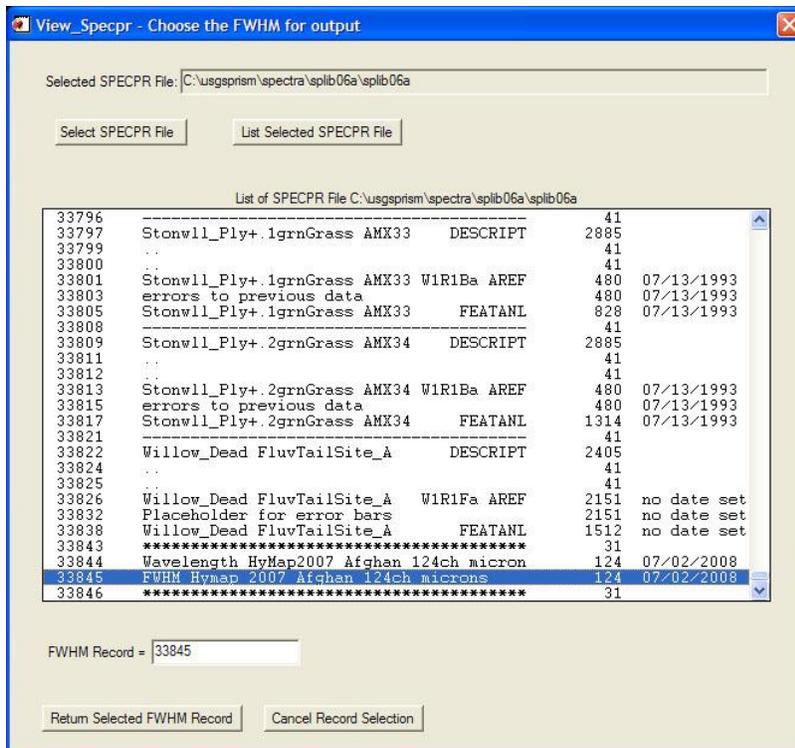


Figure 73. Choosing the bandpass (FWHM) record for the records that will be transferred.

Next, the user is asked whether he or she would like to use the selected wavelength and bandpass (FWHM) records for all the data records that were selected for transfer. Figure 74 shows the selection of the first option listed, that is, to use the selected records for all the transferred records. This option is useful when all the transferred records share the same wavelength and bandpass (FWHM) characteristics. Alternatively, the user may interactively choose the wavelength and bandpass (FWHM) records for each of the transferred records. The user is prompted sequentially for each transferred record; for this example the user would be prompted six times each for the wavelength and bandpass (FWHM) records, for the six alunite spectra selected. This option can be used when the transferred records do not have the same wavelength and bandpass (FWHM) characteristics.

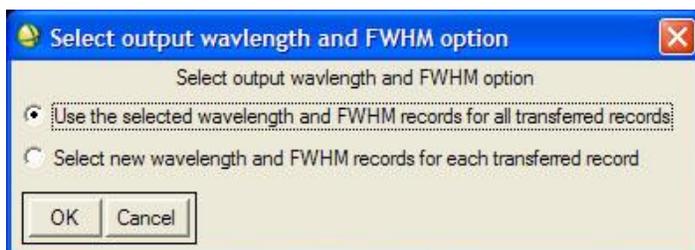


Figure 74. Prompt to use the selected wavelength and bandpass (FWHM) records for all the data records that will be transferred.

Once the wavelength and bandpass (FWHM) records have been selected, the records are transferred into the SPECPR file being viewed. After the records are transferred, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. By scrolling to the bottom of the refreshed list, the user can see the transferred records (fig. 75). The user may use ViewSPECPR “*Function 1.5 – Viewing the header, text, or DESCRIPT information in a record*” to view the header information of the transferred data records to verify the wavelength and bandpass (FWHM) pointers are set to the correct records.

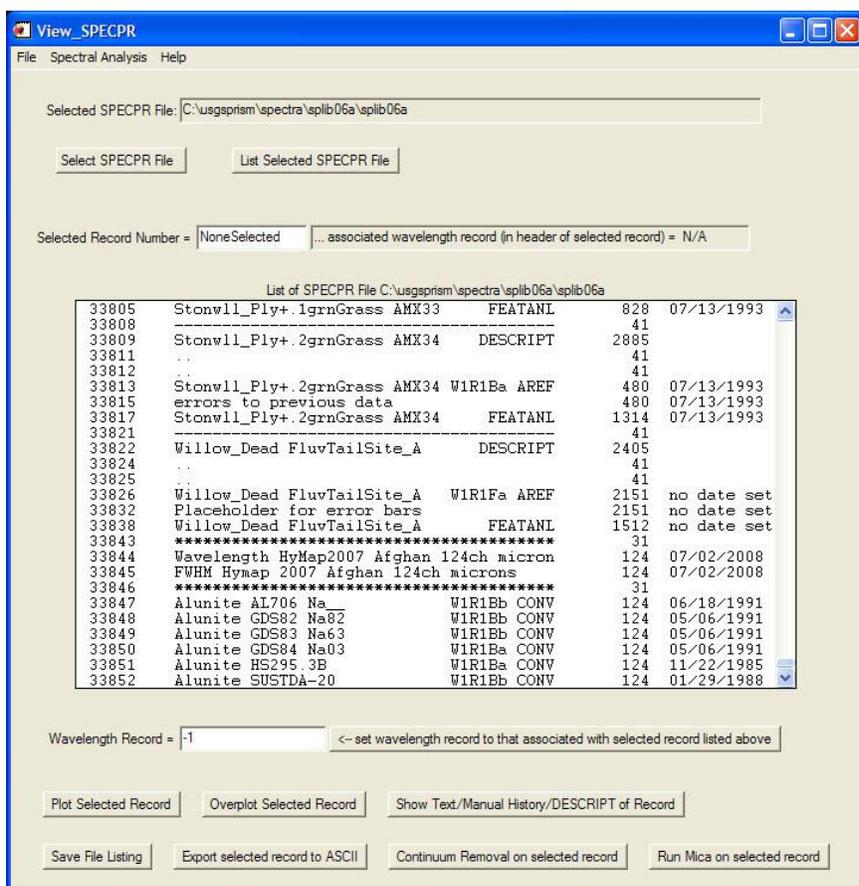


Figure 75. Refreshed SPECPR file contents list showing the records transferred with the set wave/FWHM option.

Function 1.9.4.3 – Transfer SPECPR record(s) set wave/FWHM and change title

To start the function, click on the “Transfer SPECPR record(s) into this file” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Transfer SPECPR record(s) set wave/FWHM and change title” item that appears (see fig. 67). The steps taken in this procedure are similar to *Function 1.9.4.2*, with one addition. After the

selection of the wavelength and bandpass (FWHM) records, the user is prompted to set a new output title for the transferred record.

This example shows records being transferred into the “splib06a” SPECPR file. The file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\spectra\splib06\” on Windows computers and in “/var/local/usgsprism/spectra/splib06/” on Linux computers.

In this example, a record is transferred from a SPECPR file which contains spectra that have been convolved to HyMap 2007 wavelength and bandpass (FWHM) characteristics (see fig. 68). This SPECPR file “splib06b_cvhymap07_124ch” is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers.

For illustration of this function, figure 76 shows the selection of record 192 from the “splib06b_cvhymap07_124ch” SPECPR file.

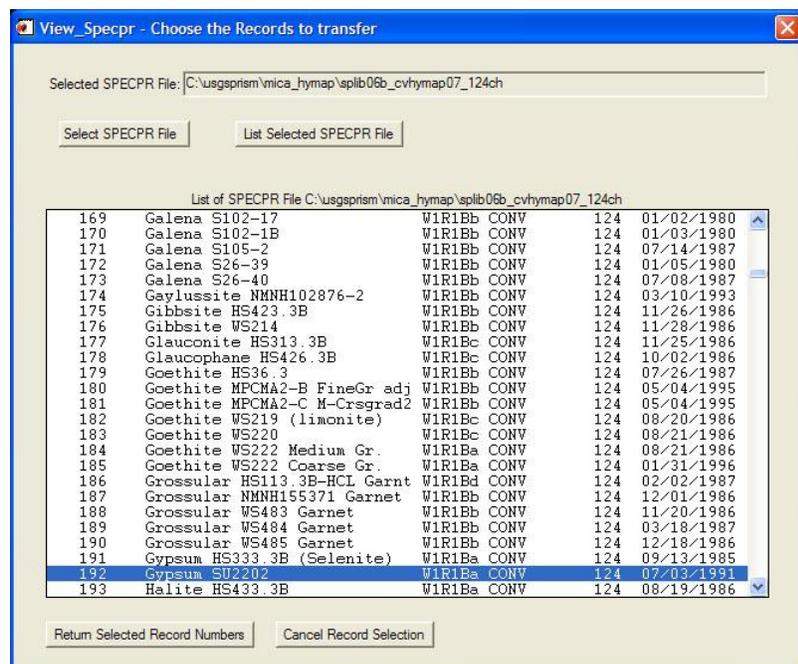


Figure 76. Choosing the records that will be transferred.

After the prompts for the selection of the wavelength and bandpass (FWHM) records, see *Function 1.9.4.2* for details on these steps; the user is prompted to set the output title (fig. 77). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

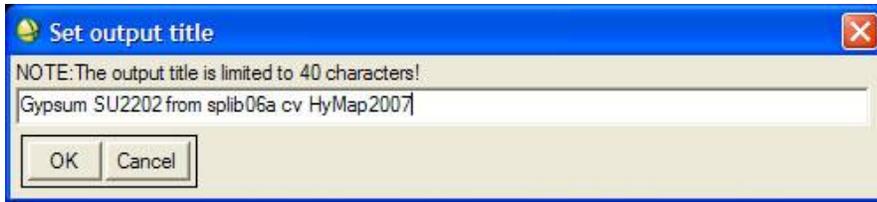


Figure 77. Setting the title for the record that will be transferred.

Once the title is accepted, the records are transferred into the SPECPR file being viewed. After the records are transferred, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. By scrolling to the bottom of the refreshed list, the user can see the transferred records (fig. 78).

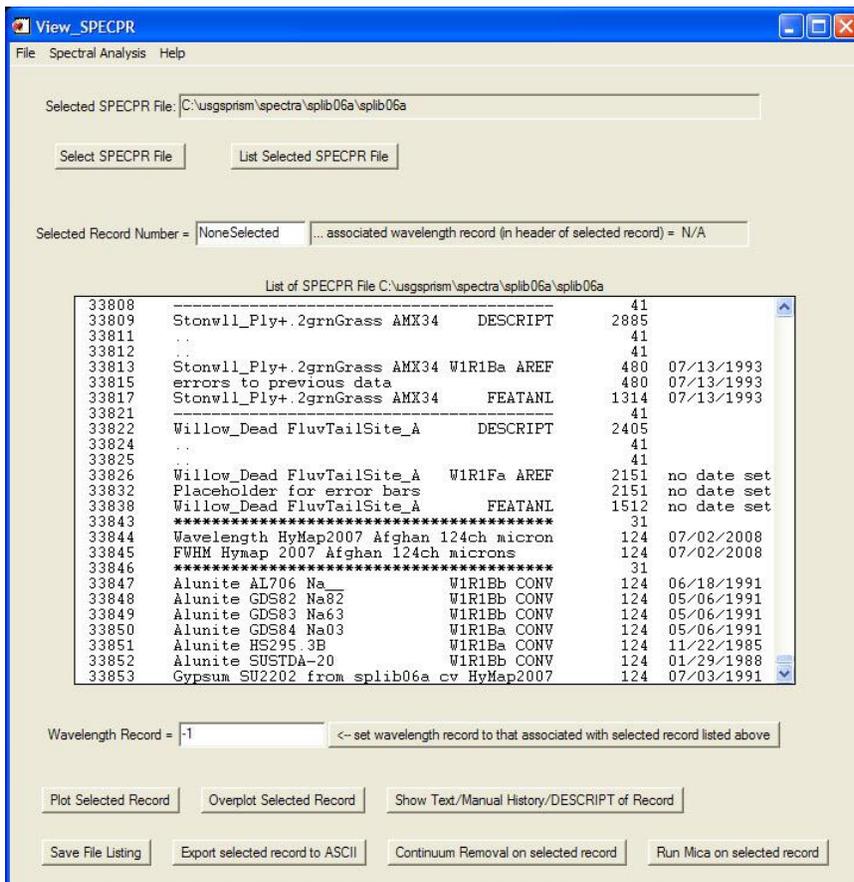


Figure 78. Refreshed SPECPR file contents list showing the transferred records.

Function 1.9.5 – Transfer SPECPR record(s) from this file

Function 1.9.5.1 – Transfer SPECPR record(s) no changes

To start the function, click on the “Transfer SPECPR record(s) from this file” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Transfer SPECPR record(s) no changes” item that appears. This function follows a similar flow to that of *Function 1.9.4.1*, with the exception that the first prompt is to choose the records to transfer from a listing of the contents of the SPECPR file being viewed. The second prompt is to choose the SPECPR file into which to transfer these records.

Function 1.9.5.2 – Transfer SPECPR record(s) set wave/FWHM

To start the function, click on the “Transfer SPECPR record(s) from this file” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Transfer SPECPR record(s) set wave/FWHM” item that appears. This function follows a similar flow to that of *Function 1.9.4.2*, with the exception that the first prompt is to choose the records to transfer from a listing of the contents of the SPECPR file being viewed. The second prompt will be to choose the SPECPR file into which to transfer these records. A listing of the destination SPECPR file will be shown for selection of the wavelength and bandpass (FWHM) records.

Function 1.9.5.3 – Transfer SPECPR record(s) set wave/FWHM and change title

To start the function, click on the “Transfer SPECPR record(s) from this file” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Transfer SPECPR record(s) set wave/FWHM and change title” item that appears. This function follows a similar flow to that of *Function 1.9.4.3*, with the exception that the first prompt will be to choose the records to transfer from a listing of the contents of the SPECPR file being viewed. The second prompt will be to choose the SPECPR file into which to transfer these records. A listing of the destination SPECPR file will be shown for selection of the wavelength and bandpass (FWHM) records. Finally, set the title for the transferred record, as shown in the description of *Function 1.9.4.3*.

Function 1.9.6 – Average ASD spectra

These functions (fig. 79) allow the user to average ASD spectra. In addition, the user is given the option to correct detector offsets. If the user selects the function “*Average and AbsRef ASD Spectra*” (fig. 79), the routine converts the average spectrum from relative reflectance to absolute reflectance.

multiplying the average spectrum by the reflectance of the Spectralon panel. A record containing a Spectralon panel's reflectance can be created if the user evaluates the ASD spectrometer's wavelength and bandpass (FWHM) characteristics using "*Function 2.17 – Wavelength/FWHM evaluation of ASD*". Or, the user may interpolate the Spectralon record within the example ASD SPECPR file "spd_asdcalib". If the user followed step 3 of the installation instructions (see the "*Installation of Software*" section of this report), the file will be located in "C:\usgsprism\spectra\asd\" on Windows computers and in "/var/local/usgsprism/spectra/asd/" on Linux computers. The Spectralon record in that file can be interpolated to the user's ASD spectrometer wavelength set (see *Function 1.9.7. Interpolate spectra*). Alternatively, the user may establish the reflectance spectrum for the Spectralon panel measured on the ASD spectrometer by another means and import these data into a SPECPR file via an ENVI spectral library using "*Function 1.9.14 – Import ENVI Spectral Library*".

Function 1.9.6.1 – Average ASD spectra

To start the function, click on the "Average ASD spectra" item in the drop-down list of the "Spectral Analysis" entry on the ViewSPECPR menu bar and select the "Average ASD spectra" item that appears (fig. 79). This example shows records being averaged using a SPECPR file containing ASD records. This file "spd_example1" is included with the PRISM software distribution. If the user followed step 3 of the installation instructions (see section "*Installation of Software*" of this report), the file will be located in "C:\usgsprism\spectra\" on Windows computers and at "/var/local/usgsprism/spectra/" on Linux computers.

Figure 80 shows the contents of this file listed in the ViewSPECPR control window. Records 21 to 75 are ASD spectra of Mylar, measured in single pass transmission. These records will be used to illustrate this function.

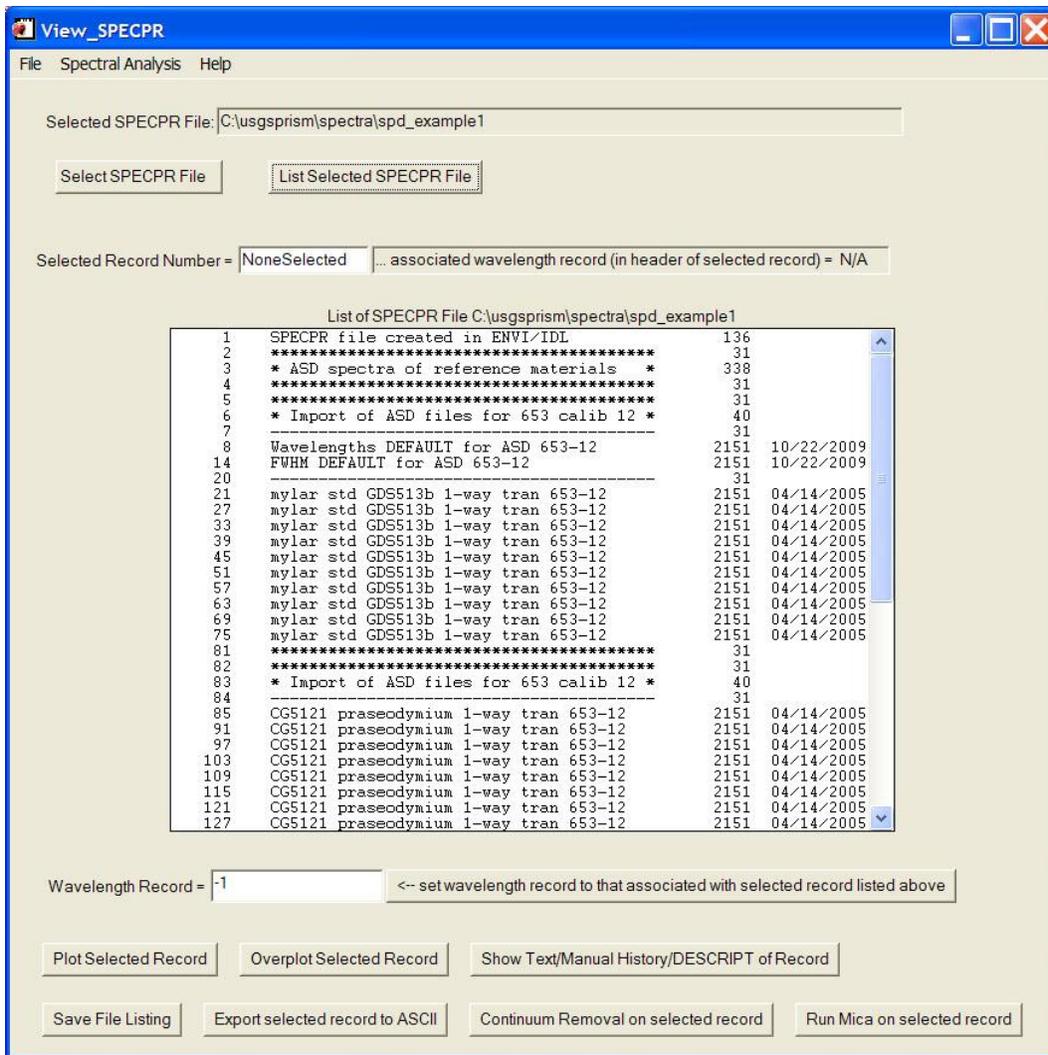


Figure 80. Listing showing ASD records to be averaged.

The user is first prompted to select the SPECPR data record that contains the wavelengths for the ASD spectra that will be averaged (fig. 81). Once the record is selected, press the “Return Selected Wavelength Record” button.

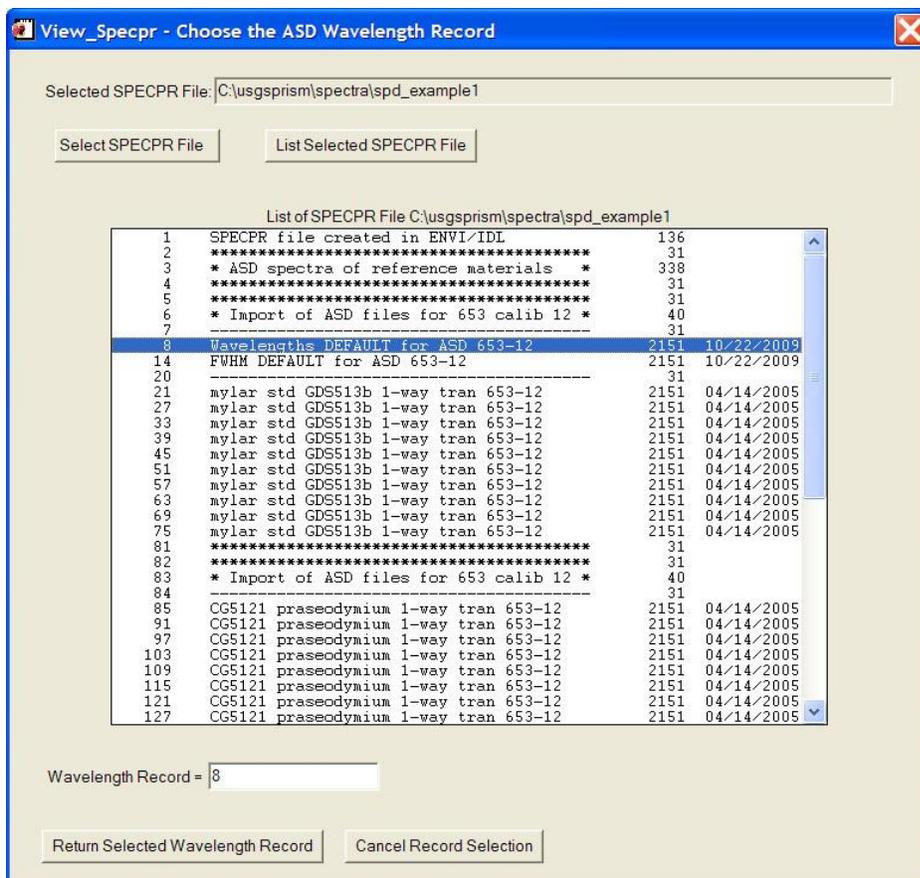


Figure 81. Choosing the wavelength record for the records that will be averaged.

Second, the user is prompted to select the SPECPR data record that contains the bandpass (FWHM) for the ASD spectra that will be averaged (fig. 82). Once the record is selected, press the “Return Selected FWHM Record” button.

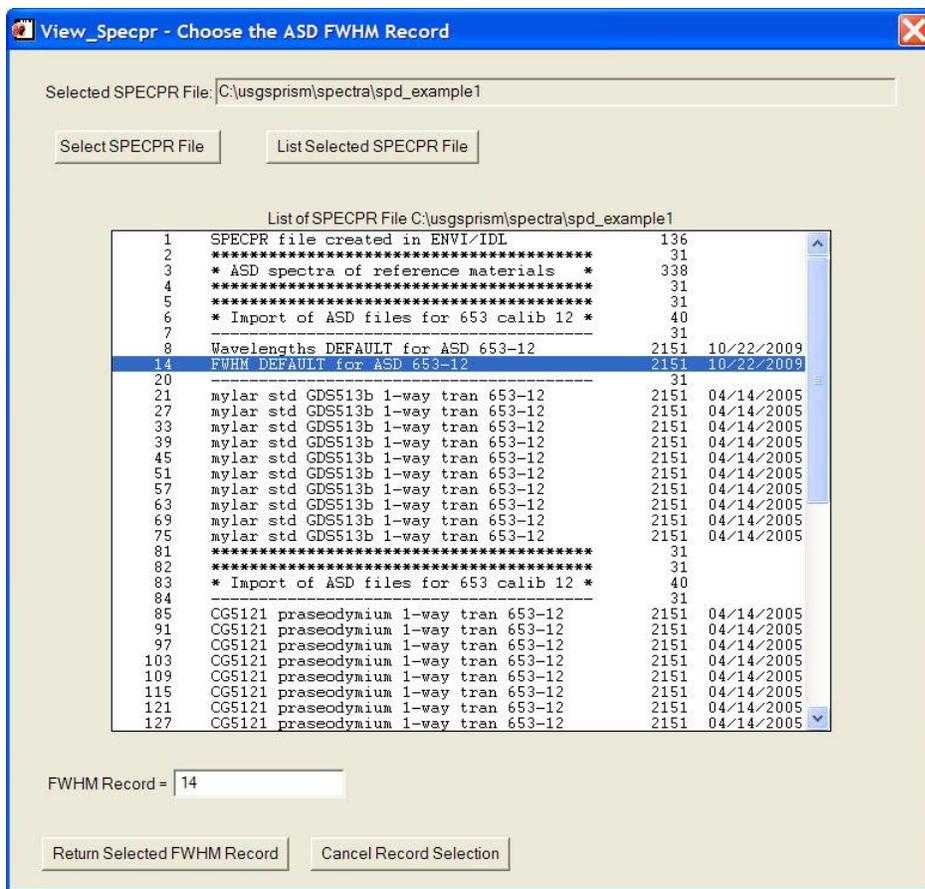


Figure 82. Selecting the bandpass (FWHM) record for the records that will be averaged.

Next, the user is prompted to select the SPECPR data record(s) that contains the ASD spectra that will be averaged (fig. 83). Once the record(s) are selected, press the “Return Selected Record Numbers” button. The user may scroll down to the desired record(s) using the scroll bar on the right. A single record may be selected by left-clicking on the record, or multiple records selected by choosing the first record and pressing and holding the Ctrl button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the selected wavelength and bandpass (FWHM) records; otherwise the program will report an error and halt execution.

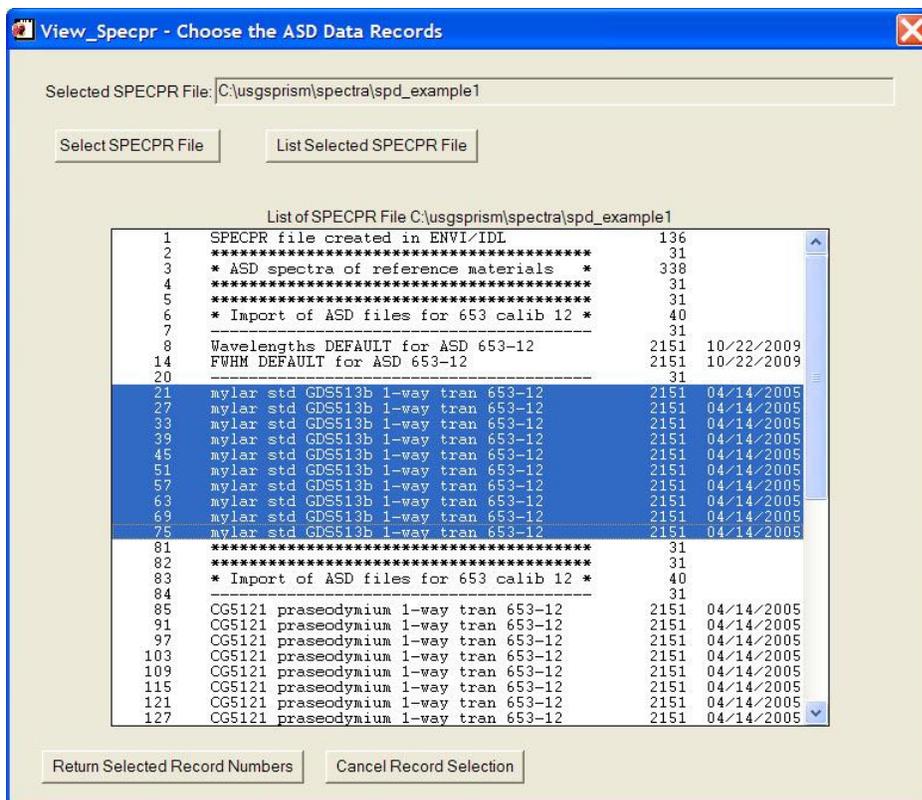


Figure 83. Selecting the data records to be averaged.

Next, the user is prompted to select an option for offset correction. If the data being averaged were collected using a spectrometer listed in the ASD instrument file, located at “C:\usgsprism\asd.txt” on Windows computers and at “/var/local/usgsprism/asd.txt” on Linux computers, and the ASD instrument number and calibration number are encoded in the header (as will be the case for spectra imported using PRISM’s “*Function 1.9.3 – Import ASD spectra*”) then the user is prompted to choose whether to proceed with or without offset correction (fig. 84). Offset correction is made using multiplicative scaling factors applied to detectors 1 and 3, assuming that detector 2 is stable at either end of its wavelength range (details of the offset correction calculations are found in *appendix D*).

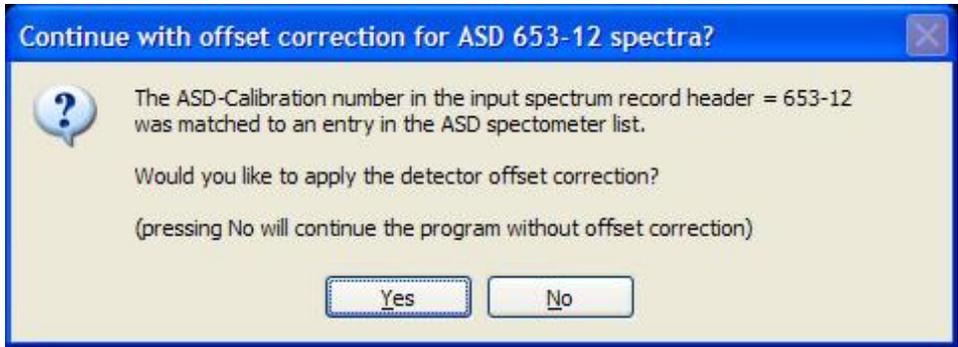


Figure 84. Prompt for detector offset correction.

Following the offset correction selection, the user is prompted to set the output title (fig. 85). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

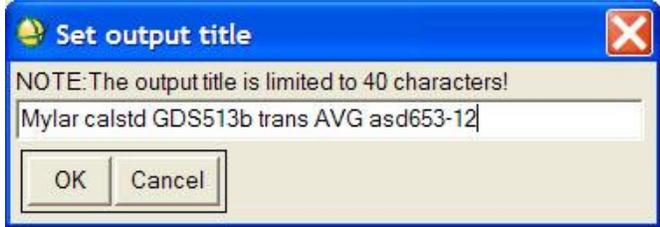


Figure 85. Setting the output title for the record that will contain the average of ASD spectra.

After the output title has been accepted, the calculations for averaging of ASD spectra are made. Subsequently, offset correction, if selected, is performed. Next, the results are written to the end of the SPECPR file being viewed. After the records are written, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. Next, the listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. Figure 86 shows the end of the file listing of “spd_example1”, showing the records written during the averaging procedure. After the record containing the average spectrum (record 284) is written, a record containing the standard deviation of the mean is written (record 290). After that, a record containing the standard deviation is written (record 296).

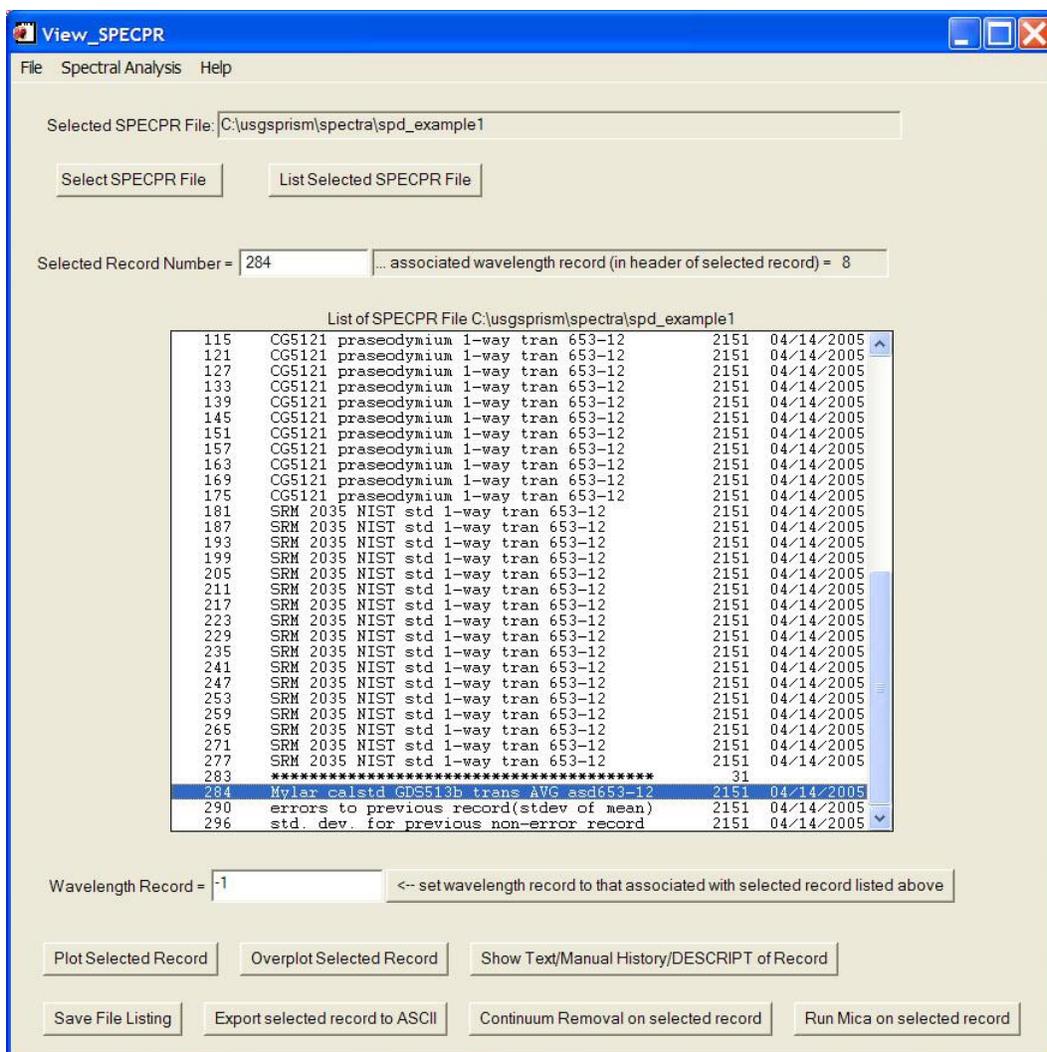


Figure 86. File listing after averaging of ASD spectra.

The header information of the average spectrum contains information about the source records used to compute the average and information about the offset correction and Spectralon correction options. By clicking on an averaged ASD spectrum, in this case, record 284, and then pressing the “Show Header Info/Text/DESCRPT Record” button, you can examine the information stored in the header of an averaged ASD record (fig. 87). If a GPS was connected to the ASD while collecting the spectra that were imported into SPECPR and subsequently averaged, the manual history will contain the average latitude and longitude coordinates of the input records, along with the GPS datum. If the GPS was not connected or not communicating with the ASD during spectral measurements, the datum value will be set to “No GPS data” and the latitude and longitude values will be set to zero. Note: if the list of data records in the manual history exceeds the available space in the header of the record containing the average spectrum, the list of data records will be written to a text record following the standard deviation record. If the list of data records is long enough to prevent the writing of the average GPS position in the

manual history of the record containing the average spectrum, the average position will be written to a text record following the data records generated by this function.

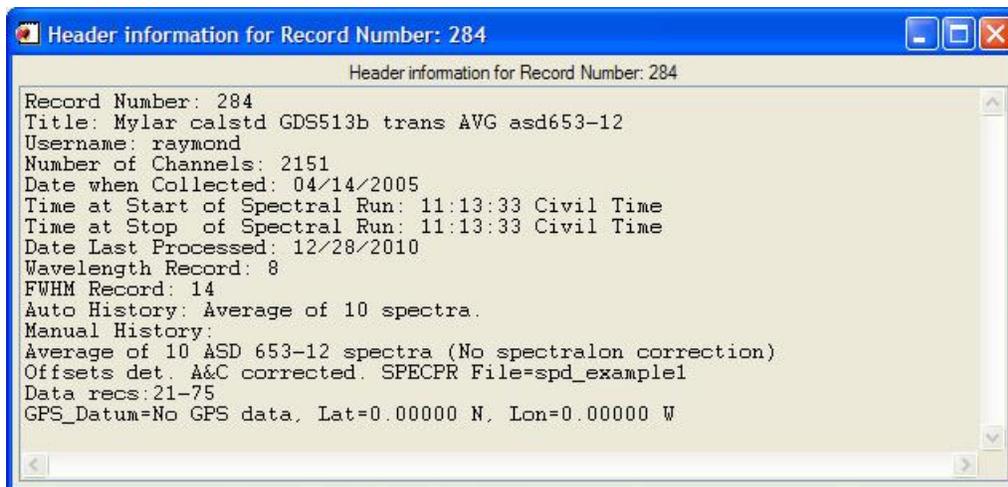


Figure 87. Header information for the average spectrum.

If the header information of the data being averaged does not contain an ASD instrument and calibration number or if the ASD instrument and calibration numbers do not match any items listed in the ASD instrument file, located at “C:\usgsprism\asd.txt” on Windows computers and at “/var/local/usgsprism/asd.txt” on Linux computers, a prompt will appear (fig. 88) asking the user to select the offset correction option. If the proper spectrometer is listed, the user may select it, for example the “653-12” option shown in figure 88. Alternatively, the user can opt to proceed using the detector splice values encoded in the header of the data records being averaged by selecting the “ASD Spectrometer not listed, use splice values” option, or if this information is not encoded in the headers the user can proceed by selecting “No Offset Correction”. If the ASD spectra were imported using PRISM’s “*Function 1.9.3 – Import ASD spectra*”, then the detector splice keywords and values will be properly recorded in the header. Once the desired option is selected, the user should press “OK” to proceed. If the splice values are found in the header of the lowest record number of the records selected to average, the program will prompt the user with the identified values. Next, the user will be prompted to set the output title (see fig. 85). Following that prompt, the program will average the spectra and create the output records.

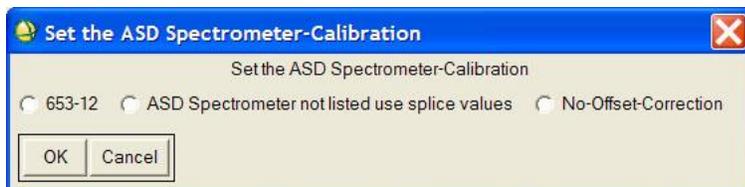


Figure 88. Selecting the option for detector offset correction.

Note: if the “asd.txt” file is not found in the default location, a warning message will be displayed to the user (fig. 89). Subsequently, the user will be prompted to choose from two options: using the splice values encoded in the data record header or proceeding without offset correction (fig. 90).



Figure 89. Message warning that the asd.txt file was not found.

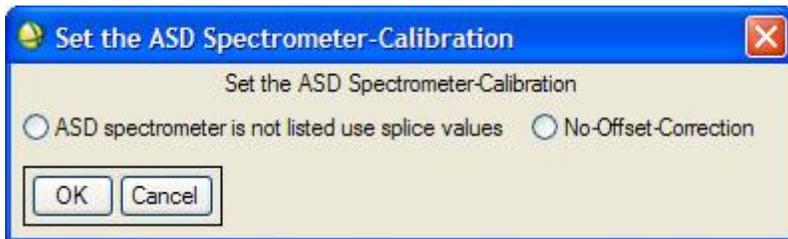


Figure 90. Offset options when asd.txt file is not found.

If the user selects the “No-Offset Correction” option, the program continues with a prompt for the user to set the output title (see fig. 85). If the user chooses to use the splice values in the record header, the program looks for the splice values. If the ASD spectra were imported using PRISM’s “*Function 1.9.3 – Import ASD spectra*”, then the detector splice keywords and values will be properly recorded in the header. If they are not found, the a message indicating this failure is displayed along with a question asking whether the user would like to proceed averaging spectra without offset correction (fig. 91). If the user presses “No”, the program execution will halt. If the user presses “Yes”, then the program continues with a prompt for the user to set the output title (see fig. 85). If the detector splice values are found in the header, a message showing the splice values is displayed and the program continues with a prompt for the user to set the output title (see fig. 85).

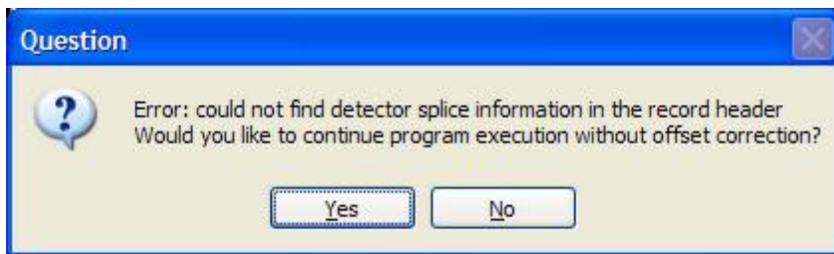


Figure 91. Options for program execution when detector splice information is not found.

Function 1.9.6.2 – Average and AbsRef ASD spectra

This function follows the same steps as *Function 1.9.6.1 – Average ASD Spectra*, with the exception that, after the selection of the bandpass (FWHM) record, the user is prompted to select the data record containing the Spectralon panel reflectance.

The example for this function uses ASD spectra measured in the field. These data are stored in the file “spd_asdfield”, which is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\spectra\asd” on Windows computers and in “/var/local/usgsprism/spectra/asd/” on Linux computers. Records 25 to 1519 in this file are ASD records of a dirt field used as a field calibration site for HyMap imaging spectrometer data (see the listing of the file in fig. 92).

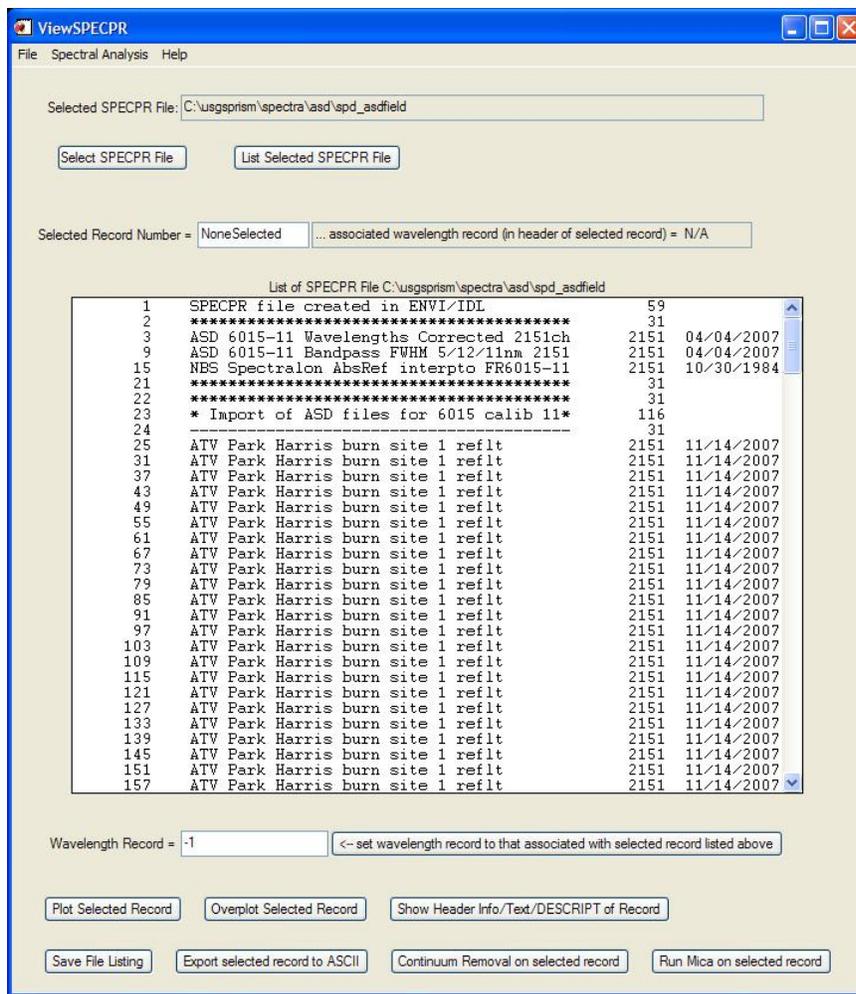


Figure 92. Listing showing ASD records to be averaged and converted to absolute reflectance.

To start the function, click on the “Average ASD spectra” item in the drop-down list of the “Spectral Analysis” entry on the ViewSPECPR menu bar and select the “Average and AbsRef ASD spectra” item that appears (see fig. 79). The user is first prompted to select the SPECPR data record that contains the wavelengths for the ASD spectra that will be averaged (fig. 93). Once the record is selected, press the “Return Selected Wavelength Record” button.

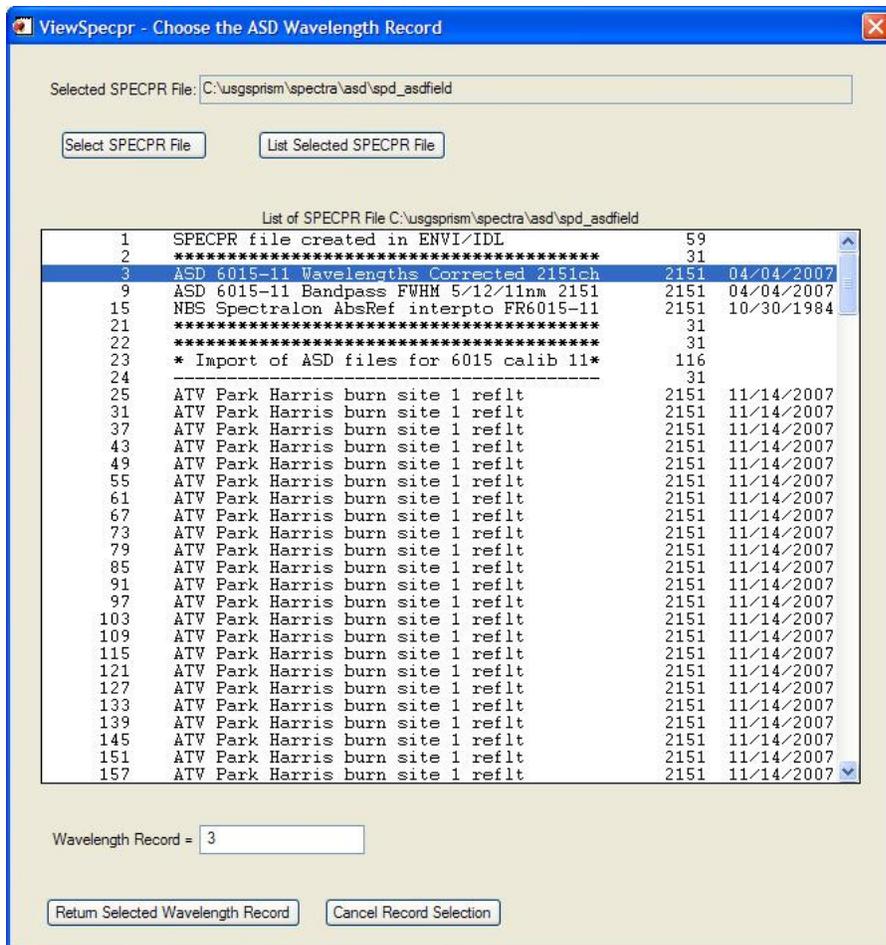


Figure 93. Choosing the wavelength record for the records that will be averaged.

Second, the user is prompted to select the SPECPR data record that contains the bandpass (FWHM) for the ASD spectra that will be averaged (fig. 94). Once the record is selected, press the “Return Selected FWHM Record” button.

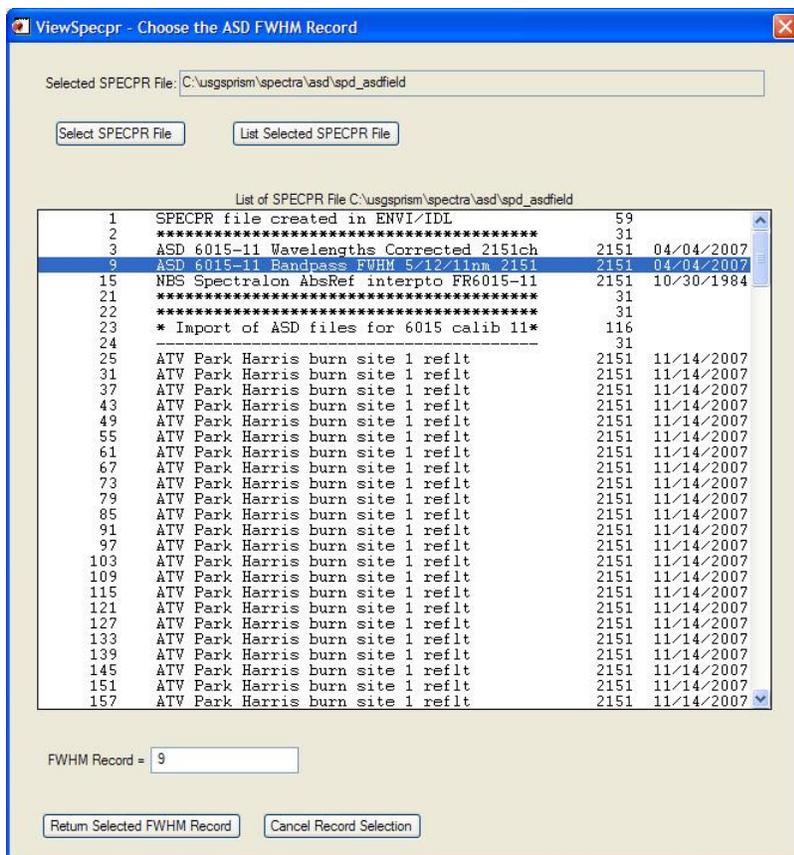


Figure 94. Selecting the bandpass (FWHM) record for the records that will be averaged.

Third, the user is prompted to select the SPECPR data record that contains the Spectralon reflectance record for the ASD spectra that will be averaged (fig. 95). Once the record is selected, press the “Return Selected Record” button.

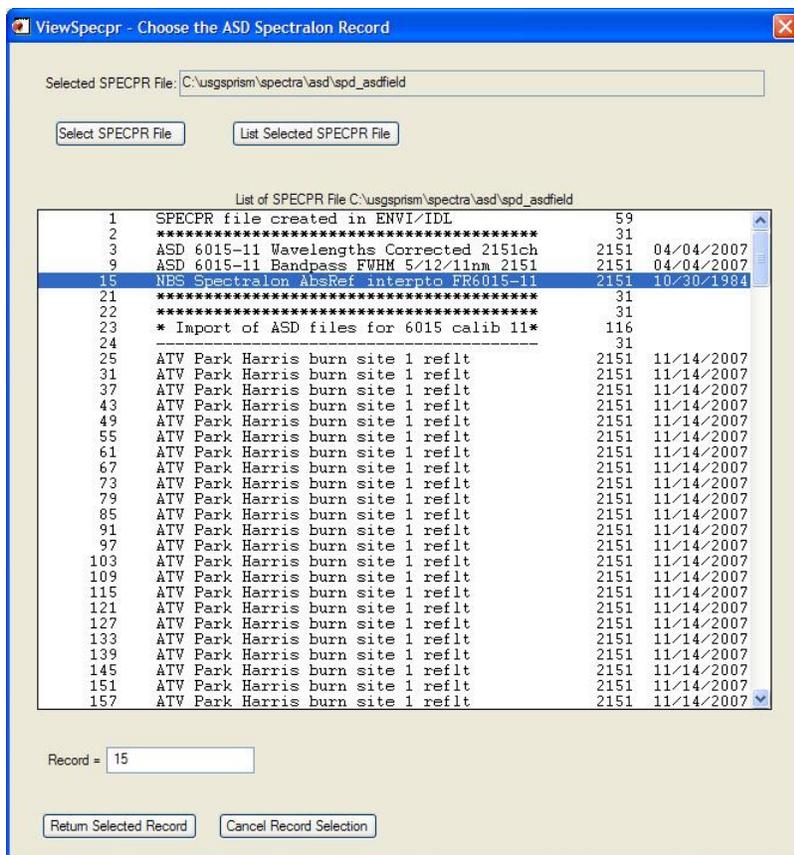


Figure 95. Selecting the Spectralon panel reflectance record for the ASD spectra that will be averaged.

Next, the user is prompted to select the SPECPR data records that contain the ASD spectra that will be averaged (fig. 96). Once the records are selected, press the “Return Selected Record Numbers” button. The user may scroll down to the desired record(s) using the scroll bar on the right. A single record may be selected by left-clicking on the record, or multiple records selected by choosing the first record and pressing and holding the “Ctrl” (control) button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the wavelength and bandpass (FWHM); otherwise the program will report an error and halt execution.

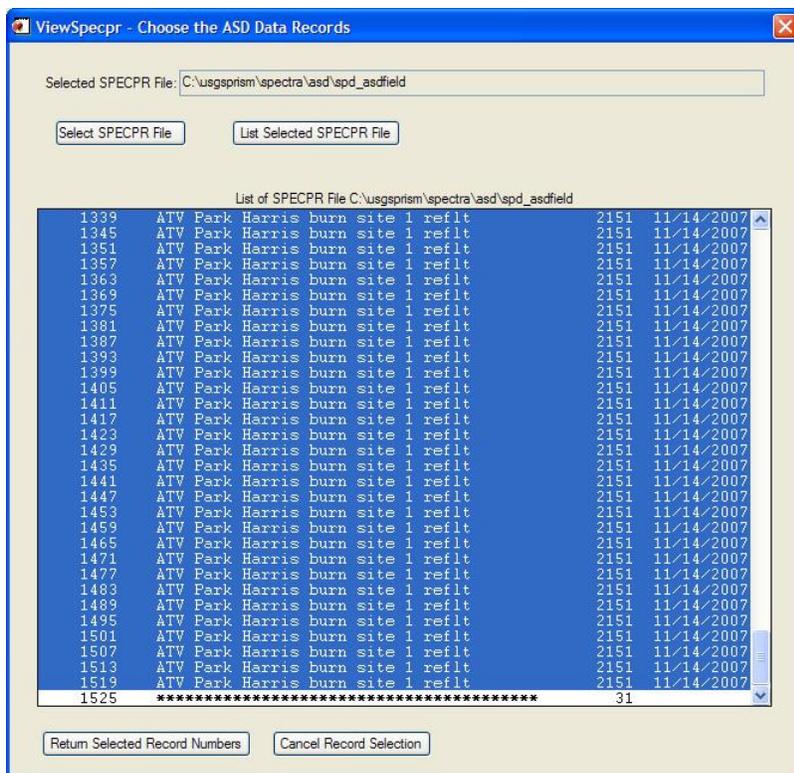


Figure 96. Selecting the data records to be averaged and corrected to absolute reflectance.

Next, the user is prompted to select an option for offset correction. If the data being averaged were collected using a spectrometer listed in the ASD instrument file, located at “C:\usgsprism\asd.txt” on Windows computers and at “/var/local/usgsprism/asd.txt” on Linux computers, and the ASD instrument number and calibration number are encoded in the header (as will be the case for spectra imported using PRISM’s “*Function 1.9.3 – Import ASD spectra*”) then the user is prompted to proceed with or without offset correction (fig. 97). Offset correction is made using multiplicative scaling factors applied to detectors 1 and 3, assuming that detector 2 is stable at either end of its wavelength range (details of the offset correction calculations are found in *appendix D*).

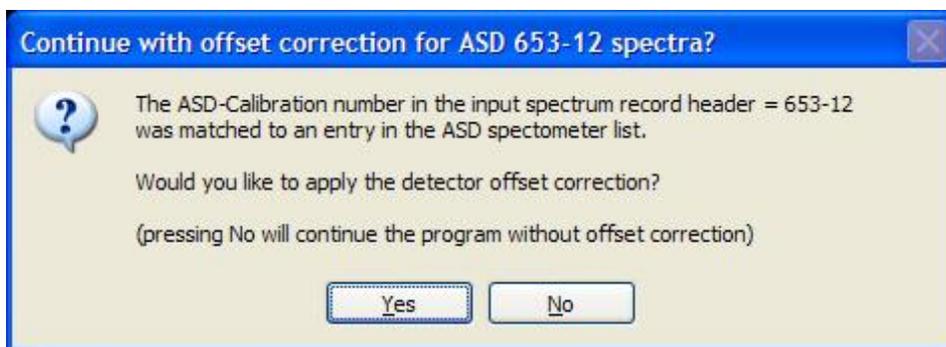


Figure 97. Prompt for detector offset correction.

Following the offset correction selection, the user is prompted to set the output title (for example, see fig. 85). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered. After the output title has been accepted, the calculations for averaging of ASD spectra are made. Subsequently, offset correction, if selected, is performed. Next, the results are written to the end of the SPECPR file being viewed. After the records are written, a message indicating the successful completion of this function is displayed. Press "OK" to dismiss the message. Next, the listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. Figure 98 shows the end of the file listing of "spd_asdfield", showing the records written during the averaging procedure. After the record containing the averaged spectrum converted to absolute reflectance (record 1526) is written, a record containing the standard deviation of the mean is written (record 1532). After that, a record containing the standard deviation is written (record 1538).



Figure 98. File listing after averaging and conversion to absolute reflectance of ASD spectra.

The header information of the average spectrum contains information about the source records used to compute the average and information about the offset correction and Spectralon correction options. By clicking on an averaged ASD spectrum, in this case, record 1526, and then pressing the “Show Header Info/Text/DESCRIPT Record” button, you can examine the information stored in the header of an averaged ASD record (fig. 99). If a GPS was connected to the ASD while collecting the spectra that were imported into SPECPR and subsequently averaged, the manual history will contain the average latitude and longitude coordinates of the input records, along with the GPS datum. If the GPS was not connected or not communicating with the ASD during spectral measurements, the datum value will be set to “No GPS data” and the latitude and longitude values will be set to zero. Note: if the list of data records in the manual history exceeds the available space in the header of the record containing the average spectrum, the list of data records will be written to a text record following the standard deviation record. If the list of data records is long enough to prevent the writing of the average GPS position in the manual history of the record containing the average spectrum, the average position will be written to a text record following the data records generated by this function.

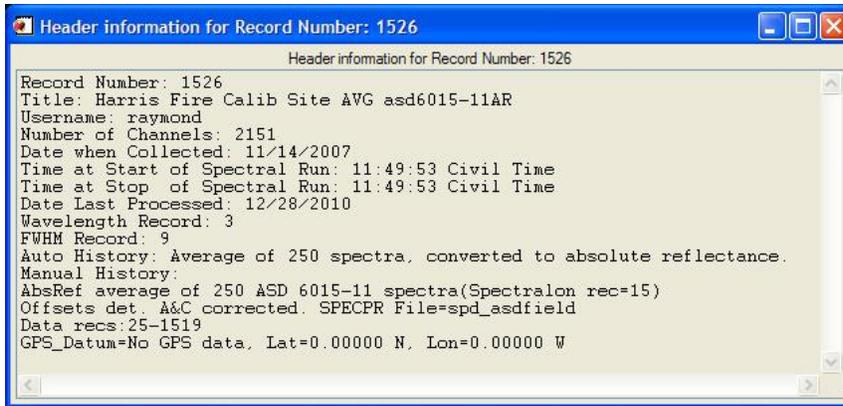


Figure 99. Header information for the spectrum of the average, converted to absolute reflectance.

If the header information of the data being averaged does not contain an ASD instrument and calibration number or if the ASD instrument and calibration numbers do match any items listed in the ASD instrument file, located at “C:\usgsprism\asd.txt” on Windows computers and at “/var/local/usgsprism/asd.txt” on Linux computers, a prompt will appear (fig. 100) asking the user to select the offset correction option. If the proper spectrometer is listed, the user may select it, for example the “653-12” option shown in figure 100. The user can opt to proceed using the detector splice values encoded in the header of the data records being averaged by selecting the “ASD Spectrometer not listed, use splice values” option, or if this information is not encoded in the headers the user can proceed by selecting the “No Offset Correction”. If the ASD spectra were imported using PRISM’s “*Function 1.9.3 – Import ASD spectra*”, then the detector splice keywords and values will be properly recorded in the header. Once the desired option is selected, the user should press “OK” to proceed. If the splice values are found in the header of the lowest record number of the records selected to average, the program will prompt the user with the identified values. Next, the user will be prompted to set the output title (for an example of this step, see fig. 85). Following that prompt, the program will average the spectra and create the output records.

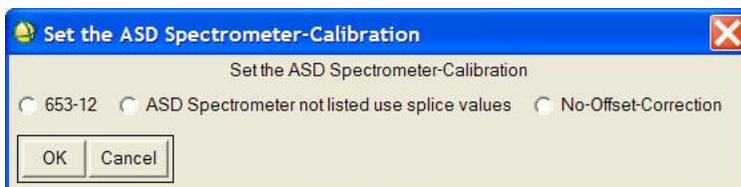


Figure 100. Selecting the option for detector offset correction.

Note: if the “asd.txt” file is not found in the default location, a warning message will be displayed to the user (fig. 101). Subsequently, the user will be prompted to choose from two options: using the splice values encoded in the data record header or proceeding without offset correction (fig. 102).



Figure 101. Message warning that the asd.txt file was not found.



Figure 102. Offset options when asd.txt file is not found.

If the user selects the “No-Offset Correction” option, the program continues with a prompt for the user to set the output title (see fig. 85). If the user chooses to use the splice values in the record header, the program looks for the splice values. If the ASD spectra were imported using PRISM’s “*Function 1.9.3 – Import ASD spectra*”, then the detector splice keywords and values will be properly recorded in the header. If they are not found, then a message indicating this failure is displayed along with a question asking whether the user would like to proceed averaging spectra without offset correction (fig. 103). If the user presses “No”, the program execution will halt. If the user presses “Yes”, then the program continues with a prompt for the user to set the output title (see fig. 85). If the detector splice values are found in the header, a message showing the splice values is displayed and the program continues with a prompt for the user to set the output title (see fig. 85).

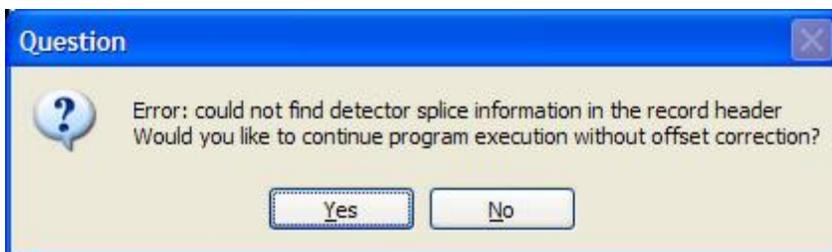


Figure 103. Options for program execution when detector splice information is not found.

Function 1.9.7 – Interpolate spectra

Interpolation of spectra is a method for converting data collected from one spectrometer to the wavelength set of another spectrometer. This method of conversion is valid when the spectrometers have similar bandpass (FWHM) characteristics, for example, when converting between different ASD spectrometers which have been evaluated and found to have slight differences in their sampling positions (see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”). PRISM uses IDL’s cubic spline interpolation routine “spl_interp” (ITT Visual Information Solutions, 2009). If there are large differences between the bandpass (FWHM) characteristics of the two spectrometers, the measurement made on the high resolution spectrometer (smaller FWHM) should be convolved (see PRISM *Function 1.9.8 – Convolve Spectra*) to the low resolution spectrometer (larger FWHM).

In this example, two files, included with the PRISM software distribution, are used, the spectral library file “splib06a” and an example file “spd_example1”. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), these files will be located in “C:\usgsprism\spectra\” on Windows computers and in “/var/local/usgsprism/spectra/” on Linux computers.

When running the interpolation from within ViewSPECPR, the routine assumes that the input and output spectra are both in the file being viewed. In this example, that will not be the case, so some extra steps will be taken to change the SPECPR file when selecting the input wavelengths and input data records. With “spd_example1” in the ViewSPECPR window, the user can start the interpolation process by pressing the “Interpolate Spectra” option under the “Spectral Analysis” entry on the menu bar (fig. 104).

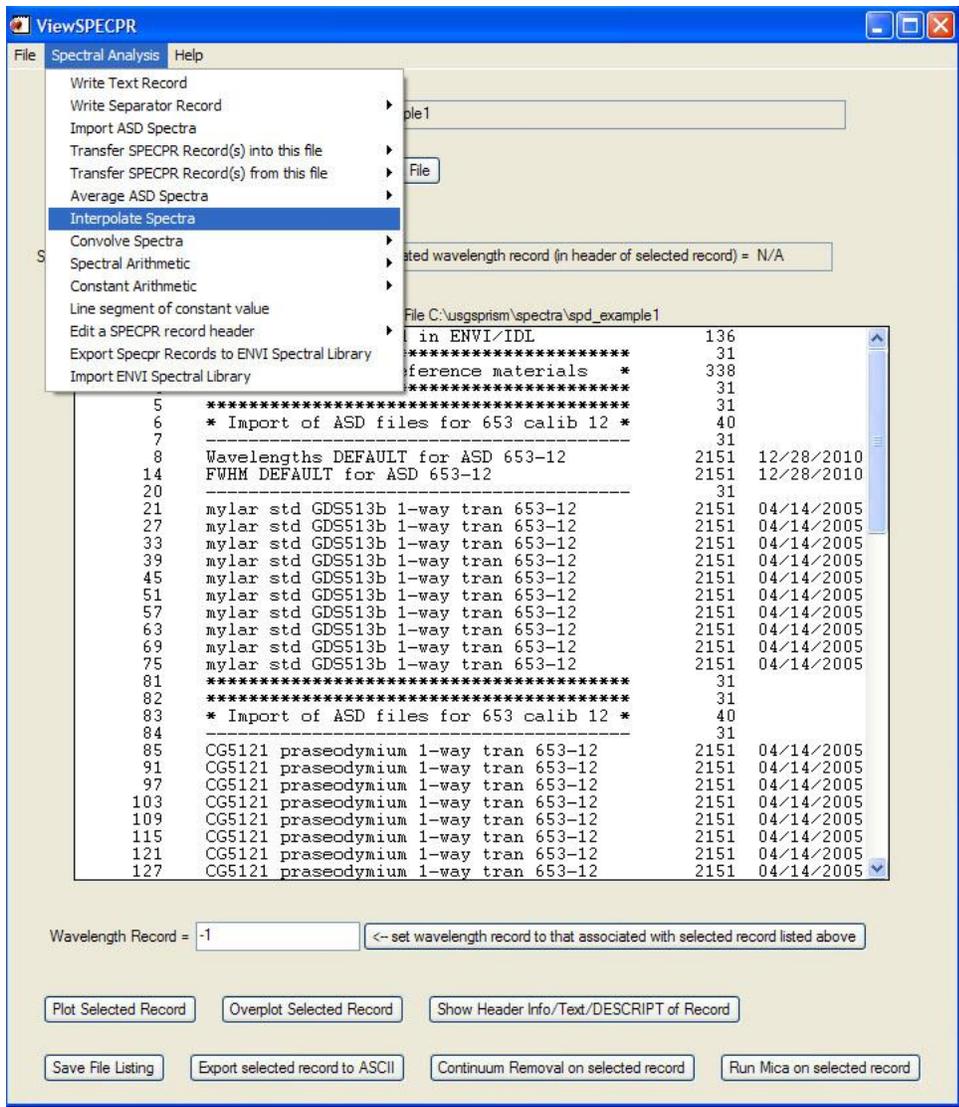


Figure 104. Default listing of file contents for the selection of the input wavelength record of the spectrum to be interpolated.

The user is first prompted to select the SPECPR data record that contains the wavelengths for the spectrum that will be interpolated; the default is to show the contents of the SPECPR file being viewed. By pressing the “Select SPECPR File” button in the top left of the widget, the user can select a different SPECPR file, in this case, the “spd_asdcalib” file. After selecting the “spd_asdcalib” file and then pressing the “List Selected SPECPR File” button, the user can choose the wavelength record (fig. 105) and press “Return Selected Wavelength Record”.

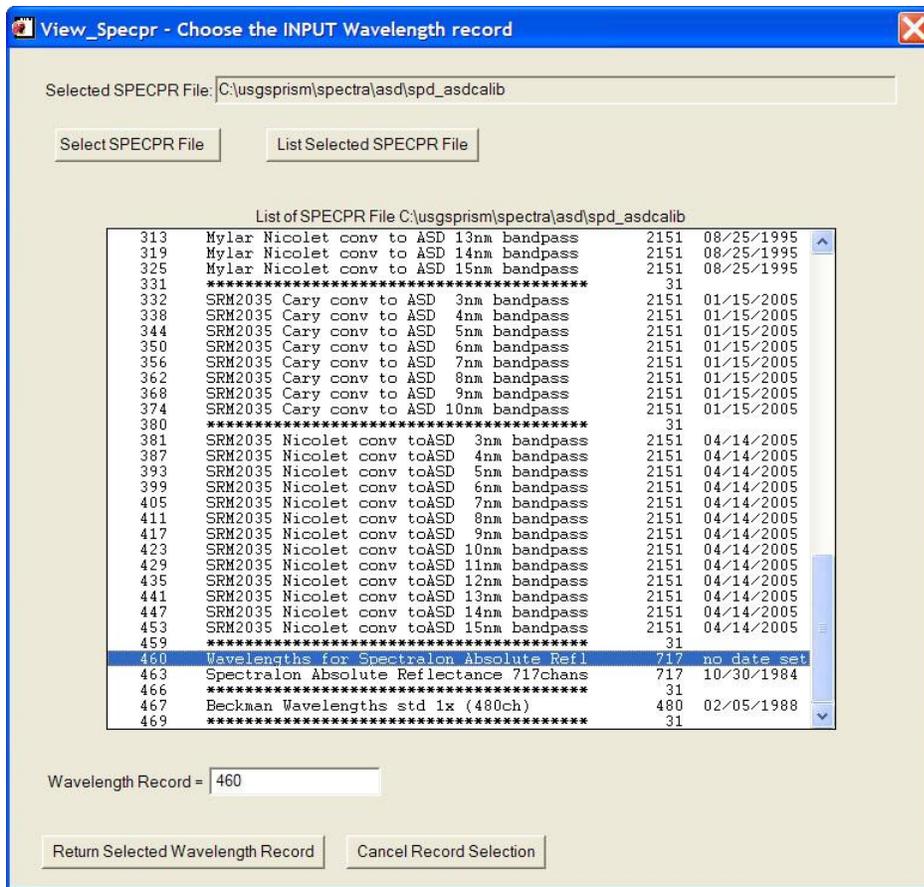


Figure 105. Listing of new file containing the input wavelength record and the spectrum to be interpolated.

Next, the user is prompted to select the SPECPR data record that contains the spectrum that will be interpolated; again, the default is to show the contents of the SPECPR file being viewed. By pressing the “Select SPECPR File” button in the top left of the widget, the user can select a different SPECPR file, in this case, the “spd_asdcalib” file. After selecting that file and then pressing the “List Selected SPECPR File” button, the user can choose the input data record to be interpolated (fig. 106) and press the “Return Selected Record” button.

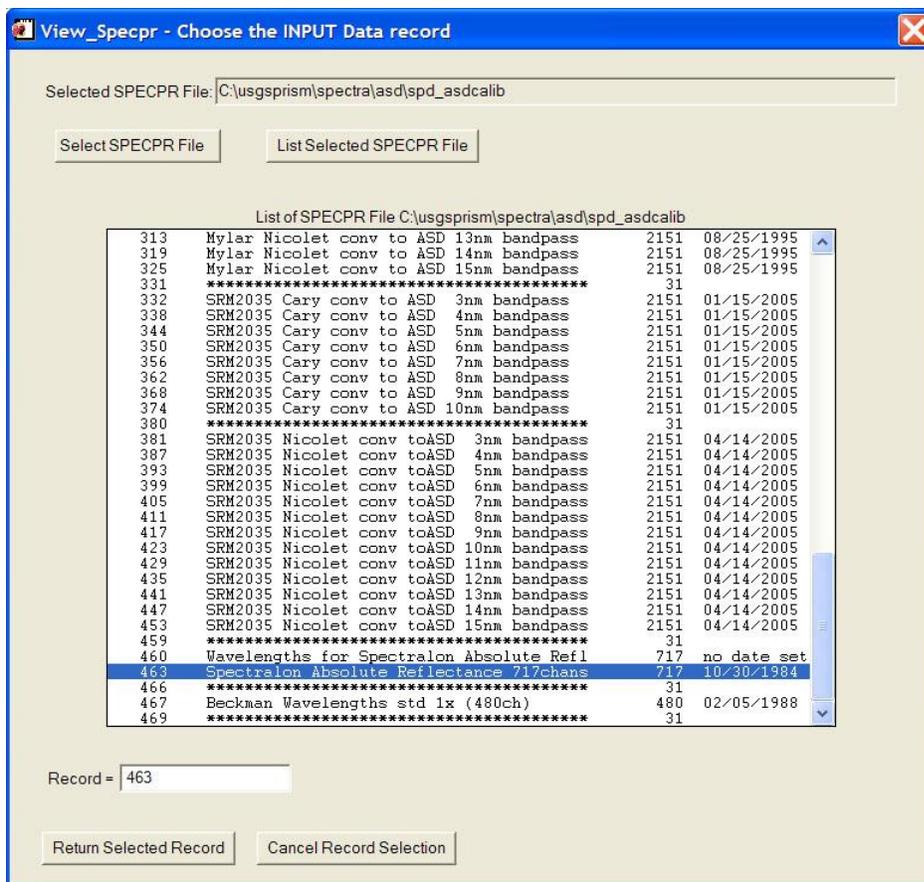


Figure 106. Selecting the spectrum to be interpolated.

Next, the user is prompted to choose the output wavelength record (fig. 107); this time the output wavelengths are in the file that was being viewed when the user started the interpolation function, in this case “spd_example1”, and there is no need to change the SPECPR file.

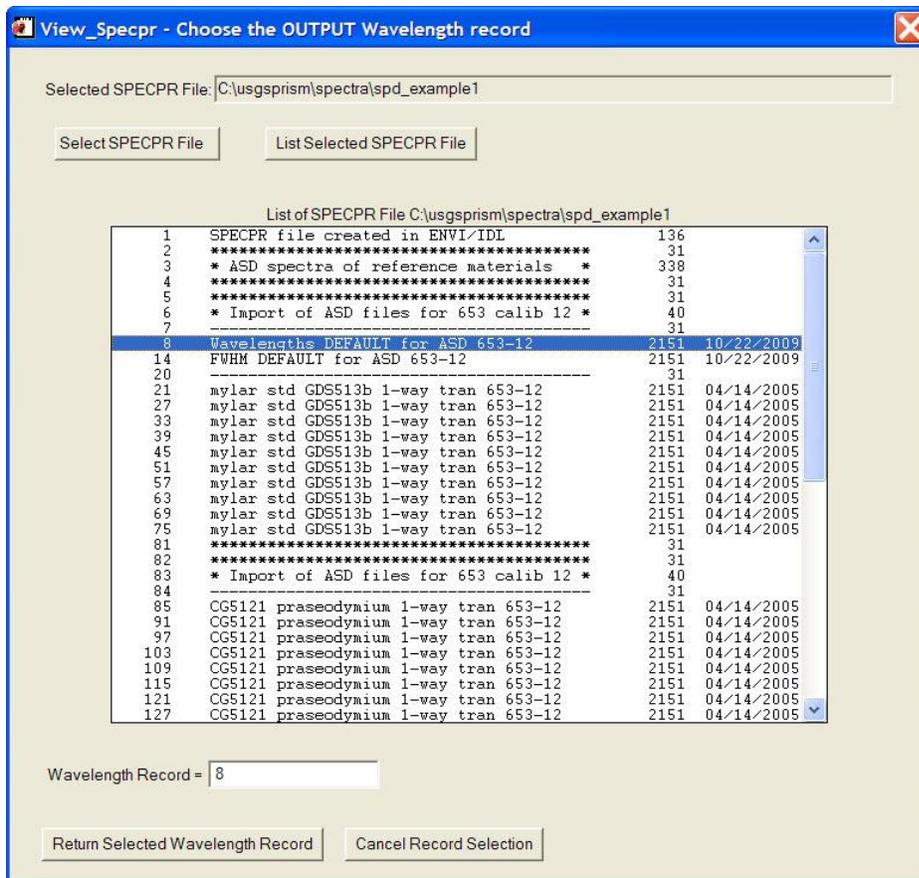


Figure 107. Selecting the output wavelength record.

Next, the user is prompted to set the output title for the interpolated spectrum (fig. 108). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

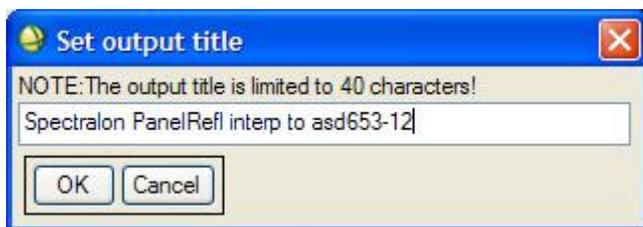


Figure 108. Setting the title for the record that will be interpolated.

Finally, the user is prompted to select the bandpass (FWHM) record to associate with the interpolated spectrum (fig. 109). In this case, the bandpasses are equivalent between the input and output spectrometers. However, if there are slight differences, the bandpass (FWHM) record of the input spectrometer should be interpolated to the new wavelengths before the data records

are interpolated, and that interpolated bandpass should be associated with the data records that will be interpolated.

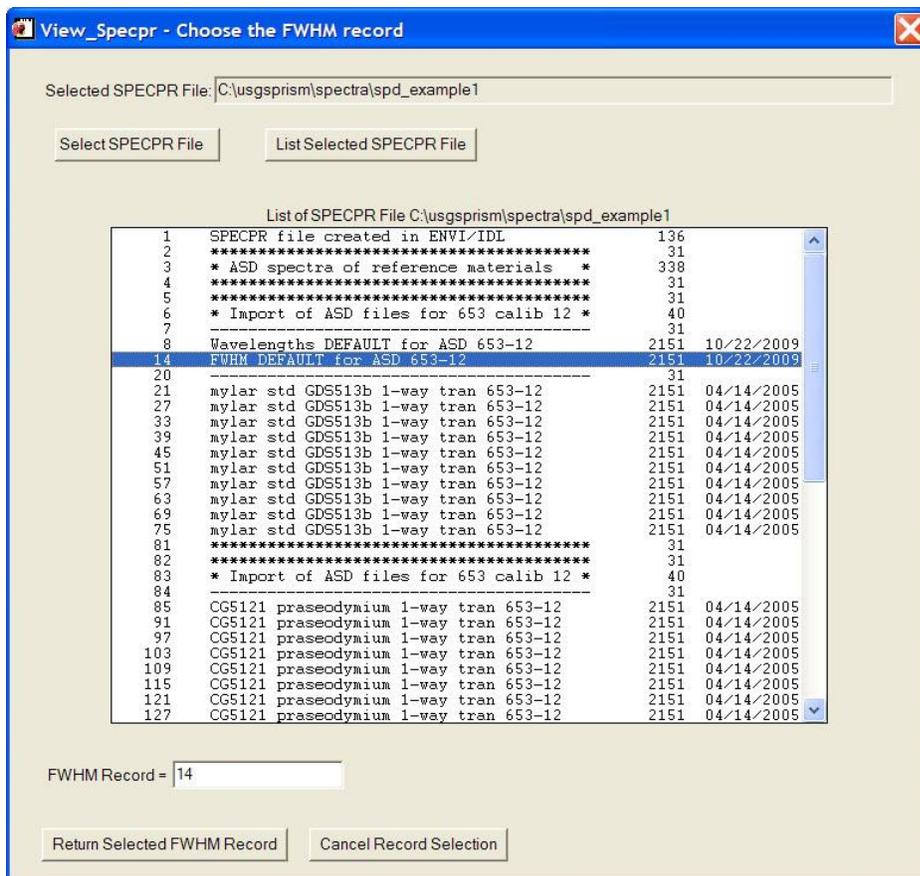


Figure 109. Selecting the bandpass (FWHM) record for the interpolated spectrum.

After the bandpass (FWHM) record is selected, the interpolation is performed. After the interpolated records are written, a message indicating the successful completion of this function is displayed. Press "OK" to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing. Figure 110 shows the interpolated record written to the end of the SPECPR file.

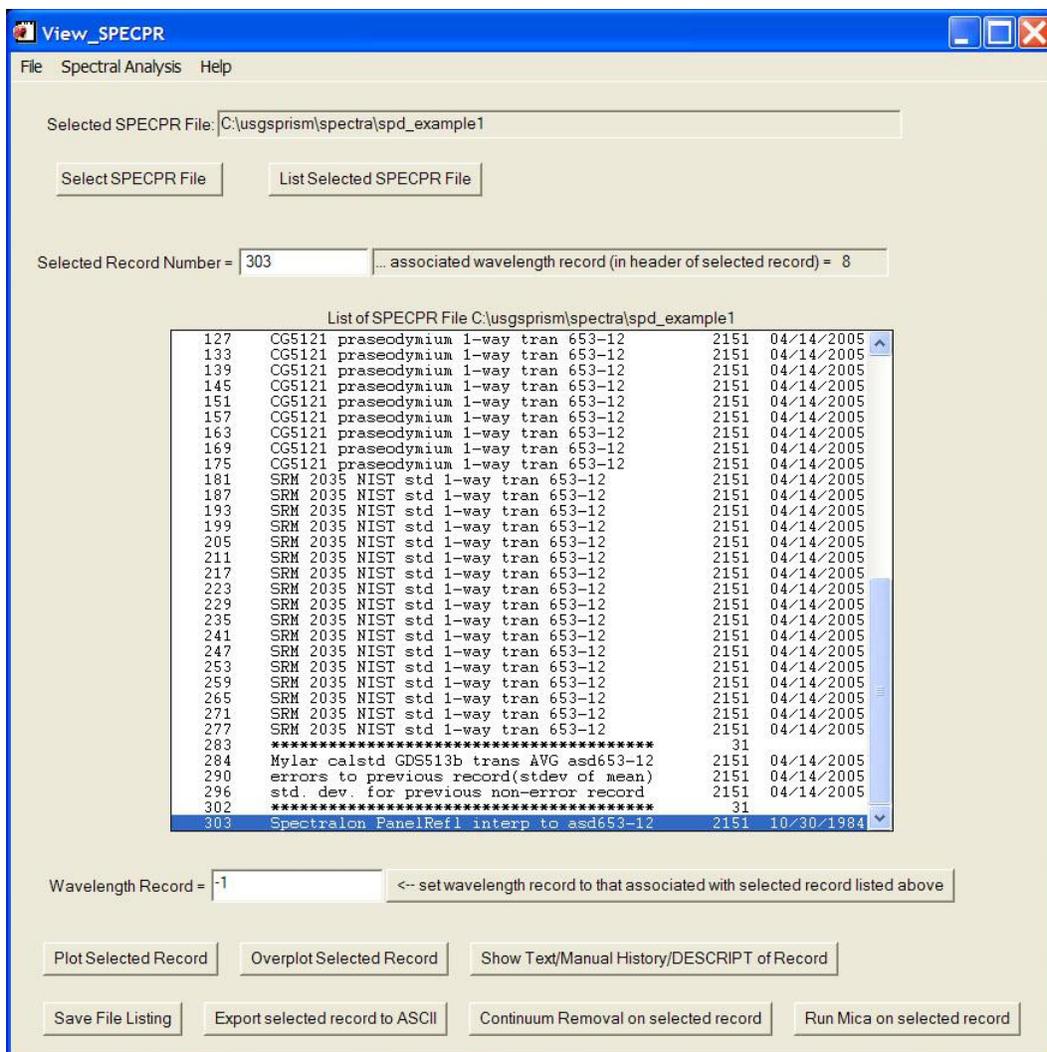


Figure 110. Selecting the bandpass (FWHM) record for the interpolated spectrum.

The header information of the interpolated spectrum contains information about the source data and input and output wavelength records. By clicking on an interpolated spectrum, in this case record 303, and then pressing the “Show Header Info/Text/DESCRIP Record” button, you can examine the information stored in the header of an interpolated record (fig. 111).

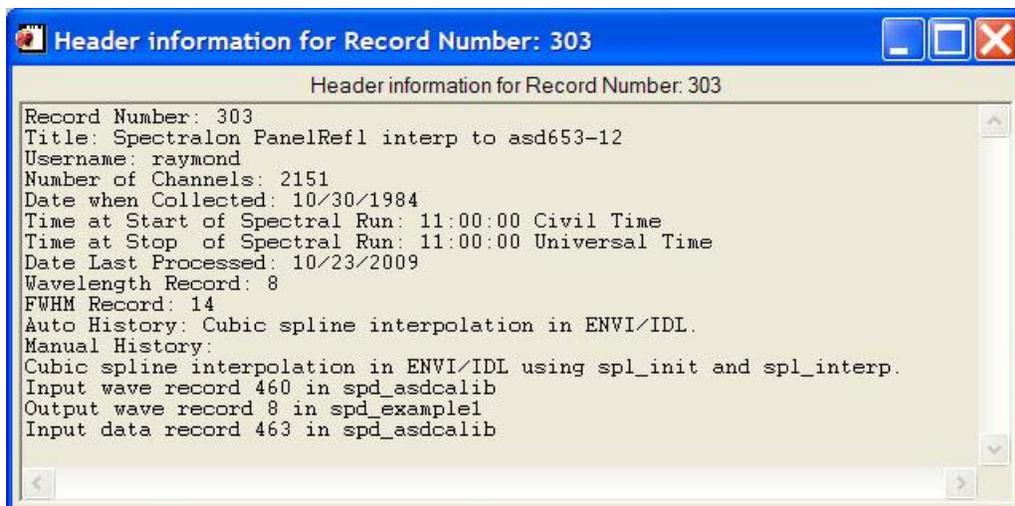


Figure 111. Header information for the interpolated spectrum.

Function 1.9.8 – Convolve spectra

When converting measurements made on one spectrometer to the sampling and bandpass (FWHM) characteristics of another, the measurement made on the high resolution spectrometer (smaller bandpass) should be convolved to the lower resolution spectrometer rather than interpolated. PRISM uses the SPECPR method of convolution (Clark, 1993), as described in Swayze (1997) and Swayze and others (2003). If there are only slight differences between the wavelength and bandpass (FWHM) characteristics of the two spectrometers, the spectra can be interpolated from one spectrometer to another (see PRISM’s “*Function 1.9.7 – Interpolate Spectra*”).

There are three functions for convolving spectra (fig. 112). “*Function 1.9.8.1 – Convolve spectra with user-set output titles*” allows the user to set the output title of each spectrum that is convolved. This is useful when convolving one or several spectra, but cumbersome when working with many spectra. “*Function 1.9.8.2 – Convolve spectra with automatic output titles*” is designed for the convolution of many records. Instead of the user having to specify the output title of each convolved spectrum, the output title of a convolved spectrum is automatically set to the input title with the last five characters replaced with a space and the letters CONV, that is, “CONV”, to indicate it is a convolved record. “*Function 1.9.8.3 – Convolve spectra with automatic output titles – ALL RECORDS*” is designed for convolving hundreds of spectra, for example, when convolving a USGS spectral library.

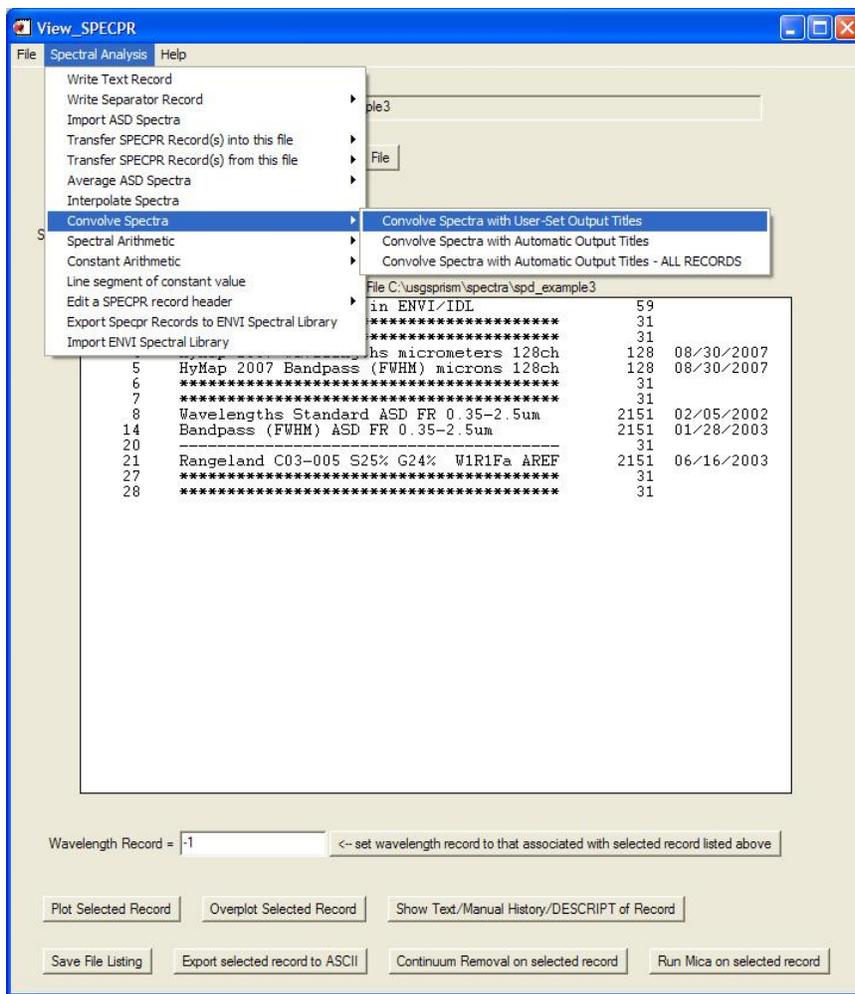


Figure 112. Initiating the convolution with user-set output titles.

Function 1.9.8.1 – Convolve spectra with user-set output titles

In this example, a file included with the PRISM software distribution is used “spd_example3”. This example file is included with the PRISM software distribution. If the user followed step 3 of the installation instructions (see section “*Installation of Software*” of this report), the file will be located in “C:\usgsprism\spectra\” on Windows computers and at “/var/local/usgsprism/spectra/” on Linux computers.

With “spd_example3” in the ViewSPECPR window, the user can start the convolution process by pressing the “Convolve Spectra” option under the “Spectral Analysis” entry on the ViewSPECPR menu bar and choosing the “Convolve Spectra with User-Set Output Titles” option (fig. 112).

The user is first prompted to select the SPECPR record that contains the wavelengths for the spectrum that will be convolved (fig. 113). In this example, a higher resolution spectrum measured on an ASD spectrometer (data record 21) will be convolved to the wavelength and bandpass (FWHM) of the HyMap imaging spectrometer, with instrument characteristics defined

in the 2007 data collection season. After selecting the wavelength record of the input spectrum (record 8 in this example), press the “Return Selected Wavelength Record” button.

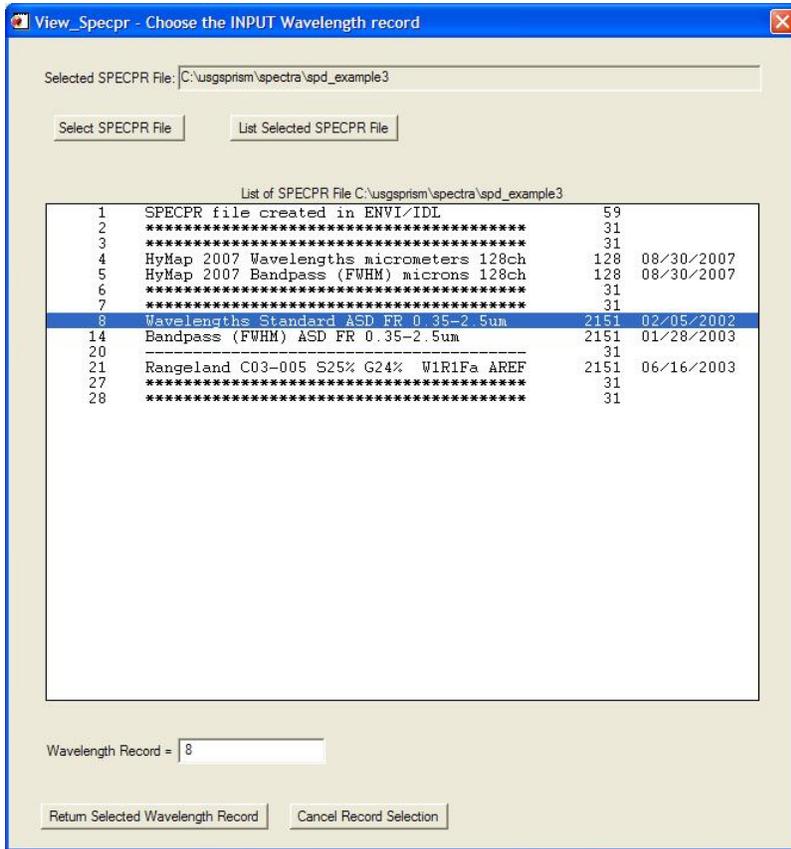


Figure 113. Setting the wavelength record for the spectrum to be convolved with user-set output titles.

Second, the user is prompted to select the SPECPR record that contains the bandpass (FWHM) for the spectrum that will be convolved (fig. 114). After selecting the wavelength record of the input spectrum (record 14 in this example), press the “Return Selected FWHM Record” button.

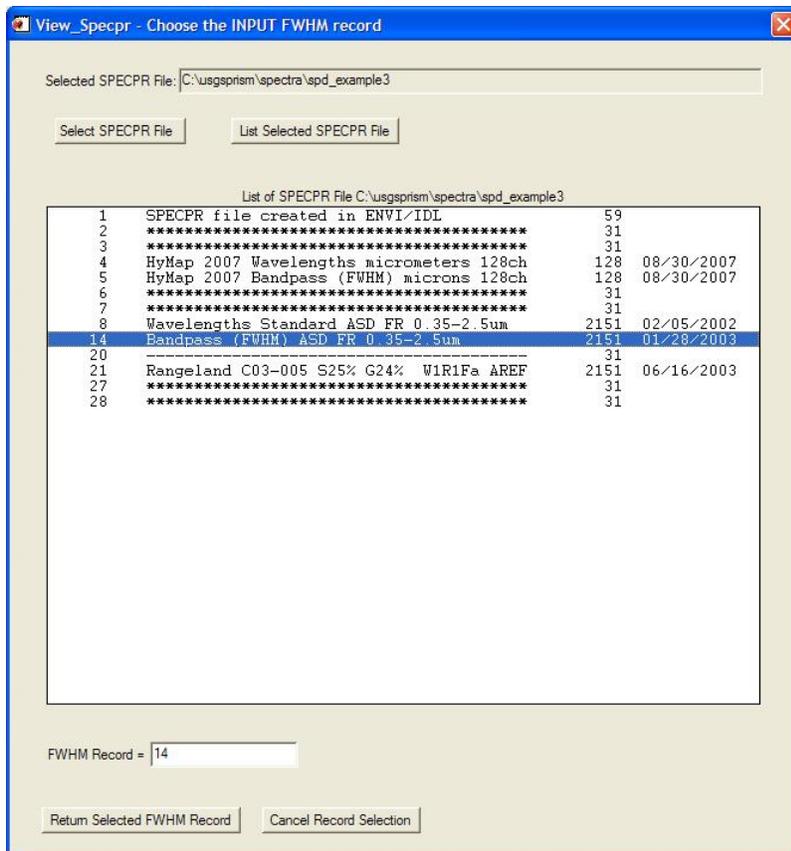


Figure 114. Setting the bandpass (FWHM) record for the spectrum to be convolved with user-set output titles.

Third, the user is prompted to select the SPECPR data record(s) that will be convolved (fig. 115). After selecting the records (record 21 in this example), press the “Return Selected Record Numbers” button. The user may scroll down to the desired record(s) using the scroll bar on the right. A single record may be selected by left-clicking on the record, or multiple records selected by choosing the first record and pressing and holding the “Ctrl” (control) button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the wavelength and bandpass (FWHM), otherwise the program will report an error and halt execution.

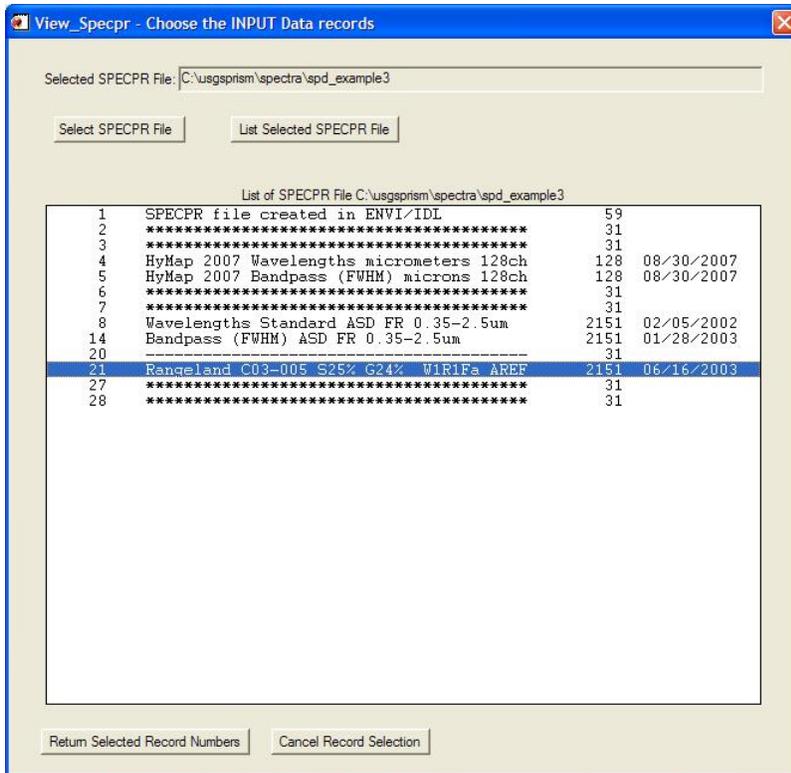


Figure 115. Setting the spectrum to be convolved with user-set output titles.

Fourth, the user is prompted to select the SPECPR record that contains the wavelengths of the spectrometer to which the input data will be convolved (fig. 116). In this example, a higher resolution spectrum measured on an ASD spectrometer (data record 21) is being convolved to the wavelength and bandpass (FWHM) of the HyMap imaging spectrometer, with instrument characteristics defined in the 2007 data collection season. After selecting the wavelength record of the output spectrometer (record 4 in this example), press the “Return Selected Wavelength Record” button.

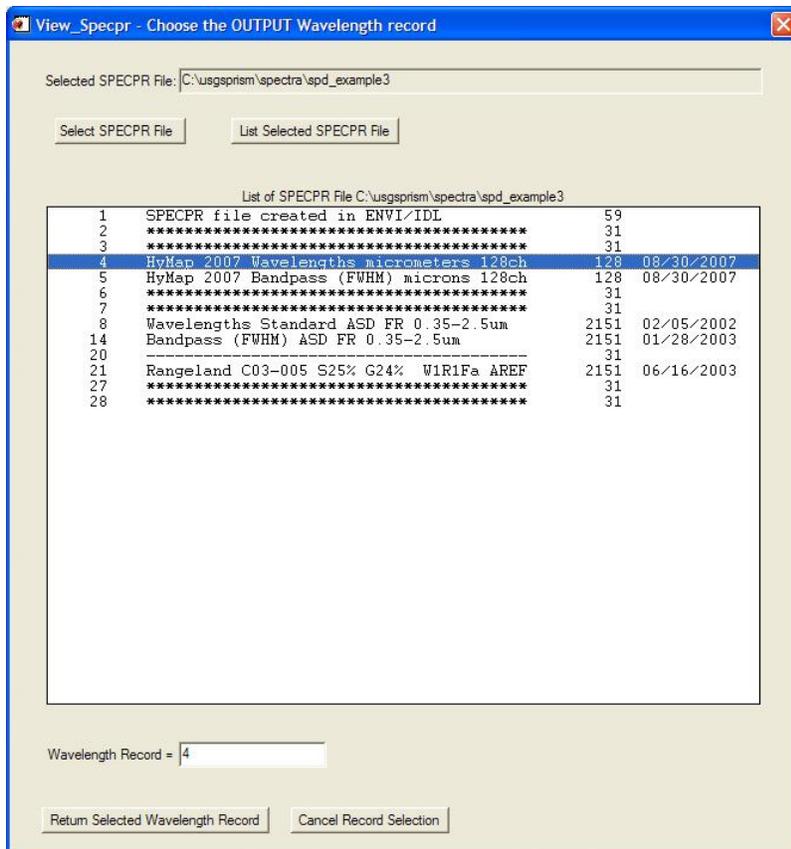


Figure 116. Setting the output wavelength record for the spectrometer to which the input data will be convolved, with user-set output titles.

Fifth, the user is prompted to select the SPECPR record that contains the bandpass (FWHM) of the spectrometer to which the input data will be convolved (fig. 117). After selecting the bandpass (FWHM) record of the output spectrometer (record 5 in this example), press the “Return Selected FWHM Record” button.

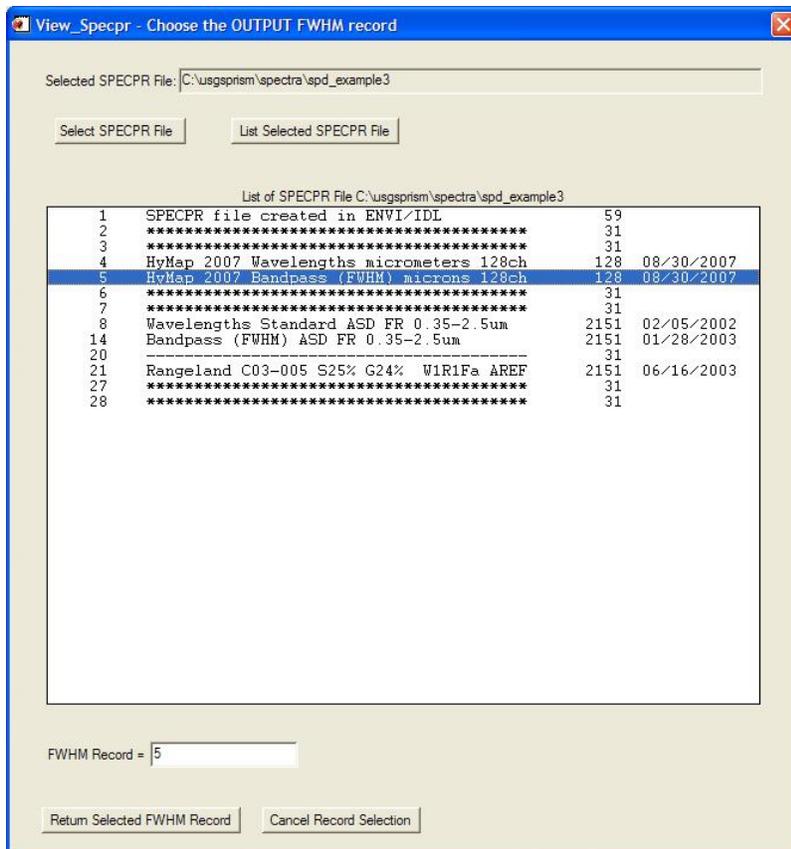


Figure 117. Setting the output bandpass (FWHM) record for the spectrometer to which the input data will be convolved, with user-set output titles.

Next, the program convolves the spectrum. This could take a few seconds for convolution between spectrometers with only a few hundred channels or as long as many minutes for spectrometers with thousands of channels. During the convolution process, a plot window shows the results of each spectral convolution as it is completed (fig. 118), in which the original spectrum is plotted with a dotted line and the convolved spectrum is plotted with a solid line.

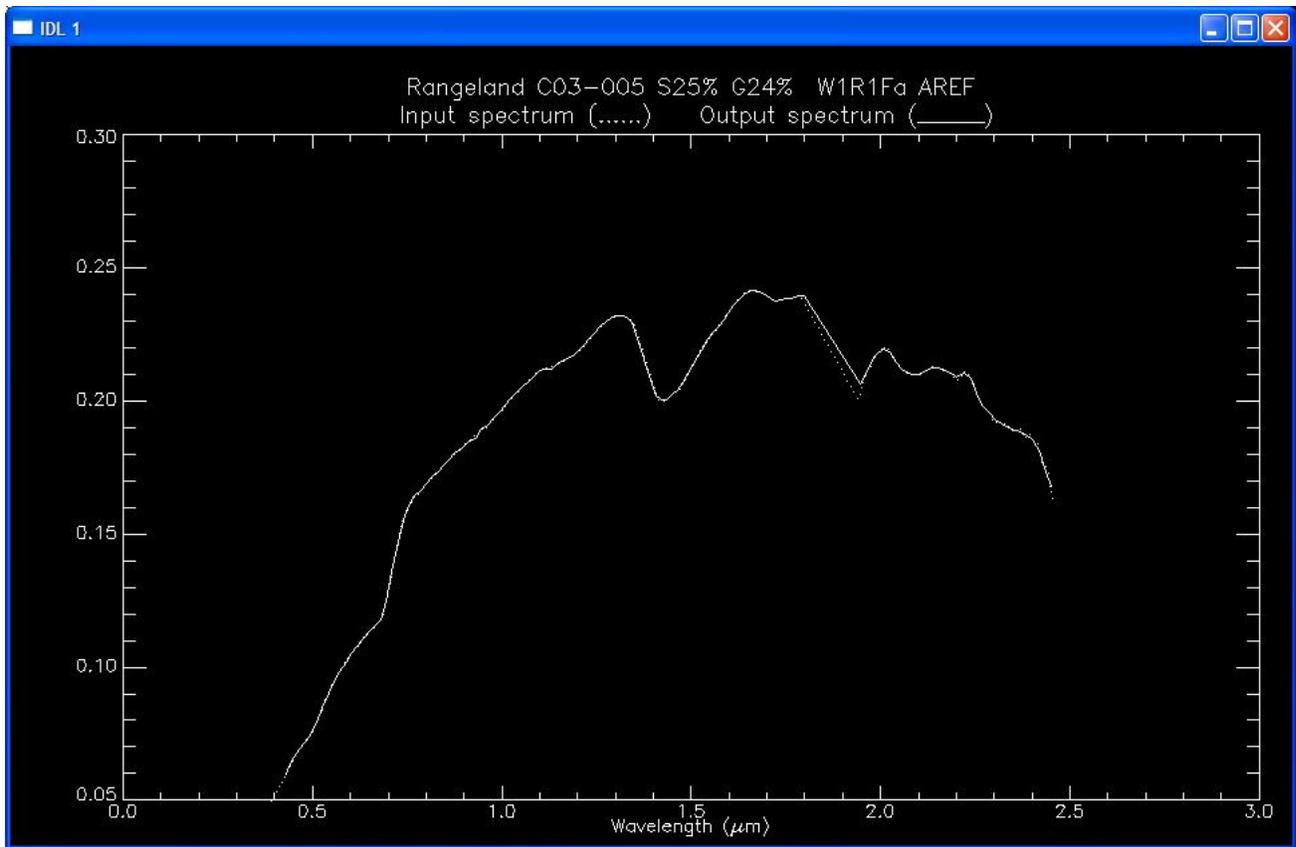


Figure 118. Plot window showing the input data being convolved, with user-set output titles.

Following the convolution, the user is prompted to set the output title (fig. 119). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

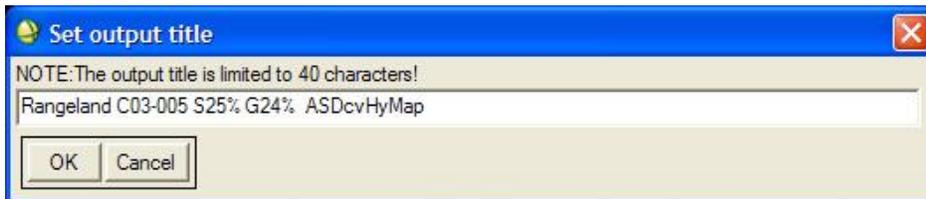


Figure 119. Setting the output title for the record that will contain the convolved spectrum.

After the output title is accepted, the program writes the output records to the end of the SPECPR file being viewed. After these records are written, a message indicating the successful completion of this function is displayed. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the list. Figure 120 shows the end of the file listing of the example file, showing the records written during the convolution procedure. First, a text separator record of asterisks is written (record 29 in this

example. Following that record, records containing information on the convolution procedure and input and output spectrometer characteristics, and wavelength and bandpass (FWHM) records are written (records 30-36 in this example). Following those records, a separator text record of dashes is written (record 37 in this example). Next, the convolved spectrum is written (record 38 in this example). Following the output spectrum, a text record containing the processing log is written (record 39 in this example). Finally, another separator record of asterisks is written to demarcate the end of the block of imported ASD spectra (record 40 in this example).

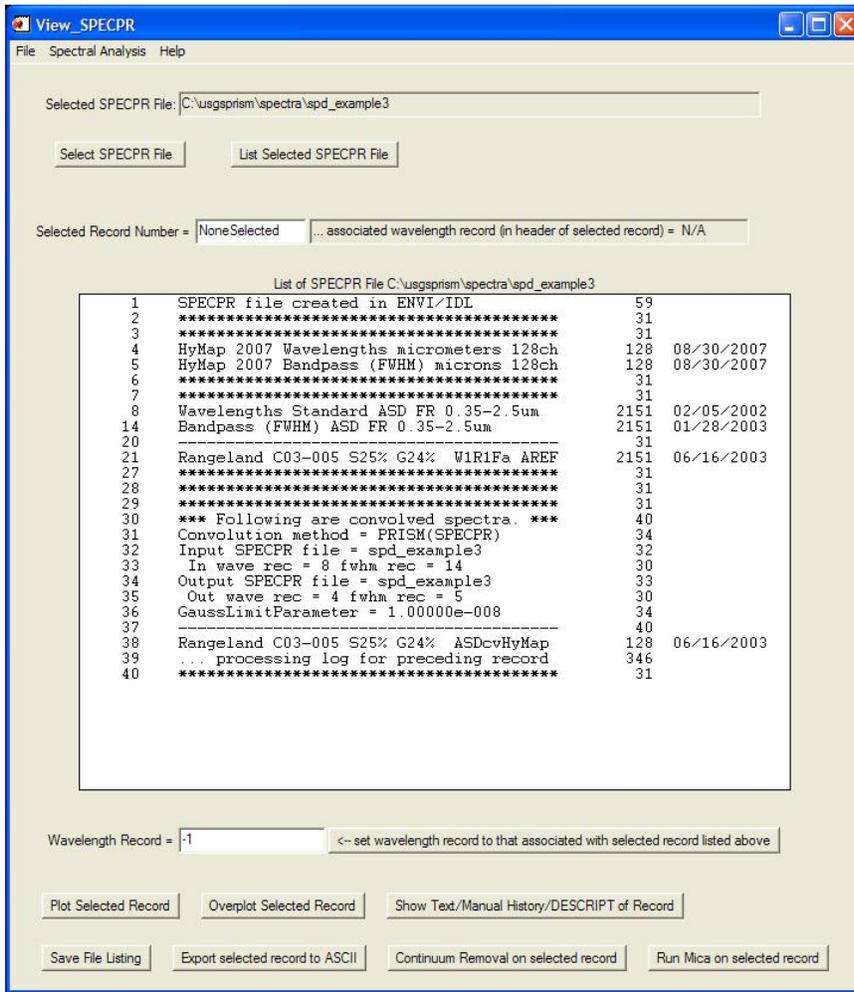


Figure 120. Records written after convolving a spectrum with user-set output titles.

The record header of the output convolved spectrum's data record contains information on the convolution procedure (fig. 121).

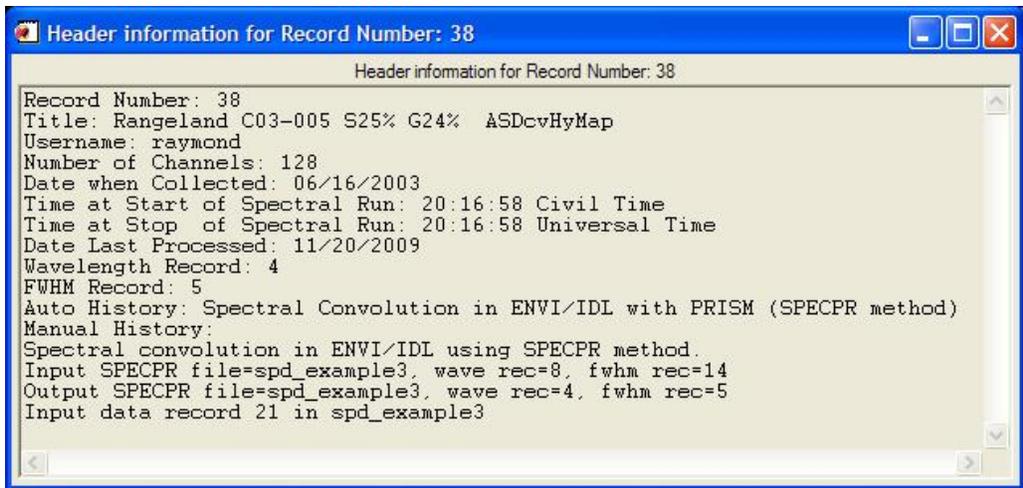


Figure 121. Record header information for the convolved spectrum.

The subsequent text record containing the processing log gives additional details on the convolution procedure (fig. 122). In particular, the log identifies channels which were set to the SPECPR deleted point value ($-1.23e^{+34}$). Channels in the output spectrometer that are beyond the wavelength range of the input spectrometer, or beyond the wavelength range of channels that contain valid data, are set to this deleted point value.

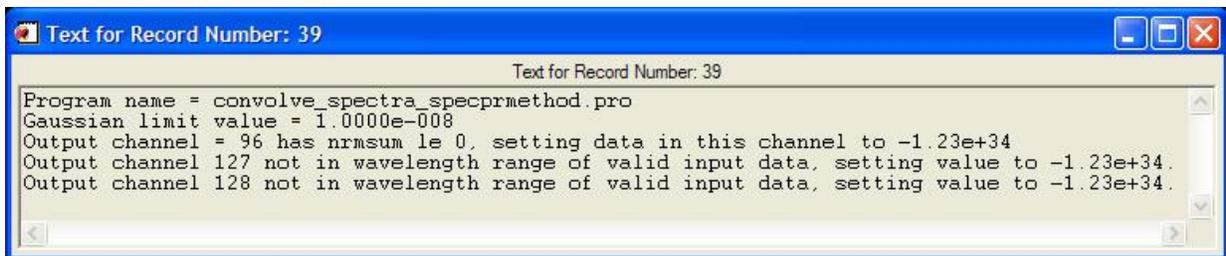


Figure 122. The contents of the text record containing the processing log information for the convolved spectrum.

Function 1.9.8.2 – Convolve spectra with automatic output titles

In this example, two files, included with the PRISM software distribution, are used, the spectral library file “splib06a” and an example “spd_example3”. If the user followed step 3 of the installation instructions (see section “*Installation of Software*” of this report), the files will be located in “C:\usgsprism\spectra\” on Windows computers and at “/var/local/usgsprism/spectra/” on Linux computers.

The spectra to be convolved are in “splib06a”. The spectrometer wavelength and bandpass (FWHM) records to which the spectrum will be convolved are in “spd_example3”. When running the convolution from ViewSPECPR, the program assumes that the input and output spectra are in the file being viewed. Since that is not the case in this example, some extra

steps will be taken to change the SPECPR file when selecting the input wavelength, bandpass (FWHM), and data records. With “spd_example3” in the ViewSPECPR window, the user can start the convolution process by pressing the “Convolve Spectra” option under the “Spectral Analysis” entry on the ViewSPECPR menu bar and choosing the “Convolve Spectra with Automatic Output Titles” option (fig. 123).

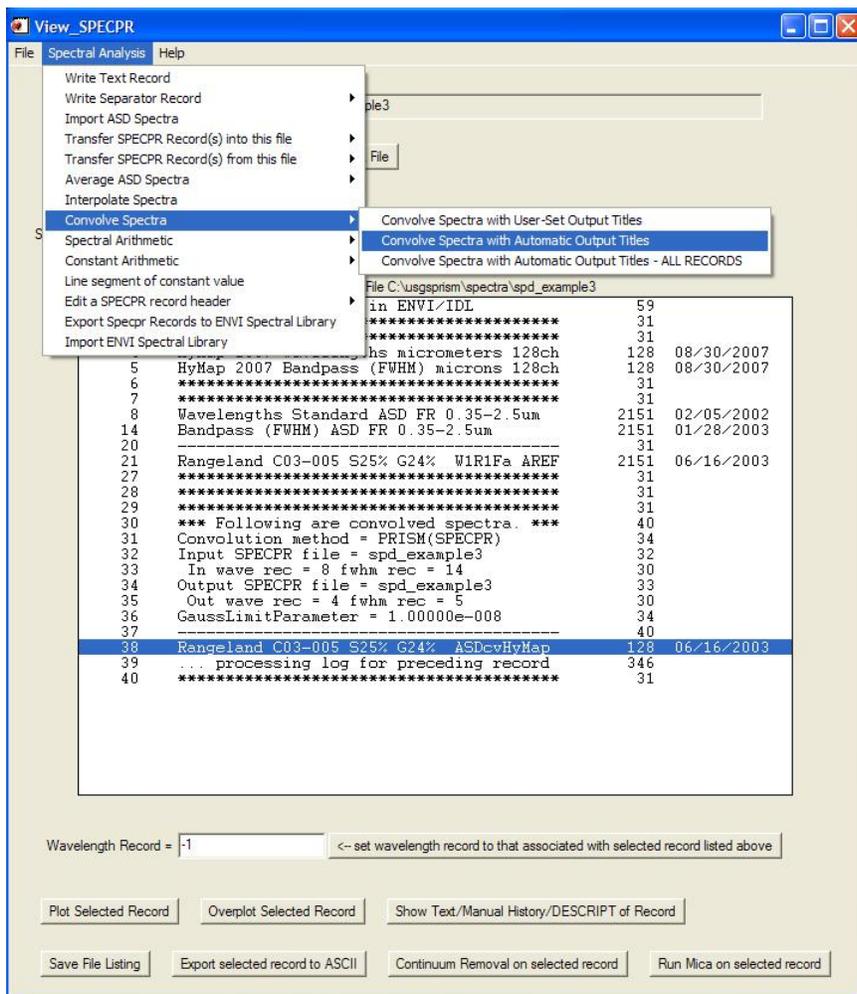


Figure 123. Initiating the convolution with automatic output titles.

The user is first prompted to select the SPECPR data record that contains the wavelengths for the spectrum that will be convolved. By default, the window that appears for this selection shows the contents of the SPECPR file being viewed (fig. 124).

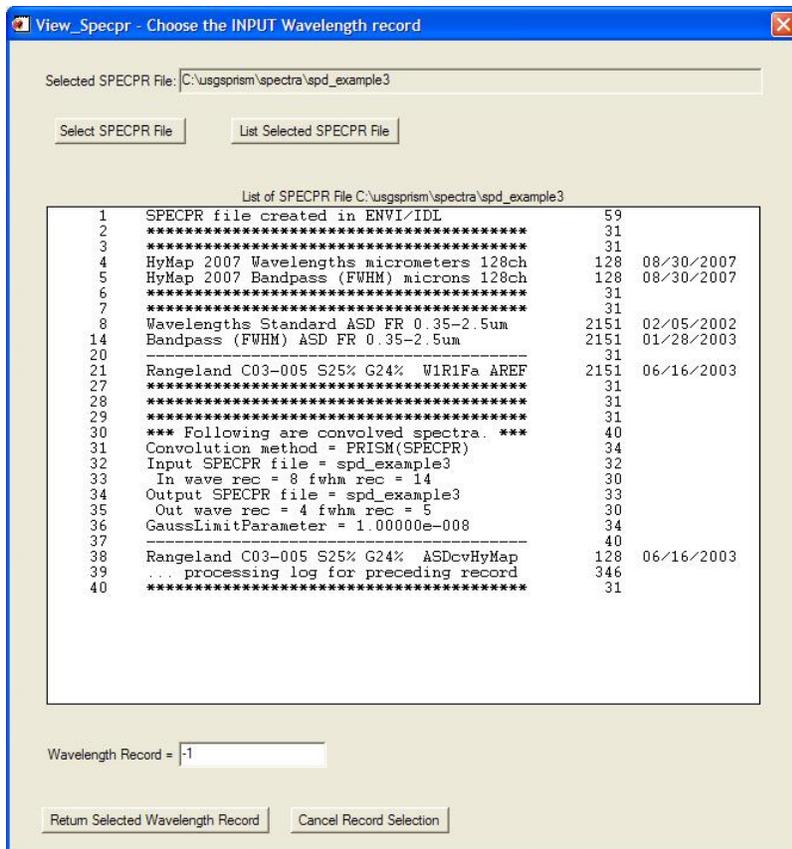


Figure 124. The default file listing that appears when convolving spectra with automatic output titles.

By pressing the “Select SPECPR File” button in the top left of the widget, the user can select a different SPECPR file, in this case, the “splib06a” file. After selecting the SPECPR file, press the “List Selected SPECPR File” button to show the contents of that file. The user can then select the wavelength record (fig. 125) that corresponds to the spectrum that will be convolved (in this example record 10) and press the “Return Selected Wavelength Record” button.

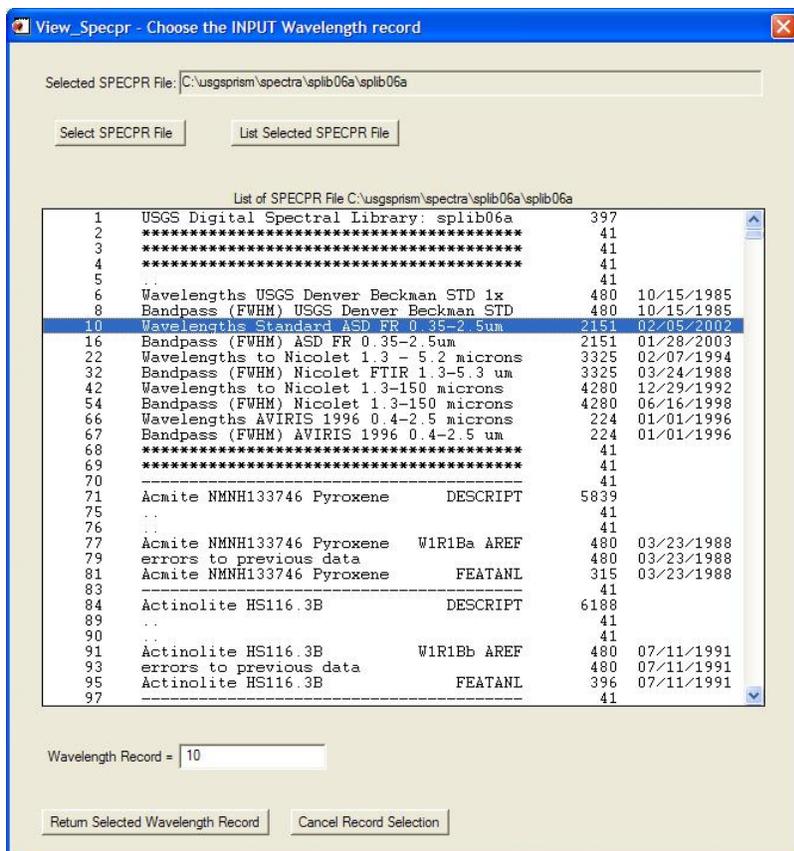


Figure 125. Selecting the input spectrometer wavelength record from the new file listing during the convolution of spectra with automatic output titles.

Next, the user is prompted to select the SPECPR data record that contains the bandpass (FWHM) for the spectrum that will be convolved. As with the wavelength record selection, the default is to show the contents of the SPECPR file being viewed. By pressing the "Select SPECPR File" button in the top left of the widget, the user can select a different SPECPR file, in this case, the "splib06a" file. After selecting the SPECPR file, press the "List Selected SPECPR File" button to show the contents of that file (fig. 126). The user can then select the bandpass (FWHM) record that corresponds to the spectrum that will be convolved (in this example record 16) and press the "Return Selected FWHM Record" button.

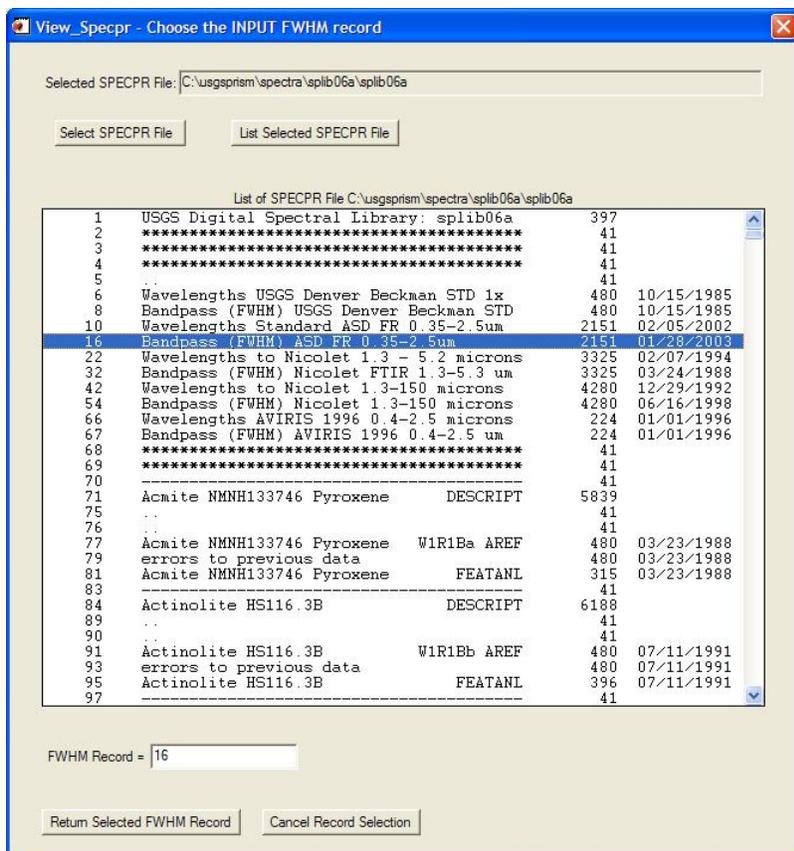


Figure 126. Selecting the input spectrometer bandpass (FWHM) record from the new file listing during the convolution of spectra with automatic output titles.

Next, the user is prompted to select the SPECPR data records that will be convolved. As with the wavelength record selection, the default is to show the contents of the SPECPR file being viewed. By pressing the “Select SPECPR File” button in the top left of the widget, the user can select a different SPECPR file, in this case, the “splib06a” file. After selecting the SPECPR file, press the “List Selected SPECPR File” button to show the contents of that file (fig. 127).

The user may scroll down to the desired record(s) using the scroll bar on the right. A single record may be selected by left-clicking on the record, or multiple records selected by choosing the first record and pressing and holding the “Ctrl” (control) button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the wavelength and bandpass (FWHM), otherwise the program will report an error and halt execution. This example shows the selection of records 28997, 29017, 29036, and 29055 (fig. 127). After selecting the desired record(s), press the “Return Selected Record Numbers” button.

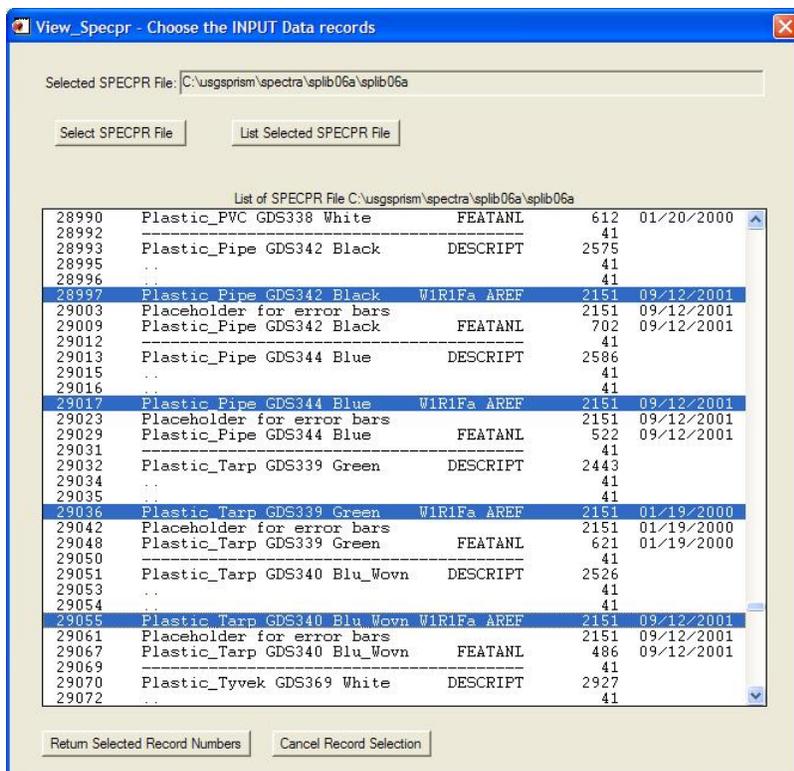


Figure 127. Selecting the input records from the new file listing during the convolution of spectra with automatic output titles.

Subsequently, the user is prompted to select the SPECPR record that contains the wavelengths of the spectrometer to which the data will be convolved (fig. 128). In this example, higher resolution spectra measured on an ASD spectrometer are being convolved to the wavelength and bandpass (FWHM) of the HyMap imaging spectrometer, with instrument characteristics defined in the 2007 data collection season. After selecting the wavelength record of the output spectrometer (record 4 in this example), press the “Return Selected Wavelength Record” button.

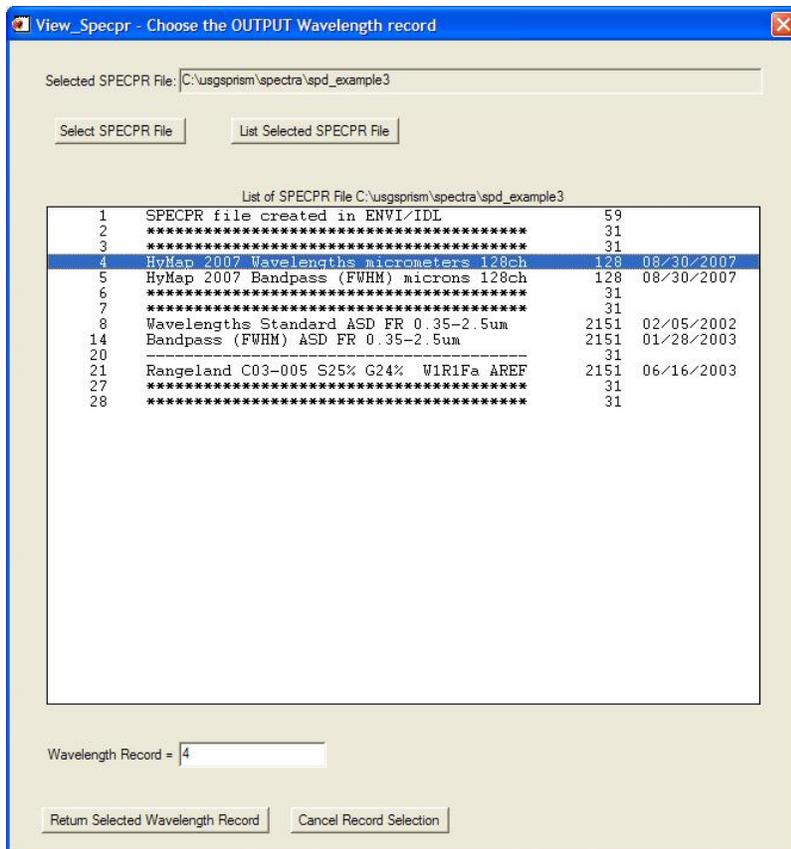


Figure 128. Setting the output wavelength record for the spectrometer to which the input data will be convolved, with automatic output titles.

Next, the user is prompted to select the SPECPR record that contains the bandpass (FWHM) of the spectrometer to which the input data will be convolved (fig. 129). After selecting the bandpass (FWHM) record of the output spectrometer (record 5 in this example), press the “Return Selected FWHM Record” button.

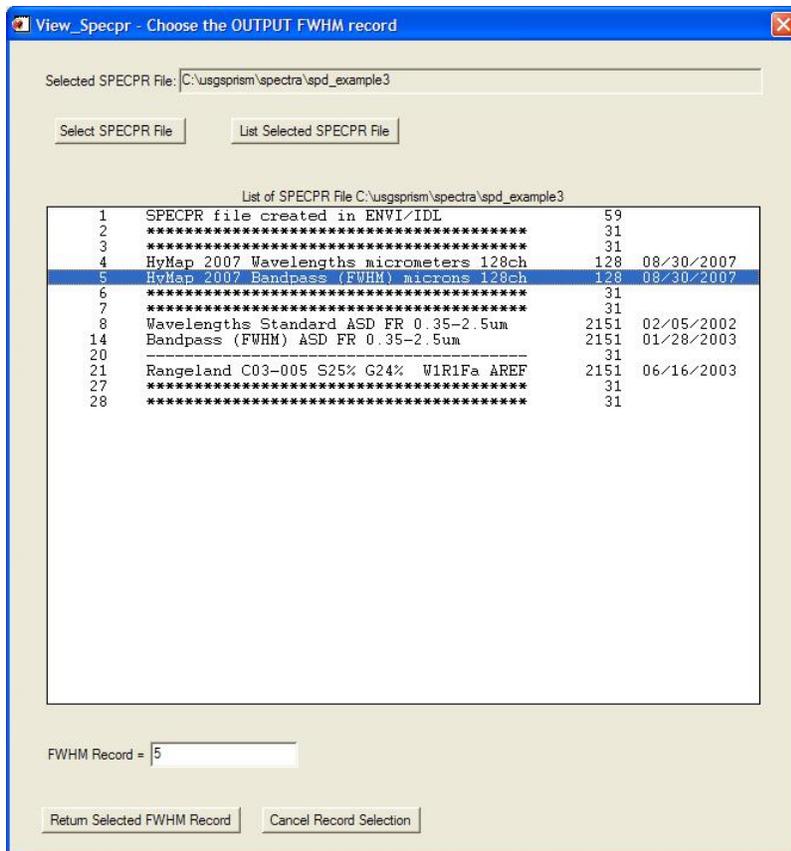


Figure 129. Setting the output bandpass (FWHM) record for the spectrometer to which the input data will be convolved, with automatic output titles.

Next, the program convolves the spectra. For each spectrum, the calculation could take a few seconds, when using spectrometers with only a few hundred channels, or as long as many minutes, for spectrometers with thousands of channels. During the convolution process, a plot window shows the results of each spectral convolution as it is completed. After the final plot appears (fig. 130), the results are written to the SPECPR file being viewed and a window appears advising the user the routine completed successfully. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing.

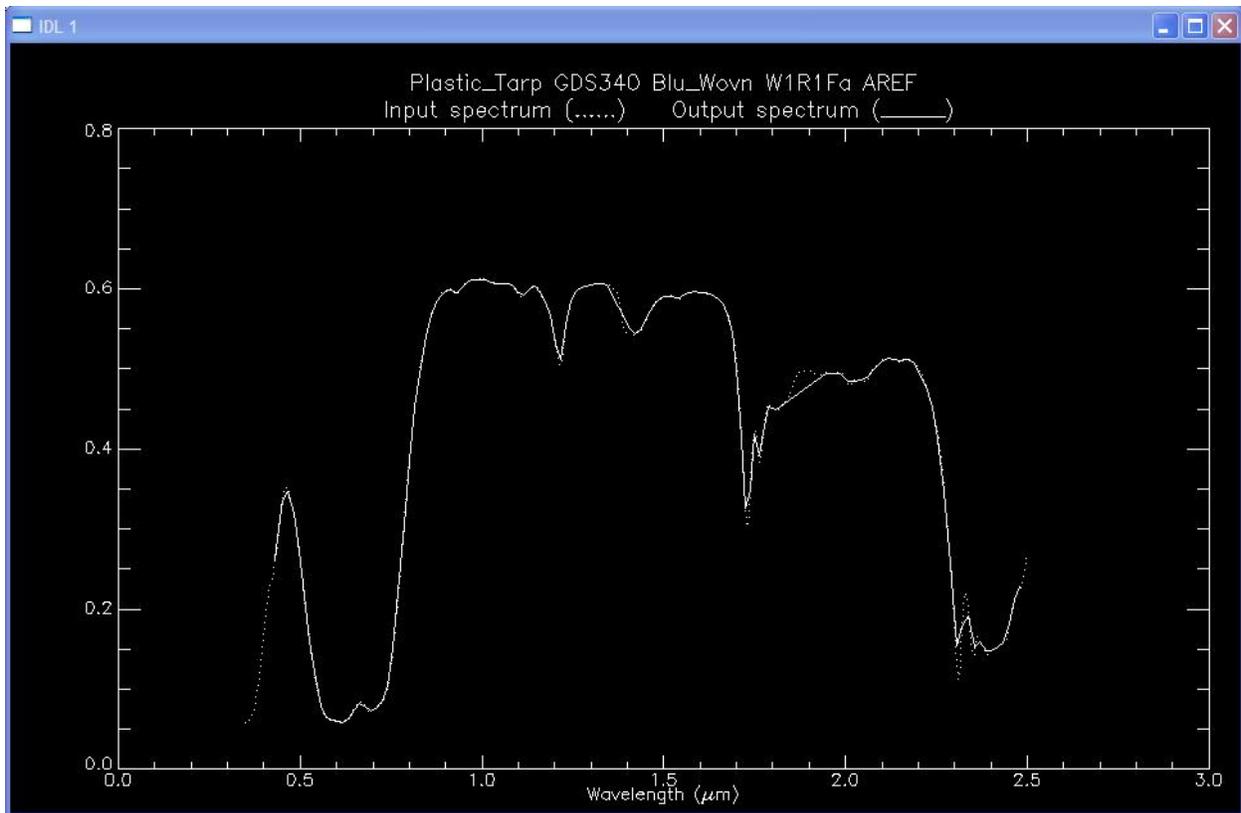


Figure 130. Plot window showing the input data being convolved, with automatic output titles.

Figure 131 shows the listing of the records that were written to the end of the SPECPR file being viewed. A separator text record of asterisks is written (record 41 in this example). Following that record, records containing information on the convolution procedure and input and output spectrometer characteristics, wavelength, and bandpass (FWHM) records (records 42-48 in this example) are written. Following those records, a separator text record of dashes is written (record 49 in this example). Next, the first convolved spectrum is written (record 50 in this example) with the same output title as the input spectrum except the last five characters are replaced with a space and the letters CONV, that is, “ CONV”, to indicate this is a convolved record. Following the convolved spectrum, a text record containing its processing log is written (record 51 in this example). Subsequently, each additional convolved record is written, followed by its processing log. Finally, a text separator record of asterisks is written to demarcate the end of the block of convolved spectra (record 58).



Figure 131. Records written after convolving a spectrum with automatic output titles.

The header information of a convolved spectrum contains information about the source data record and the input wavelength and bandpass (FWHM) records and output wavelength and bandpass (FWHM) records used to compute the convolved spectrum. By clicking on a convolved spectrum, in this case record 50, and then pressing the “Show Header Info/Text/DESCRIPT Record” button, you can examine the information stored in the header of a convolved record (fig. 132).

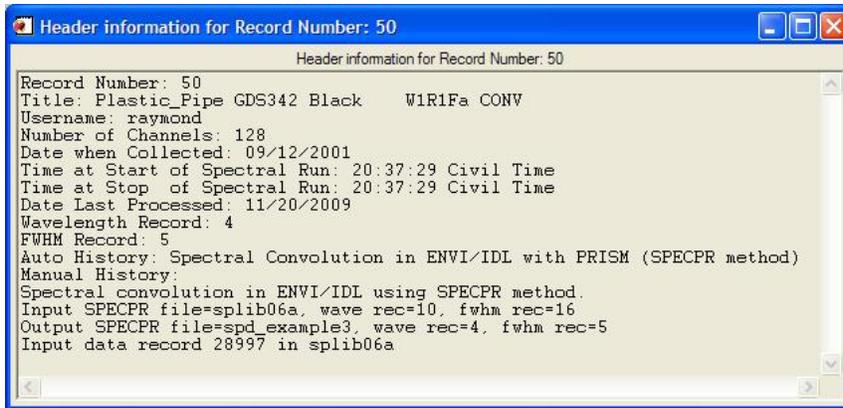


Figure 132. Record header information for a spectrum convolved with automatic output titles.

The processing log gives additional details on the convolution procedure (fig. 133), in particular, the channels which were set to the SPECPR deleted point value ($-1.23e^{+34}$). Channels in the output spectrometer that are beyond the wavelength range of the input spectrometer, or beyond the wavelength range of channels that contain valid data, are set to this deleted point value.

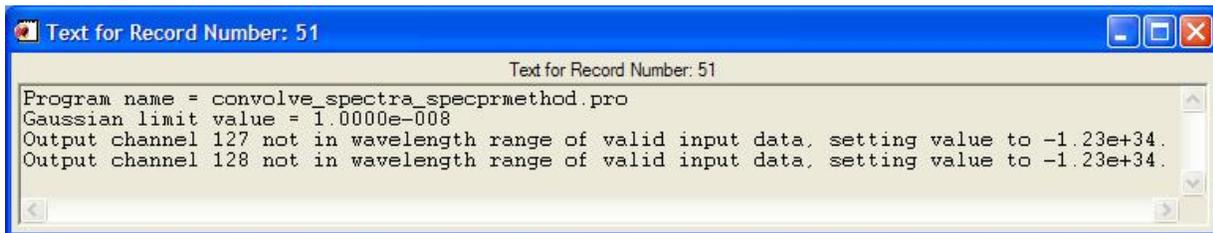


Figure 133. Processing log information for a spectrum convolved with automatic output titles.

Function 1.9.8.3 – Convolve spectra with automatic output titles – ALL RECORDS

In this example, two files, included with the PRISM software distribution, are used, the spectral library file “splib06a” and an example “spd_example3”. If the user followed step 3 of the installation instructions (see section “*Installation of Software*” of this report), the files will be located in “C:\usgsprism\spectra\” on Windows computers and at “/var/local/usgsprism/spectra/” on Linux computers.

The spectra to be convolved are in “splib06a”. The spectrometer wavelength and bandpass (FWHM) records to which the spectrum will be convolved are in “spd_example3”. When running the convolution from ViewSPECPR, the program assumes that the input and output spectra are in the file being viewed. Since that is not the case in this example, some extra steps will be taken to change the SPECPR file when selecting the input wavelength, bandpass (FWHM), and data records. With “spd_example3” in the ViewSPECPR window, the user can start the convolution process by pressing the “Convolve Spectra” option under the “Spectral

Analysis” entry on the menu bar and choosing the “Convolve Spectra with Automatic Output Titles – ALL RECORDS” option (fig. 134).

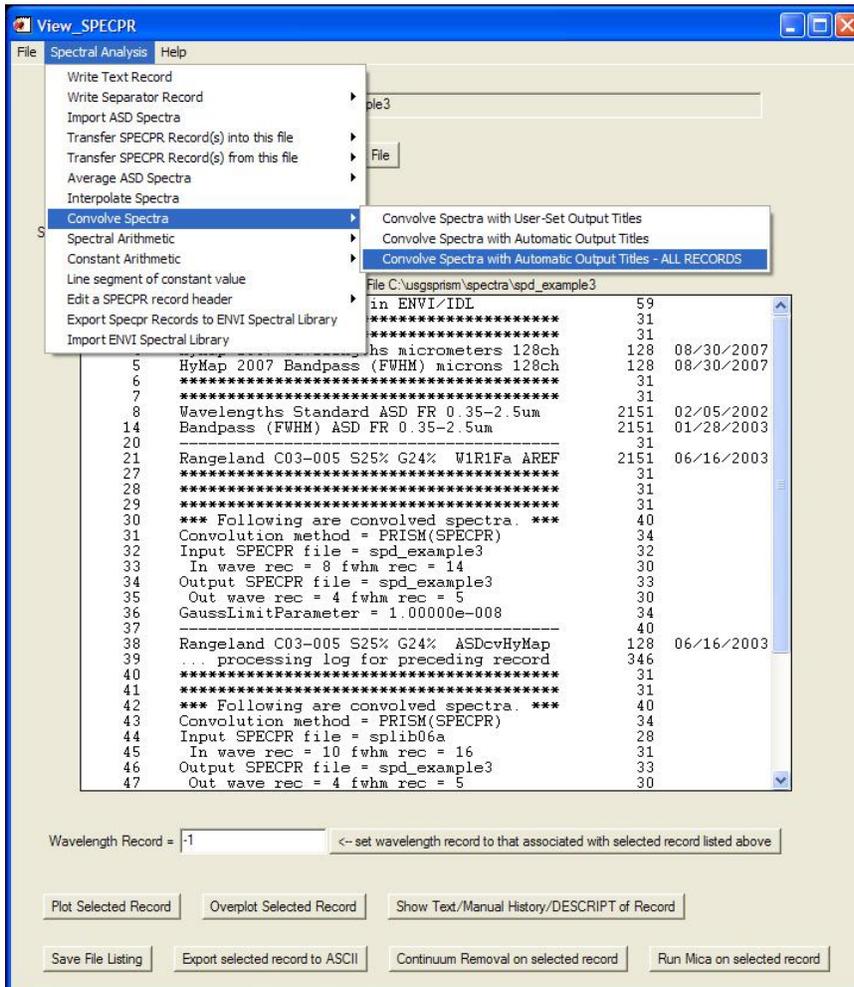


Figure 134. Initiating the convolution with automatic output titles – ALL RECORDS.

The user is first prompted to select the SPECPR data record that contains the wavelengths for the spectrum that will be convolved; the default is to show the contents of the SPECPR file being viewed (fig. 135). By pressing the “Select SPECPR File” button in the top left of the widget, the user can select a different SPECPR file, in this case, the “splib06a” file.

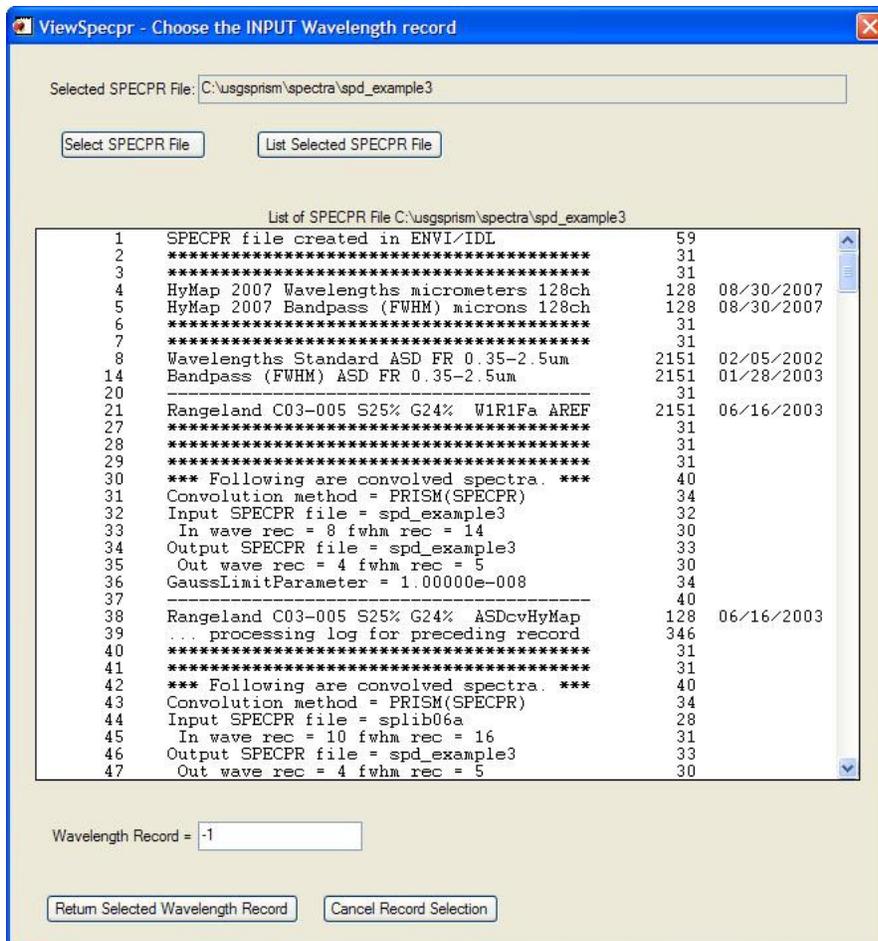


Figure 135. The default file listing that appears when convolving spectra with automatic output titles – ALL RECORDS.

After selecting the SPECPR file, press the “List Selected SPECPR File” button to show the contents of that file. The user can then select the wavelength record (fig. 136) that corresponds to the spectrum that will be convolved (in this example record 10) and press the “Return Selected Wavelength Record” button.

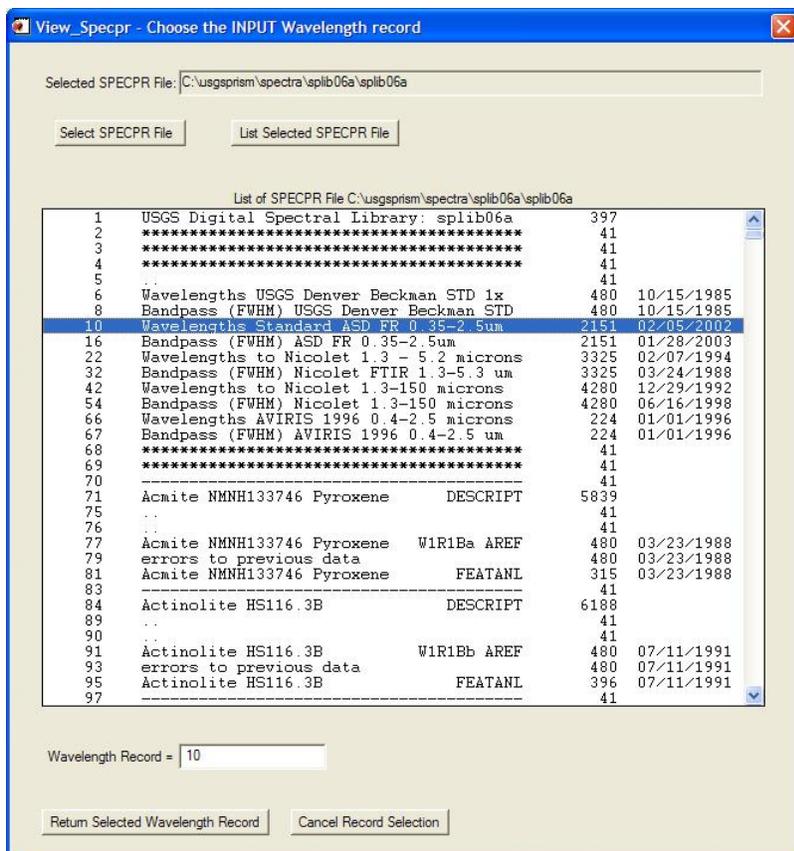


Figure 136. Selecting the input spectrometer wavelength record from the new file listing during the convolution of spectra with automatic output titles – ALL RECORDS.

Next, the user is prompted to select the SPECPR data record that contains the bandpass (FWHM) for the spectrum that will be convolved. As with the wavelength record selection, the default is to show the contents of the SPECPR file being viewed. By pressing the “Select SPECPR File” button in the top left of the widget, the user can select a different SPECPR file, in this case, the “splib06a” file. After selecting the SPECPR file, press the “List Selected SPECPR File” button to show the contents of that file (fig. 137). The user can then select the bandpass (FWHM) record that corresponds to the spectrum that will be convolved (in this example record 16) and press the “Return Selected FWHM Record” button.

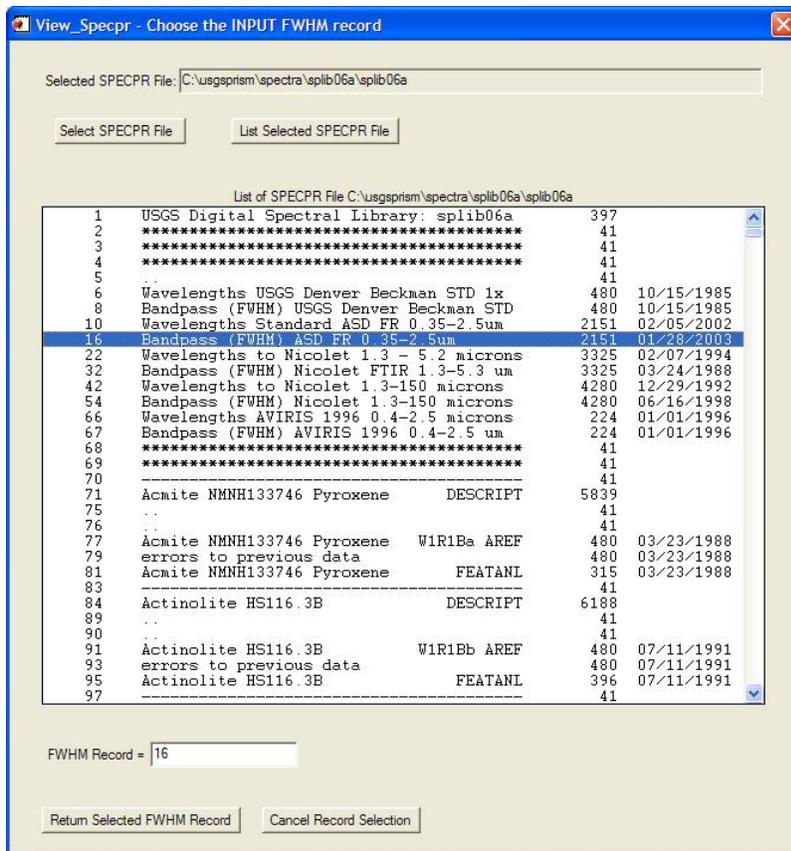


Figure 137. Selecting the input spectrometer bandpass (FWHM) record from the new file listing during the convolution of spectra with automatic output titles – ALL RECORDS.

Following the selection of the wavelength and bandpass (FWHM) records, the routine determines which data records, in the SPECPR file containing those records, have the same number of channels as the wavelength record. This step can take a minute or more for large SPECPR files. After the program has determined the data records that will be convolved, the user is prompted to select the SPECPR record that contains the wavelengths of the spectrometer to which the data will be convolved (fig. 138). In this example, higher resolution spectra measured on an ASD spectrometer are being convolved to the wavelength and bandpass (FWHM) of the HyMap imaging spectrometer, with instrument characteristics defined in 2007. After selecting the wavelength record of the output spectrometer (record 4 in this example), press the “Return Selected Wavelength Record” button.

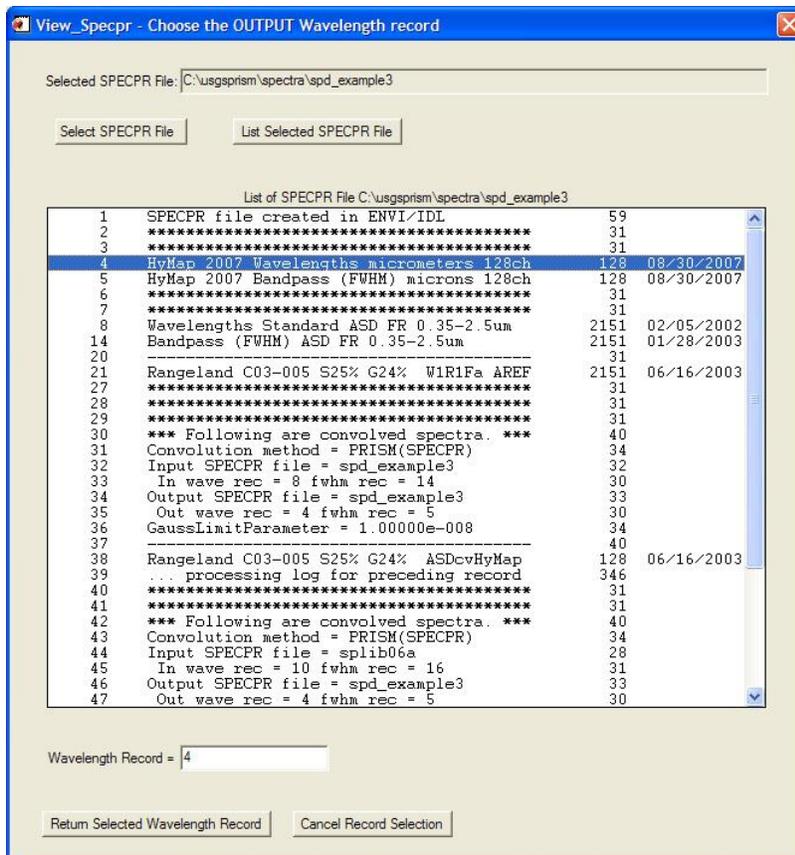


Figure 138. Setting the output wavelength record for the spectrometer to which the input data will be convolved, with automatic output titles – ALL RECORDS.

Next, the user is prompted to select the SPECPR record that contains the bandpass (FWHM) of the spectrometer to which the input data will be convolved (fig. 139). After selecting the bandpass (FWHM) record of the output spectrometer (record 5 in this example), press the “Return Selected FWHM Record” button.

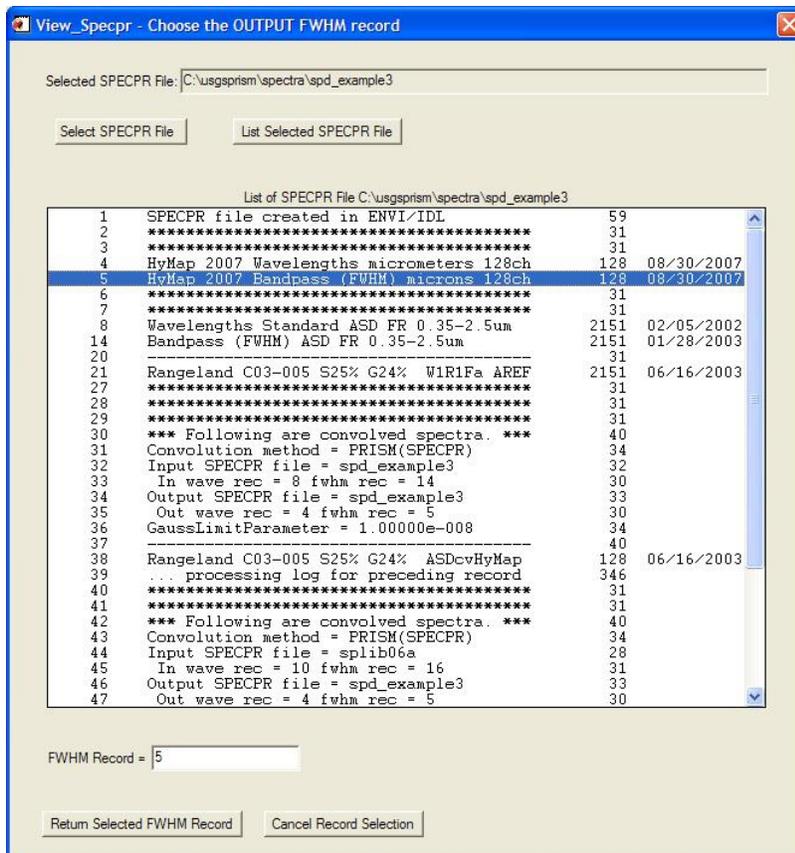


Figure 139. Setting the output bandpass (FWHM) record for the spectrometer to which the input data will be convolved, with automatic output titles – ALL RECORDS.

Next, the program convolves the spectra. For each spectrum, the calculation could take a few seconds, when using spectrometers with only a few hundred channels, or as long as many minutes, for spectrometers with thousands of channels. For a large SPECPR file, such as splib06a, this function could take several hours to complete. During the convolution process, a plot window shows the results of each spectral convolution as it is completed. When the last record is convolved, a window appears advising the user the routine completed successfully. Press “OK” to dismiss the message. The listing of the SPECPR file will refresh, with the new records appearing at the bottom of the listing.

Figure 140 shows the listing of some of the records that were written to the SPECPR file being viewed. A separator text record of asterisks is written (record 59 in this example). Following that record, records containing information on the convolution procedure and input and output spectrometer characteristics, wavelength, and bandpass (FWHM) records (records 60-66 in this example) are written. Following those records, a separator text record of dashes is written (record 67 in this example). Next, the first convolved spectrum is written (record 68 in this example) with the same output title as the input spectrum except the last five characters are replaced with a space and the word CONV, that is, “ CONV”, to indicate this is a convolved record. Subsequently, each additional convolved record is written (records 68-372 in this

example). After the listing of convolved records, a separator text record of asterisks is written to demarcate the end of the block of convolved spectra.



Figure 140. Records written after convolving spectra with automatic output titles – ALL RECORDS.

The record header of a convolved spectrum contains information about the source data record and the input wavelength and bandpass (FWHM) records and output wavelength and bandpass (FWHM) records used to compute the convolved spectrum. By clicking on a convolved spectrum, in this case record 68, and then pressing the “Show Header Info/Text/DESCRIP Record” button, you can examine the information stored in the header of a convolved record (fig. 141).

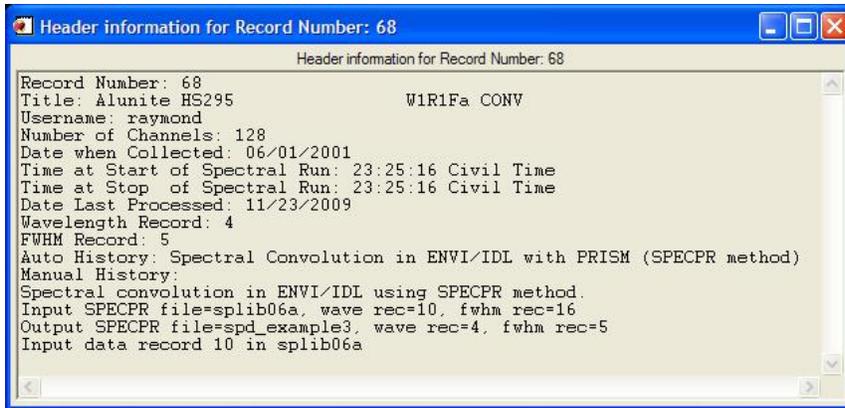


Figure 141. Record header information for a spectrum convolved with automatic output titles – ALL RECORDS.

The processing logs are not written when using the “ALL RECORDS” convolution option. For details on the processing logs generated during the convolution procedure, see the previous section of this report, “*Function 1.9.8.2 – Convolve spectra with automatic output titles*”.

Function 1.9.9 – Spectral arithmetic

These functions allow the user to perform simple math functions with spectra stored in SPECPR records (fig. 142).

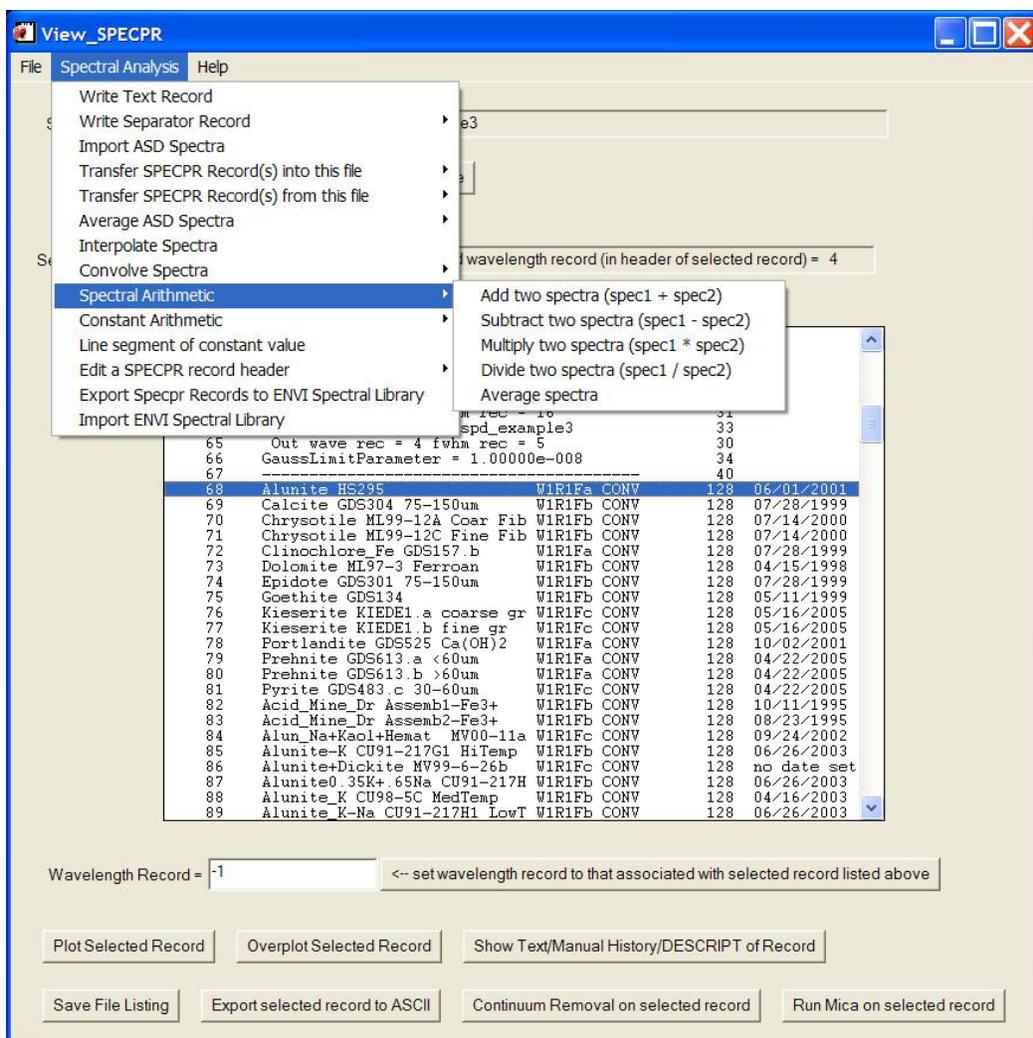


Figure 142. Arithmetic functions for spectra.

Function 1.9.9.1 – Add two spectra (spec1 + spec2)

The addition of two spectra can be initiated by selecting the “Add two spectra (spec1 + spec2)” option under the drop-down window that appears when the user clicks on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (fig. 142).

After starting the routine, the user is prompted to choose the first spectrum (fig. 143).

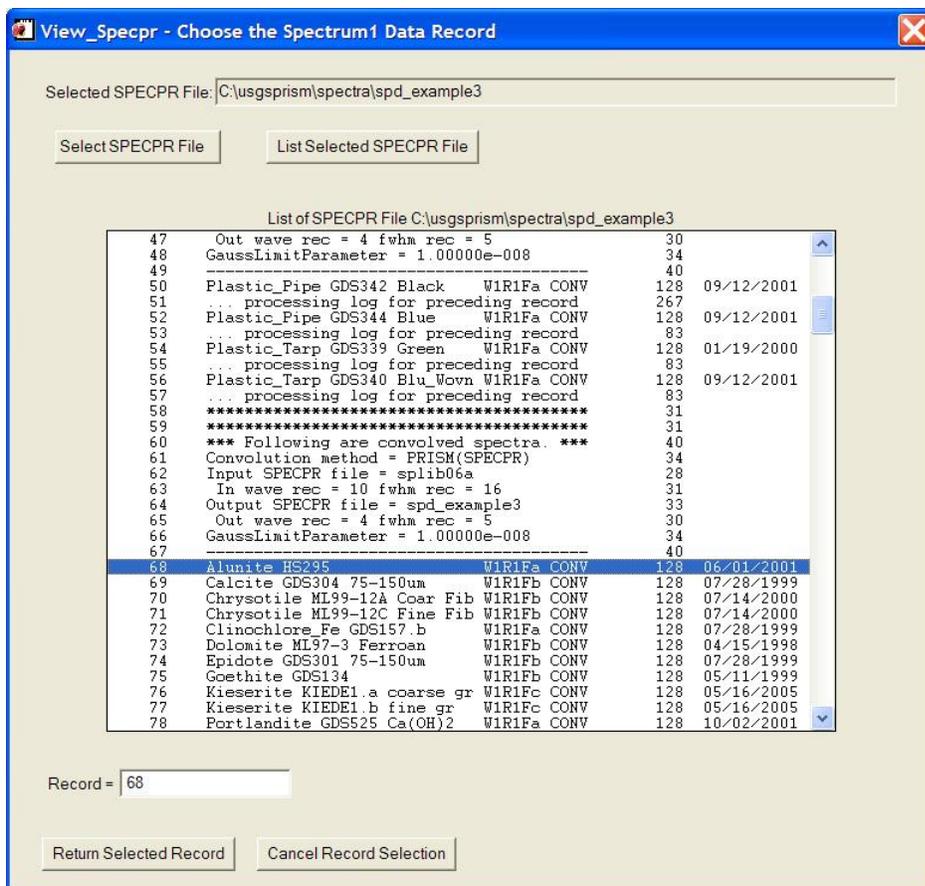


Figure 143. Selecting the first spectrum for the “Add two spectra (spec1 + spec2)” function.

Next, the user is prompted to choose the second spectrum (fig. 144). The second spectrum should have the same number of channels as the first spectrum.

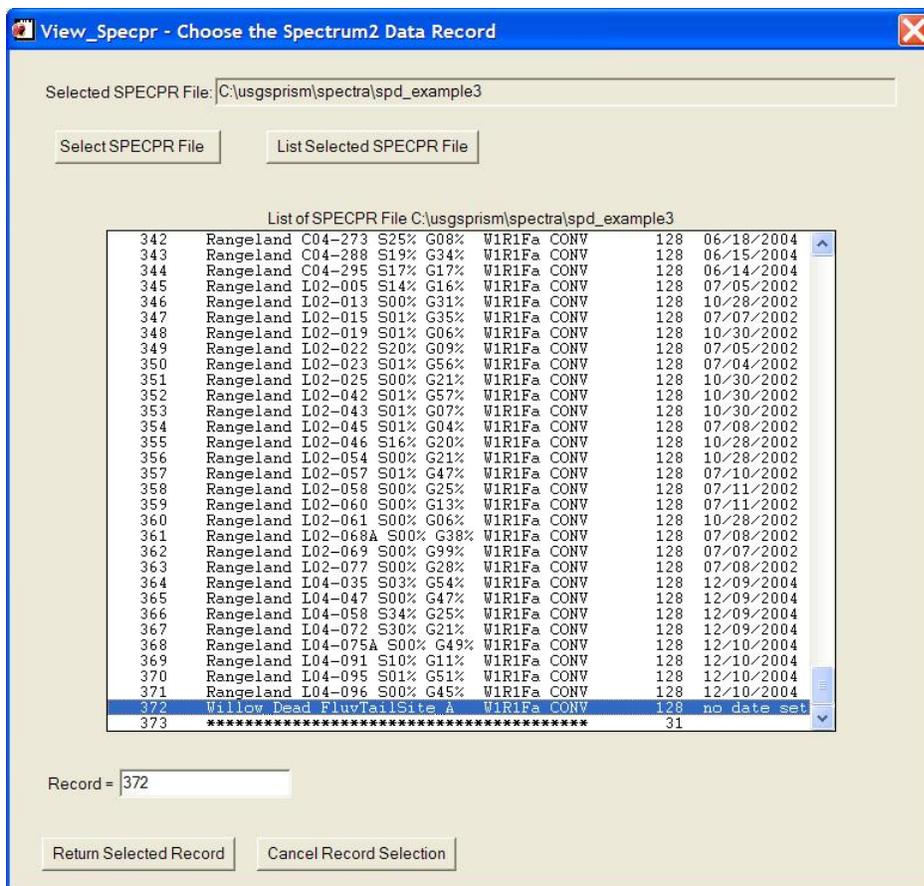


Figure 144. Selecting the second spectrum for the “Add two spectra (spec1 + spec2)” function.

Next, the user is prompted to set the wavelength record pointer for the output record (fig. 145).

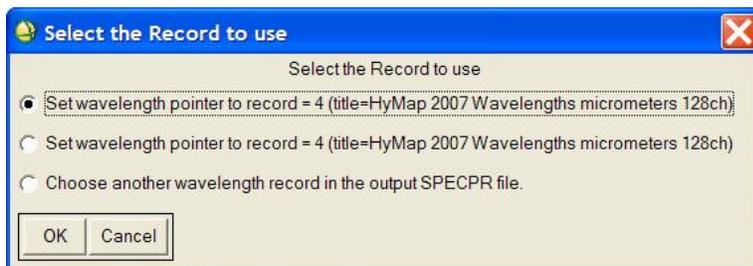


Figure 145. Selecting the wavelength record for the output spectrum of the “Add two spectra (spec1 + spec2)” function.

If the input records for spectrum1 and spectrum2 have their wavelength pointers set, the prompt will include the option of setting the wavelength pointer of the output spectrum to one of these records. Alternatively, the user may select another record interactively by choosing the last

option. If the input records for spectrum1 and spectrum2 do not have their wavelength pointers set, the user is prompted to select the wavelength record from a listing of the SPECPR file being viewed.

Next, the user is prompted to set the bandpass (FWHM) record pointer for the output record (fig. 146). If the input records for spectrum1 and spectrum2 have their bandpass (FWHM) pointers set, the prompt will include the option of setting the bandpass (FWHM) pointer of the output spectrum to one of these records. Alternatively, the user may select another record interactively by choosing the last option. If the input records for spectrum1 and spectrum2 do not have their bandpass (FWHM) pointers set, the user is prompted to select the bandpass (FWHM) record from a listing of the SPECPR file being viewed.



Figure 146. Selecting the bandpass (FWHM) record for the output spectrum of the “Add two spectra (spec1 + spec2)” function.

Next, the user is prompted to set the output title (fig. 147). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

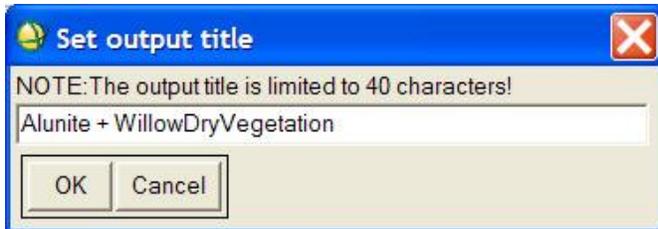


Figure 147. Setting the title for the output spectrum of the “Add two spectra (spec1 + spec2)” function.

After the output title is accepted, the output spectrum is written and a message advising that the function has completed successfully appears (fig. 148). Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh, with the new record appearing at the bottom of the listing.



Figure 148. Completion message of the “Add two spectra (spec1 + spec2)” function.

Function 1.9.9.2 – Subtract two spectra (spec1 - spec2)

The subtraction of two spectra can be initiated by selecting the “Subtract two spectra (spec1 - spec2)” option under the drop-down window that appears when the user clicks on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 142). The program follows the same flow as “*Function 1.9.9.1 – Add two spectra (spec1 + spec2)*”.

Function 1.9.9.3 – Multiply two spectra (spec1 * spec2)

The multiplication of two spectra can be initiated by selecting the “Multiply two spectra (spec1 * spec2)” option under the drop-down window that appears when the user clicks on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 142). The program follows the same flow as “*Function 1.9.9.1 – Add two spectra (spec1 + spec2)*”.

Function 1.9.9.4 – Divide two spectra (spec1 / spec2)

The division of two spectra can be initiated by selecting the “Divide two spectra (spec1 / spec2)” option under the drop-down window that appears when the user clicks on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 142). The program follows the same flow as “*Function 1.9.9.1 – Add two spectra (spec1 + spec2)*”.

Function 1.9.9.5 – Average spectra

The averaging of spectra can be initiated by selecting the “Average spectra” option under the drop-down list that appears when the user clicks on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 142). In contrast to averaging ASD spectra (see *Function 1.9.6*), this function is generally applicable to spectra collected on any spectrometer. Therefore, this function does not perform offset correction or conversion to absolute reflectance.

The user is first prompted to select the SPECPR data record that contains the wavelengths for the spectra that will be averaged (fig. 149). Once the record is selected, press the “Return Selected Wavelength Record” button.

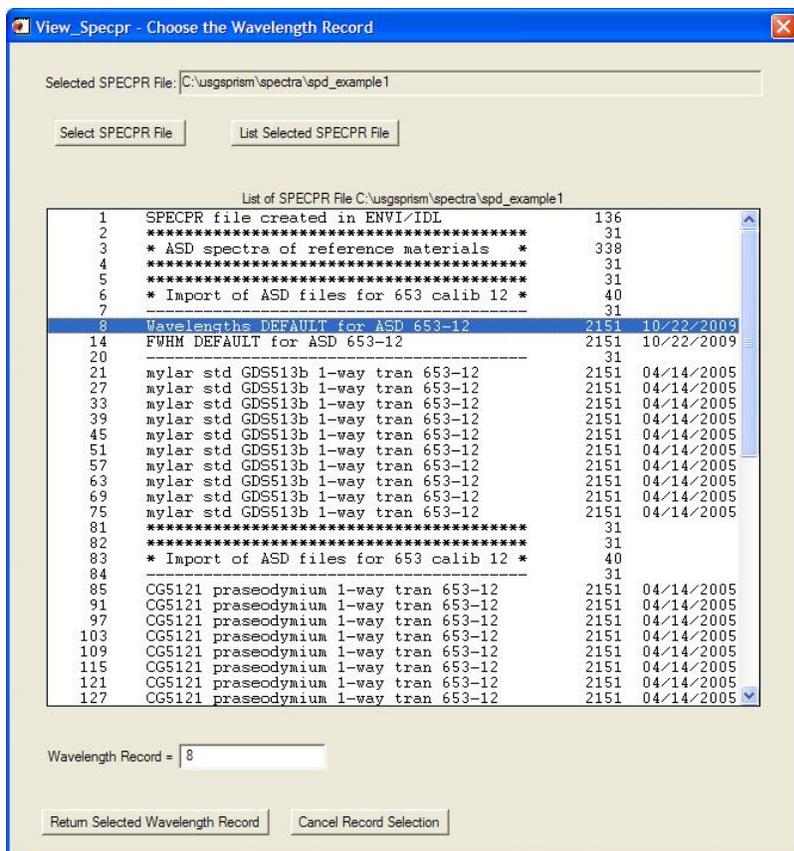


Figure 149. Choosing the wavelength record for the spectra to be averaged.

Second, the user is prompted to select the SPECPR data record that contains the bandpass (FWHM) for the spectra that will be averaged (fig. 150). Once the record is selected, press the “Return Selected FWHM Record” button.



Figure 150. Selecting the bandpass (FWHM) record for the spectra to be averaged.

Next, the user is prompted to select the SPECPR data records that contain the spectra that will be averaged (fig. 151). The user may scroll down to the desired record(s) using the scroll bar on the right. Multiple records can be selected by choosing the first record and pressing and holding the “Ctrl” (control) button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the wavelength and bandpass (FWHM), otherwise the program will report an error and halt execution. Once the records are selected, press the “Return Selected Record Numbers” button.

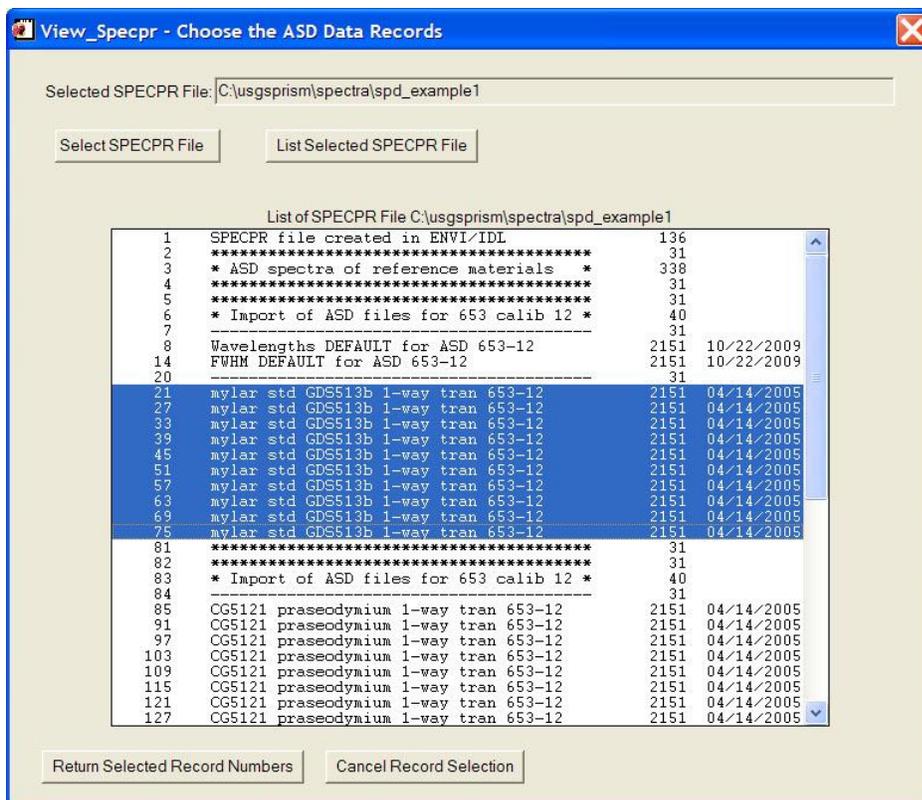


Figure 151. Selecting the records for the spectra to be averaged.

Next, the user is prompted to set the output title (fig. 152). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

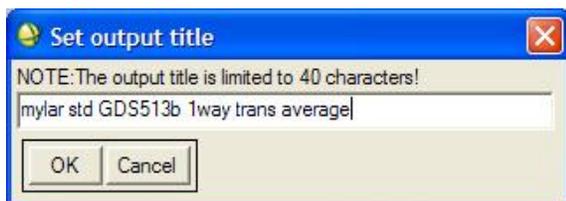


Figure 152. Setting the title for the record that will contain the average spectrum.

After the output title is accepted, the output spectrum is written and a message advising that the function has completed successfully appears. Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh, with the new record appearing at the bottom of the listing.

Function 1.9.10 – Constant arithmetic

These functions allow the user to perform simple math functions with a constant value applied to a spectrum stored in a SPECPR record (fig. 153). A constant value means a single, user-defined value that will be applied to each channel. The manner in which the value is applied depends on the selected mathematical operator, for example, “*Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)*” will add a user-defined value to each channel of the spectrum.

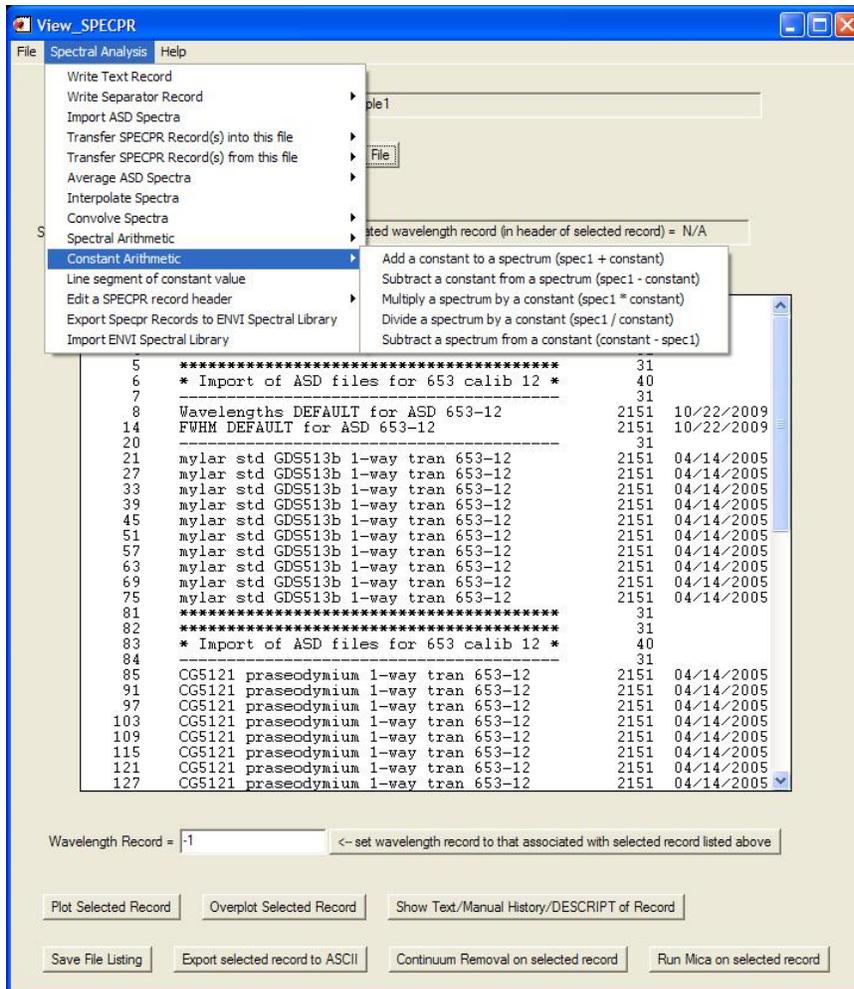


Figure 153. Arithmetic functions for spectra and constant values.

Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)

The addition of a constant value to a spectrum can be initiated by selecting the “Add a constant to a spectrum (spec1 + constant)” option under the drop-down window that appears when the user clicks on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (fig. 153).

The user is prompted to choose the spectrum (fig. 154).

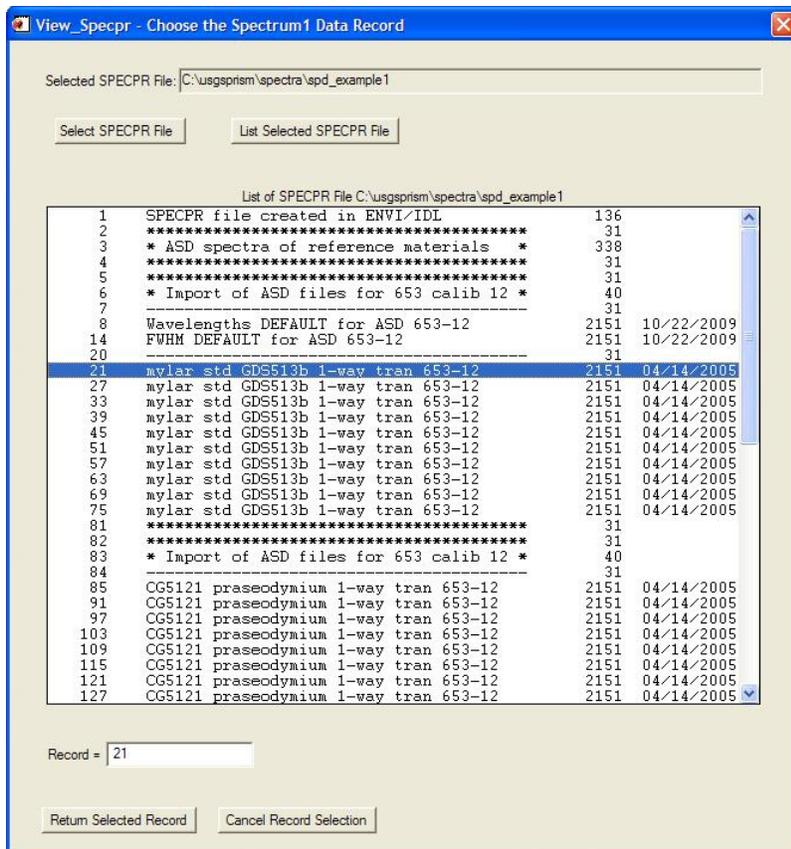


Figure 154. Selecting the spectrum for the “Add a constant to a spectrum (spec1 + constant)” function.

Next, the user is prompted to set the constant value (fig. 155). A default value of 1.0 is present. The user may change this value to the desired number (see fig. 156).



Figure 155. Setting the constant value for the “Add a constant to a spectrum (spec1 + constant)” function, default value of 1 is shown.



Figure 156. Edited constant value for the “Add a constant to a spectrum (spec1 + constant)” function.

Next, the user is prompted to set the wavelength record pointer for the output record (fig. 157). If the input record for the spectrum has its wavelength pointer set, the prompt will include the option of setting the wavelength pointer of the output spectrum to this record. Alternatively, the user may select another record interactively by choosing the last option.

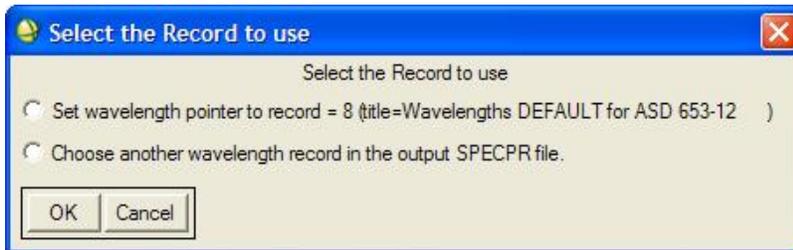


Figure 157. Selecting the wavelength record for the output spectrum of the “Add a constant to a spectrum (spec1 + constant)” function.

Next, the user is prompted to set the bandpass (FWHM) record pointer for the output record (fig. 158). If the input record for the spectrum has its bandpass (FWHM) pointer set, the prompt will include the option of setting the bandpass (FWHM) pointer of the output spectrum to this record. Alternatively, the user may select another record interactively by choosing the last option.

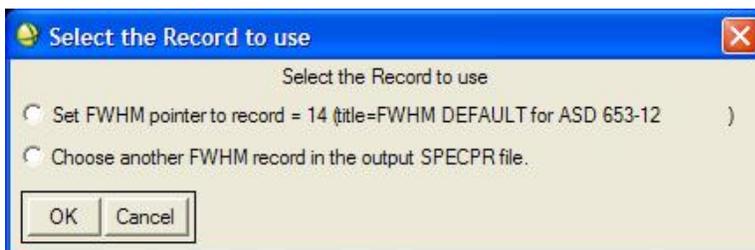


Figure 158. Selecting the bandpass (FWHM) record for the output spectrum of the “Add a constant to a spectrum (spec1 + constant)” function.

Next, the user is prompted to set the output title (fig. 159). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

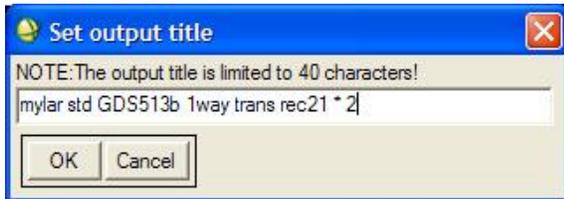


Figure 159. Setting the title for the output spectrum of the “Add a constant to a spectrum (spec1 + constant)” function.

After the output title is accepted, the output spectrum is written and a message advising that the function has completed successfully appears. Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh, with the new record appearing at the bottom of the listing.

Function 1.9.10.2 – Subtract a constant from a spectrum (spec1 - constant)

The subtraction of a constant from a spectrum can be initiated by selecting the “Subtract a constant from a spectrum (spec1 - constant)” option under the drop-down window that appears when the user clicks on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 153). The program follows the same flow as “*Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 1.9.10.3 – Multiply a spectrum by a constant (spec1 * constant)

The multiplication of a spectrum by a constant can be initiated by selecting the “Multiply a spectrum by a constant (spec1 * constant)” option under the drop-down window that appears when the user clicks on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 153). The program follows the same flow as “*Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 1.9.10.4 – Divide a spectrum by a constant (spec1 / constant)

The division of a spectrum by a constant can be initiated by selecting the “Divide a spectrum by a constant (spec1 / constant)” option under the drop-down window that appears when the user clicks on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 153). The program follows the same flow as “*Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 1.9.10.5 – Subtract a spectrum from a constant (constant - spec1)

The subtraction of a spectrum from a constant can be initiated by selecting the “Subtract a spectrum from a constant (constant - spec1)” option under the drop-down window that appears when the user clicks on the “Constant Arithmetic” item under the “Spectral Analysis” entry of

the ViewSPECPR menu bar (see fig. 153). The program follows the same flow as “*Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 1.9.11 – Line segment of constant value

This function allows the user to make a spectrum in which all channels have the same constant value. The function can be initiated by selecting the “Line segment of constant value” option under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 53). The number of channels in the output spectrum will be dependent on the wavelength record that the user associates with the spectrum in the second step of the program.

First, the user is prompted to set the constant value (fig. 160). A default value of 1.0 is present. The user may change this value to the desired number (fig. 161).



Figure 160. Setting the constant value for the “Add Line segment of constant value” function, default value of 1 is shown.



Figure 161. Edited constant value for the “Line segment of constant value” function.

Next, the user is prompted to select the SPECPR record that contains the wavelengths for the spectrum that will be generated (fig. 162). Once the record is selected, press the “Return Selected Wavelength Record” button.

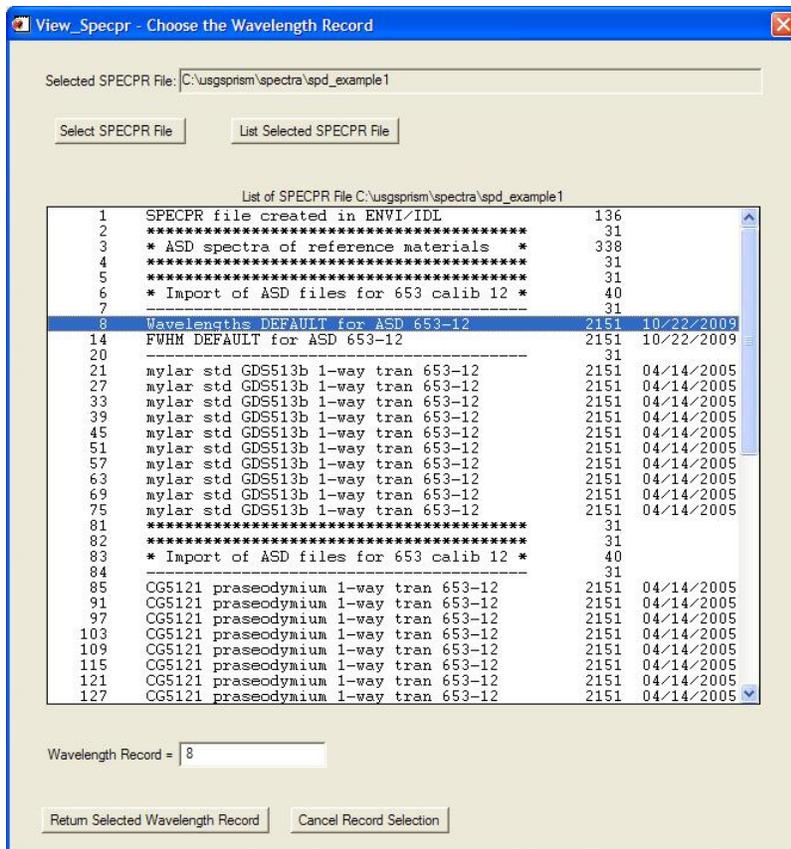


Figure 162. Choosing the wavelength record for the line segment to be generated.

Next, the user is prompted to select the SPECPR record that contains the bandpass (FWHM) for the spectrum that will be generated (fig. 163). Once the record is selected, press the “Return Selected FWHM Record” button. However, since this is not a measured spectrum, the user may either choose the bandpass (FWHM) record associated with the wavelength record (fig. 163) or the user may opt to press the “Cancel Record Selection” button and not set the bandpass (FWHM) pointer.

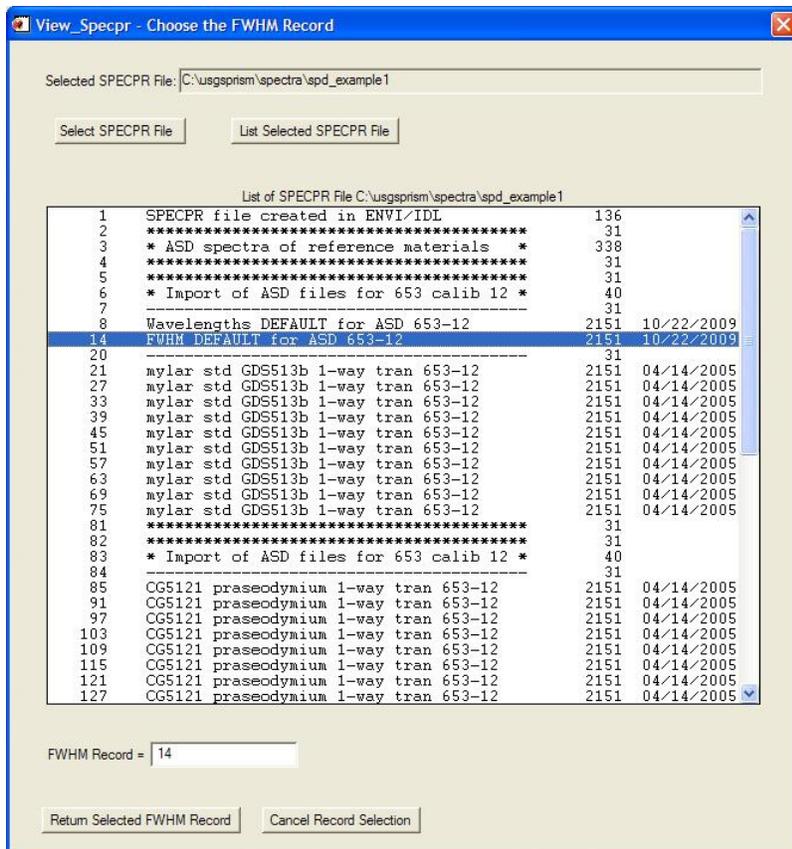


Figure 163. Selecting the bandpass (FWHM) record for the spectra to be averaged.

Next, the user is prompted to set the output title (fig. 164). The output title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered.

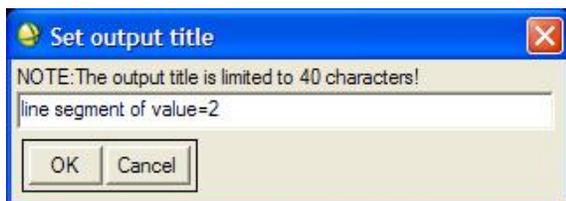


Figure 164. Setting the title for the output spectrum of the “Line segment of constant value” function.

After the output title is accepted, the output spectrum is written and a message advising that the function has completed successfully appears. Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh, with the new record appearing at the bottom of the listing.

Function 1.9.12 – Edit a SPECPR record header

These functions allow the user to edit the header information of a SPECPR record, including the spectrum's title, wavelength record pointer, and bandpass (FWHM) record pointer (fig. 165).

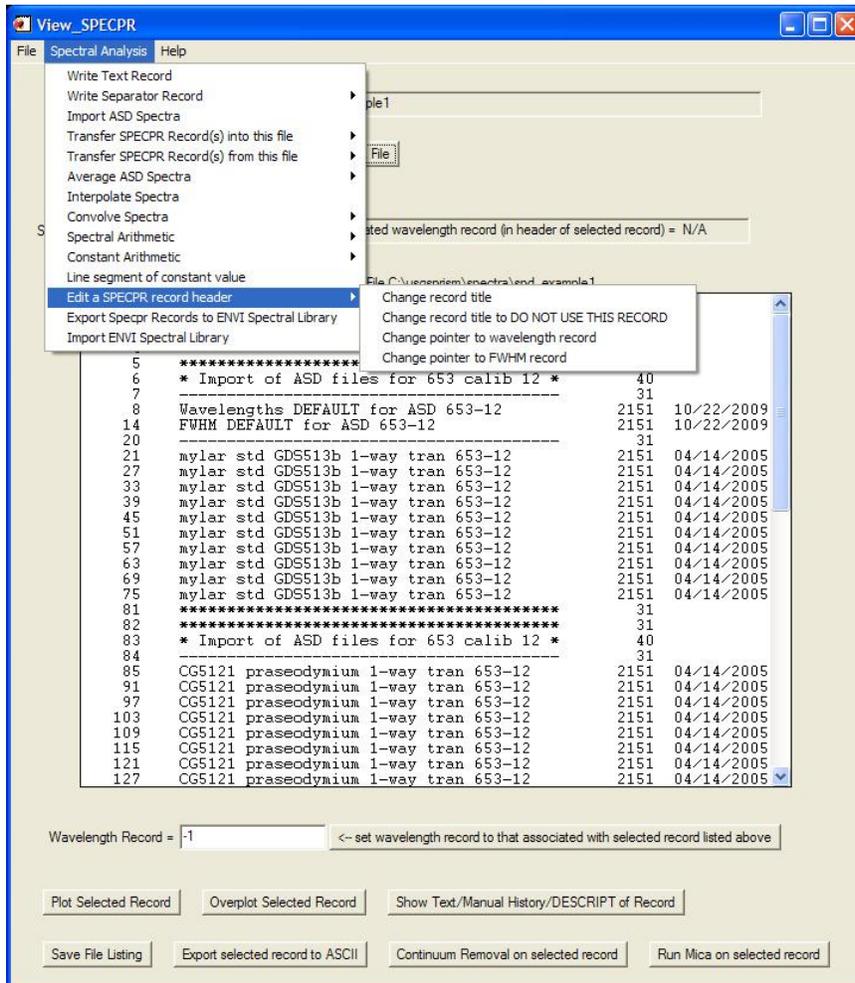


Figure 165. Functions for editing the header information of a SPECPR record.

As a precaution, each time one of these functions is used, a backup copy of the SPECPR file being edited is created. It is saved in the same directory as the SPECPR file, with the following naming convention:

Backup File = “. ”+ *<SPECPR filename>* +”_backup_”+YYYYmmmDD_HH_MM_SS
where,

<SPECPR filename> is the name of the SPECPR file being edited

YYYY is the year, for example 2009

mmm is the three letter abbreviation for the month, for example Nov for November

DD is the day of the month, for example 24

HH is the hour of the current system time, on a 24 hour clock, for example 10 for 10 a.m. and 14 for 2 p.m.

MM is the minute of the current system time

SS is the second of the current system time

Function 1.9.12.1 – Change record title

This function allows the user to change a spectrum's title by editing the SPECPR record header information. The program can be initiated by selecting the "Change record title" option under the drop-down window that appears when the user clicks on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the ViewSPECPR menu bar (see fig. 165).

First, the user is prompted to select the record to edit (fig. 166). Once the record is selected, press the "Return Selected Record" button.

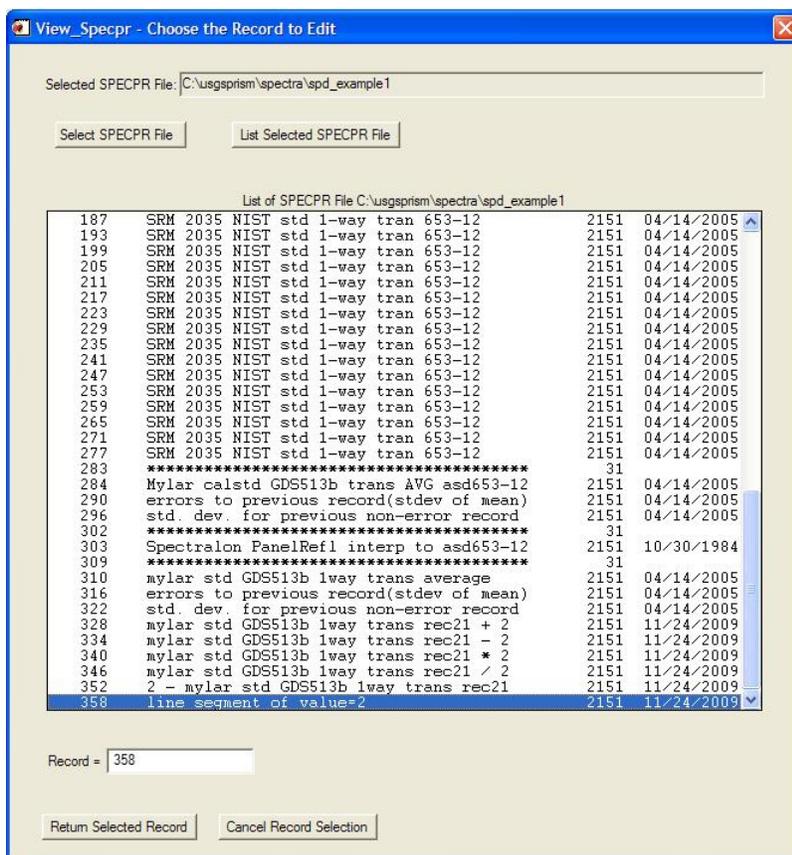


Figure 166. Selecting the record to edit.

Next the user is advised that the selected record will be edited (fig. 167); at this point the user may press "Cancel" to stop the routine.

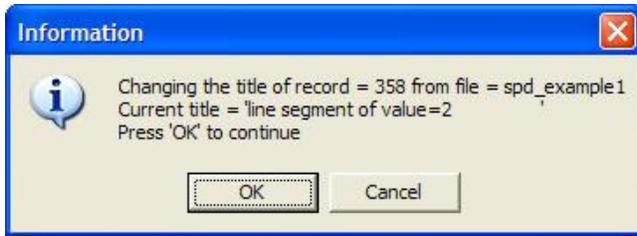


Figure 167. Information message that the record title is being changed.

Next the user is prompted to edit the existing title (fig. 168). The title is limited to 40 characters. If the title exceeds 40 characters the user will be prompted that an error occurred and the output title should be re-entered. The user may press “Cancel” to stop the routine.

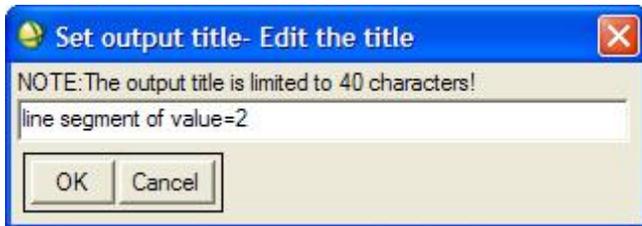


Figure 168. Prompt to edit the title.

After the title has been edited (fig. 169), press “OK” to continue.

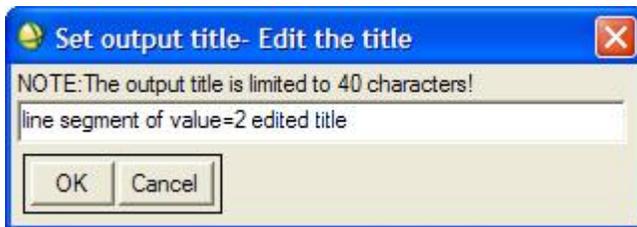


Figure 169. The edited title.

After the title has been accepted, the user is once again prompted to confirm the wish to change the SPECPR file (fig. 170). Press “Yes” to continue.

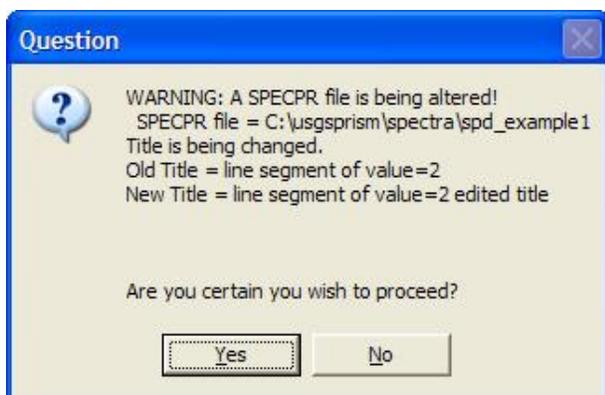


Figure 170. Confirmation message that the user wishes to change the record title.

Next the program makes a backup copy of the SPECPR file before changing the record's title. The backup file follows naming convention described previously. In this case, the backup file for "C:\usgsprism\spectra\spd_example1" is "C:\usgsprism\spectra\spd_example1_backup_2009Nov24_10_51_36". The "." at the beginning of the filename can indicate to the system that the file is a "hidden" file and the user may have to alter the system settings to see this file in the listing of the folder's contents. After the backup copy has been made and the SPECPR file is edited to change the title, a message advising that the function has completed successfully appears (fig. 171). Click the "OK" button to dismiss the message. The listing of the SPECPR file will refresh.



Figure 171. Message advising the user that the title has been changed.

Function 1.9.12.2 – Change record title to "DO NOT USE THIS RECORD"

This function allows the user to change a spectrum's title to "DO NOT USE THIS RECORD". The program can be initiated by selecting the "Change record title to DO NOT USE THIS RECORD" option under the drop-down window that appears when the user clicks on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the ViewSPECPR menu bar (see fig. 165).

First, the user is prompted to select the record to edit (fig. 172). Once the record is selected, press the "Return Selected Record" button.

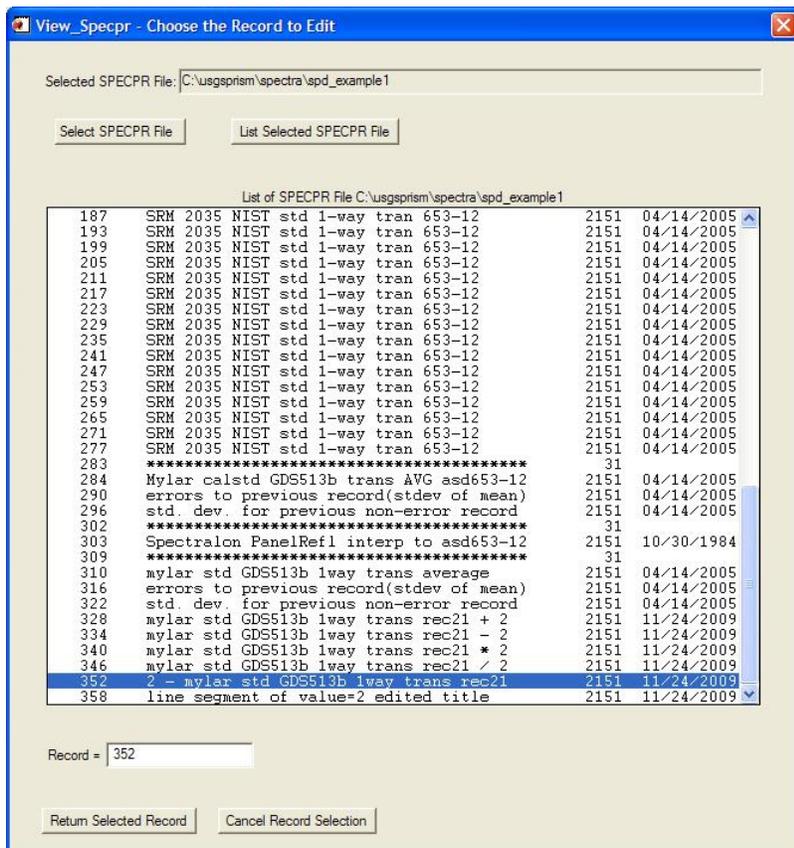


Figure 172. Selecting the record to edit, changing the title to “DO NOT USE THIS RECORD”.

Next the user is advised that the selected record will be edited (fig. 173); at this point the user may press “Cancel” to stop the routine.



Figure 173. Information message that the record title is being changed.

The user is prompted to confirm the wish to change the title of the SPECPR record to “DO NOT USE THIS RECORD” (fig. 174). Press “Yes” to continue.



Figure 174. Confirmation message that the user wishes to change the record title to “DO NOT USE THIS RECORD”.

Next the program makes a backup copy of the SPECPR file before changing the record’s title. The backup file follows the naming convention described previously. In this case, the backup file for “C:\usgsprism\spectra\spd_example1” is “C:\usgsprism\spectra\spd_example1_backup_2009Nov24_11_02_08”. The “.” at the beginning of the filename may indicate to the system that the file is a “hidden” file, in which case, the user may have to alter the system settings to see this file in the listing of the folder’s contents. Note: because the backup filename changes with the current time, it will differ from previous backup files. Therefore, previous backup files are not overwritten.

After the backup copy has been made and the SPECPR file is edited to change the title, a message advising that the function has completed successfully appears (fig. 175). Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh.



Figure 175. Message advising the user that the title has been changed.

Function 1.9.12.3 – Change pointer to wavelength record

This function allows the user to change the spectrum’s pointer to the wavelength record. The program can be initiated by selecting the “Change pointer to wavelength record” option under the drop-down window that appears when the user clicks on the “Edit a SPECPR record header” item under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 165).

First, the user is prompted to select the record to edit (fig. 176). Once the record is selected, press the “Return Selected Record” button.

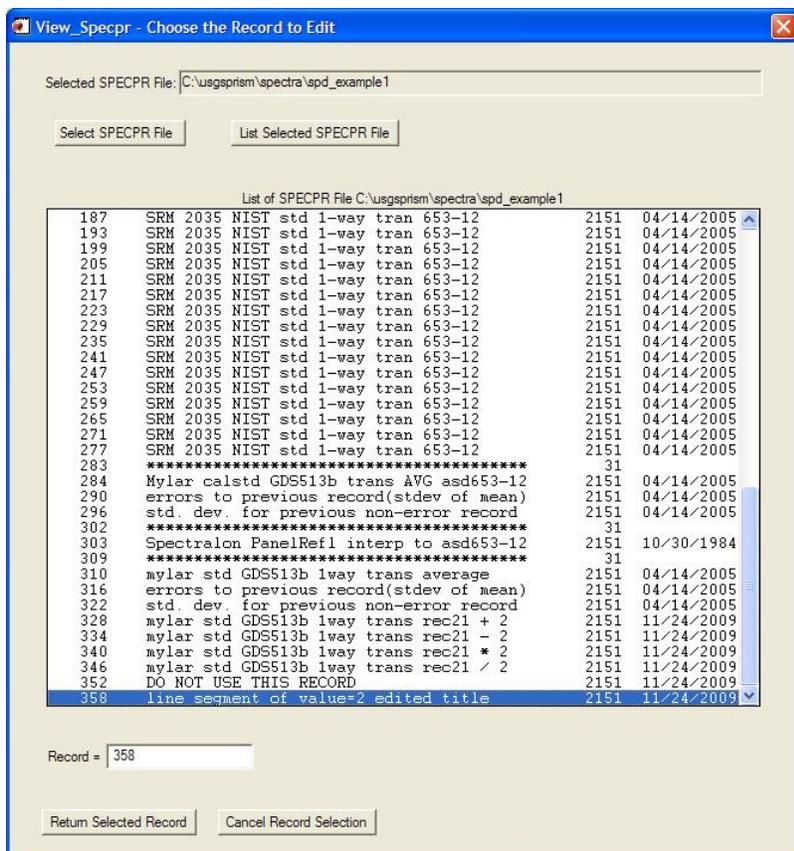


Figure 176. Selecting the record to edit, changing the pointer to the wavelength record.

Next, the user is prompted to choose the new wavelength record to associate with the edited spectrum (fig. 177).

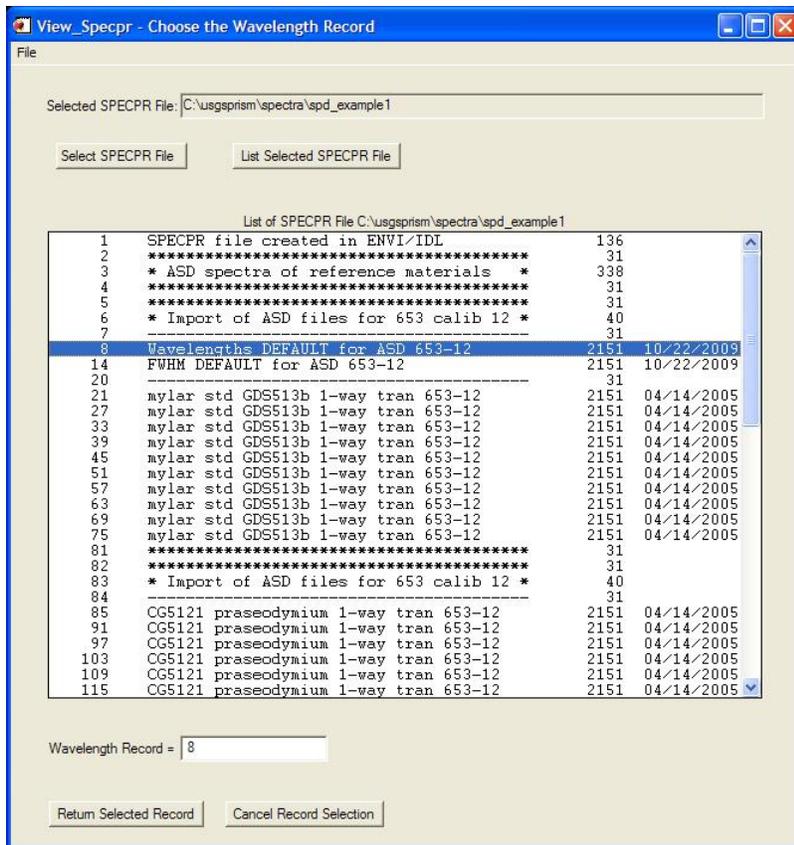


Figure 177. Selecting the wavelength record to associate with the edited record.

The user is prompted to confirm the wish to edit the SPECPR file, changing the pointer to the wavelength record (fig. 178). Press “Yes” to continue.



Figure 178. Confirmation message that the user wishes to change the pointer to the wavelength record.

Next the program makes a backup copy of the SPECPR file before changing the record's wavelength pointer. The backup file follows the naming convention described previously. In this case, the backup file for "C:\usgsprism\spectra\spd_example1" is "C:\usgsprism\spectra\spd_example1_backup_2009Nov24_13_07_40". The "." at the beginning of the filename may indicate to the system that the file is a "hidden" file, in which case, the user may have to alter the system settings to see this file in the listing of the folder's contents. Note: because the backup filename changes with the current time, it will differ from previous backup files. Therefore, previous backup files are not overwritten.

After the backup copy has been made and the SPECPR file is edited to change the wavelength pointer, a message advising that the function has completed successfully appears (fig. 179). Click the "OK" button to dismiss the message.



Figure 179. Message advising the user that the wavelength pointer has been changed.

Function 1.9.12.4 – Change pointer to FWHM record

This function allows the user to change a spectrum's pointer to the bandpass (FWHM) record. The program can be initiated by selecting the "Change pointer to FWHM record" option under the drop-down window that appears when the user clicks on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the ViewSPECPR menu bar (see fig. 165).

First, the user is prompted to select the record to edit (fig. 180). Once the record is selected, press the "Return Selected Record" button.

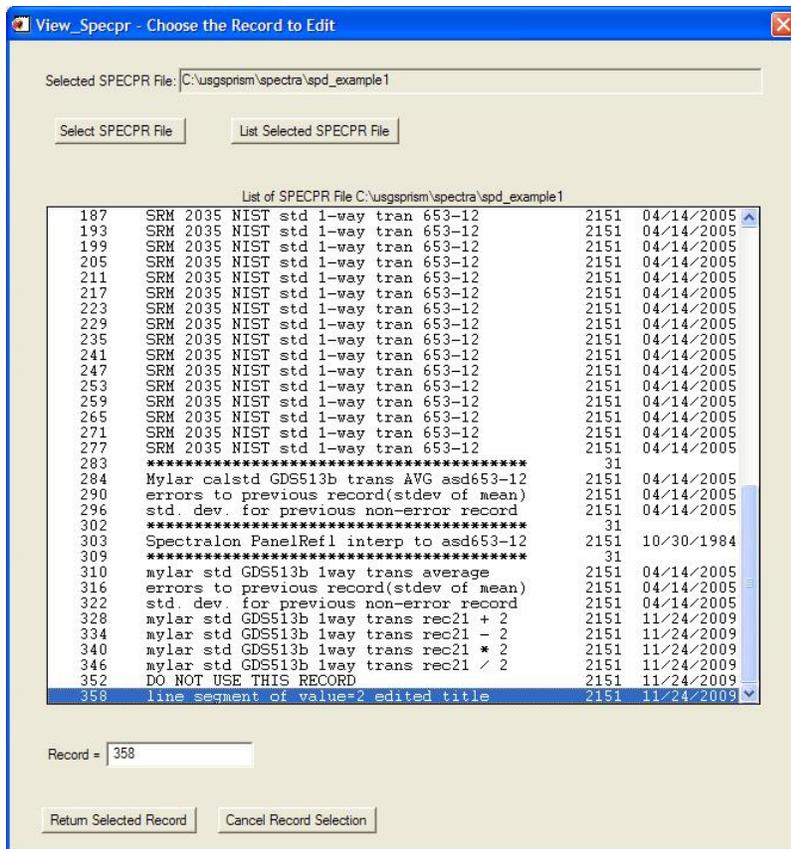


Figure 180. Selecting the record to edit, changing the pointer to the FWHM record.

Next, the user is prompted to choose the new bandpass (FWHM) record to associate with the edited spectrum (fig. 181).

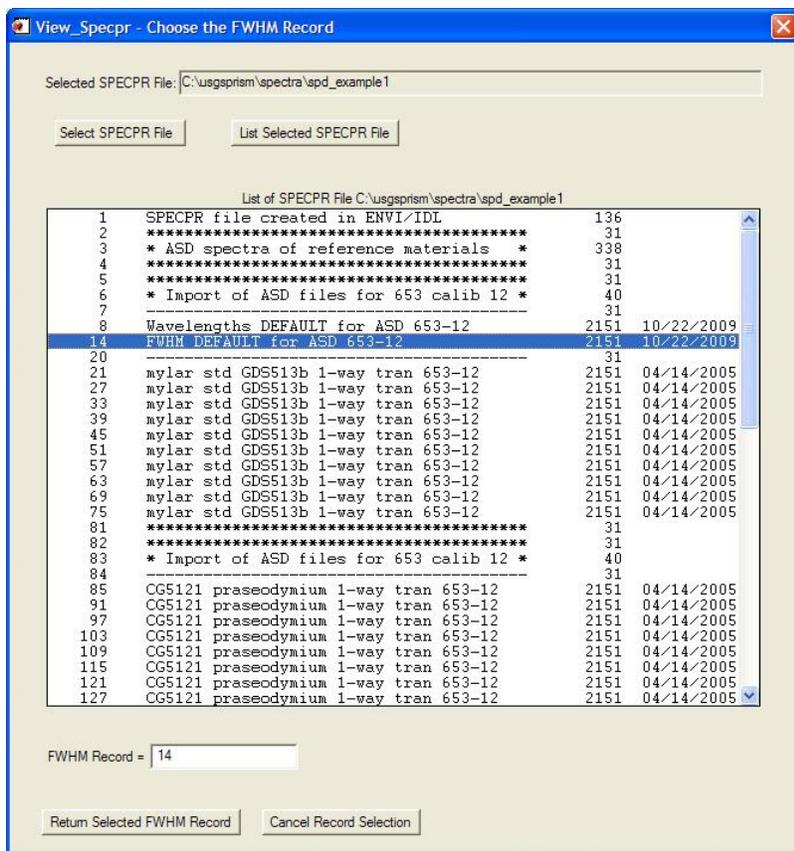


Figure 181. Selecting the bandpass (FWHM) record to associate with the edited record.

The user is prompted to confirm the wish to edit the SPECPR file, changing the pointer to the bandpass (FWHM) record (fig. 182). Press “Yes” to continue.



Figure 182. Confirmation message that the user wishes to change the pointer to the bandpass (FWHM) record.

Next the program makes a backup copy of the SPECPR file before changing the record's bandpass (FWHM) pointer. The backup file follows naming convention described previously. In this case, the backup file for "C:\usgsprism\spectra\spd_example1" is "C:\usgsprism\spectra\spd_example1_backup_2009Nov24_13_18_04". The "." at the beginning of the file may indicate to the system that the file is a "hidden" file, in which case, the user may have to alter the system settings to see this file in the listing of the folder's contents. Note: because the backup filename changes with the current time, it will differ from previous backup files. Therefore, previous backup files are not overwritten.

After the backup copy has been made and the SPECPR file is edited to change the bandpass (FWHM) pointer, a message advising that the function has completed successfully appears (fig. 183). Click the "OK" button to dismiss the message. The listing of the SPECPR file will refresh.



Figure 183. Message advising the user that the bandpass (FWHM) pointer has been changed.

Function 1.9.13 – Export SPECPR Records to ENVI Spectral Library

This function allows the user to export spectra stored in a SPECPR file to an ENVI spectral library file. The output ENVI spectral library file will be created during the program execution. The function can be initiated by selecting the "Export SPECPR Records to ENVI Spectral Library" option under the "Spectral Analysis" entry of the ViewSPECPR menu bar (see fig. 53).

First, the user is prompted to select the wavelength record that is associated with the spectra to export (fig. 184). Press "Return Selected Wavelength Record" after choosing the record.

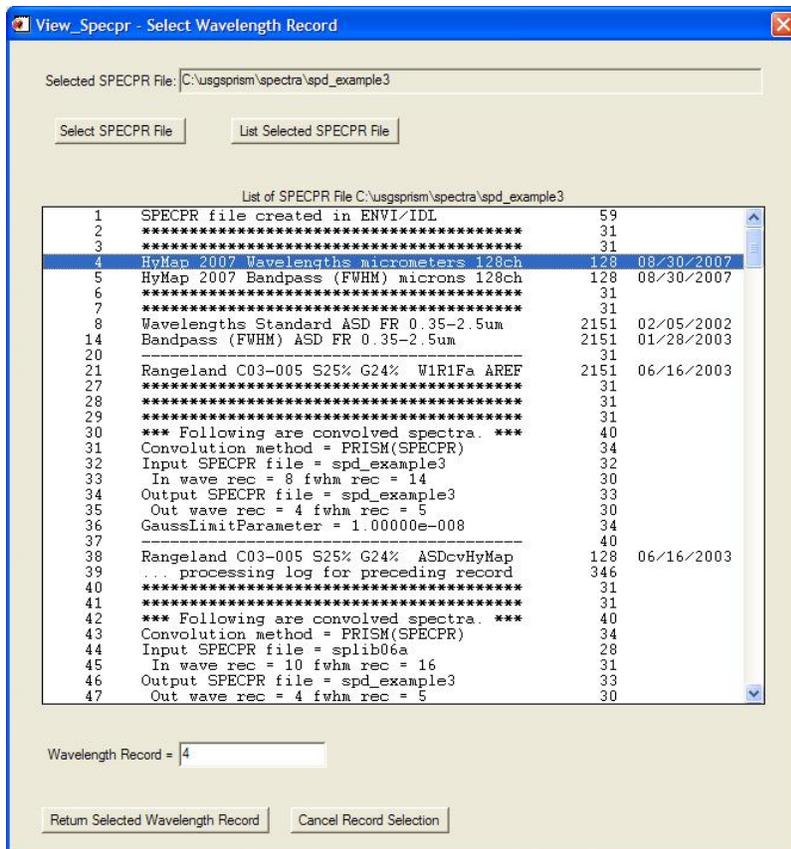


Figure 184. Selecting the wavelength record that is associated with the spectra to export to an ENVI spectral library.

Next, the user is prompted to select the bandpass (FWHM) record that is associated with the spectra to export (fig. 185). Press “Return Selected FWHM Record” after choosing the record.

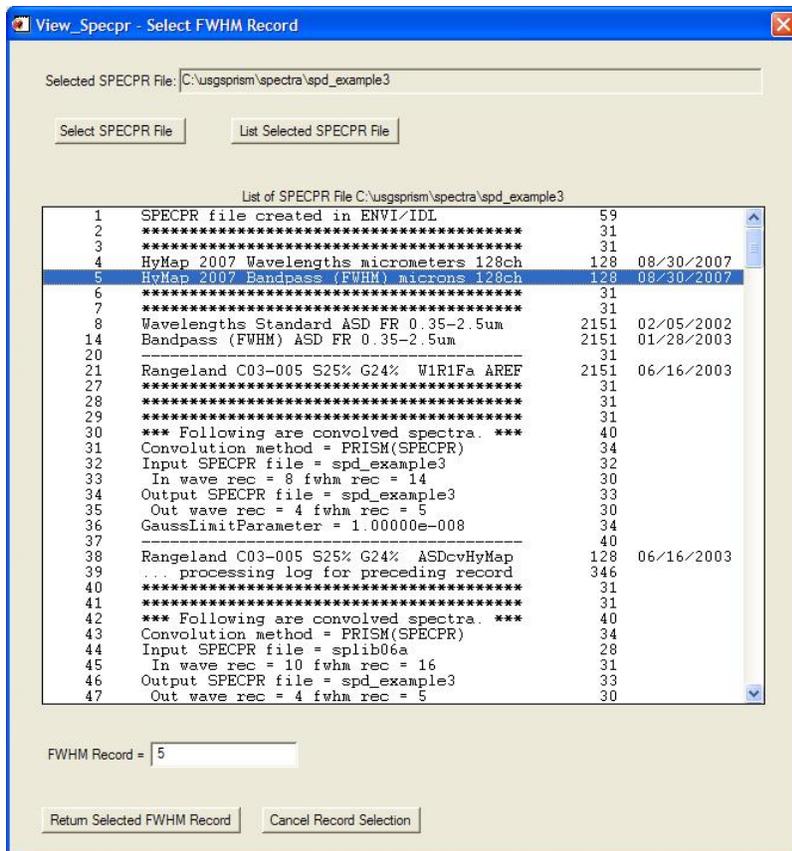


Figure 185. Selecting the bandpass (FWHM) record that is associated with the spectra to export to an ENVI spectral library.

Next, the user is prompted to select the spectra to export (fig. 186). Press “Return Selected Record Numbers” after choosing the record(s). The user may scroll down to the desired record(s) using the scroll bar on the right. Multiple records can be selected by choosing the first record and pressing and holding the “Ctrl” (control) button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the wavelength and bandpass (FWHM), otherwise the program will report an error and halt execution.

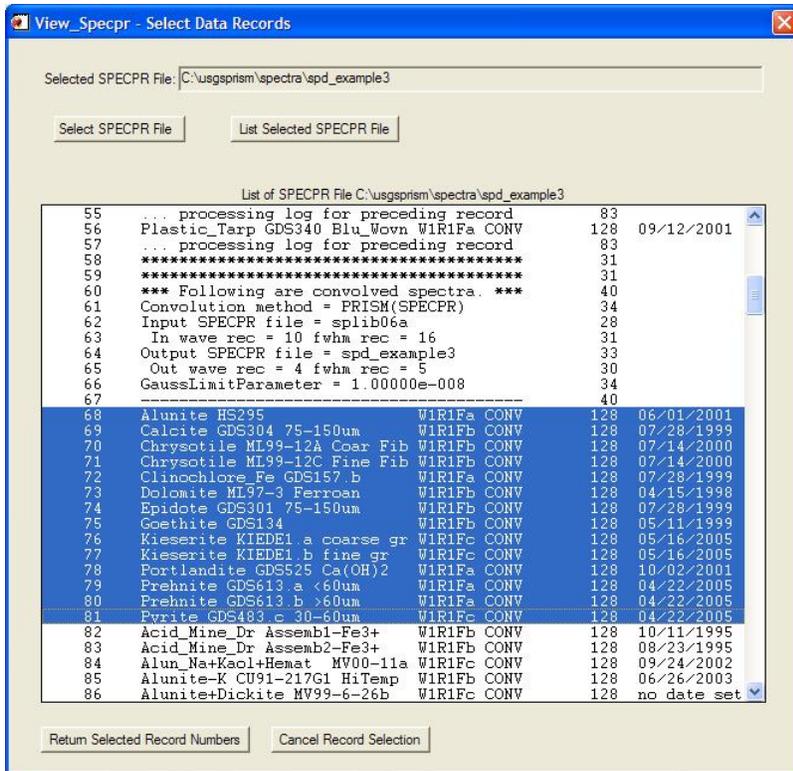


Figure 186. Selecting the spectra to export to an ENVI spectral library.

Next, the user is prompted to set the output ENVI spectral library filename (fig. 187). The user should include the “.sli” extension at the end of the filename because ENVI expects this extension to be present at the end of spectral library filenames.

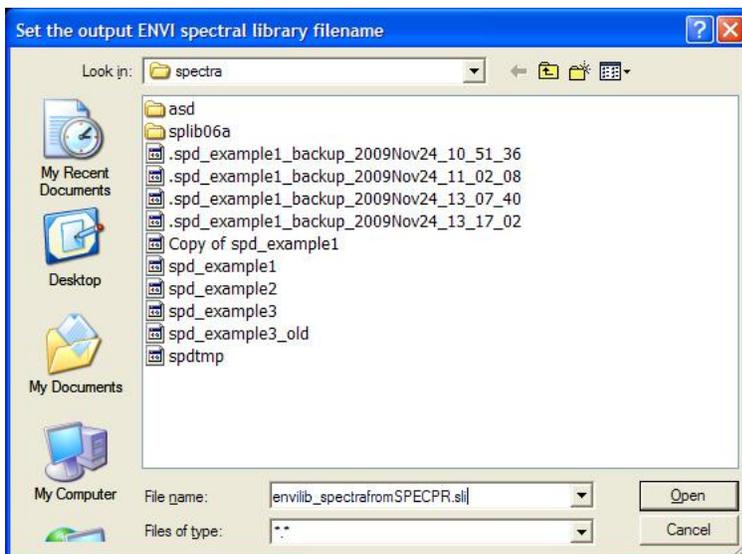


Figure 187. Setting the filename for the ENVI spectral library.

Next, the user is prompted to set the wavelength units (fig. 188). Press “OK” after choosing the appropriate unit.



Figure 188. Setting the wavelength units for the ENVI spectral library file.

Next, the user is prompted to set the reflectance scale factor (fig. 189). Press “OK” after setting the value.

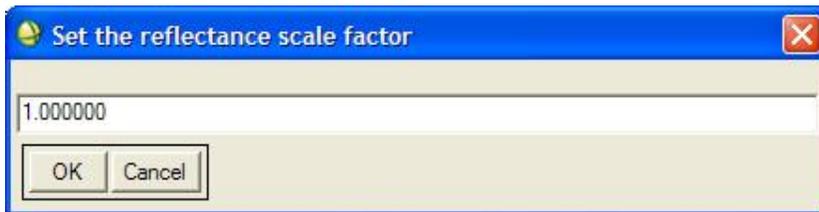


Figure 189. Setting the reflectance scale factor for the ENVI spectral library file.

After the ENVI spectral library is created, a message advising that the function has completed successfully appears (fig. 190). Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh.



Figure 190. Message advising the user that the ENVI spectral library file has been created.

The file will appear in the ENVI available bands list (fig. 191).



Figure 191. The newly created ENVI spectral library file listed in the ENVI available bands list.

The contents of the ENVI spectral library file containing the exported records may be listed in ENVI using the “Spectral Library Viewer” of ENVI (fig. 192). By clicking on the titles, the user can plot the spectra (fig. 193).

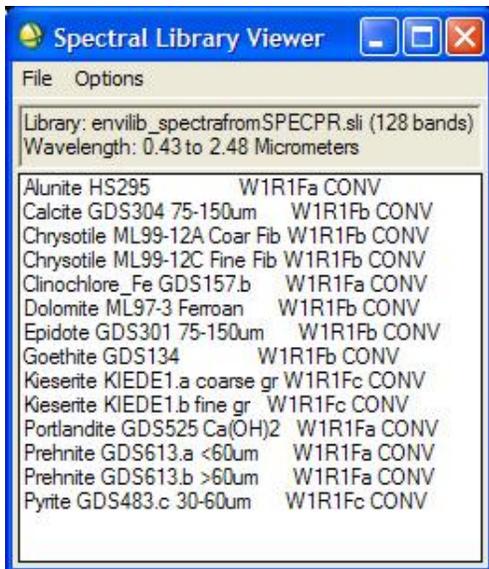


Figure 192. The contents of the newly created ENVI spectral library listed using the “Spectral Library Viewer” function of ENVI.

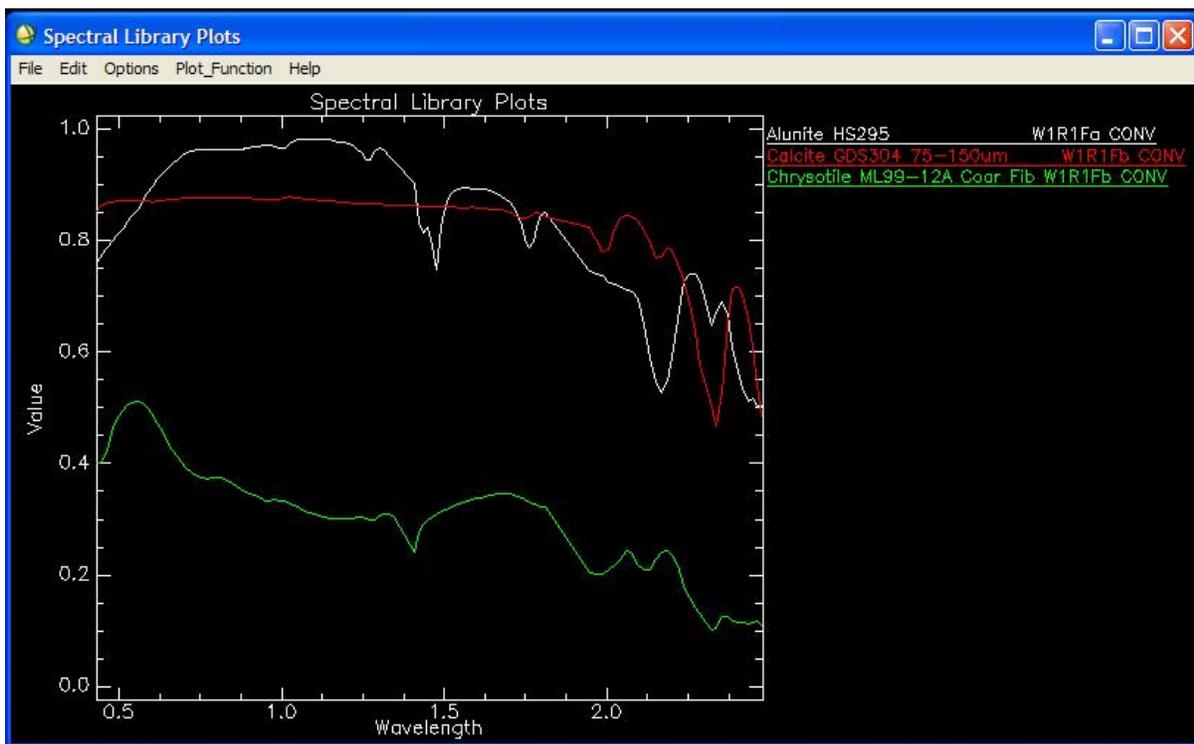


Figure 193. Spectra from the newly created ENVI spectral library.

Note that the header of the ENVI spectral library file has the data ignore value set to the SPECPR deleted point value of $-1.23e^{+34}$. Thus, any channel that contains this data value is not plotted in ENVI.

Function 1.9.14 – Import ENVI Spectral Library

This function allows the user to import spectra stored in an ENVI spectral library file to the SPECPR file being viewed. The function can be initiated by selecting the “Import ENVI Spectral Library” option under the “Spectral Analysis” entry of the ViewSPECPR menu bar (see fig. 53).

First, the user is prompted to select the ENVI spectral library file (fig. 194). After selecting the file, press “Open” to continue the program.

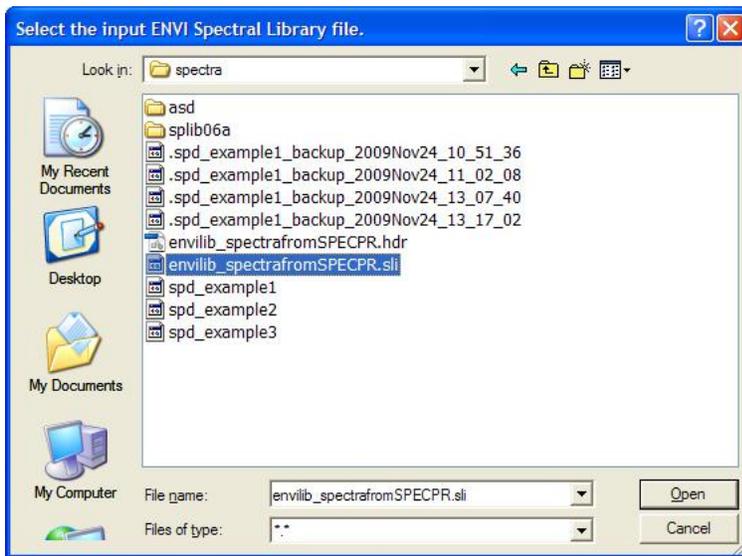


Figure 194. Selecting the ENVI spectral library file to be imported into the SPECPR file being viewed.

After the spectra in the ENVI spectral library are imported, a message advising that the function has completed successfully appears (fig. 195). Click the “OK” button to dismiss the message. The listing of the SPECPR file will refresh with imported spectra at the bottom of the listing.



Figure 195. Message advising the user that the ENVI spectral library file has been imported.

The imported spectra appear at the end of the listing of the SPECPR file being viewed (fig. 196). Before the imported spectra are written, several records are written. First, a text separator record of asterisks (record 394) is written. Next, a text record with a title indicating the following spectra were imported from ENVI (record 395) is written. Next, a text separator record of dashes (record 396) is written. Then, a data record containing the wavelength values found in the ENVI header to the spectral library file (record 397) is written. Then, a data record containing the bandpass (FWHM) values found in the ENVI header to the spectral library file (record 398) is written. Note: if the bandpass (FWHM) values are not set in the header of the ENVI spectral library file, then this record will not be created. After these records, the data records containing the spectra from the ENVI spectral library are written (records 399 to 412). Finally, another text separator record of asterisks (record 413) is written to demarcate the end of the block of records generated from the importation of an ENVI spectral library.



Figure 196. Records written after importing an ENVI spectral library.

The record headers of the wavelength and data records contain additional information on the source file of the imported spectra. To view, select the record and press the “Show Header Info/Text/DESCRIP of Record”. Figure 197 shows the header information in the wavelength record written in this example. The last two lines of the header information give the input ENVI spectral library filename and directory location.

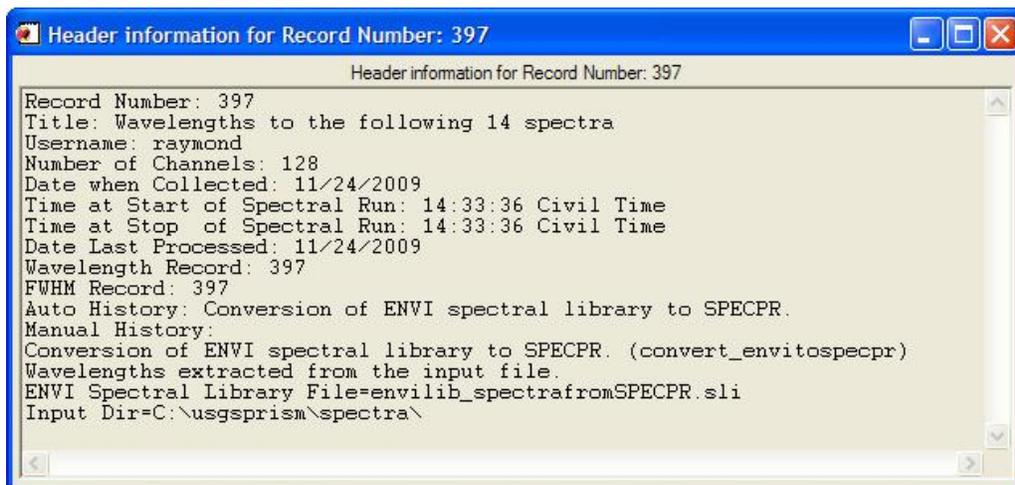


Figure 197. Header information in the wavelength record written when importing an ENVI spectral library.

As noted in the function’s description, if the bandpass (FWHM) values are not set in the header of the ENVI spectral library file, then this record will not be created and the imported spectra will not have their pointers set to a bandpass (FWHM) record. This could be problematic if the spectra will be compared with spectra measured on other spectrometers, as the interpolation and convolution functions require bandpass (FWHM) information. Thus, if the bandpass (FWHM) values are not set in an ENVI spectral library file, but these values are known, it is best to set these values in the ENVI header before importing the ENVI spectral library. Otherwise, later, the user may need to separately import the bandpass (FWHM) values into a SPECPR record and use “*Function 1.9.12.4 – Change pointer to FWHM record*” to set the bandpass (FWHM) pointers for records that do not have that pointer set.

Function 1.10 – Viewing the “Help file”

The “Help file” (this document) can be opened by clicking on the “Help” menu item at the top of the ViewSPECPR control window (see fig. 4) and choosing the “Help on PRISM” option that appears. Select the “PRISM_help.htm” document. If the user followed the instructions in the “*Installation of Software*” section of this report, the help file will be located at “C:\usgsprism\PRISM_help.htm” on Windows computers and at “/var/local/usgsprism/PRISM_help.htm”. An internet browser window should appear with an HTML version of this report. If a Web browser fails to launch when attempting to view the help file, the user should consult their ENVI/IDL User’s Guide.

Function 1.11 – Quitting the ViewSPECPR program

The program can be closed by clicking on the “File” menu entry in the top left corner of the ViewSPECPR control window (see fig. 2) and choosing the “Quit” option that appears. Note: The main widget and all plot windows and text information boxes will automatically close when quitting the program. However, continuum removal iPlot windows, continuum removal interface GUIs, and DESCRIPT windows will not automatically close.

iPlot Functions

This section describes some selected functions of the iPlot tool in ENVI/IDL that may be useful when working with plots produced from ViewSPECPR. For comprehensive information on the iPlot tool, consult the documentation provided with your installed ENVI/IDL version.

Export plot to encapsulated PostScript and other image formats

This feature of iPlot allows the user to export the contents of the plot window to an encapsulated PostScript (.eps) file. The advantage offered by the use of this function is that the individual vector elements of the plot (such as the font of the title, the thickness of the x-axis, or the color of the plot line) can be manipulated when the eps file is imported into a program such as Adobe Illustrator[®]. To start the export process, click the “Save as” option under the file menu of the iPlot window (fig. 198).

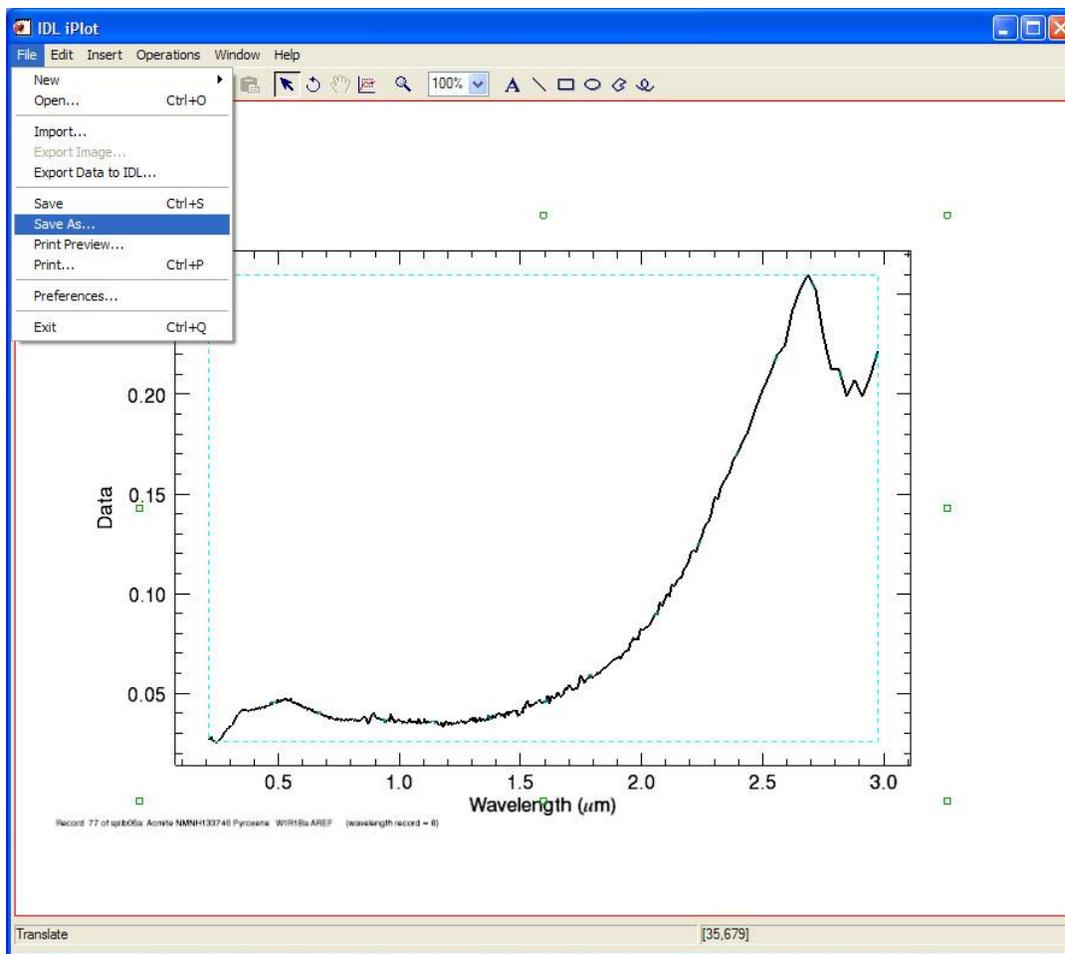


Figure 198. Exporting the plot to an encapsulated PostScript file.

In the window that appears, choose encapsulated PostScript (.eps) as the type to save, set the output title (fig. 199), and press save to create the PostScript file. Alternatively, the user could choose one of the image formats, for example JPEG, in which to save the plot.

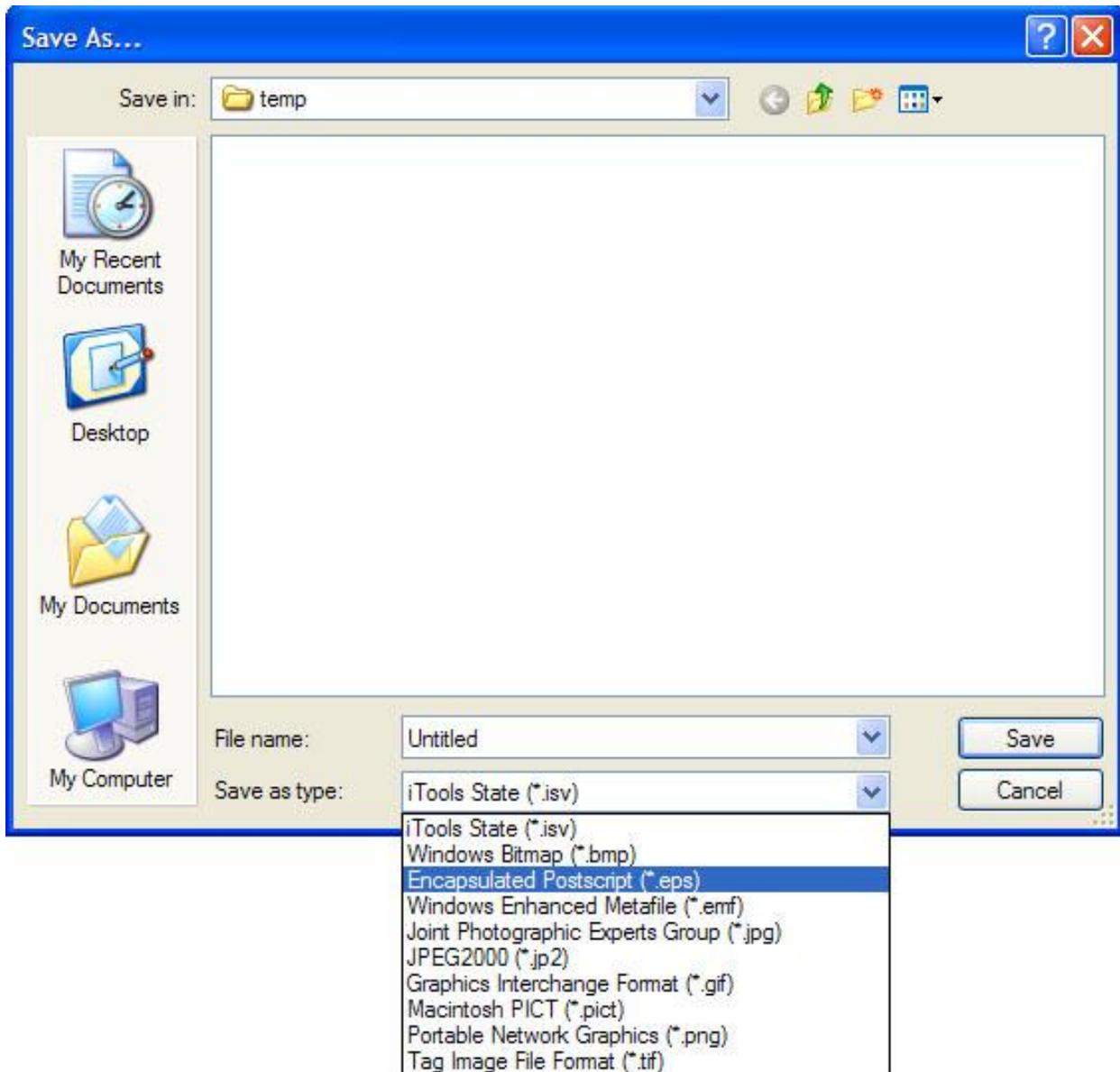


Figure 199. Exporting the plot to an encapsulated PostScript file – step 1.

Module 2. Spectral Analysis Functions

A variety of functions for importing/exporting data to/from SPECPR files, managing and editing SPECPR records, and applying arithmetic, convolution and interpolation functions to spectra stored in SPECPR data records can be accessed from the “Spectral Analysis” item in the PRISM list of modules (fig. 200). Many of these routines are the same as those accessed from the “Spectral Analysis” menu item of the *ViewSPECPR Module* (see the “*Function 1.9 – ViewSPECPR spectral analysis functions*” section of this report). The essential difference between the use of the routines from the “Spectral Analysis” item in the PRISM drop-down list,

compared to their use from within the ViewSPECPR module, is that the routines invoked from within the ViewSPECPR module assume that the input/output SPECPR file is the one that is being viewed. Thus, the routines, when invoked from the “Spectral Analysis” item in the PRISM drop-down list, prompt the user to select the input and output SPECPR files.

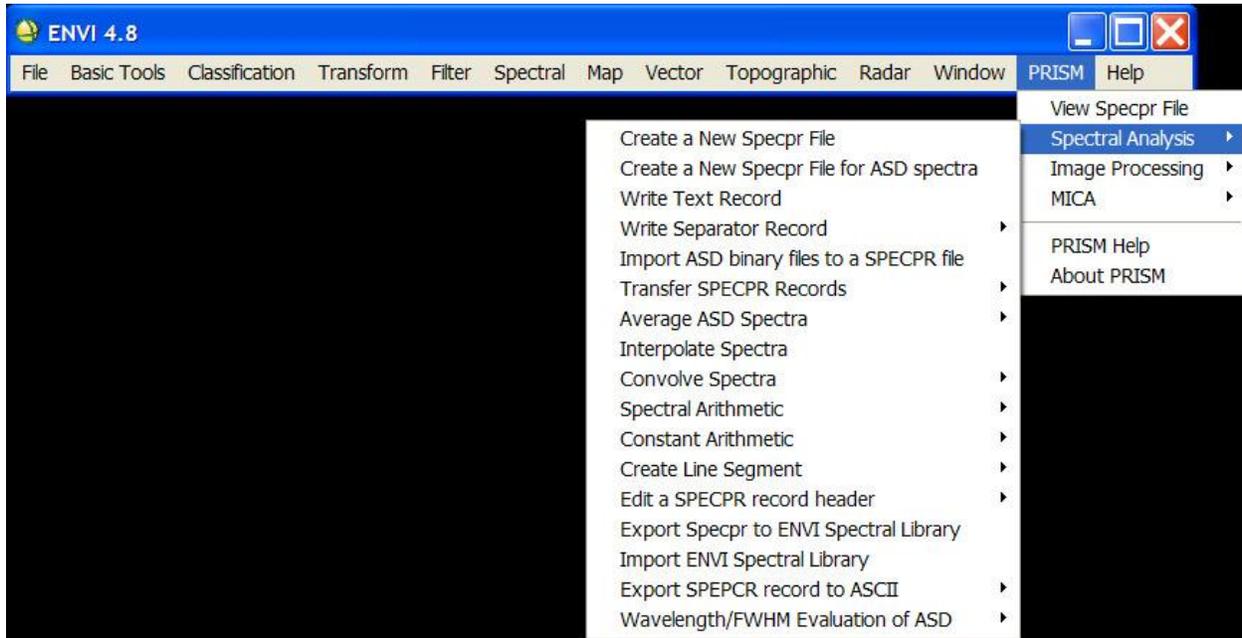


Figure 200. Spectral analysis functions available under the PRISM menu item.

Function 2.1 – Create a new SPECPR file

This function allows the user to create a new SPECPR file, to which two records are added. The first record added is a text record, containing some default information on the file’s creation. The user is prompted to enter additional information to store in this record, if desired. The second record is a text separator record of asterisks.

The function can be initiated by selecting the “Create a New SPECPR File” option under the “Spectral Analysis” module of the “PRISM” menu entry on the main ENVI menu bar (fig. 200). The user is first prompted to set the directory location and filename of the SPECPR file to create (fig. 201).

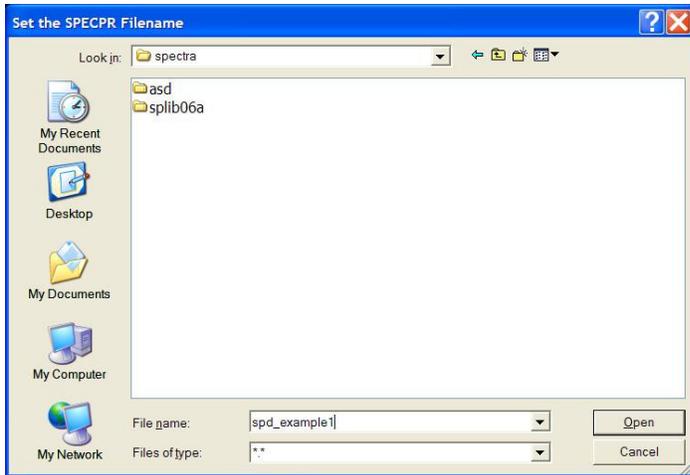


Figure 201. Setting the name of the SPECPR file to create.

Next, a window appears with some default text to store in the first record (fig. 202).

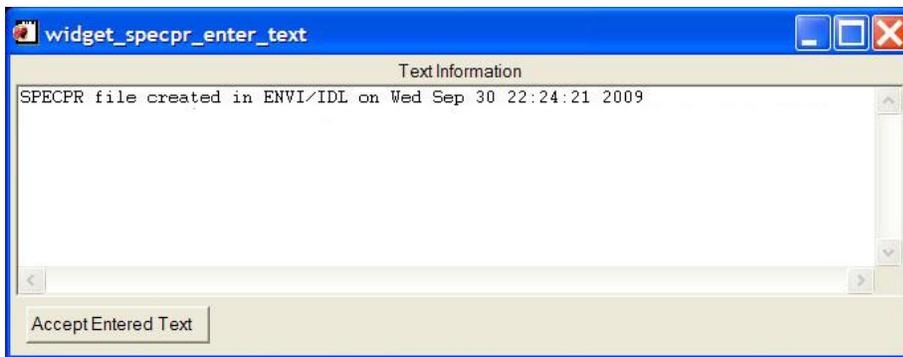


Figure 202. Default information to store in the text record when creating a SPECPR file.

The user may edit this text or add text (fig. 203).

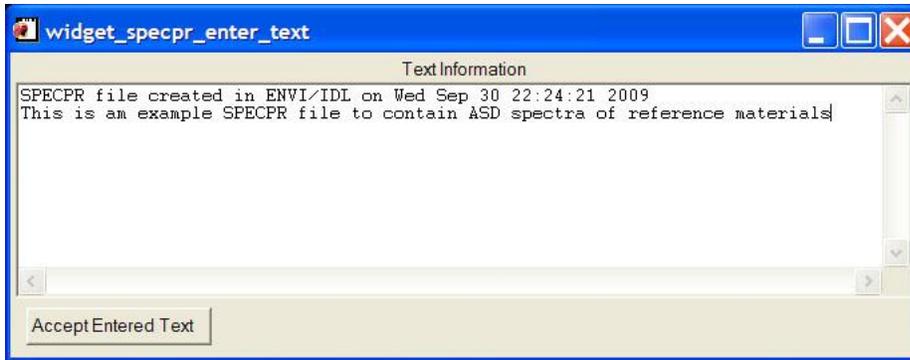


Figure 203. Adding information to the text record when creating a SPECPR file.

Once the text is entered as desired, press the “Accept Entered Text” button to continue the program. Next, the program creates the SPECPR file and writes this text record. Subsequently, a text separator record of asterisks is added to the file. Next, a message indicating the successful completion of the program is displayed. Press “OK” to dismiss the window. Now that the SPECPR file has been created, the user can list its contents (see the *Module 1. ViewSPECPR* section of this report, in particular “*Function 1.1 – Listing the contents of a SPECPR file*”) to examine the text record (record 1) and the separator record (record 2) that were written to the newly created file (fig. 204).

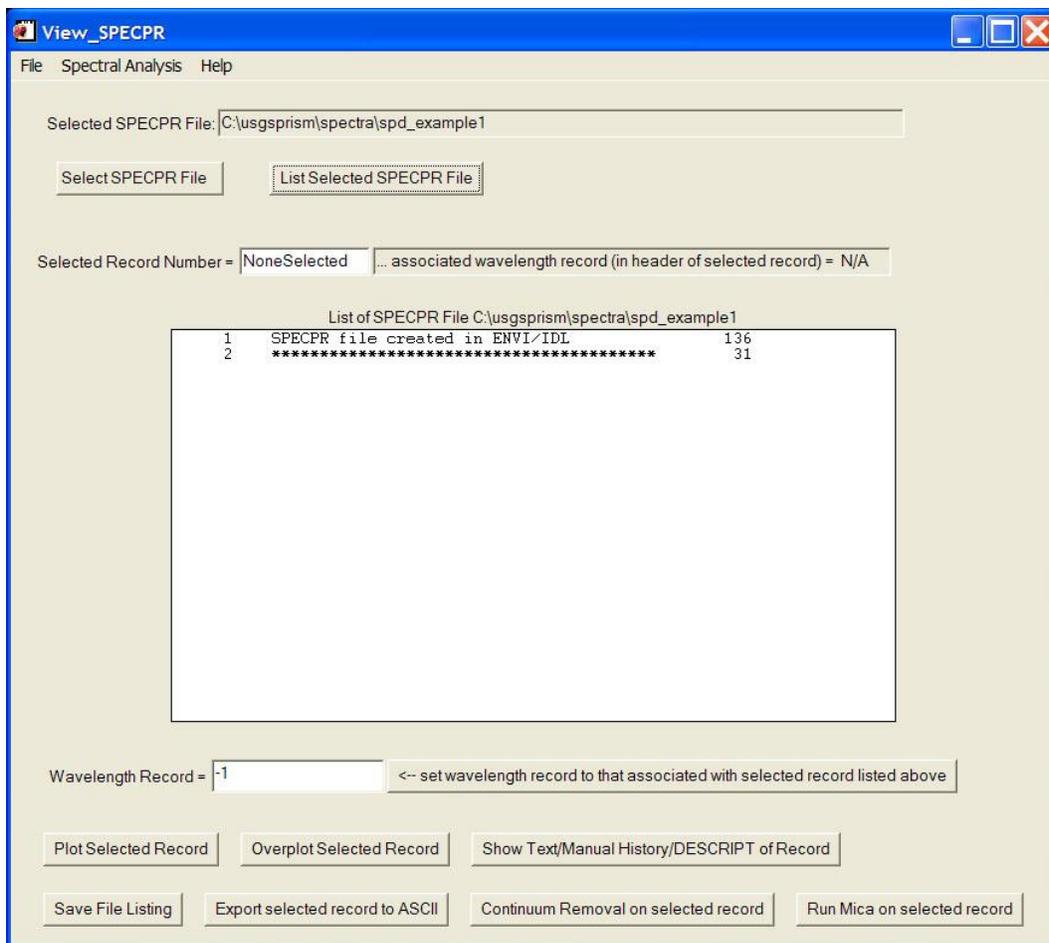


Figure 204. Listing the contents of the newly created SPECPR file.

Function 2.2 – Create a new SPECPR file for ASD spectra

This function allows the user to create a new SPECPR file for ASD spectra. The difference between this function and “*Function 2.1 – Create a new SPECPR file*” is that it allows the user to add wavelength, bandpass (FWHM), and Spectralon reflectance records for an ASD spectrometer. These records will be transferred from an existing SPECPR file and may have been created with “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”. All types of spectra can be stored in any SPECPR file; however, this function sets up the basic records needed for ASD spectra at the beginning of the SPECPR file.

The SPECPR file created with this function will contain a text record, a text separator record of asterisks, the records containing the wavelength, bandpass (FWHM), and Spectralon reflectance records for an ASD spectrometer, and, finally, another text separator record of asterisks.

The function can be initiated by selecting the “Create a New SPECPR File for ASD spectra” option under the “Spectral Analysis” module of the “PRISM” menu entry on the main ENVI menu bar (see fig. 200). The user is first prompted to set the directory location and filename of the SPECPR file to create (fig. 205).

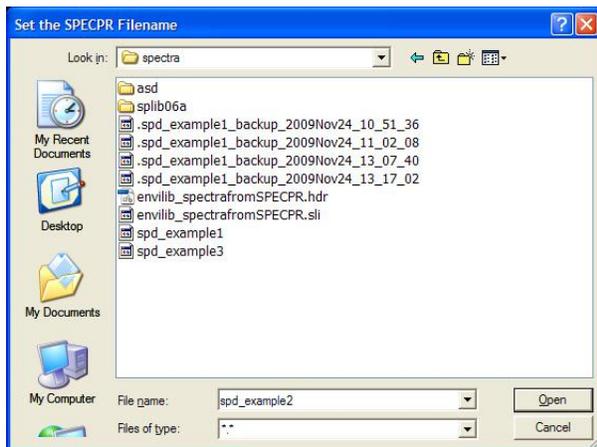


Figure 205. Setting the name of the SPECPR file to create for ASD spectra.

Next, a window appears with some default text to store in the first record (fig. 206).

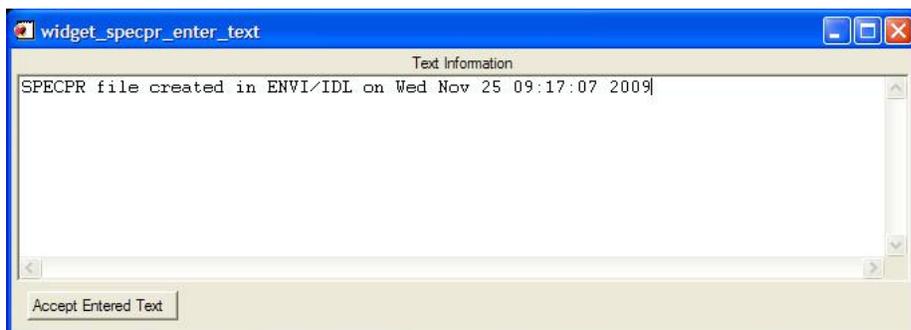


Figure 206. Default information to store in the text record when creating a SPECPR file for ASD spectra.

The user may edit this text or add text (fig. 207).

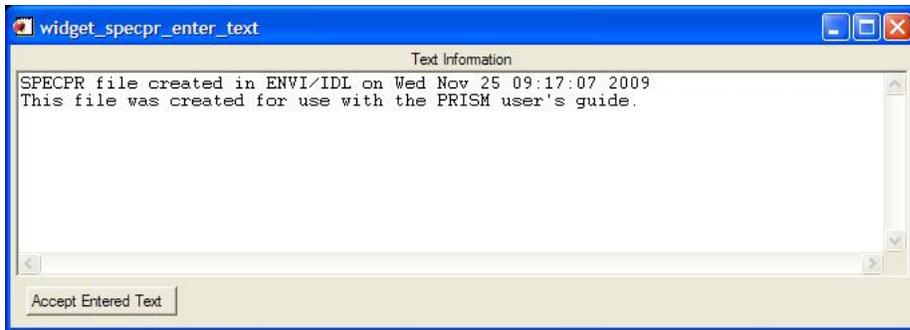


Figure 207. Adding information to the text record when creating a SPECPR file for ASD spectra.

Once the text is entered as desired, press the “Accept Entered Text” button to continue the program. At this point, the SPECPR file is created and the text and separator records are written. The user is then prompted to choose the SPECPR file containing the ASD wavelength, bandpass (FWHM), and Spectralon reflectance records to transfer into the new SPECPR file (fig. 208).

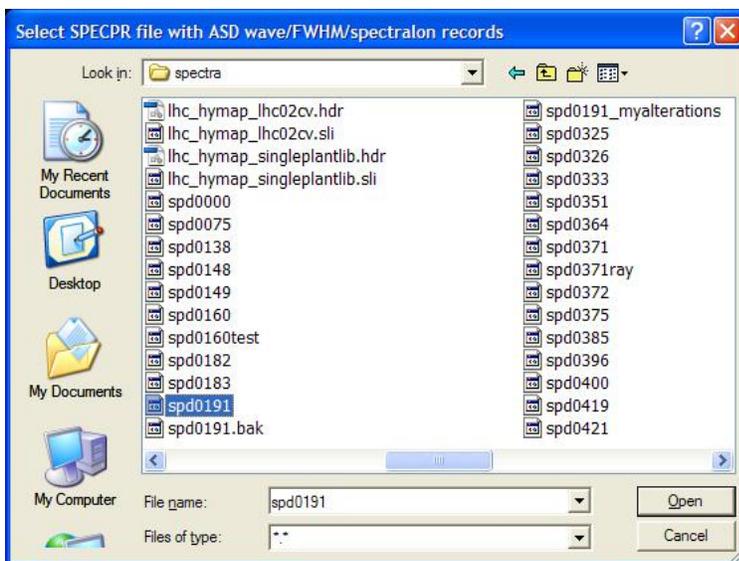


Figure 208. Selecting the SPECPR file containing the ASD wavelength, bandpass (FWHM), and Spectralon reflectance records to transfer into the new SPECPR file.

Next, the user is prompted to select the records to transfer (fig. 209), that is, the records containing the ASD wavelength, bandpass (FWHM), and Spectralon reflectance. The user may scroll down to the desired records using the scroll bar on the right. Multiple records can be selected by choosing the first record and pressing and holding the “Ctrl” (control) button when clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired

block and then pressing and holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block.

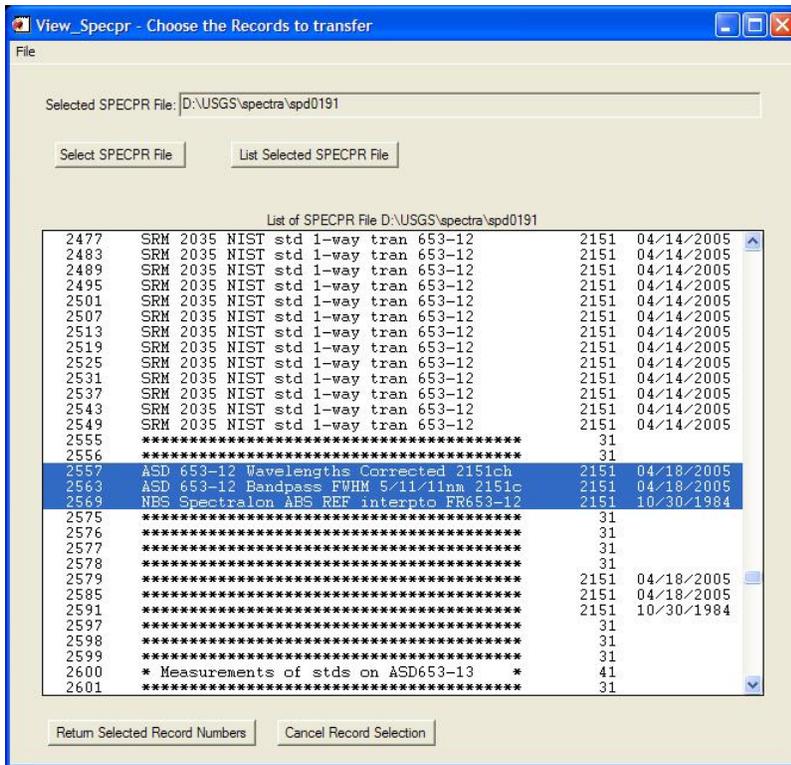


Figure 209. Selecting the ASD wavelength, bandpass (FWHM), and Spectralon reflectance records to transfer into the new SPECPR file.

Press the “Return Selected Record Numbers” button to continue the program. The spectra are transferred into the newly created SPECPR file. Next, a text separator record of asterisks is written. Finally, a message advising the user that the function has completed successfully appears (fig. 210). Click the “OK” button to dismiss the message.



Figure 210. Message advising the user that the SPECPR file for ASD spectra was created.

Now that the SPECPR file has been created, the user can view its contents (see the *Module 1. ViewSPECPR* section of this report, in particular “*Function 1.1 – Listing the contents of a SPECPR file*”) to examine the text record and the separator record that were written to the newly created file (fig. 211).



Figure 211. Listing the contents of the newly created SPECPR file for ASD spectra.

Function 2.3 – Write text record

To start the function, click on the “Write text record” item in the drop-down list of the “Spectral Analysis” item listed under the PRISM entry of the ENVI menu bar (see fig. 200).

First, the user is prompted to select the SPECPR file to which the text record will be written (fig. 212). Once the file is selected, press “Open” to continue the program. Subsequently, this function follows the same steps in the “*Function 1.9.1 – Write a text record*” section of this report.

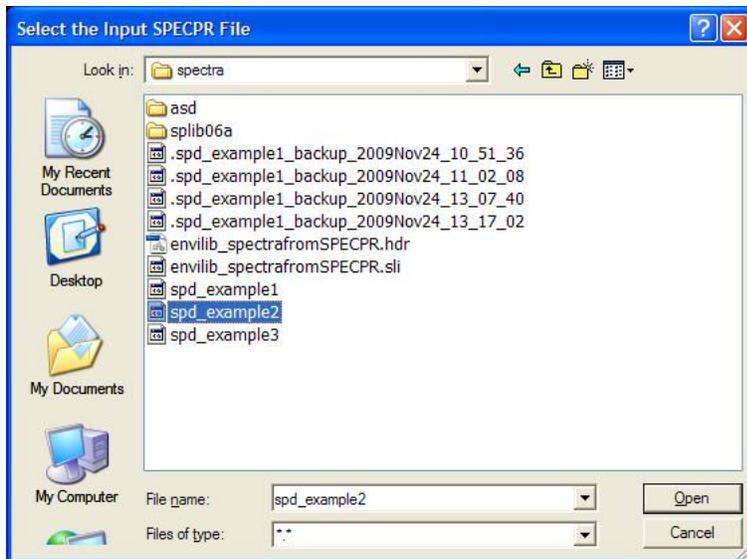


Figure 212. Selecting a SPECPR file for adding a text record.

Function 2.4 – Write separator record

These functions provide a convenient way to write text records that have titles of all asterisks (*) or all dashes (-). These are simply used to mark divisions between blocks of spectra or data. For example, figure 4 shows three such records before and after the data records that contain the wavelengths and bandpass (FWHM) of the spectrometers in the USGS splib06a spectral library. Also, between the records of each sample material in that library, separator records of dashes are used (see fig. 4).

Function 2.4.1 – Separator of asterisks *****

To start the function, click on the “Write separator record” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see fig. 200). Select the “Separator of asterisks *****” item from the list that appears.

When this function is selected, a text record with a title of 40 asterisks (*) is written to a SPECPR file. The user is first prompted to select the SPECPR file to which the text separator record will be written (see fig. 212). Press “Open” to continue the program. After selecting the SPECPR file, the separator record is written and a message indicating the successful writing of this record is displayed. Press “OK” to dismiss this window.

Function 2.4.2 – Separator of dashes -----

To start the function, click on the “Write separator record” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry on the ENVI menu bar (see fig. 200). Select the “Separator of dashes -----” item from the list that appears.

When this function is selected, a text record with a title of 40 dashes (-) is written to a SPECPR file. The user is first prompted to select the SPECPR file to which the text separator record will be written (see fig. 212). Press “Open” to continue the program. After selecting the

SPECPR file, the separator record is written and a message indicating the successful writing of this record is displayed. Press “OK” to dismiss this window.

Function 2.5 – Import ASD binary files into a SPECPR file

This function allows the user to import spectra collected using ASD full range spectrometers. Full range refers to spectrometers that produce spectra with 2151 channels with 1 nm (0.001 μm) sampling increments, starting at the wavelength of 350 nm (0.35 μm) and ending at 2500 nm (2.5 μm). In PRISM, these are considered to be the default wavelengths of ASD spectra. Thus, this function is designed to work with ASD spectrometers with three detectors, a visible/near-infrared detector (VNIR), a shortwave infrared 1 (SWIR1) detector, and a shortwave infrared 2 (SWIR2) detector. Drawing on over 15 years of experience with five ASD spectrometers maintained by the USGS Spectroscopy Laboratory in Denver, Colorado, PRISM defines the default bandpass (FWHM) characteristics for these detectors as 5 nm (0.005 μm) for the VNIR, 11 nm (0.011 μm) for the SWIR1, and 11 nm (0.011 μm) for the SWIR2. However, PRISM also contains routines for the user to estimate the wavelength and bandpass (FWHM) characteristics of their ASD spectrometer (see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*” for details) and to create custom wavelength and bandpass (FWHM) records, which may differ from the nominal characteristics. The user may then link imported ASD spectra to these custom wavelength and bandpass (FWHM) records. Alternatively, the user may use the default wavelength and bandpass (FWHM) records. PRISM works only with ASD binary files in their older format (with a size of 9,088 bytes); consult the documentation of ASD software to see how to record data in this format and how to convert data collected in the newer format back to the old format.

The function can be initiated by selecting the “Import ASD binary files into a SPECPR file” option under the “Spectral Analysis” module of the “PRISM” menu entry on the main ENVI menu bar (see fig. 200). When using this function, the user is first prompted to choose the ASD binary files. Example ASD binary files are included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the files will be located in “C:\usgsprism\spectra\asd\raw_binaries\” on Windows computers and in “/var/local/usgsprism/spectra/asd/raw_binaries/” on Linux computers. Figure 213 shows an example of selecting all of the ASD files with the name of “cg5121”, “mylar”, and “srm2035”.

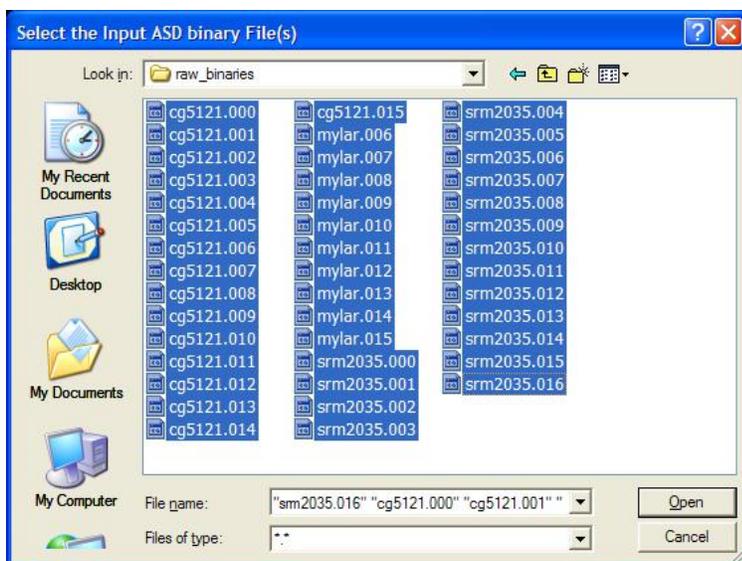


Figure 213. Selecting ASD binary files for import into an existing SPECPR file for ASD spectra.

The user is then prompted to select the SPECPR file into which the ASD spectra will be imported (fig. 214).

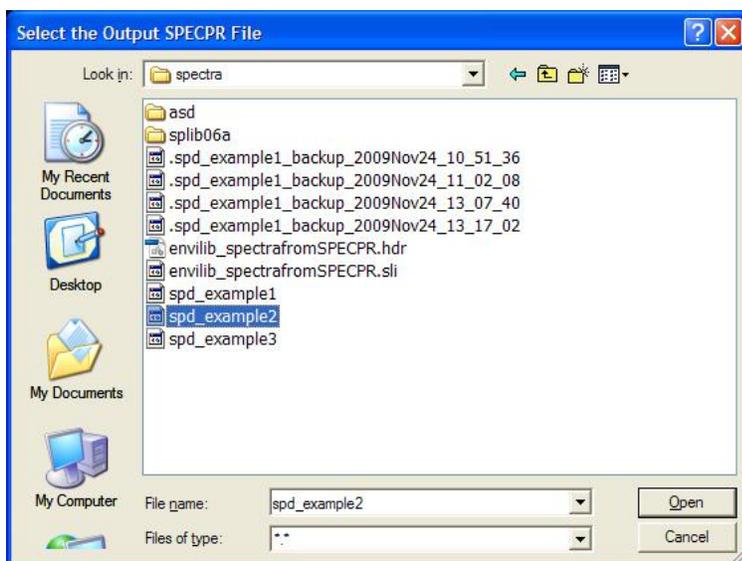


Figure 214. Selecting the SPECPR file into which the ASD spectra will be imported.

Next, the user is asked if this SPECPR file contains the wavelength and bandpass (FWHM) records that correspond to the ASD spectra being imported (fig. 215). PRISM works best when each spectrum is linked to the wavelength and bandpass (FWHM) records that characterize the spectrometer on which it was collected. In the case of ASD spectra, the user may have customized wavelength and bandpass (FWHM) records using “*Function 2.17* –

Wavelength/FWHM evaluation of ASD”; see that section of this report for additional details on performing this evaluation. If the user does not have a custom set of wavelength and bandpass (FWHM) records for the ASD spectra, then the user may choose to continue importing spectra using a set of default wavelengths and bandpass (FWHM) values for ASD full range spectrometers by clicking “No” in answer to the prompt shown in figure 215. The user may select “No” and later use the custom PRISM routines to establish wavelengths and bandpass (FWHM) records for the ASD spectrometer (see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”). If the user has established the wavelength and bandpass (FWHM) characteristics of the spectrometer through another means, then before using this function, the user can import the wavelength and bandpass (FWHM) records by importing them into a SPECPR file from an ENVI spectral library using “*Function 2.15 – Import ENVI Spectral Library*”.



Figure 215. Selecting ASD binary files for import into a SPECPR file.

If “Yes” is selected, the user will be prompted to choose the wavelength record from a listing of the contents of the SPECPR file into which the ASD spectra are being imported (fig. 216). The user should select the wavelength record and press “Return Selected Wavelength Record”.

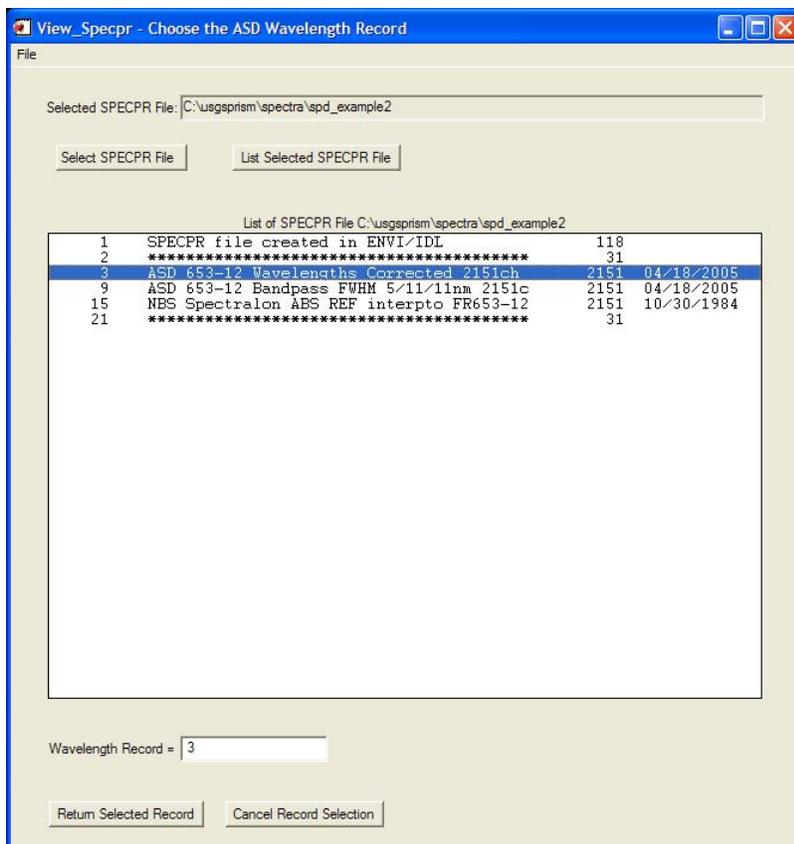


Figure 216. Selecting the wavelength record in the SPECPR file into which ASD spectra will be imported.

Next, the user is prompted to select the bandpass (FWHM) record. After selecting the record, the user should press “Return Selected FWHM Record” (fig. 217).

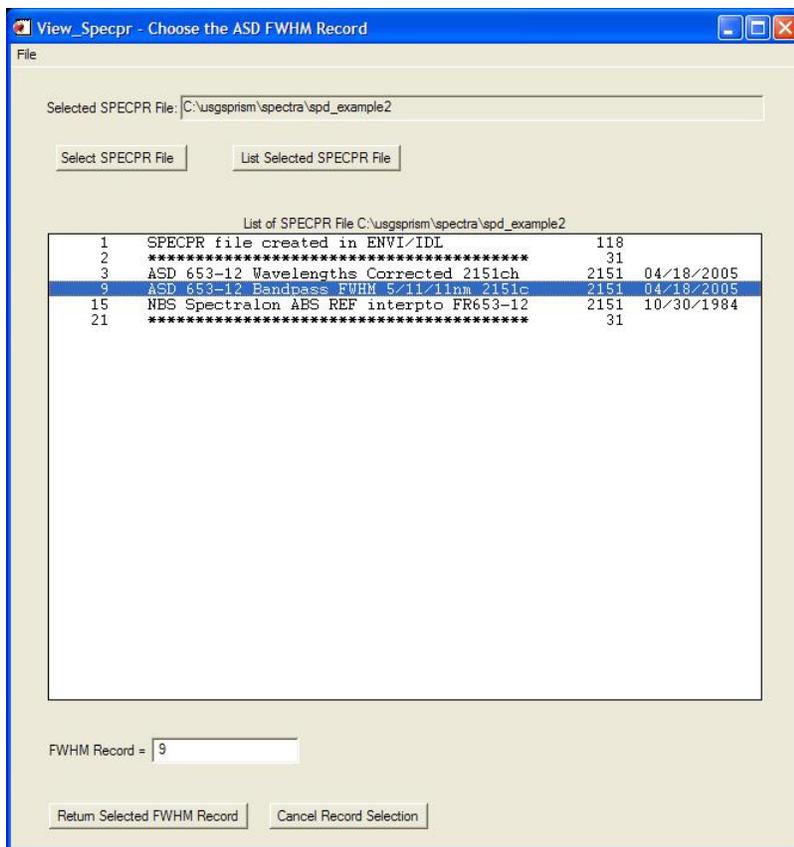


Figure 217. Selecting the bandpass (FWHM) record in the SPECPR file into which ASD spectra will be imported.

If “No” was selected when the user was asked if the SPECPR file contains the wavelength and bandpass (FWHM) records that correspond to the ASD spectra being imported, then default records for ASD wavelength and bandpass (FWHM) will be created (for details on these default values see “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”).

After the ASD spectra are imported, a message indicating the successful completion of the function is displayed. Press “OK” to dismiss the window (fig. 218).

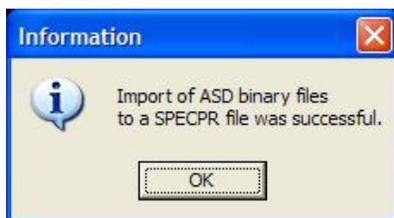


Figure 218. Message advising the user that the ASD spectra were imported into the SPECPR file.

Figure 219 shows the resulting file listing after pressing “Yes”, choosing the wavelength and bandpass (FWHM) records, and importing the selected ASD binaries.

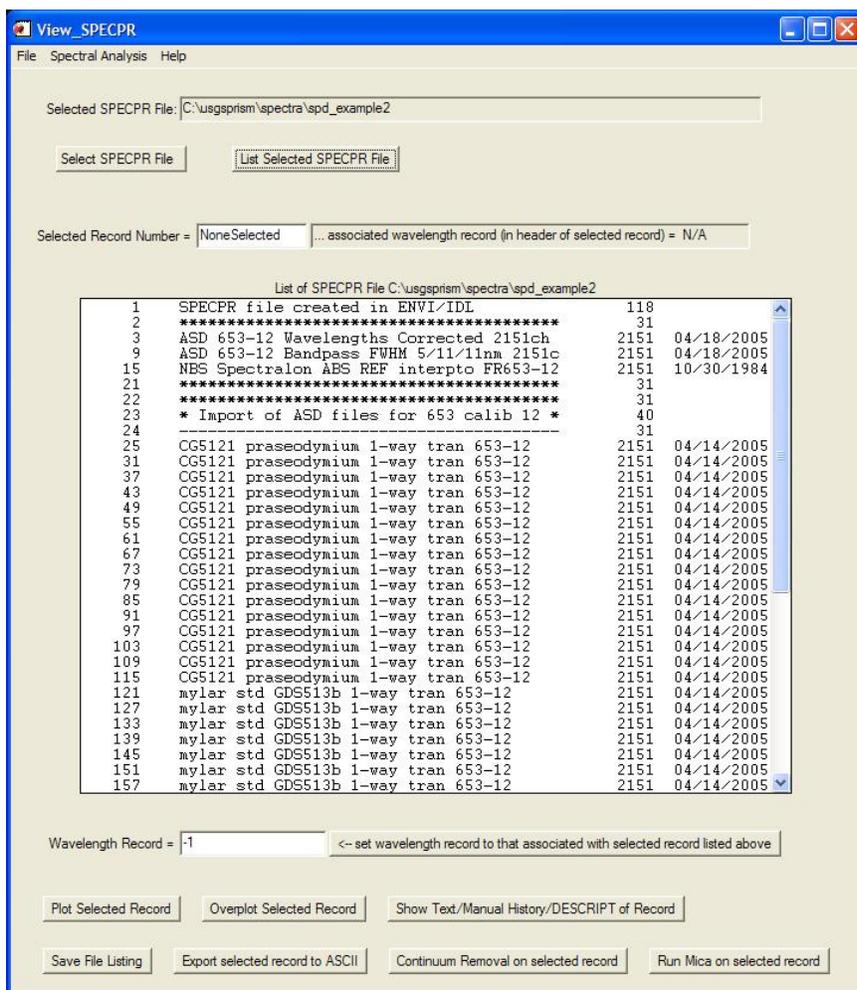


Figure 219. Listing of the SPECPR file after importing ASD spectra.

Before the data records of the imported spectra are written, a text separator record of asterisks is written (record 22 in this example). Next, a text record indicating that the following spectra are imported ASD spectra is written (record 23 in this example). The title of the text record includes the ASD spectrometer number and calibration number, ASD 653 and calibration 12, in this example. These values were extracted from the first ASD binary file during the program execution. Next, a text separator record of dashes is written (record 24 in this example).

The records containing the ASD spectra have pointers to the wavelength and bandpass (FWHM) records set in their headers. By clicking on an imported record and then pressing the “Show Header Info/Text/DESCRIP Record” button, you can examine the information stored in the header of an imported ASD record (fig. 220). If a GPS was connected to the ASD while collecting the spectra, the manual history will contain the latitude and longitude coordinates stored in the ASD binary file, along with the GPS datum. If the GPS was not connected or not communicating with the ASD during spectral measurements, the datum value will be set to “No GPS data” and the latitude and longitude values will be set to zero.

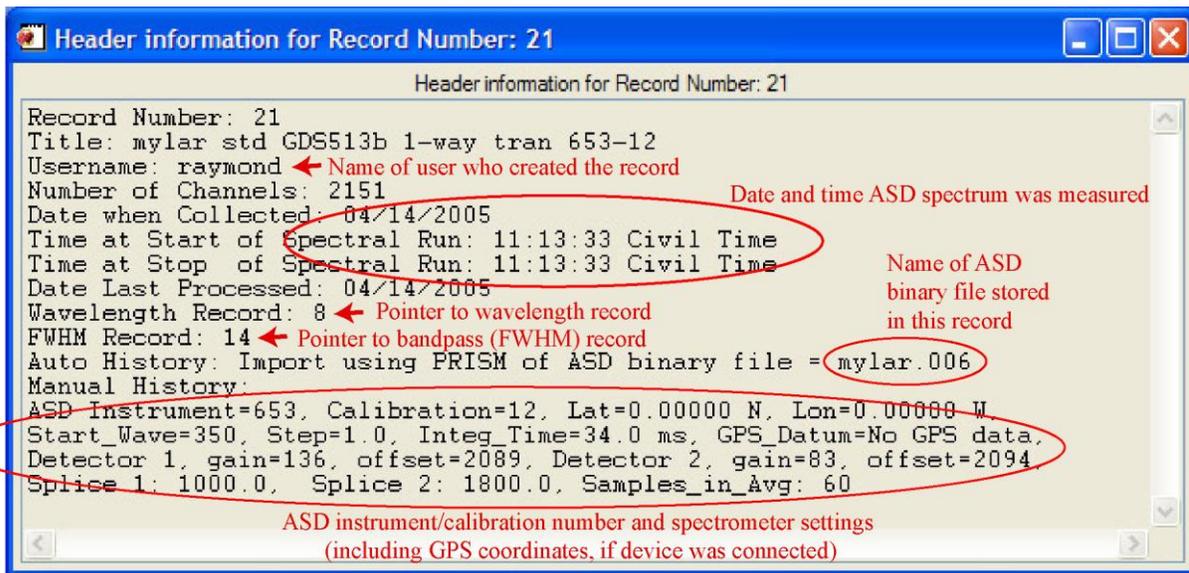


Figure 220. Header information for a record containing an imported ASD spectrum.

Function 2.6 – Transfer SPECPR record(s)

These functions provide a means to transfer records between SPECPR files. “*Function 2.6.1 – Transfer SPECPR record(s) no changes*” transfers records without changing any of the header information, including without changing the pointers to the wavelength and bandpass (FWHM) records. This function should only be used when transferring text records or data records that have pointers to wavelength and bandpass (FWHM) records that exist in the same record numbers in both the SPECPR file from which records are being transferred and the SPECPR file into which they are being transferred. “*Function 2.6.2 – Transfer SPECPR record(s) set wave/FWHM*” allows the user to set the pointers to the wavelength and bandpass (FWHM) records in the SPECPR file into which the data record(s) are being transferred. “*Function 2.6.3 – Transfer SPECPR record(s) set wave/FWHM and change title*” also allows the title to be changed as well as the pointers to the wavelength and bandpass (FWHM) records.

Function 2.6.1 – Transfer SPECPR record(s) no changes

To start the function, click on the “Transfer SPECPR record(s)” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see fig. 200). Select the “Transfer SPECPR record(s) no changes” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.4.1 – Transfer SPECPR record(s) no changes*”. However, after selecting the records to transfer, the user is prompted to select the output SPECPR file into which the records will be transferred.

Function 2.6.2 – Transfer SPECPR record(s) set wave/FWHM

To start the function, click on the “Transfer SPECPR record(s)” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see

fig. 200). Select the “Transfer SPECPR record(s) set wave/FWHM” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.4.2 – Transfer SPECPR record(s) set wave/FWHM*”. However, after selecting the records to transfer, the user is prompted to select the output SPECPR file into which the records will be transferred.

Function 2.6.3 – Transfer SPECPR record(s) set wave/FWHM and change title

To start the function, click on the “Transfer SPECPR record(s)” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see fig. 200). Select the “Transfer SPECPR record(s) set wave/FWHM and change title” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.4.3 – Transfer SPECPR record(s) set wave/FWHM and change title*”. However, after selecting the records to transfer, the user is prompted to select the output SPECPR file into which the records will be transferred.

Function 2.7 – Average ASD spectra

These functions allow the user to average ASD spectra. In addition, the user is given an option to correct detector offsets. If the user selects the function “*Function 2.7.1 - Average and AbsRef ASD Spectra*”, the routine converts the average spectrum from relative reflectance to absolute reflectance.

If the user has imported ASD spectra into a SPECPR file using PRISM “*Function 2.5 – Import ASD binary files into a SPECPR file*” then the header information of each ASD spectral record will contain the detector splice wavelengths that are needed to correct the offsets between ASD detectors (fig. 220). If the user has imported spectra in a different manner, the user may edit the ASD list file, located at “C:\usgsprism\asd.txt” on Windows computers and at “/var/local/usgsprism/asd.txt” on Linux computers, to add the spectrometer details and configure the offset correction for the detectors (see *appendix D*). Offset correction is made using multiplicative scaling factors applied to detectors 1 and 3, assuming that detector 2 is stable at either end of its wavelength range (details of the offset correction calculations are found in *appendix D*). If “*Function 2.7.1 – Average and AbsRef ASD spectra*” is selected, a correction for the absorption of the Spectralon reflectance panel can be applied to convert the average spectrum from relative reflectance to absolute reflectance. This is accomplished by multiplying the average spectrum by the reflectance of the Spectralon panel. A record containing a Spectralon panel’s reflectance is created if the user establishes the ASD spectrometer’s wavelength and bandpass (FWHM) characteristics using “*Function 2.17 – Wavelength/FWHM evaluation of ASD*”. Or, the user may interpolate the Spectralon record within the example ASD SPECPR file “spd_asdcalib”. If the user followed step 3 of the installation instructions (see the “*Installation of Software*” section of this report), the file will be located in “C:\usgsprism\spectra\asd\” on Windows computers and in “/var/local/usgsprism/spectra/asd/” on Linux computers. The Spectralon record in that file can be interpolated to the user’s ASD spectrometer wavelength set (see *Function 2.8 – Interpolate spectra*). Alternatively, the user may establish the reflectance spectrum for the Spectralon panel measured on the ASD spectrometer by another means and import these data into a SPECPR file via an ENVI spectral library using “*Function 2.15 – Import ENVI Spectral Library*”.

Function 2.7.1 – Average and AbsRef ASD spectra

To start the function, click on the “Average ASD spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see fig. 200). Select the “Average and AbsRef ASD spectra” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.6.2 – Average and AbsRef ASD Spectra*”. However, before any other prompts, the user is asked to set the input/output SPECPR file. This is the file from which input data records will be read and to which the average spectrum and other records will be written.

Function 2.7.2 – Average ASD spectra

To start the function, click on the “Average ASD spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see fig. 200). Select the “Average ASD spectra” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.6.1 – Average ASD Spectra*”. However, before any other prompts, the user is asked to set the input/output SPECPR file. This is the file from which input data records will be read and to which the average spectrum and other records will be written.

Function 2.8 – Interpolate spectra

To start the function, click on the “Interpolate spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (see fig. 200). The steps taken in this function are similar to those in “*Function 1.9.7 – Interpolate Spectra*”. However, before any other prompts, the user is asked to set the input SPECPR file. Also, after selecting the record to interpolate, the user is prompted to set the output SPECPR file to which the interpolated spectrum will be written.

Function 2.9 – Convolve spectra

When converting measurements made on one spectrometer to the sampling and bandpass (FWHM) characteristics of another, the measurement made on the high resolution spectrometer (smaller bandpass) should be convolved to the lower resolution spectrometer rather than interpolated. PRISM uses the SPECPR method of convolution (Clark, 1993), as described in Swayze (1997) and Swayze and others (2003). If there are only slight differences between the wavelength and bandpass (FWHM) characteristics of the two spectrometers, the spectra can be interpolated from one spectrometer to another (see PRISM’s “*Function 2.8 – Interpolate Spectra*”).

There are four functions for convolving spectra (fig. 221). “*Function 2.9.1 – Convolve spectra with user-set output titles*” allows the user to set the output title of each spectrum that is convolved. This is useful when convolving one spectrum or several spectra at a time, but cumbersome when working with many spectra. “*Function 2.9.2 – Convolve spectra with automatic output titles*” is designed for the convolution of many records. Instead of the user having to specify the output title of each convolved spectrum, the output title of a convolved spectrum is automatically set to the input title with the last five characters replaced with a space and the letters CONV, that is, “ CONV”, to indicate it is a convolved record. “*Function 2.9.3 – Convolve spectra with automatic output titles – ALL RECORDS*” is designed for convolving all spectra in a SPECPR file that have the same number of channels as a set of user-selected wavelength and bandpass (FWHM) records. *Function 2.9.4 – Convolve USGS Spectral Library*

splib06b will convolve all spectra in USGS spectral library version 6 (Clark and others, 2007), using an oversampled adaptation of that library, *splib06b*.

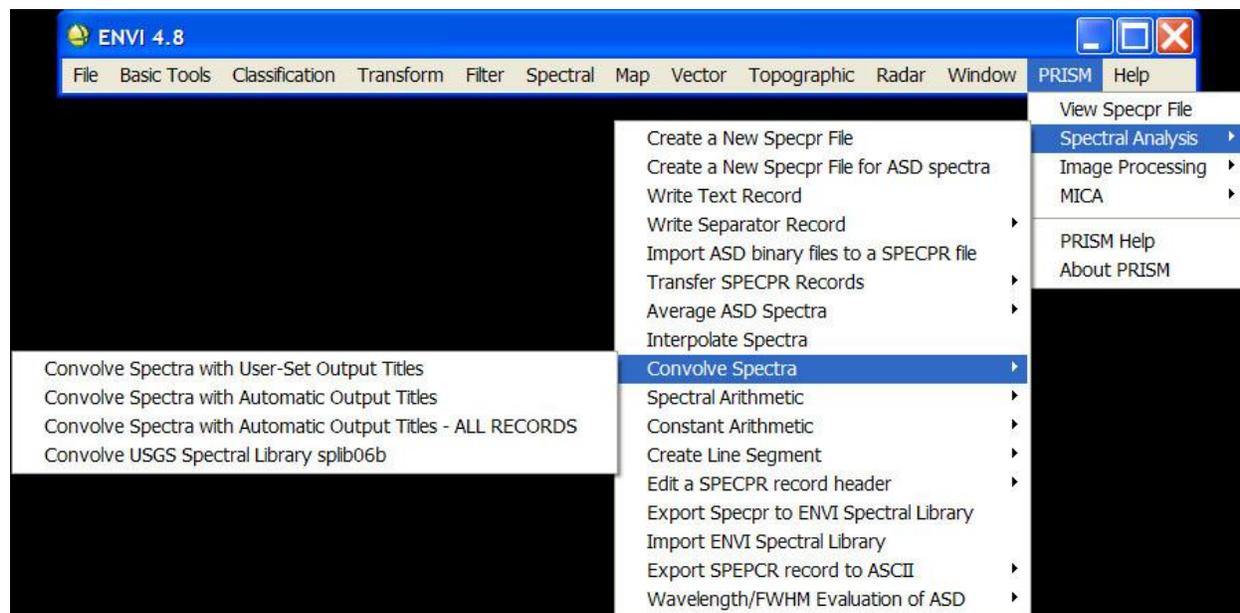


Figure 221. Convolution functions available under the PRISM menu item.

Function 2.9.1 – Convolve spectra with user-set output titles

To start the function, click on the “Convolve spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (fig. 221). Select the “Convolve spectra with user-set output titles” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.8.1 – Convolve Spectra with user-set output titles*”. However, before any other prompts, the user is asked to set the input SPECPR file. Also, after selecting the record(s) to convolve, the user is prompted to set the output SPECPR file to which the convolved spectra will be written.

Function 2.9.2 – Convolve spectra with automatic output titles

To start the function, click on the “Convolve spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (fig. 221). Select the “Convolve spectra with automatic output titles” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.8.2 – Convolve Spectra with automatic output titles*”. However, before any other prompts, the user is asked to set the input SPECPR file. Also, after selecting the record(s) to convolve, the user is prompted to set the output SPECPR file to which the convolved spectra will be written.

Function 2.9.3 – Convolve spectra with automatic output titles – ALL RECORDS

To start the function, click on the “Convolve spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (fig. 221). Select

the “Convolve spectra with automatic output titles – ALL RECORDS” item from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.8.3 – Convolve Spectra with automatic output titles – ALL RECORDS*”. However, before any other prompts, the user is asked to set the input SPECPR file. Also, after selecting the input wavelength and bandpass (FWHM) records, the user is prompted to set the output SPECPR file to which the convolved spectra will be written.

Function 2.9.4 – Convolve USGS Spectral Library splib06b

This function will convolve all spectra in USGS spectral library version 6 (Clark and others, 2007), using an oversampled adaptation of that library, “splib06b”. This file is included with the PRISM software distribution. If step 3 of the installation instructions was followed (see the “*Installation of Software*” section of this report), the file will be located in “C:\usgsprism\spectra\splib06\” on Windows computers and in “/var/local/usgsprism/spectra/splib06/” on Linux computers. To start the function, click on the “Convolve spectra” item in the drop-down list of the “Spectral Analysis” item listed under the “PRISM” entry of the ENVI menu bar (fig. 221). Select the “Convolve USGS Spectral Library splib06b” item from the list that appears. The program looks for splib06b in the default location. If it is not found, the user will be prompted to find and select the file. The user is prompted to set a string that describes the output spectrometer to which the spectral library will be convolved, for example, HyMap2007, AVIRIS2010, or Hyperion (fig. 222).

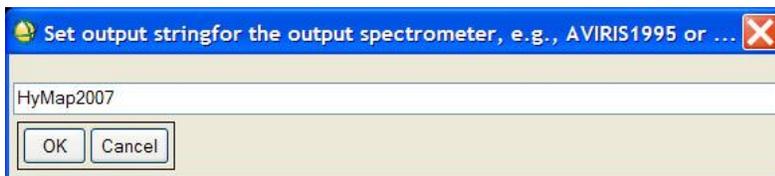


Figure 222. Setting a string describing the output spectrometer.

Next, the user is prompted to select an existing SPECPR file that contains the wavelength and bandpass (FWHM) records that characterize the output spectrometer (fig. 223).

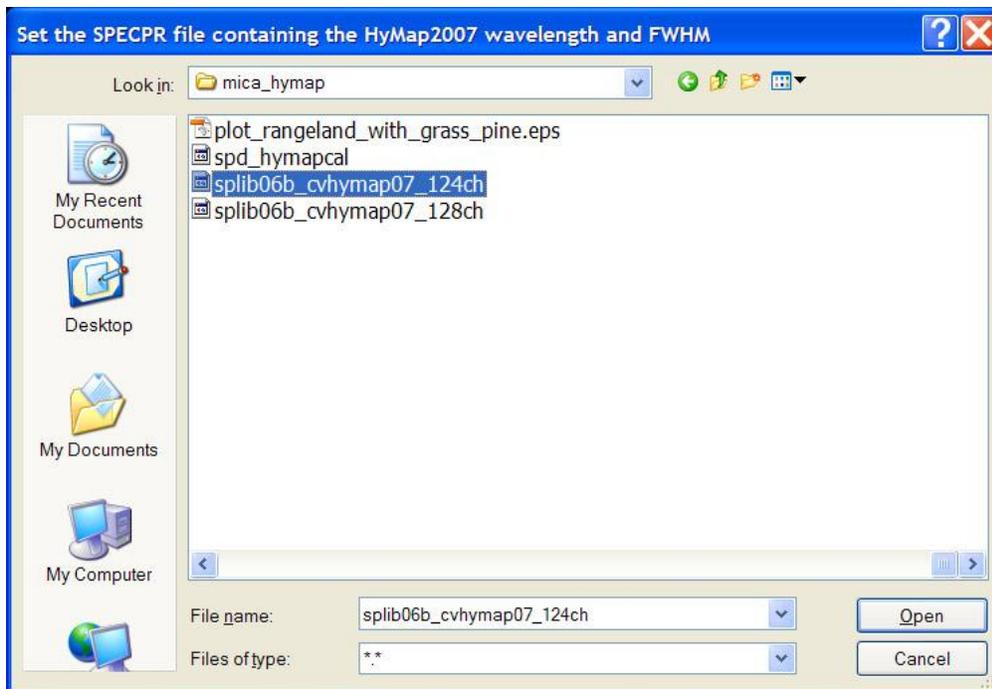


Figure 223. Selecting the SPECPR file with the wavelength and bandpass (FWHM) records for the output spectrometer.

Next, the user is prompted to select the wavelength record that characterizes the output spectrometer from the listing of the selected SPECPR file (fig. 224).

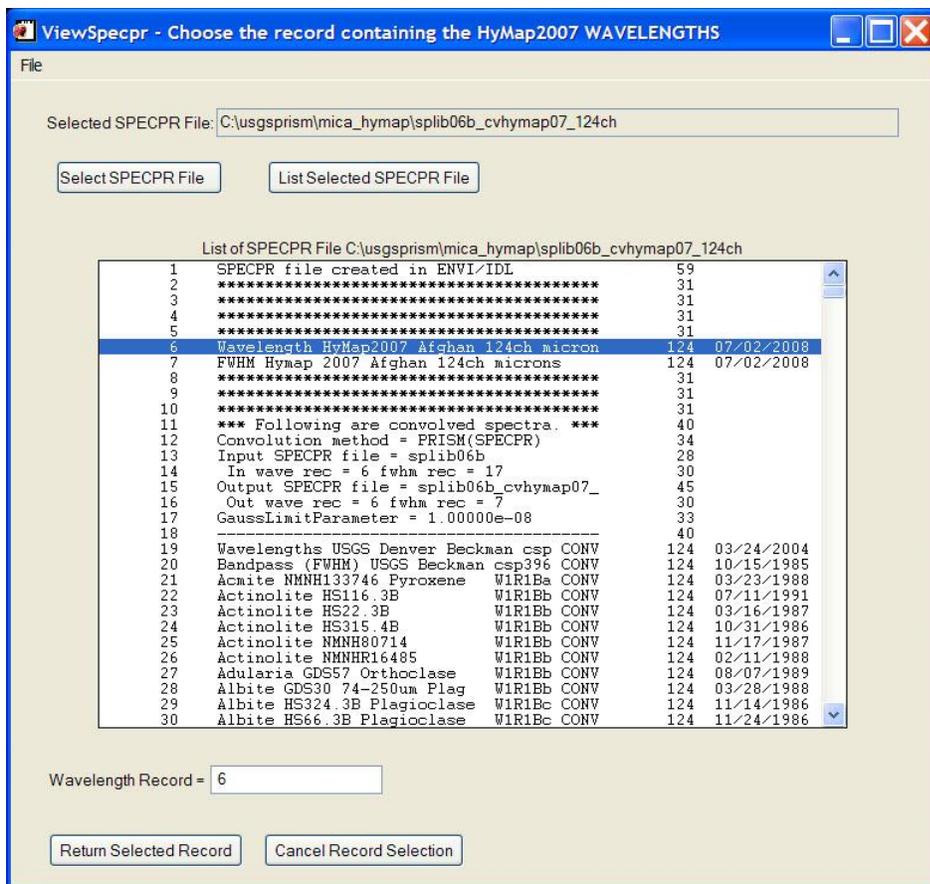


Figure 224. Selecting the wavelength record for the output spectrometer.

Next, the user is prompted to select the bandpass (FWHM) record that characterizes the output spectrometer from the listing of the selected SPECPR file (fig. 225).

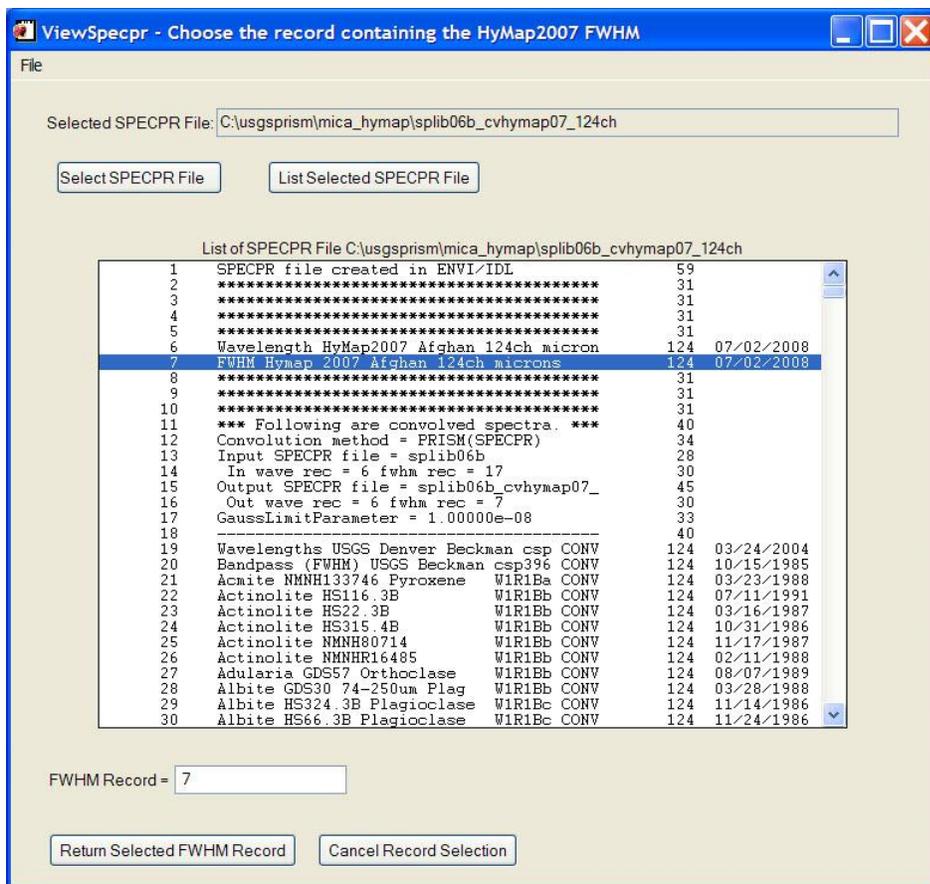


Figure 225. Selecting the bandpass (FWHM) record for the output spectrometer.

Next, the user is prompted to set the name of the output SPECPR file that will be created to contain the convolved spectral library (fig. 226).

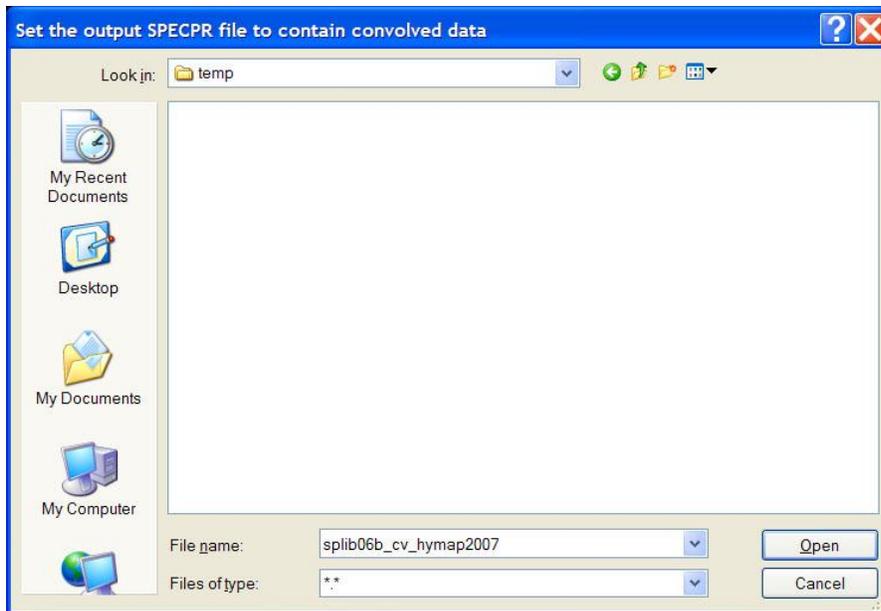


Figure 226. Setting the output SPECPR that will be created to contain the convolved library spectra.

Next, the program will convolve all the spectra listed in splib06b in these steps: first, creating the output SPECPR file, second, copying the wave/FWHM records, and third, convolving the spectral library. The data from the different spectrometers in splib06b are convolved sequentially, first the Beckman spectra, then the ASD spectra, then the two Nicolet wavelength and bandpass (FWHM) sets, and finally the AVIRIS spectra. The function will display plots of the original and convolved spectra as it processes the data. The function could take many hours to complete, depending on the speed of the computer being used.

Function 2.10 – Spectral arithmetic

These functions allow the user to perform simple math functions with spectra stored in SPECPR records.

Function 2.10.1 – Add two spectra (spec1 + spec2)

To start the function, click on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Add two spectra (spec1 + spec2)” option from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.9.1 – Add two spectra (spec1 + spec2)*”. However, that function assumes that the SPECPR file being viewed is the SPECPR file to use for input and output. Therefore, before any of the steps listed for that function, the user is asked to set the input SPECPR file for the first spectrum. Also, the user is prompted to select the input SPECPR file for the second spectrum. Additionally, the user is asked to select the output SPECPR file for the output spectrum.

Function 2.10.2 – Subtract two spectra (spec1 - spec2)

To start the function, click on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Subtract two spectra (spec1 - spec2)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.10.1 – Add two spectra (spec1 + spec2)*”.

Function 2.10.3 – Multiply two spectra (spec1 * spec2)

To start the function, click on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Multiply two spectra (spec1 * spec2)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.10.1 – Add two spectra (spec1 + spec2)*”.

Function 2.10.4 – Divide two spectra (spec1 / spec2)

To start the function, click on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Divide two spectra (spec1 / spec2)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.10.1 – Add two spectra (spec1 + spec2)*”.

Function 2.10.5 – Average spectra

To start the function, click on the “Spectral Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Average Spectra” option from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.9.5 – Average spectra*”. However, that function assumes that the SPECPR file being viewed is the SPECPR file to use for input and output. Therefore, before any of the steps listed for that function, the user is asked to set the input SPECPR file. After choosing the records to average, the user is asked to set the SPECPR file for the output records.

Function 2.11 – Constant arithmetic

These functions allow the user to perform simple math functions with spectra stored in SPECPR records and a constant value. A constant value means a user-defined value that will be applied to each channel. The manner in which the value is applied depends on the selected mathematical operator, for example, “*Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)*” will add the same user-defined value to each channel of the spectrum.

Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)

To start the function, click on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Add a constant to a spectrum (spec1 + constant)” option from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.10.1 – Add a constant to a spectrum (spec1 + constant)*”. However, that function assumes that the SPECPR file being viewed is the SPECPR file to use for input and output. Before any of the steps listed for that function, the user is asked to set the input SPECPR file. After choosing the record for spectrum1, the user is asked to set the output SPECPR file.

Function 2.11.2 – Subtract a constant from a spectrum (spec1 - constant)

To start the function, click on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Subtract a constant from a spectrum (spec1 - constant)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 2.11.3 – Multiply a spectrum by a constant (spec1 * constant)

To start the function, click on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Multiply a spectrum by a constant (spec1 * constant)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 2.11.4 – Divide a spectrum by a constant (spec1 / constant)

To start the function, click on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Divide a spectrum by a constant (spec1 / constant)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 2.11.5 – Subtract a spectrum from a constant (constant - spec1)

To start the function, click on the “Constant Arithmetic” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Subtract a spectrum from a constant (constant - spec1)” option from the list that appears. The steps taken in this function are similar to those in “*Function 2.11.1 – Add a constant to a spectrum (spec1 + constant)*”.

Function 2.12 – Create a line segment

Function 2.12.1 – Line segment of constant value

This function allows the user to make a spectrum in which all channels have the same constant value. To start the function, click on the “Create a line segment” item under the “Spectral Analysis” entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the “Line segment of constant value” option from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.11 – Line segment of constant value*”. However, after setting the value of the constant, the user is prompted to set the SPECPR file in which the wavelength record is stored and to which the line segment will be appended.

Function 2.13 – Edit a SPECPR record header

These functions allow the user to edit the header information of a SPECPR record, including the spectrum’s title, wavelength record pointer, and bandpass (FWHM) record pointer. As a precaution, each time one of these functions is used, a backup copy of the SPECPR file being edited is created. It is saved in the same directory as the SPECPR file, with the following naming convention:

Backup File = “. ”+ <SPECPR filename> +”_backup_”+YYYYmmmDD_HH_MM_SS

where,

<SPECPR filename> is the name of the SPECPR file being edited

YYYY is the year, for example 2009

mmm is the three letter abbreviation for the month, for example Nov for November

DD is the day of the month, for example 24

HH is the hour of the system time when the backup is created, on a 24 hour clock, for example 10 for 10 a.m. and 14 for 2 p.m.

MM is the minute of the system time when the backup is created

SS is the second of the system time when the backup is created

Function 2.13.1 – Change record title

This function allows the user to change a spectrum's title by editing its SPECPR record header information. To start the function, click on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the "Change record title" option from the list that appears.

The steps taken in this function are similar to those in "*Function 1.9.12.1 – Change record title*". However, before any of the listed steps, the user is prompted to select the SPECPR file that contains the record to be changed.

Function 2.13.2 – Change record title to "DO NOT USE THIS RECORD"

This function allows the user to change a spectrum's title by editing its SPECPR record header information. To start the function, click on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the "Change record title to "DO NOT USE THIS RECORD"" option from the list that appears.

The steps taken in this function are similar to those in "*Function 1.9.12.2 – Change record title to "DO NOT USE THIS RECORD"*". However, before any of the listed steps, the user is prompted to select the SPECPR file that contains the record to be changed.

Function 2.13.3 – Change pointer to wavelength record

This function allows the user to change a spectrum's wavelength record pointer by editing its SPECPR record header information. To start the function, click on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the "Change pointer to wavelength record" option from the list that appears.

The steps taken in this function are similar to those in "*Function 1.9.12.3 – Change pointer to wavelength record*". However, before any of the listed steps, the user is prompted to select the SPECPR file that contains the record to be changed.

Function 2.13.4 – Change pointer to FWHM record

This function allows the user to change a spectrum's bandpass (FWHM) record pointer by editing its SPECPR record header information. To start the function, click on the "Edit a SPECPR record header" item under the "Spectral Analysis" entry of the PRISM entry of the ENVI menu bar (see fig. 200). Select the "Change pointer to FWHM record" option from the list that appears.

The steps taken in this function are similar to those in “*Function 1.9.12.4 – Change pointer to FWHM record*”. However, before any of the listed steps, the user is prompted to select the SPECPR file that contains the record to be changed.

Function 2.14 – Export SPECPR to ENVI Spectral Library

This function allows the user to export spectra stored in a SPECPR file to an ENVI spectral library file. The output ENVI spectral library file will be created during the program execution. To start the function, click on the “Export SPECPR to ENVI Spectral Library” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar (see fig. 200).

The steps taken in this function are similar to those in “*Function 1.9.13 – Export SPECPR Records to ENVI Spectral Library*”. However, before any of the listed steps, the user is prompted to select the SPECPR file that contains the records to be exported.

Function 2.15 – Import ENVI Spectral Library

This function allows the user to import spectra stored in an ENVI spectral library file into a SPECPR file. To start the function, click on the “Import ENVI Spectral Library” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar (see fig. 200).

The steps taken in this function are similar to those in “*Function 1.9.14 – Import ENVI Spectral Library*”. However, after selecting the ENVI spectral library file, the user is prompted to select the SPECPR file into which these spectra will be imported.

Function 2.16 – Export SPECPR record to ASCII

These functions (fig. 227) let the user export a spectrum from a data record to an ASCII text file. These functions export all the channels of the spectrum stored in the selected record. “Deleted points”, also referred to as “deleted channels”, in spectra are stored in SPECPR record with the value of $-1.23e^{+34}$ (see the SPECPR documentation; Clark, 1993). In some cases, for example the USGS Spectral Library splib06a, deleted channels are set because the spectrometer was configured to collect data over only a subset of its full wavelength range capability (see Clark and others, 2007). In other cases, the deleted channel value is assigned to channels which contain invalid or corrupted data, for example channels within wavelength regions of strong atmospheric absorption in field spectra.

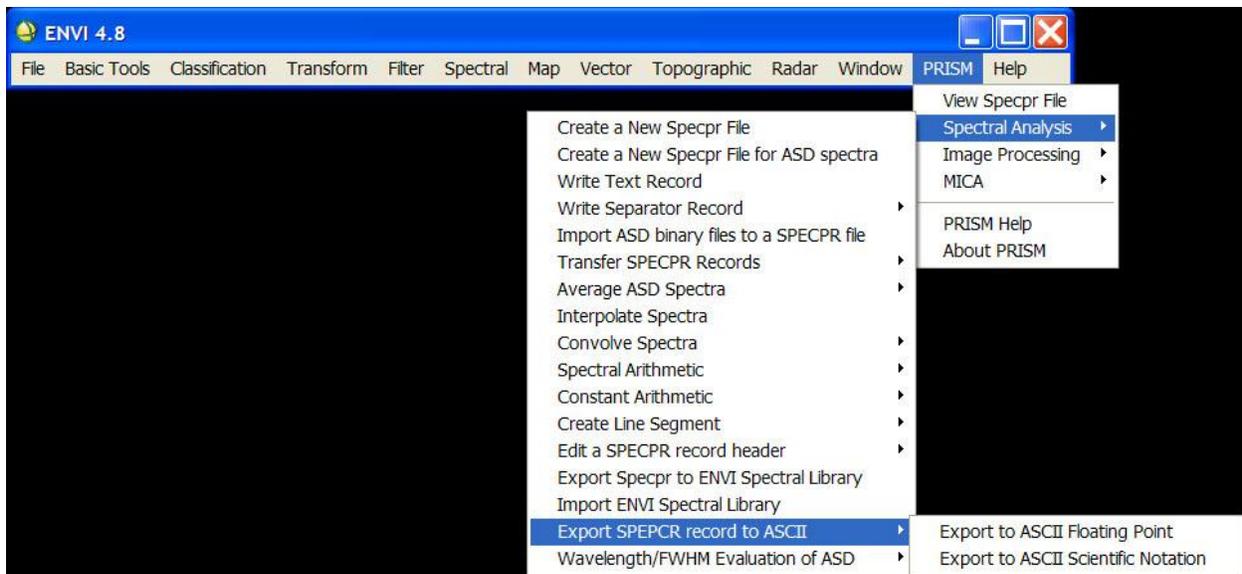


Figure 227. Functions for exporting spectra to an ASCII text file.

Function 2.16.1 Export to ASCII Floating Point

This function allows the user to export a spectrum to an ASCII text file in floating point format. To start the function, click on the “Export SPECPR record to ASCII” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar. Select the “Export to ASCII Floating Point” option from the list that appears (fig. 227).

First, the user is prompted to select the SPECPR file that contains the record that will be exported (fig. 228).

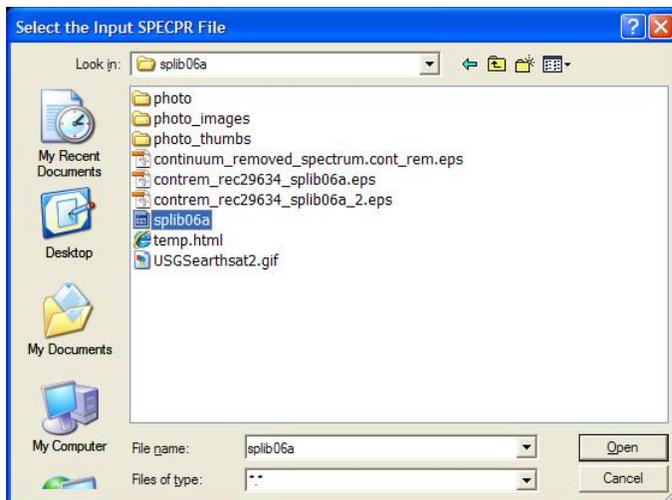


Figure 228. Selecting the SPECPR file containing the record to export to an ASCII text file in floating point format.

Next, the user is prompted to select the record that will be exported from the listing of the SPECPR file (fig. 229).

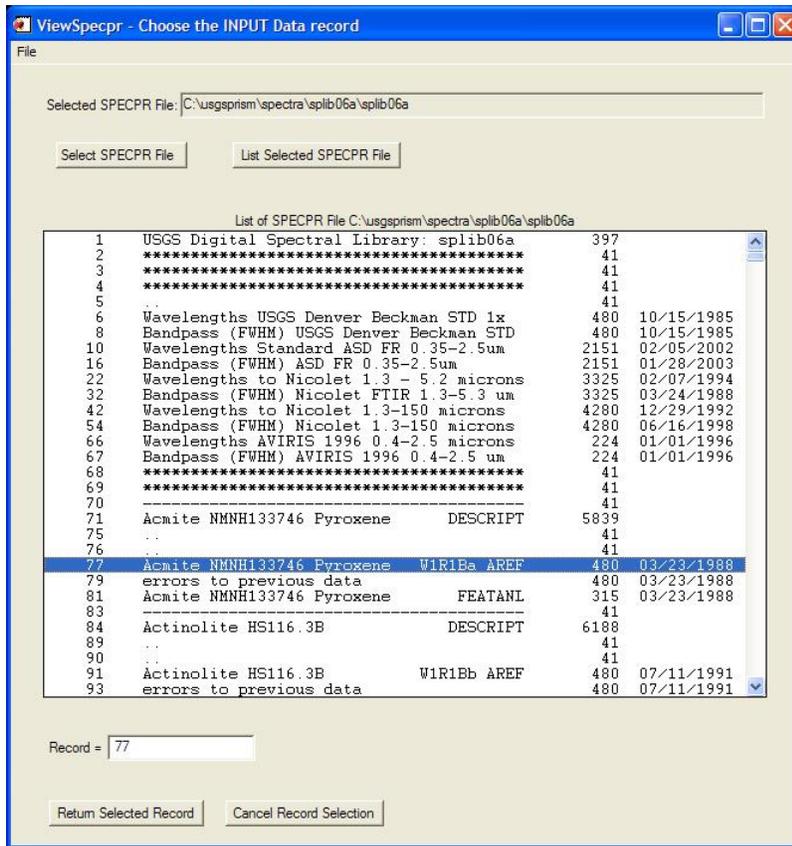


Figure 229. Selecting the SPECPR record to export to an ASCII text file in floating point format.

Next, the user is prompted to set the output filename of the ASCII text file (fig. 230). A default filename is pre-set in the filename box; the pre-set name includes the record number and SPECPR filename. The default directory is the directory that contains the SPECPR file. The user may change the output directory and (or) the filename, if desired. After setting the file, press “Open” to continue.

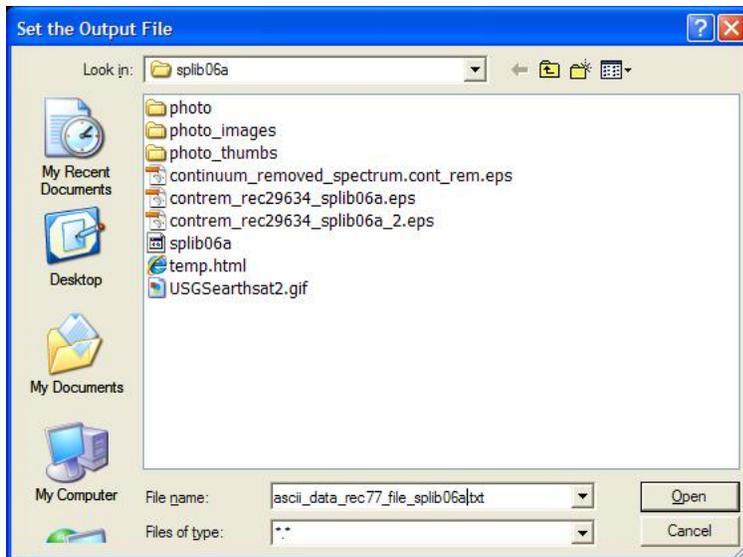


Figure 230. Selecting the output ASCII text file to hold the exported spectrum in floating point format.

After the text file is created, a message appears advising the user that the function has completed successfully. Click the “OK” button to dismiss the message.

Figure 231 shows a listing of the ASCII text file created in this example. In this listing, the first line contains all asterisks (*). This indicates a value that is beyond the default floating point format of “f22.8”, where the floating point data are printed with 8 digits after the decimal point. The format allows up to 12 digits to be printed before the decimal point. In particular, the SPECPR deleted channel value of $-1.23e^{+34}$ exceeds the display range of this floating point function. In order to see the values of such channels, use “*Function 2.16.2 – Export to ASCII Scientific Notation*” to export the values stored in the selected record to a text file.

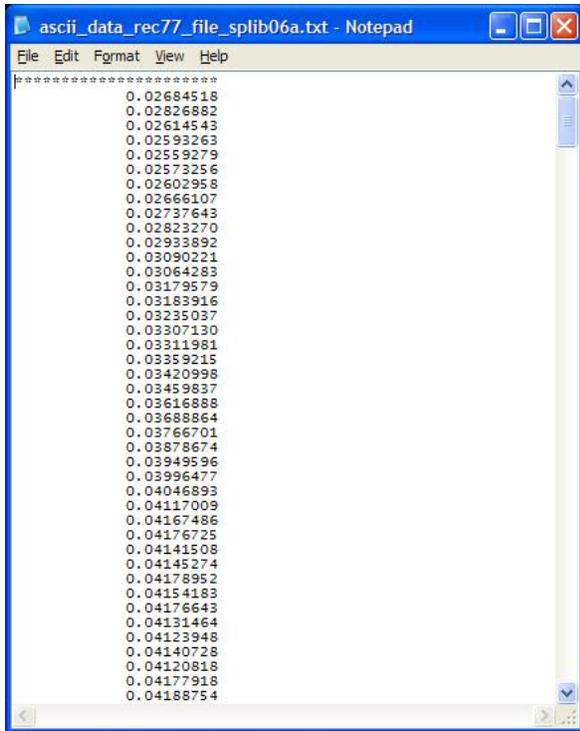


Figure 231. Values from a text file containing a record exported in floating point format.

Function 2.16.2 – Export to ASCII Scientific Notation

This function allows the user to export a spectrum to an ASCII text file in scientific notation format. To start the function, click on the “Export SPECPR record to ASCII” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar. Select the “Export to ASCII Scientific Notation” option from the list that appears (see fig. 227).

The steps taken in this function are the same as those in “*Function 2.16.1 – Export to ASCII Floating Point*”. Figure 232 shows a listing of the ASCII text file created using this function for the record used as an example in “*Function 2.16.1 – Export to ASCII Floating Point*”. In this listing, the values that exceeded the display capabilities of the floating point format are readable in scientific notation. PRISM uses IDL’s default scientific notation format (ITT Visual Information Solutions, 2009).

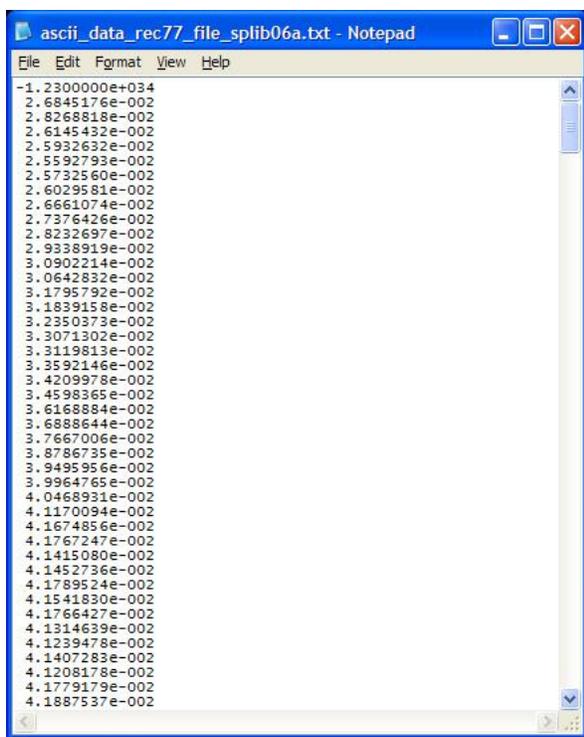


Figure 232. Values from a text file containing a record exported in scientific notation format.

Function 2.17 – Wavelength/FWHM evaluation of ASD

The *Spectroscopy Laboratory* of the U.S. Geological Survey has used and maintained five ASD spectrometers over the last 15 years. Four PRISM functions allow the user to evaluate the spectral characteristics, wavelength sampling position, and bandpass (FWHM) of an ASD spectrometer in order to detect instrument problems and verify its proper performance. The functions were developed by the USGS Spectroscopy Laboratory to routinely evaluate the performance of an ASD spectrometer. Significant changes in spectrometer performance over time, revealed by shifts in wavelength positions of absorption features, have been detected with these functions. Such shifts can arise during a field season. PRISM's functions for evaluating the spectral characteristics of ASD spectrometers are also useful after annual maintenance, usually done between field seasons, as spectral characteristics may change due to repair and replacement of spectrometer parts. In general, these evaluations are made by comparing the transmission spectra of reference materials collected with the ASD spectrometer being evaluated to measurements of these materials made by higher resolution laboratory spectrometers.

These estimation methods are somewhat coarse when compared to rigorous laboratory definitions of wavelength and bandpass characteristics using scanning monochromators. The coarseness of the evaluation arises primarily from the limitations of the reference materials used as wavelength standards. Despite this, these evaluations are still useful, simple, and relatively inexpensive. Also, the measurements can be implemented in the field using reflected sunlight. If an instrument problem occurs prior to or during a field session, these methods can be applied to the transmission measurements of the standard materials and the results may be used to correct spectra collected with the wavelength-shifted spectrometer.

The spectral characteristics of an ASD spectrometer are evaluated using measurements made of the transmission of light through reference materials. PRISM is configured to work with one-way, or single pass, transmission measurements, where “one-way” indicates the light passes only once through the reference material. In order to evaluate an ASD’s spectral characteristics, the user must make such measurements of reference materials using the spectrometer. Three reference materials have been characterized for these evaluations in PRISM: a thin sheet of Mylar plastic, a National Institute of Standards and Technology (NIST) standard reference material 2035 (SRM2035) containing rare earth elements, and a praseodymium-doped Corning glass #5121. Mylar is typically distributed by ASD with their spectrometers and is widely available. The NIST standard reference material SRM2035 is available for purchase. Corning glass #5121 (CG5121) is rare because it is no longer produced.

In order to compare an ASD-measured spectrum with high signal-to-noise to the reference spectra, it is suggested that the user set their spectrometer to integrate 60 samples for spectral measurements and 240 samples for the white reference and dark current. In addition, the user should record at least 24 measurements of 1-way transmission with those settings. Using “*Function 2.5 – Import ASD binary files*”, the user’s measurements of the reference materials can be imported into a SPECPR file and then an average spectrum of each reference material can be calculated using “*Function 2.7.2 – Average ASD spectra*”.

Subsequently, *Functions 2.17.1 - 2.17.4* can be used to evaluate the spectral characteristics of these averaged ASD measurements relative to the spectra of these materials collected using higher resolution laboratory spectrometers. Each of these routines generates a text report and spectral feature comparison plots. The reports and plots show the comparisons of continuum- removed absorption features from the ASD measurement of a reference material to the continuum-removed feature of the reference material made on a higher resolution laboratory spectrometer, after convolution to various bandpass (FWHM) values. The reported fit values from spectral feature comparisons (*Function 1.7.1*) and visual inspection of spectral plots can be used to determine the best match. The bandpass (FWHM) of the best match is the estimate of the ASD spectrometer’s bandpass at the absorption feature’s wavelength position. For a detector in the ASD spectrometer, an estimated bandpass (FWHM) can be calculated by averaging the bandpass estimates for all the features that fall within that detector’s wavelength range. These procedures have been used to establish the bandpass (FWHM) of each feature to the nearest 1 nm (0.001 μm); that value is considered to be the error in bandpass (FWHM) determination for these functions in PRISM.

The reference materials, Mylar, SRM2035, and CG5121, have features that fall into the different ASD detector ranges. Mylar has strong, narrow absorption features best suited for characterizing the SWIR2 detector, but no useful features in the VNIR detector range and only one in the SWIR1 detector range. In contrast, CG5121 has strong, narrow features best for evaluating the VNIR detector. Unfortunately, CG5121 is no longer produced. The SRM2035 absorption features, though slightly broader than CG5121 features, can be used to evaluate the VNIR detector. SRM2035 also has many features in the SWIR1 detector range and, thus, can be used to evaluate the SWIR1 spectral characteristics, although these features are fairly broad.

After the bandpass (FWHM) of each detector is estimated, the user can compare the band center positions of the absorption features as measured using the ASD spectrometer to the band center positions of the convolved reference measurement. The comparison is made by subtracting the reference band center from the ASD measured band center. If there are consistent differences, for each detector in the ASD spectrometer, a potential wavelength correction can be

calculated by averaging the difference values in that detector's wavelength range. For wavelength corrections, averaged differences less than half the 1 nm sampling interval of the ASD are considered to be within the error of the measurement/estimation procedures; thus, only corrections for averaged wavelength shifts of greater than 0.5 nm should be considered for implementation.

A SPECPR file containing the reference spectra, measured on the laboratory spectrometers and convolved to various bandpass (FWHM) values, is included with the PRISM software distribution (see the "*Installation of Software*" section of this report). If the default directory in step 3 of the installation instructions was used, this file will be located at "C:\usgsprism\spectra\asd\spd_asdcalib" on Windows computers and at "/var/local/usgsprism/spectra/asd/spd_asdcalib" on Linux computers.

Shifts in wavelength position and evaluations of bandpass (FWHM) are characterized more consistently using strong, narrow absorption features, as compared to weak, broad absorption features. Thus, not all absorption features are used in the bandpass (FWHM) estimates and wavelength corrections. The suggested features to use for the reference materials are shown in figures 233-236. Note: some features of the CG5121 are not used because of the coarse sampling interval and bandpass (FWHM) properties of the reference Beckman spectrometer in certain wavelength regions (for details on these regions, see Clark and others, 2007). Using the results of the evaluations, "*Function 2.17.5*" can be run to generate custom wavelength and bandpass (FWHM) records for the spectrometer. With this function, a Spectralon reflectance spectrum can be interpolated to the user's ASD spectrometer characteristics. The Spectralon reflectance spectrum calculated using an ASD's estimated spectral characteristics is also an approximation. A more finely detailed determination of a Spectralon panel's absolute reflectance spectrum may be achieved by measuring its reflectance relative to other substances and converting these relative measurements to absolute reflectance. Labsphere (the manufacturer of Spectralon) and ASD can provide the user with estimates of their particular Spectralon panel's reflectance, although these are commonly provided at coarse wavelength sampling.

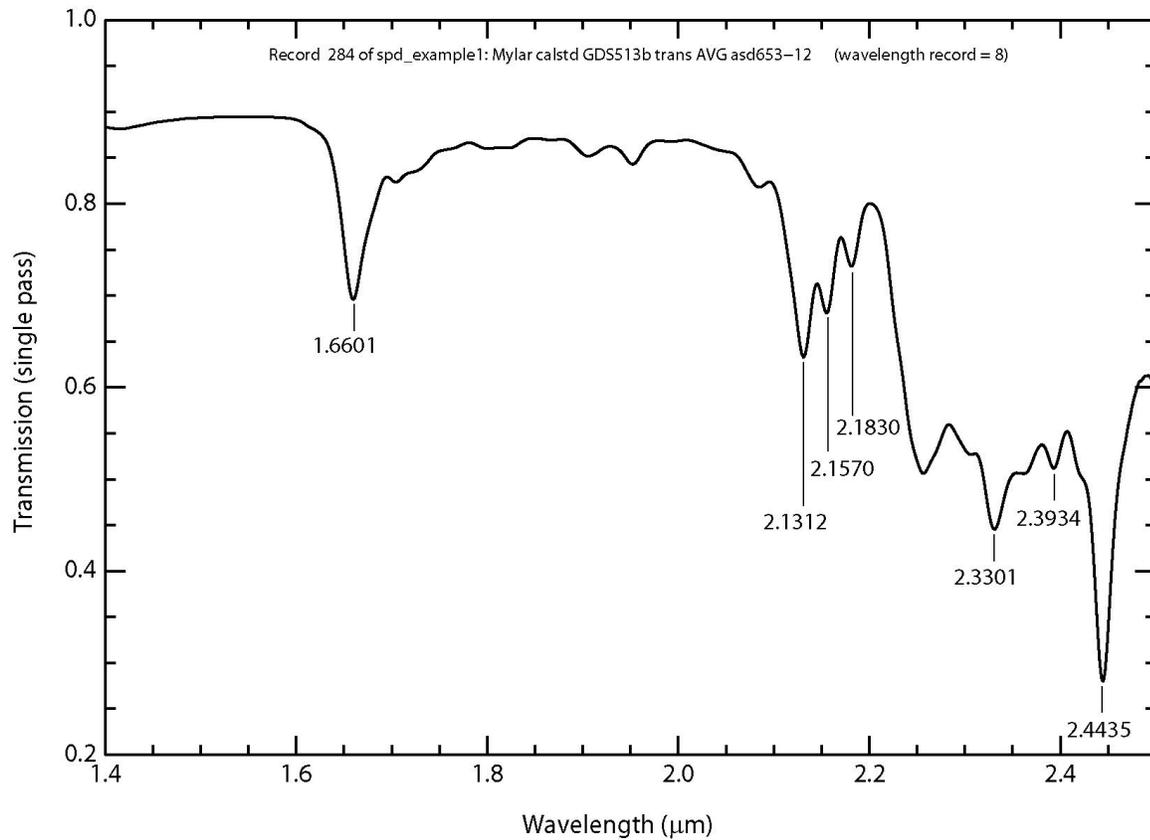


Figure 233. Mylar single pass transmission spectrum measured with an ASD spectrometer. Strong, narrow absorption features used in evaluating ASD spectral characteristics, SWIR detectors, are labeled using band centers from the reference spectrometer.

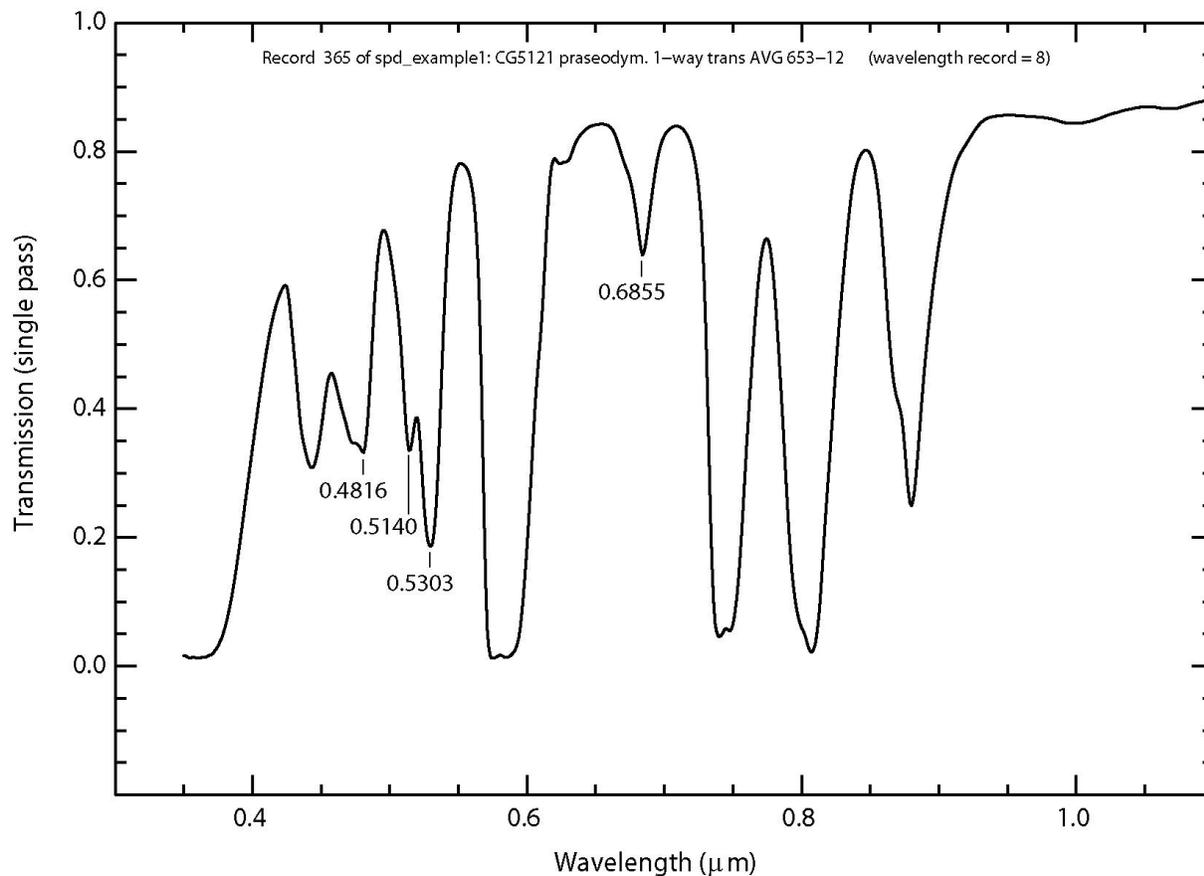


Figure 234. CG5121 single pass transmission spectrum measured with an ASD spectrometer. Strong absorption features used in evaluating the ASD VNIR detector are labeled using band centers from the reference spectrometer.

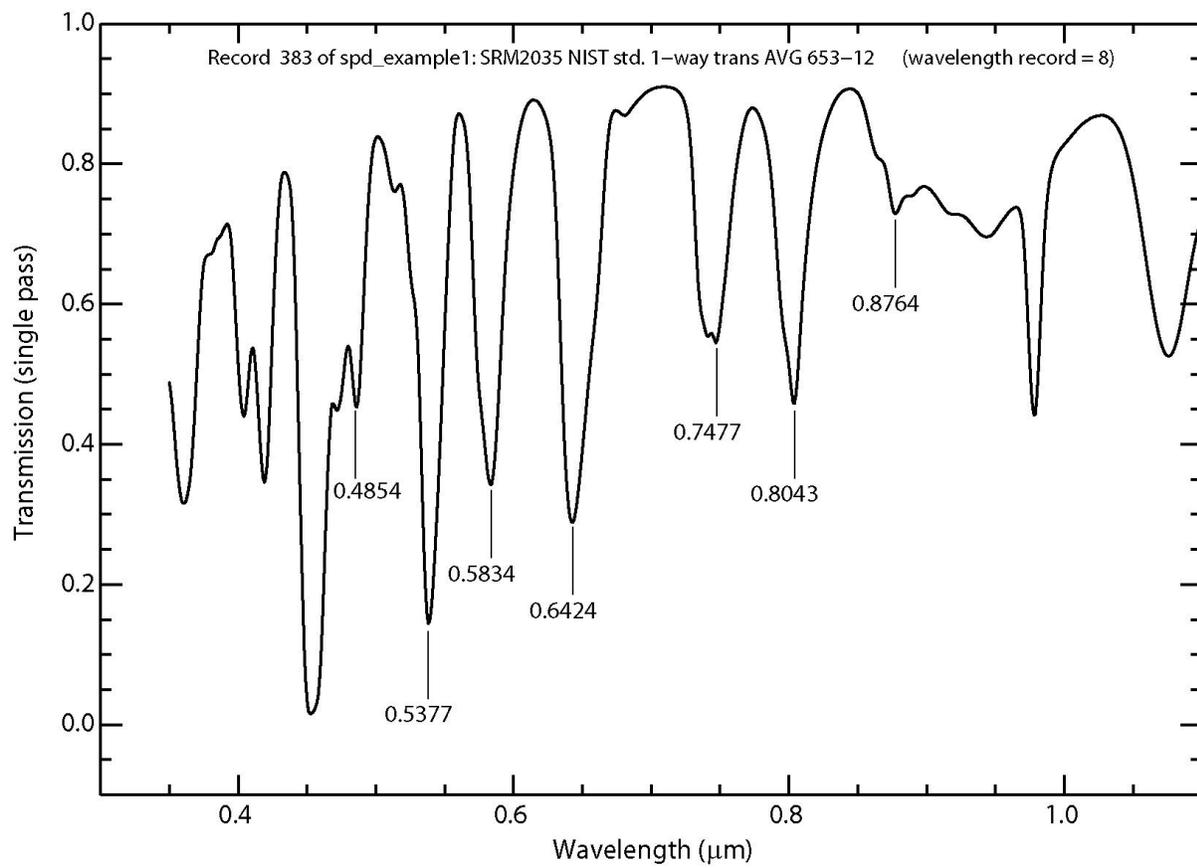


Figure 235. NIST SRM2035 single pass transmission spectrum measured with an ASD spectrometer. Strong absorption features used in evaluating the ASD VNIR detector are labeled using band centers from the reference spectrometer.

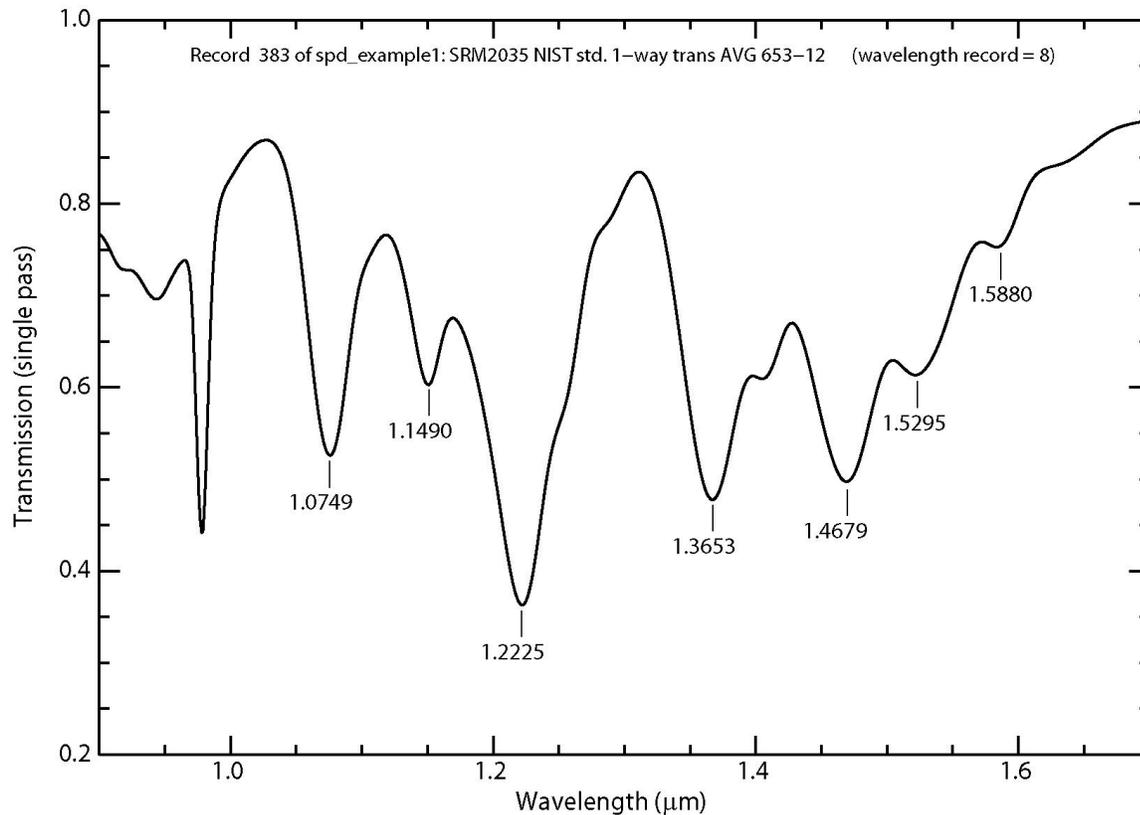


Figure 236. NIST SRM2035 single pass transmission spectrum measured with an ASD spectrometer. Relatively strong absorption features used in evaluating the ASD SWIR1 detector are labeled using band centers from reference spectrometer.

Function 2.17.1 – Compare reference to ASD measurements for Mylar

This function evaluates the spectral characteristics of an ASD spectrometer by comparing measurements of Mylar made using the ASD being evaluated to spectra of Mylar measured with a higher resolution Nicolet laboratory spectrometer. The ASD measurement of the Mylar plastic sheet should be made in one-way, or single pass, transmission (see the discussion of measurement procedures in *Function 2.17*).

This routine generates a text report and spectral feature comparison plots. The reports and plots show the spectral feature comparisons (see *Function 1.7.1*) between the ASD measurement of Mylar and the Nicolet spectrometer measurement of Mylar, after convolution of the Nicolet measurement to various bandpass (FWHM) values. The reported fit values and spectral plots can be used to determine the best match between the measured spectrum and one of the convolved reference spectra. The bandpass (FWHM) of the best match is the estimate of the ASD spectrometer’s bandpass at the absorption feature’s wavelength position. For a detector in the ASD spectrometer, an estimated bandpass (FWHM) can be calculated by averaging the bandpass estimates for the features that fall within that detector’s wavelength range.

To start the routine, click on the “Wavelength/FWM evaluation of ASD” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar. Select the “Compare reference to ASD measurements for Mylar” option from the list that appears (fig. 237).

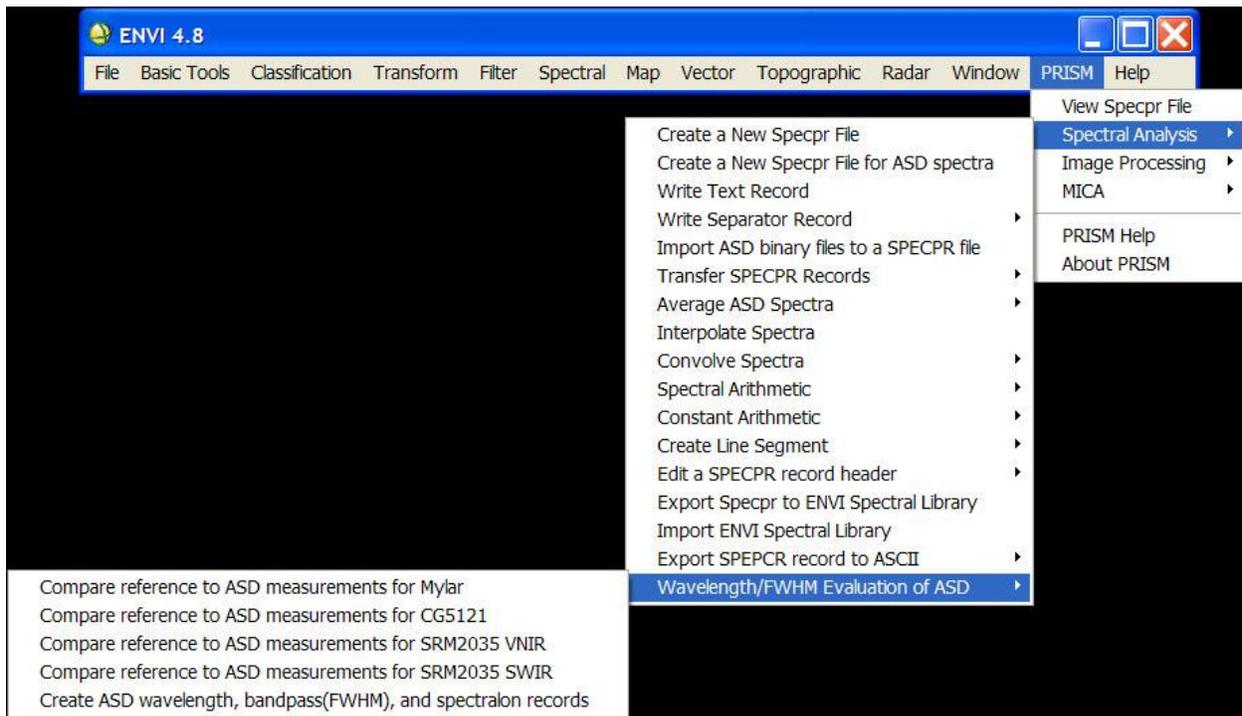


Figure 237. Functions for evaluating ASD spectrometer characteristics.

The user is first prompted to set the name of a file that will contain the output report in text format (fig. 238). In this example, the output report file is set to “asd653-12_mylar.txt”. This file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in the directory “C:\usgsprism\spectra\asd\asd653-12_calib\mylar\” on Windows computers and at “/var/local/usgsprism/spectra/asd/asd653-12_calib/mylar/” on Linux computers.

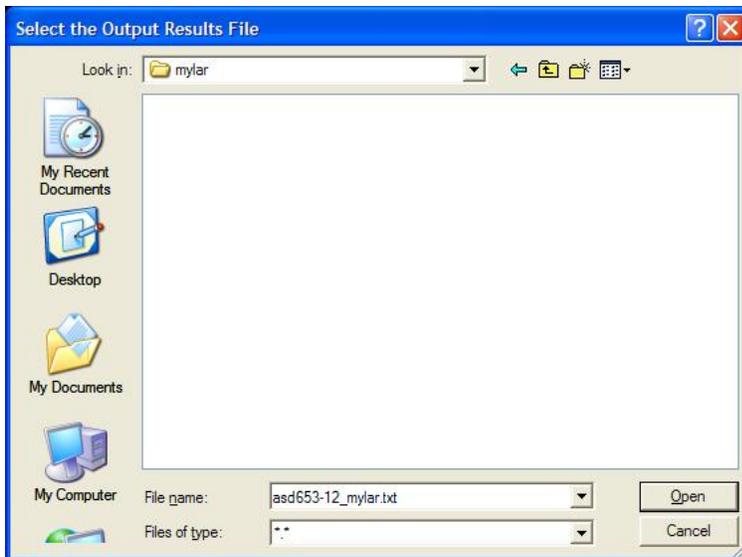


Figure 238. Setting the filename for the output report.

Next, the program checks to see if the SPECPR file containing the reference materials measured on the laboratory spectrometers is present in the default location. This file “spd_asdcalib” is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\spectra\asd\” on Windows computers and in “/var/local/usgsprism/spectra/asd/”. If the file is present in the default location, a message indicating this will be displayed (fig. 239). Press “OK” to continue.

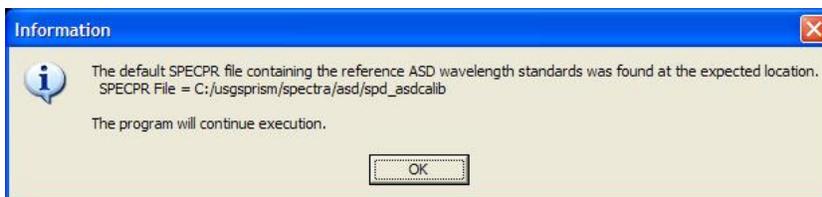


Figure 239. Message indicating the SPECPR file, containing spectra of reference materials measured on the reference laboratory spectrometers, was found.

If the SPECPR file is not found in the default location, the user will be asked if the file is in a different location and to respond “Yes” to select it. If the user responds “No”, the program will be halted. If the user responds “Yes”, the user will be prompted to select the file (this selection window is not shown here).

Next, the user is prompted to select the SPECPR file that contains the spectrum of Mylar measured using the ASD spectrometer that the user is evaluating. Figure 240 shows the selection of “spd_example1”. This file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*”

section of this report), this file will be located in “C:\usgsprism\spectra\” on Windows computers and in “/var/local/usgsprism/spectra/” on Linux computers.

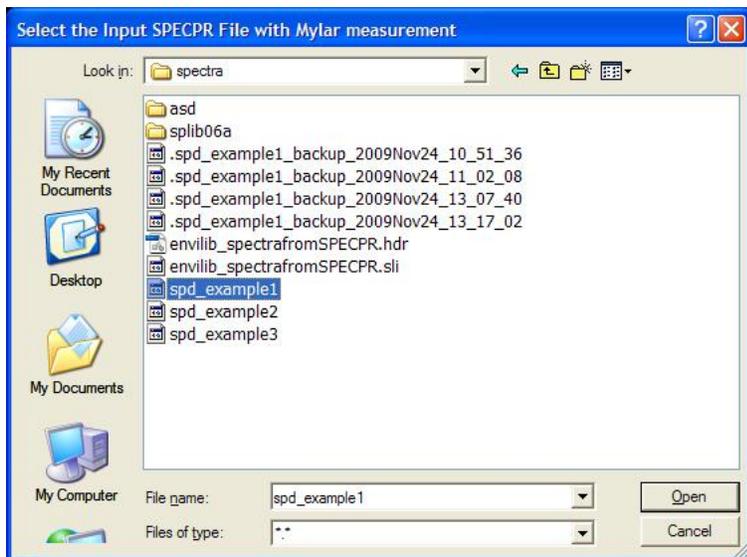


Figure 240. Selecting the SPECPR file that contains the spectrum of Mylar that was measured using the ASD spectrometer that the user is evaluating.

Next, the user is prompted to select the record that contains the Mylar one-way transmission spectrum (fig. 241). In this example, the averaged one-way transmission spectrum of Mylar is record 284. Press the “Return Selected Record” button after selecting the appropriate record.

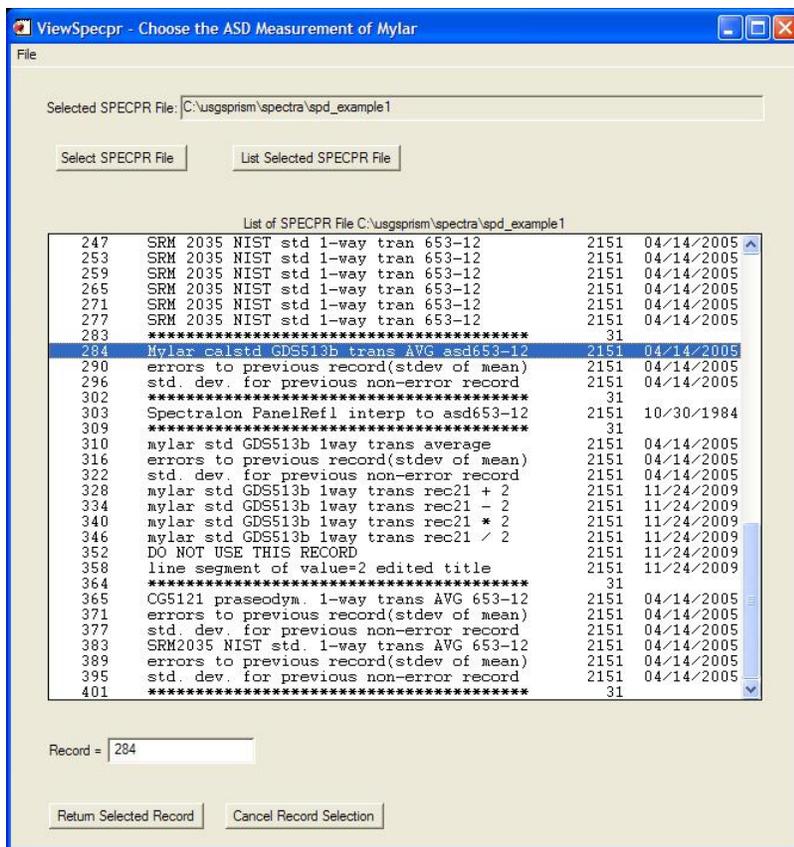


Figure 241. Selecting the record that contains the one-way transmission spectrum of Mylar that was measured using the ASD spectrometer that the user is evaluating.

Next, the routine compares the measured spectrum to the reference spectrum convolved to various bandpass (FWHM) values. The output report is written to the file specified earlier. Plots that compare spectral features between the ASD measured spectrum and the convolved reference spectra are created in the same directory. A message indicating the successful completion of the program is displayed (fig. 242). Press “OK” to dismiss the message.

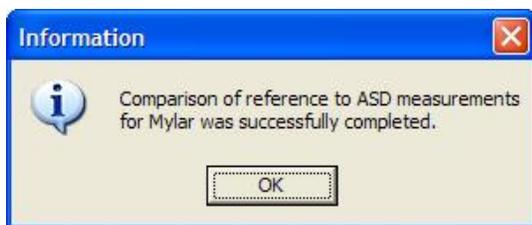


Figure 242. Message indicating the successful completion of the ASD evaluation using spectra of Mylar.

Figure 243 shows the beginning of the text report. Some initial reporting is made, lines of text showing the SPECTPR files that were used and the records that were read. Next, each feature of the Mylar spectrum is analyzed. For each feature, the absorption feature from the ASD-

measured spectrum is compared to the absorption feature in spectra convolved to the ASD default wavelength positions and various bandpass (FWHM) values from 3 nm to 15 nm in 1 nm increments. Thus, the rows of the report on the first feature, at 1.6601 μm , pertain to convolutions to increasing bandpass of the spectrum measured on the high resolution laboratory spectrometer.

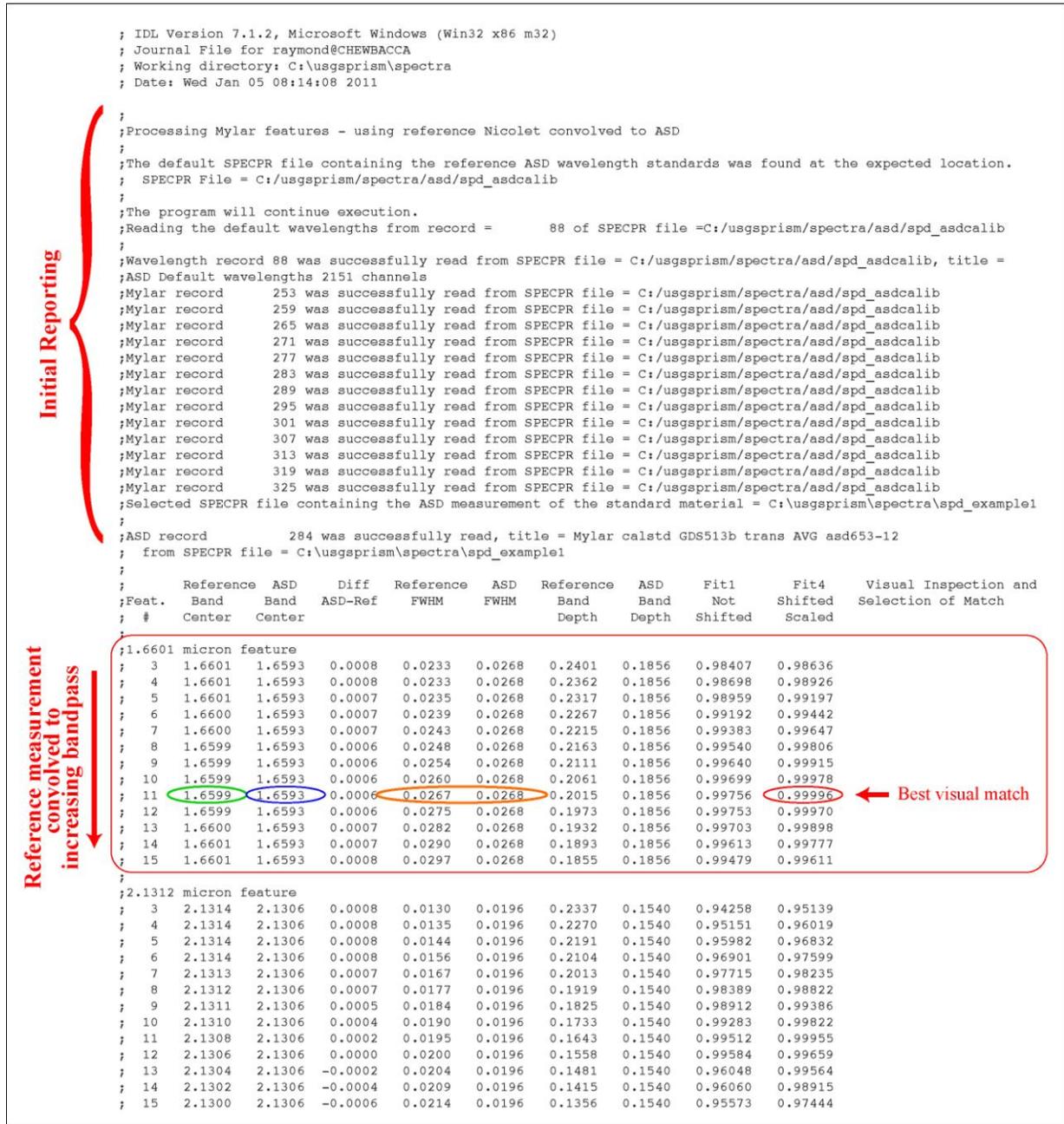


Figure 243. Report on the ASD evaluation using spectra of Mylar; the beginning of the file is shown.

For each absorption feature, the user must evaluate at which bandpass (FWHM) the ASD-measured feature is most similar to the feature in the convolved reference spectra. The

columns of the feature report are a helpful starting point, in particular, the last fit column, labeled “Fit4 Shifted Scaled”. This column contains the fit value of the spectral feature comparison (see *Function 1.7.1*) between the ASD-measured feature and the reference feature convolved to increasing bandpass (FWHM) after shifting the band center of the ASD (and the entire continuum-removed feature) to the band center position of the convolved reference spectrum. In this example, the best match (highest fit value) indicated by this column is for the 11 nm bandpass (fig. 243).

Next, the user should examine the plots that were created in the same directory as the output report. In this example, the plot containing the ASD-measured feature compared to the 11 nm bandpass convolution of the 1.6601 μm feature is “plot_scaled_shifted_comparison_mylar_1.6601_fwhm11_try2_reshift.eps”. This plot along with the next smaller bandpass (10 nm) and the next higher bandpass (12 nm) are shown in figure 244. The plot files for this example are included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in the directory “C:\usgsprism\spectra\asd\asd653-12_calib\mylar\” on Windows computers and at “/var/local/usgsprism/spectra/asd/asd653-12_calib/mylar/” on Linux computers.

From the plots in figure 244, the best match in a visual sense is the 11 nm bandpass (FWHM) plot. In the plot of the 10 nm convolution (top plot in fig. 244) the convolved feature (thick line) shows a narrower feature than the ASD measurement (thin line), and the two lines do not agree as well as the lines in the 11 nm convolution (middle plot of fig. 244). In the plot of the 12 nm convolution (bottom plot in fig. 244) the convolved feature (thick line) is broader than the ASD measurement (thin line), and the two lines do not agree as well as the lines in the 11 nm convolution.

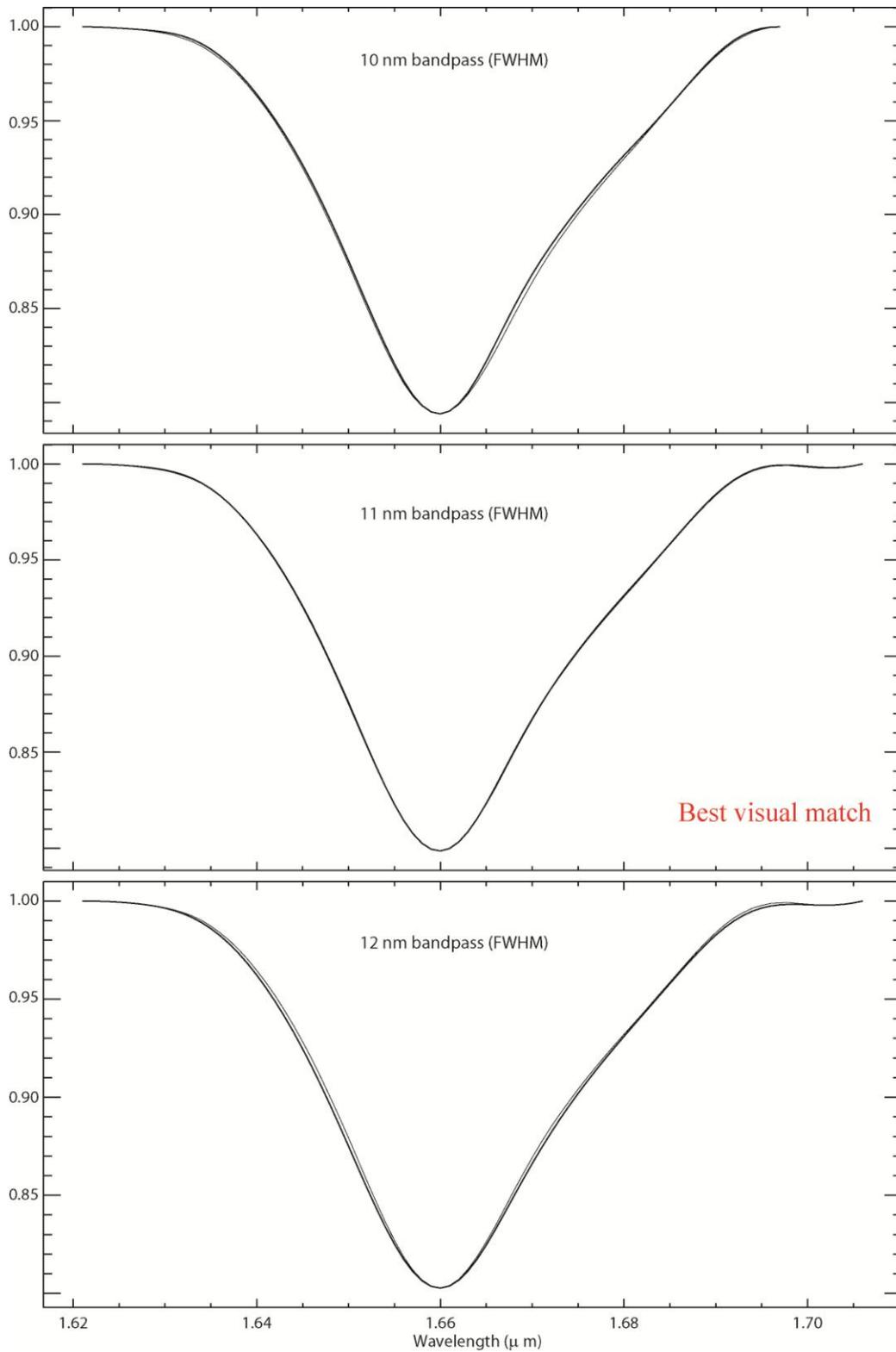


Figure 244. Plots from the ASD evaluation using spectra of Mylar, for the 1.6601 μm feature. The thin line is the ASD measurement, the thick line is the convolved reference spectrum.

Usually, the highest fit number in the text report, as shown by the red circle in figure 243, is a good guide to the best visual match. In addition, the similarity in feature width, indicated by the orange circle in figure 243, often supports the best visual match selection. Generally, the feature width will be narrower (smaller) than the ASD-measured feature for convolutions of the reference to bandpass values that are smaller than the ASD's bandpass, and broader (larger) for convolutions to bandpass values that are larger than the ASD's bandpass. The best match of the ASD-measured feature to the convolved features is typically one of the bandpass values with the closest agreement in the feature width. Sometimes the similarity in band depth is useful as a last deciding factor. For example, when there are two bandpass values that appear very close to the measured spectrum with fit values that are both high, the user may use the closest match in band depth to select the best match from the two possibilities.

Thus, the evaluation of the best match for each feature can be conducted in the manner described, using information from the report on feature parameters, the fit values, and the comparison plots to arrive at the bandpass (FWHM) that is the closest match to the ASD measured spectral feature. The most reliable features in making these determinations are shown in figures 233-236 for the various reference materials. A useful Excel spreadsheet, "pub_asd_653-12_2151chan.xls", for averaging these estimates for each ASD detector is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the "*Installation of Software*" section of this report), this file will be located at "C:\usgsprism\spectra\asd\asd653-12_calib\" on Windows computers and at "/var/local/usgsprism/spectra/asd/asd653-12_calib/" on Linux computers. Considering the limitations of this evaluation process, including the small number of features available in each detector, the accuracy of the bandpass (FWHM) determination is considered to be no better than the 1 nm increment to which the reference spectra are convolved. Thus, the average bandpass computed from the reliable features in a detector range should be rounded to the nearest whole integer value.

Figure 245 shows the bandpass estimates, from the spreadsheet calculations, for the example ASD evaluation in this report. The SWIR1 detector estimate, from both the Mylar and the SRM2035 features, is 11 nm. The bandpass estimates for the ASD detectors can be used to establish a bandpass (FWHM) record for the ASD spectrometer (see "*Function 2.17.5 Create ASD wavelength, bandpass (FWHM), spectralon records*").

Microsoft Excel - pub_asd_653-12_2151chan.xls

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Geneva 9 B I U

J44 Overall Bandpass Estimate

1	ASD FR 653-12		Full Wavelength Set 2151 Channels		Measurement Date:	April 14, 2005			
3	Bandpass Determinations								
4	Reference Material	Reference Spectrometer	Feature Name	Matching BP (nm) (from width, depth and shape)					
5	Corning Glass 5121 - Praseodymium	Beckman	0.4413 micron	no good match					
6	Corning Glass 5121 - Praseodymium	Beckman	0.4816 micron	6					
7	Corning Glass 5121 - Praseodymium	Beckman	0.5140 micron	5					
8	Corning Glass 5121 - Praseodymium	Beckman	0.5303 micron	5					
9	Corning Glass 5121 - Praseodymium	Beckman	0.5861 micron	too broad					
10	Corning Glass 5121 - Praseodymium	Beckman	0.6855 micron	4					
11	Corning Glass 5121 - Praseodymium	Beckman	0.7410 micron	too broad					
12	Corning Glass 5121 - Praseodymium	Beckman	0.8075 micron	poor res. in beckman					
13	Corning Glass 5121 - Praseodymium	Beckman	0.8808 micron	poor res. in beckman					
14	Corning Glass 5121 - Praseodymium	Beckman	1.5104 micron	too broad					
15	SRM2035 VNIR	Cary	0.4854 micron	6					
16	SRM2035 VNIR	Cary	0.5377 micron	5					
17	SRM2035 VNIR	Cary	0.5834 micron	5					
18	SRM2035 VNIR	Cary	0.6424 micron	5					
19	SRM2035 VNIR	Cary	0.7477 micron	3					
20	SRM2035 VNIR	Cary	0.8043 micron	4					
21	SRM2035 VNIR	Cary	0.8764 micron	4					
22	SRM2035 SWIR	Cary	1.0749 micron	13					
23	SRM2035 SWIR	Cary	1.1490 micron	11					
24	SRM2035 SWIR	Cary	1.2225 micron	12					
25	SRM2035 SWIR	Cary	1.3653 micron	11					
26	SRM2035 SWIR	Cary	1.4679 micron	11					
27	SRM2035 SWIR	Cary	1.5295 micron	11					
28	SRM2035 SWIR	Cary	1.5880 micron	11					
29	Mylar	Nicolet	1.6601 micron	11					
30	Mylar	Nicolet	1.9053 micron	too weak					
31	Mylar	Nicolet	1.9535 micron	too weak					
32	Mylar	Nicolet	2.1312 micron	11					
33	Mylar	Nicolet	2.1570 micron	12					
34	Mylar	Nicolet	2.1830 micron	12					
35	Mylar	Nicolet	2.2558 micron	too broad					
36	Mylar	Nicolet	2.3301 micron	10					
37	Mylar	Nicolet	2.3934 micron	10					
38	Mylar	Nicolet	2.4190 micron	too weak					
39	Mylar	Nicolet	2.4435 micron	11					
43	Results for ASD Bandpass								
44	Detector	Channel Range	Wavelength Range	Average Bandpass Calculation	Bandpass Estimate	Average Bandpass SRM2035	Bandpass Estimate SRM2035	Overall Bandpass Average	Overall Bandpass Estimate
45	Detector 1 VNIR	1 to 651	0.350 to 1.000	5.0	5	4.6	5	4.7	5
46	Detector 2 SWIR1	652 to 1451	1.001 to 1.800	11.0	11	11.4	11	11.4	11
47	Detector 3 SWIR2	1452 to 2151	1.801 to 2.500	11.0	11				11

Ready Sum=27 NUM

Figure 245. The bandpass estimate part of the spreadsheet for evaluating ASD spectral characteristics.

With a bandpass estimate determined for a detector, the user can compare the band center positions of the convolved reference spectrum, the one convolved to the bandpass estimate, to the band center positions of the ASD measurement. These values are indicated in the text report shown in figure 243 with green and blue circles, respectively. These values come from the central wavelength of the quadratic function fitted to the three central-most channels in the absorption feature, that is, the band minimum channel and one channel on either side (for details see *Function 1.7 – Performing continuum removal on a record*). The second column of the report in figure 243 shows that the band center position of the reference spectrum shifts slightly as the spectrum is convolved to coarser bandpass. Other features can show greater shifts. For this reason, the bandpass estimate is made first, so that the band center from the ASD-measured spectral feature can be compared to the appropriate convolved reference spectrum. Figure 246 shows the wavelength position portion of the spreadsheet for evaluating ASD spectrometer

characteristics, showing that for this example, there are only very small differences between the band centers from the ASD-measured spectrum calculated using the default ASD channel positions and from the reference spectrum convolved to the bandpass estimate.

Reference Material	Reference Spectrometer	Feature Name	Reference Band Center	ASD Band Center	Difference (Ref-ASD)
Corning Glass 5121 - Praseodymium	Beckman	0.4413 micron	0.4417	0.4422	-0.0005
Corning Glass 5121 - Praseodymium	Beckman	0.4816 micron	0.4811	0.4809	0.0002
Corning Glass 5121 - Praseodymium	Beckman	0.5140 micron	0.5140	0.5138	0.0002
Corning Glass 5121 - Praseodymium	Beckman	0.5303 micron	0.5302	0.5298	0.0004
Corning Glass 5121 - Praseodymium	Beckman	0.5861 micron	0.5867	not checked	too broad
Corning Glass 5121 - Praseodymium	Beckman	0.6855 micron	0.6855	0.6842	0.0013
Corning Glass 5121 - Praseodymium	Beckman	0.7410 micron	0.7419	0.7401	too broad
Corning Glass 5121 - Praseodymium	Beckman	0.8075 micron	0.8095	0.8071	poor res. in beckman
Corning Glass 5121 - Praseodymium	Beckman	0.8808 micron	poor res. in beckman	0.8799	poor res. in beckman
Corning Glass 5121 - Praseodymium	Beckman	1.5104 micron	too broad		too broad
SRM2035 VNIR	Cary	0.4854 micron	0.4880	0.4867	-0.0007
SRM2035 VNIR	Cary	0.5377 micron	0.5383	0.5384	-0.0001
SRM2035 VNIR	Cary	0.5834 micron	0.5833	0.5835	-0.0002
SRM2035 VNIR	Cary	0.6424 micron	0.6427	0.6427	0.0000
SRM2035 VNIR	Cary	0.7477 micron	0.7468	0.7470	-0.0002
SRM2035 VNIR	Cary	0.8043 micron	0.8041	0.8036	0.0005
SRM2035 VNIR	Cary	0.8764 micron	0.8770	0.8767	0.0003
SRM2035 SWIR	Cary	1.0749 micron	1.0752	1.0752	0.0000
SRM2035 SWIR	Cary	1.1490 micron	1.1500	1.1492	0.0008
SRM2035 SWIR	Cary	1.2225 micron	1.2229	1.2228	0.0001
SRM2035 SWIR	Cary	1.3653 micron	1.3661	1.3659	0.0002
SRM2035 SWIR	Cary	1.4679 micron	1.4685	1.4685	0.0000
SRM2035 SWIR	Cary	1.5295 micron	1.5297	1.5292	0.0005
SRM2035 SWIR	Cary	1.5880 micron	1.5887	1.5887	0.0000
Mylar	Nicolet	1.6601 micron	1.6599	1.6593	0.0006
Mylar	Nicolet	1.9053 micron	1.9054	1.9045	too narrow and weak
Mylar	Nicolet	1.9535 micron	1.9533	1.9527	too narrow and weak
Mylar	Nicolet	2.1312 micron	2.1308	2.1306	0.0002
Mylar	Nicolet	2.1570 micron	2.1568	2.1566	0.0002
Mylar	Nicolet	2.1830 micron	2.1825	2.1822	0.0003
Mylar	Nicolet	2.2558 micron	2.2533	2.2537	too broad
Mylar	Nicolet	2.3301 micron	2.3308	2.3308	0.0000
Mylar	Nicolet	2.3934 micron	2.3939	2.3937	0.0002
Mylar	Nicolet	2.4190 micron	2.4191	2.4187	too narrow and weak
Mylar	Nicolet	2.4435 micron	2.4445	2.4447	-0.0002

Detector	Channel Range	Wavelength Range	Average Difference Calculation	AVG Diff SRM2035	Overall AVG	ADJUSTMENT greater than 0.5 nm
Detector 1 VNIR	1 to 651	0.350 to 1.000	0.0003	-0.0001	0.0001	NO
Detector 2 SWIR1	652 to 1451	1.001 to 1.800	0.0006	0.0002	0.0003	NO
Detector 3 SWIR2	1452 to 2151	1.801 to 2.500	0.0001		0.0001	NO

Figure 246. The wavelength position part of the spreadsheet for evaluating ASD spectral characteristics.

If there are consistent differences in the band center positions, then the reported ASD wavelength positions may be in error and the averaged difference may be used as a correction factor to compute new wavelength positions for the detector (see “Function 2.17.5 Create ASD wavelength, bandpass (FWHM), spectralon records”). If these differences are consistently greater than 1 nm, it is recommended that the correction factor be implemented. If the differences fall between 0.5 and 1 nm, the user should consider implementing the correction

factor or remeasuring the standards and reevaluating the spectrometer. If the differences are consistently less than 0.5 nm, the measurements are indicating no correction factor for ASD wavelengths is needed. In some cases, band center positions have been found to have large positive differences (greater than 1 nm) at one end of the detector and large negative differences at the other end of the detector. These values have been found to be indicative of a detector problem, which can be resolved by proper servicing of the spectrometer. Data collected using an instrument showing such shifts need to be corrected with more sophisticated correction factors than the simple offset correction available, by default, in *Function 2.17.5*.

Function 2.17.2 – Compare reference to ASD measurements for CG5121

This function evaluates the spectral characteristics of an ASD spectrometer by using measurements of Corning Glass #5121 (CG5121) made using the spectrometer being evaluated in comparison to measurements of the material that were made on a higher resolution Beckman laboratory spectrometer. The ASD measurement of the CG5121 glass should be made in one-way, or single pass, transmission (see the discussion of measurement procedures in *Function 2.17*).

To start the routine, click on the “Wavelength/FWHM evaluation of ASD” item under the “Spectral Analysis” option in the “PRISM” drop-down menu that appears under the ENVI menu bar (see fig. 237). Select the “Compare reference to ASD measurements for CG5121” option from the list that appears (see fig. 237). This function follows the same steps as “*Function 2.17.1– Compare reference to ASD measurements for Mylar*”. An ASD measurement of CG5121 can be found in record 365 of SPECPR file “spd_example1” (see fig. 241). An example report and comparison plots are included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), these files will be located in a “cg5121” subdirectory of “C:\usgsprism\spectra\asd\asd653-12_calib\” on Windows computers and in “/var/local/usgsprism/spectra/asd/asd653-12_calib/” on Linux computers.

Function 2.17.3 – Compare reference to ASD measurements for SRM2035 VNIR

This function evaluates the spectral characteristics of an ASD spectrometer by using measurements of NIST Standard Reference Material 2035 (SRM2035) made using the spectrometer being evaluated in comparison to measurements of the material that were made on a higher resolution Cary UV/VIS laboratory spectrometer. The ASD measurement of the SRM2035 glass should be made in one-way, or single pass, transmission (see the discussion of measurement procedures in *Function 2.17*).

To start the routine, click on the “Wavelength/FWHM evaluation of ASD” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar. Select the “Compare reference to ASD measurements for SRM2035 VNIR” option from the list that appears (see fig. 237). This function follows the same steps as “*Function 2.17.1– Compare reference to ASD measurements for Mylar*”. An ASD measurement of SRM2035 can be found in record 383 of SPECPR file “spd_example1” (see fig. 241). An example report and comparison plots are included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), these files will be located in a “srm2035_vnir” subdirectory of “C:\usgsprism\spectra\asd\asd653-12_calib\” on Windows computers and in “/var/local/usgsprism/spectra/asd/asd653-12_calib/” on Linux computers.

Function 2.17.4 – Compare reference to ASD measurements for SRM2035 SWIR

This function evaluates the spectral characteristics of an ASD spectrometer by using measurements of NIST Standard Reference Material 2035 (SRM2035) made using an ASD spectrometer in comparison to measurements of the material that were made on a higher resolution Nicolet laboratory spectrometer. The ASD measurement of the SRM2035 glass should be made in one-way, or single pass, transmission (see the discussion of measurement procedures in *Function 2.17*).

To start the routine, click on the “Wavelength/FWHM evaluation of ASD” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar. Select the “Compare reference to ASD measurements for SRM2035 SWIR” option from the list that appears (fig. 237). This function follows the same steps as “*Function 2.17.1 Compare reference to ASD measurements for Mylar*”. An ASD measurement of SRM2035 can be found in record 383 of SPECPR file “spd_example1” (see fig. 241). An example report and comparison plots are included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), these files will be located in a “srm2035_swir” subdirectory of “C:\usgsprism\spectra\asd\asd653-12_calib\” on Windows computers and in “/var/local/usgsprism/spectra/asd/asd653-12_calib/” on Linux computers.

Function 2.17.5 – Create ASD wavelength, bandpass (FWHM), spectralon records

This function creates wavelength and bandpass records for an ASD spectrometer using values provided by the user. In addition, the function interpolates a Spectralon reflectance measurement to the ASD spectral characteristics, creating a Spectralon reflectance record for the ASD spectrometer, which can be used to correct ASD relative reflectance spectra to absolute reflectance (see “*Function 2.7.1 – Average and AbsRef ASD spectra*”). In addition to the bandpass estimates and wavelength corrections estimated from Functions 2.17.1 – 2.17.4, or by other means, the routine will prompt the user to enter the wavelengths of the detector splices, that is, the wavelength values of the channels at the ends of the ASD detectors. These can be found in the header information of any record that contains a spectrum, measured on the ASD, which has been imported into a SPECPR file using “*Function 2.5 – Import ASD binary files into a SPECPR file*” (see fig. 220).

To start the routine, click on the “Wavelength/FWHM evaluation of ASD” item under the “Spectral Analysis” item of the “PRISM” entry of the ENVI menu bar. Select the “Create ASD wavelength, bandpass (FWHM), spectralon records” option from the list that appears (see fig. 237).

First, the user is prompted for the wavelength, in micrometers, of the last channel of the first ASD detector (that is, the “default” wavelength value of the last channel of the first detector) (fig. 247). For this example, using ASD 653-12, the header information of an imported ASD spectrum shows this value to be 1.0000 μm (see fig. 220). After the value is entered, press “OK” to continue.

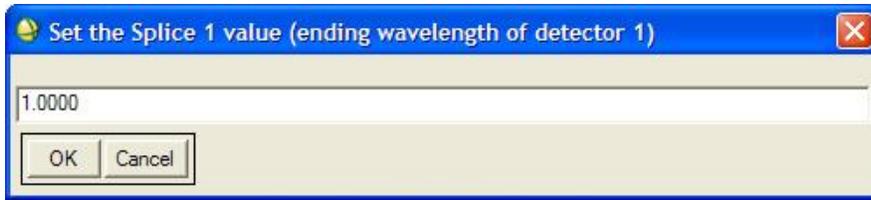


Figure 247. Entering the splice 1 wavelength value (in micrometers).

Next, the user is prompted for the wavelength, in micrometers, of the last channel of the second ASD detector (that is, the “default” wavelength value of the last channel) (fig. 248). For this example, using ASD 653-12, the header information of an imported ASD spectrum shows this value to be 1.8000 μm (see fig. 220). Press “OK” to continue.

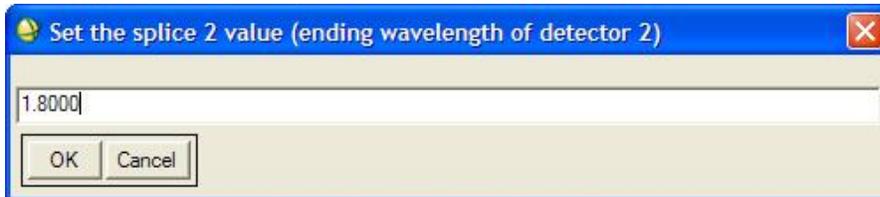


Figure 248. Entering the splice 2 wavelength value (in micrometers).

Next, the user is prompted for the wavelength adjustment, in micrometers, for the first ASD detector (fig. 249). For this example, using ASD 653-12, the calculations show the average difference (see fig. 246) in wavelength position between the ASD measurement and the reference spectrum to be 0.0001 μm (0.1 nm). In general, for average differences less than 0.0005 μm (0.5 nm) no adjustment is needed. Enter “0” (zero) when the evidence indicates no adjustment is justified. Press “OK” to continue.

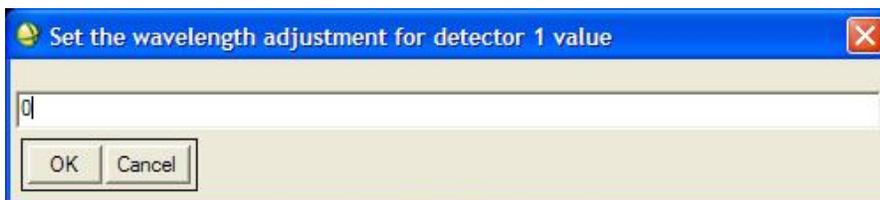


Figure 249. Entering the wavelength adjustment, in micrometers, for detector 1.

Next, the user is prompted for the wavelength adjustment, in micrometers, for the second ASD detector (fig. 250). For this example, using ASD 653-12, the calculations show the average difference (see fig. 246) in wavelength position between the ASD measurement and the reference spectrum to be 0.0003 μm (0.3 nm). In general, for average differences less than 0.0005 μm (0.5

nm) no adjustment is warranted. Enter “0” (zero) when no adjustment is needed. Press “OK” to continue.

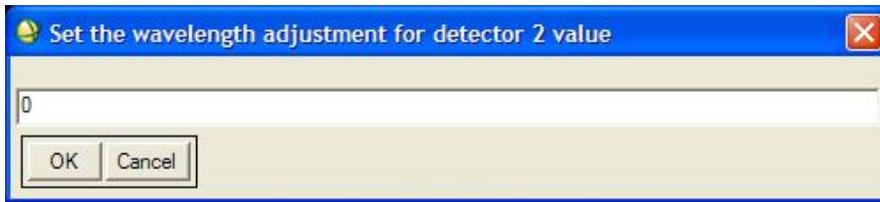


Figure 250. Entering the wavelength adjustment, in micrometers, for detector 2.

Next, the user is prompted for the wavelength adjustment, in micrometers, for the third ASD detector (fig. 251). For this example, using ASD 653-12, the calculations show the average difference (see fig. 246) in wavelength position between the ASD measurement and the reference spectrum to be 0.0001 μm (0.1 nm). In general, for average differences less than 0.0005 μm (0.5 nm) no adjustment is warranted. Enter “0” (zero) when no adjustment is needed. Press “OK” to continue.

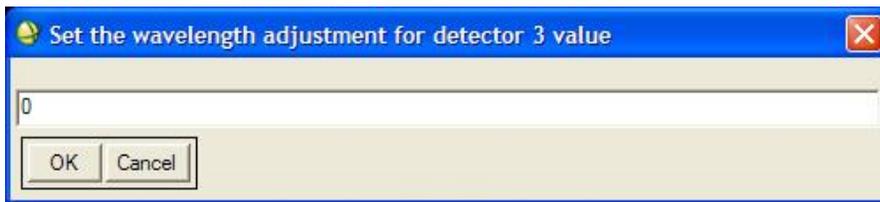


Figure 251. Entering the wavelength adjustment, in micrometers, for detector 3.

Next, the user is prompted for the bandpass estimate, in micrometers, for the first ASD detector (fig. 252). For this example, using ASD 653-12, the calculations show the average bandpass (see fig. 245) to be 0.005 μm (5 nm). Enter the value and press “OK” to continue.

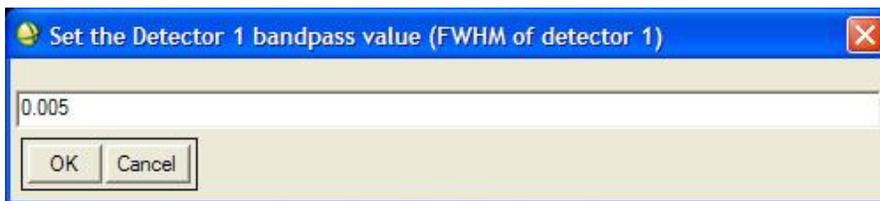


Figure 252. Entering the bandpass (FWHM) estimate, in micrometers, for detector 1.

Next, the user is prompted for the bandpass estimate, in micrometers, for the second ASD detector (fig. 253). For this example, using ASD 653-12, the calculations show the average bandpass (see fig. 245) to be 0.011 μm (11 nm). Enter the value and press “OK” to continue.

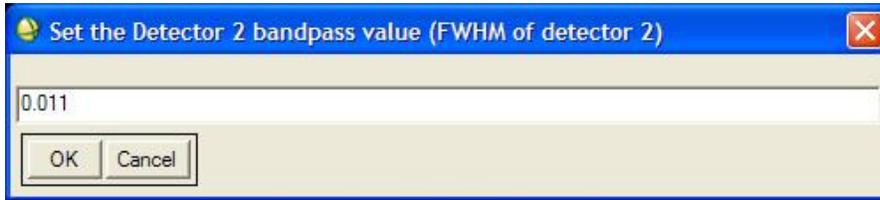


Figure 253. Entering the bandpass (FWHM) estimate, in micrometers, for detector 2.

Next, the user is prompted for the bandpass estimate, in micrometers, for the third ASD detector (fig. 254). For this example, using ASD 653-12, the calculations show the average bandpass (see fig. 245) to be 0.011 μm (11 nm). Enter the value and press “OK” to continue.

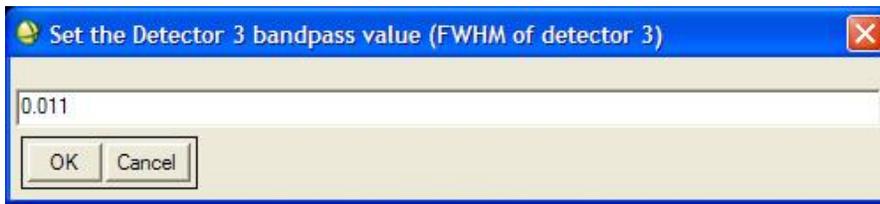


Figure 254. Entering the bandpass (FWHM) estimate, in micrometers, for detector 3.

Next, the user is prompted to set the output SPECPR file (fig. 255) in which to write the ASD wavelength and bandpass (FWHM) records and the interpolated Spectralon reflectance spectrum. Press “Open” to continue.

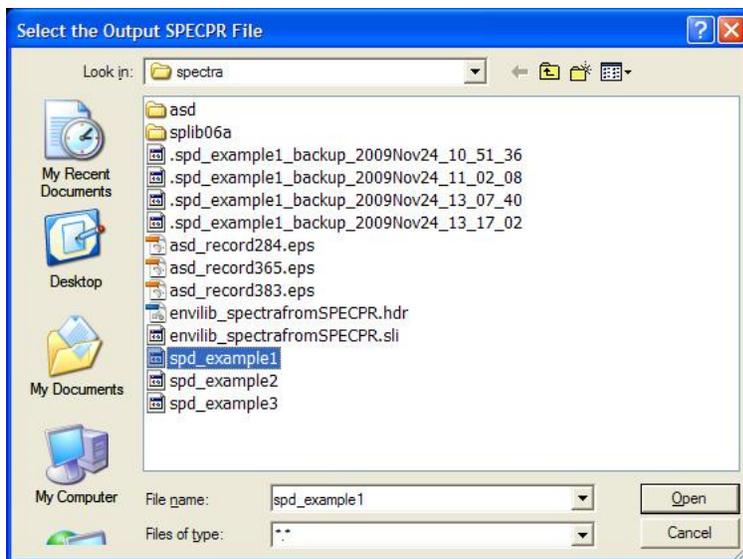


Figure 255. Setting the output SPECPR file for the ASD wavelength and bandpass (FWHM) records and Spectralon reflectance.

Next, the user is prompted for the ASD spectrometer number, in this case, “653”. Enter the value and press “OK” to continue (fig. 256).

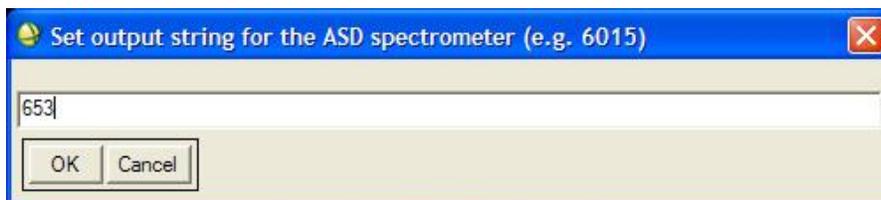


Figure 256. Entering the ASD spectrometer number.

Next, the user is prompted for the spectrometer’s calibration number, in this case, “12”. Enter the value and press “OK” to continue (fig. 257).

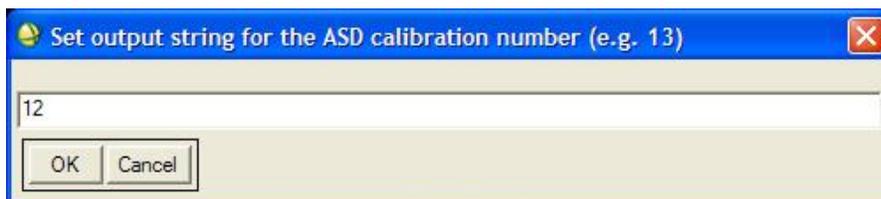


Figure 257. Entering the spectrometer’s calibration number.

Next, the ASD wavelength and bandpass (FWHM) records are added to the output SPECPR file, and the Spectralon reflectance spectrum is interpolated to the ASD spectrometer's newly established spectral characteristics. A message indicating the successful completion of the function appears (fig. 258). Press "OK" to dismiss the message.

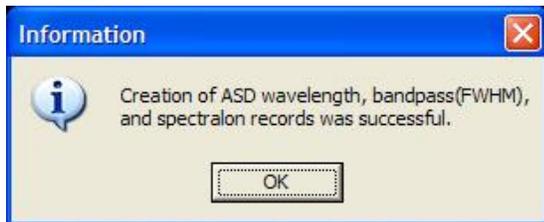


Figure 258. Message indicating the successful creation of the ASD wavelength and bandpass (FWHM) records and Spectralon reflectance spectrum.

The records are appended to the output SPECPR file (see fig. 259 for a listing of the records created in this example). The titles of the three newly created data records (records 403, 409, and 415) contain the ASD spectrometer and calibration numbers "653-12" to indicate the spectrometer for which these records were created.

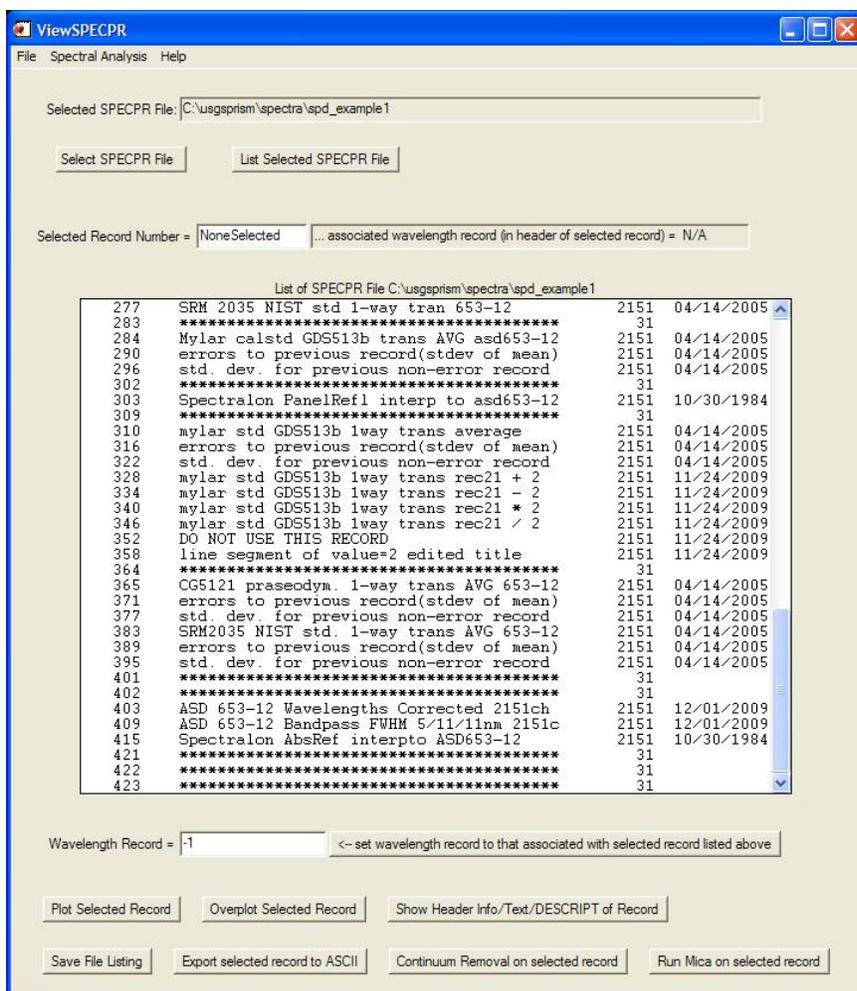


Figure 259. Listing of the records written to the end of the output SPECPR file.

The history fields of the record headers of the wavelength, bandpass (FWHM), and Spectralon reflectance spectra contain information on the values used in their creation (figs. 260-262).

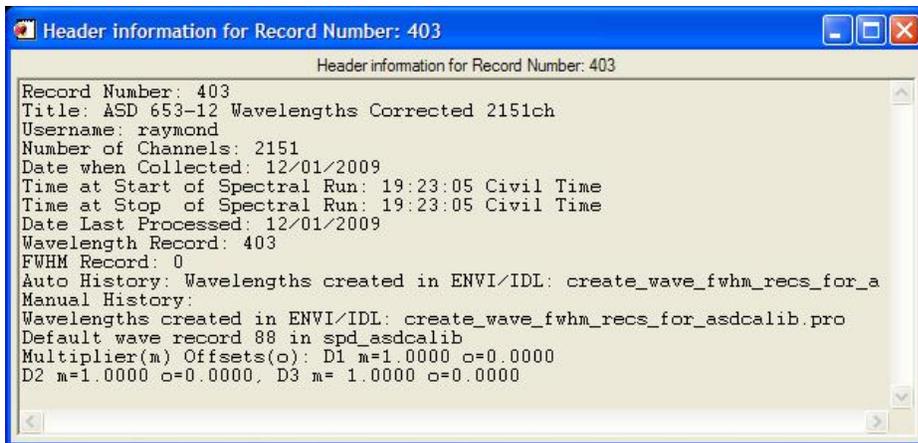


Figure 260. Header information in the ASD wavelength record.

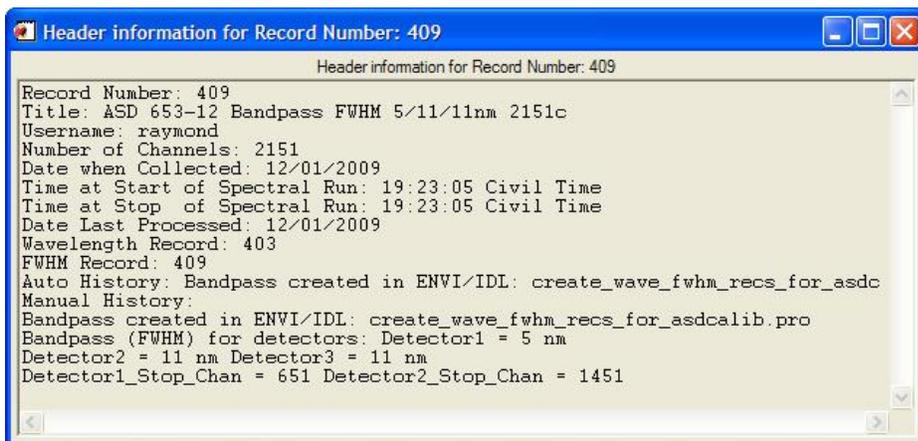


Figure 261. Header information in the ASD bandpass (FWHM) record.

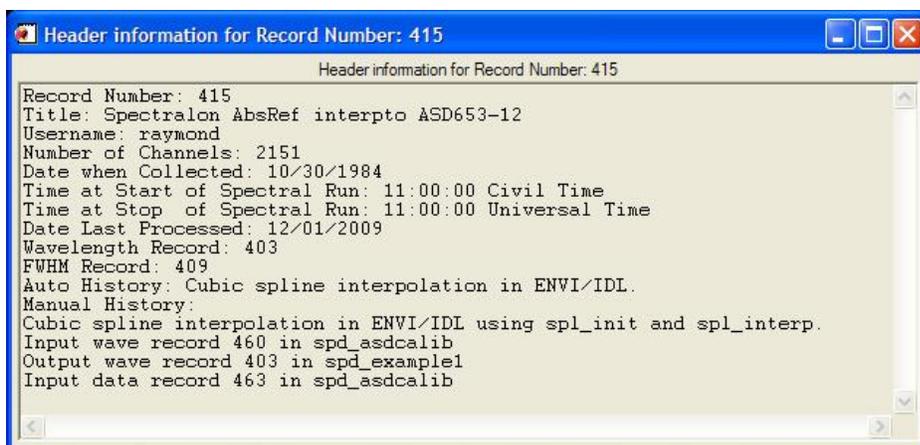


Figure 262. Header information in the Spectralon reflectance record.

Module 3. Image Processing Functions

These functions allow the user to apply correction factors to imaging spectrometer data. They are intended to be used to apply radiative transfer ground calibration (RTGC) corrections of the type described by Clark and others (2002). The RTGC method employs empirical correction factors developed using field-measured spectra of calibration areas. The average of field measurements of the ground calibration site needs to be converted to absolute reflectance and convolved to the imaging spectrometer spectral characteristics. In the most straight-forward correction, the convolved field spectrum is divided by the average of atmospherically corrected reflectance spectra for the pixels that cover the calibration area. Commonly used programs for atmospheric correction of imaging spectrometer data are the radiative transfer codes ACORN (ImSpec; see <http://www.imspec.com/index.html>), ATCOR (ReSe Applications; see <http://www.rese.ch/products/index.html>), FLAASH (ITT Visual Information Solutions; see <http://www.itvis.com/ProductServices/ENVI/ENVIModules/ACM.aspx>), and HATCH (Qu and others, 2003), among others.

PRISM lets the user apply a simple multiplier correction to an atmospherically corrected image cube using “*Function 3.1 – Apply RTGC multiplier correction to image cube*”. In cases where the radiative transfer correction underestimates or overestimates the path radiance to a noticeable degree, an additional correction factor may be needed. This additive correction factor is applied to the atmospherically corrected data before the application of the multiplier factor; often, this factor can be estimated using the darkest pixels in the visible wavelengths of the image cube (see Clark and others, 2002). The offset and multiplier factors can be applied using “*Function 3.2 – Apply RTGC offset and multiplier corrections to image cube*”.

With the exception of the radiative transfer correction, all steps for calibrating an imaging spectrometer dataset using the RTGC approach can be performed using the functions in PRISM. Field spectra can be imported to a SPECPR file (“*Function 2.5 – Import ASD binary files*”). They can be averaged and converted to absolute reflectance (“*Function 2.7.1 – Average and AbsRef ASD spectra*”). This averaged spectrum can be convolved to the spectral characteristics of the imaging spectrometer (“*Function 2.9 – Convolve spectra*”). The spectra from pixels of imaging spectrometer data over a calibration site can be imported from an ENVI spectral library

(“Function 2.15 – Import ENVI Spectral Library”). The average spectrum for these pixels can be computed (“Function 2.10.5 – Average spectra”) and divided by the image cube’s scaling factor (“Function 2.11.4 – Divide a spectrum by a constant (spec1 / constant)”) to convert them to unitless reflectance values (0 to 1). Finally, the multiplicative correction factor can be computed by dividing the convolved field spectrum by the image pixel average (“Function 2.10.4 – Divide two spectra (spec1 / spec2)”). Finally, this correction factor can be applied to an image cube (Function 3.1 – Apply RTGC multiplier correction to image cube).

Function 3.1 – Apply RTGC multiplier correction to image cube

To start the routine, click on the “Apply RTGC multiplier correction to image cube” item under the “Image Processing” item of the “PRISM” entry of the ENVI menu bar (fig. 263).

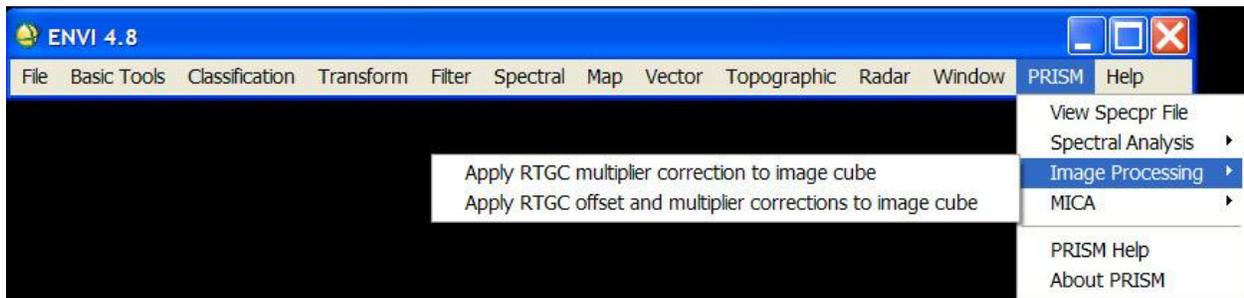


Figure 263. Image processing functions in PRISM.

First, the user is prompted to select the image cube to which the multiplier correction will be applied (fig. 264). Press “Open” to continue.

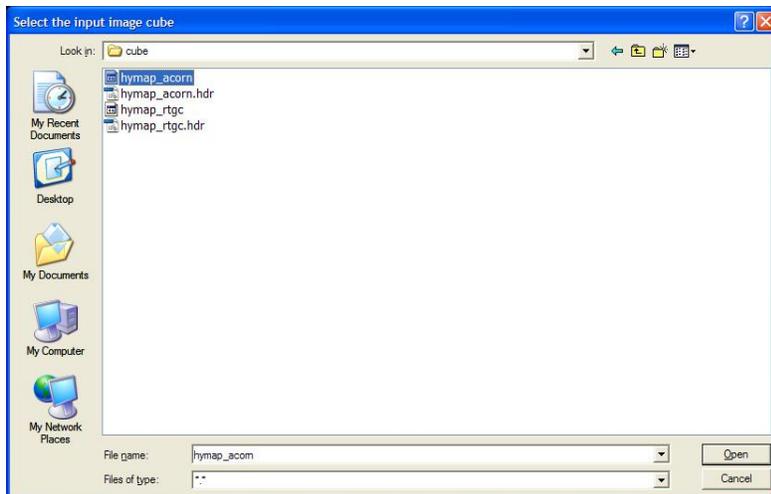


Figure 264. Selecting the image cube to which the multiplier correction will be applied.

Next, the user is prompted to enter the value of the input cube's scale factor (fig. 265). The scale factor is the value that was applied to the atmospherically corrected reflectance data before it was stored as an integer. Commonly, a value of 10,000 is used as the scale factor; however, the user should consult the documentation of the program that was used to compute the atmospherically corrected reflectance data. Before applying the RTGC multiplier, this function will divide the values of the input image cube by this scale factor. Once the value is entered, press "OK" to continue.

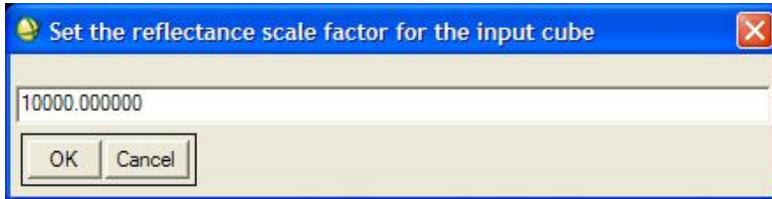


Figure 265. Setting the input cube's scale factor.

Next the user is prompted to set the input SPECPR file that contains the multiplier correction (fig. 266).

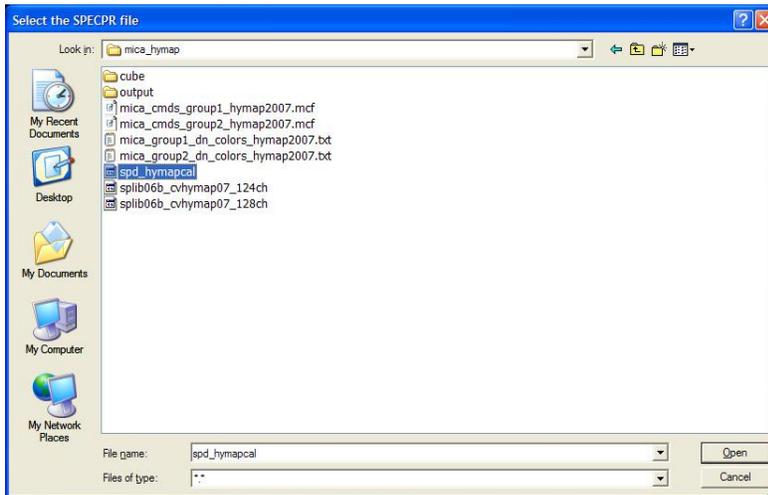


Figure 266. Selecting the SPECPR file that contains the multiplier record.

Next the user is prompted to select the record that contains the wavelengths of the imaging spectrometer (fig. 267).

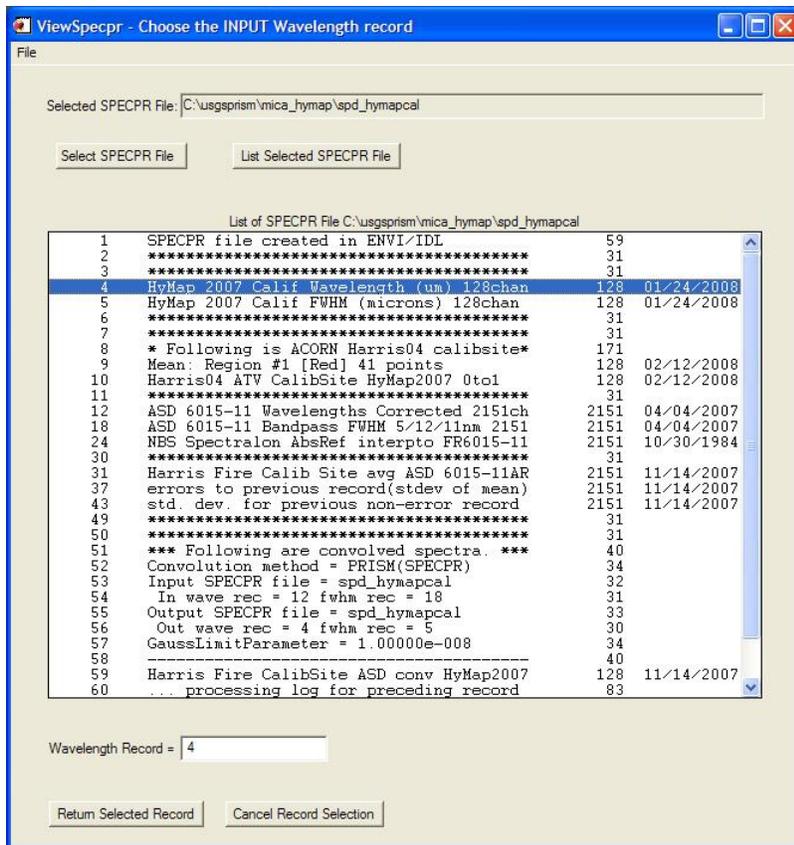


Figure 267. Selecting the record that contains the wavelengths of the imaging spectrometer.

Next the user is prompted to select the record that contains the bandpass (FWHM) of the imaging spectrometer (fig. 268).

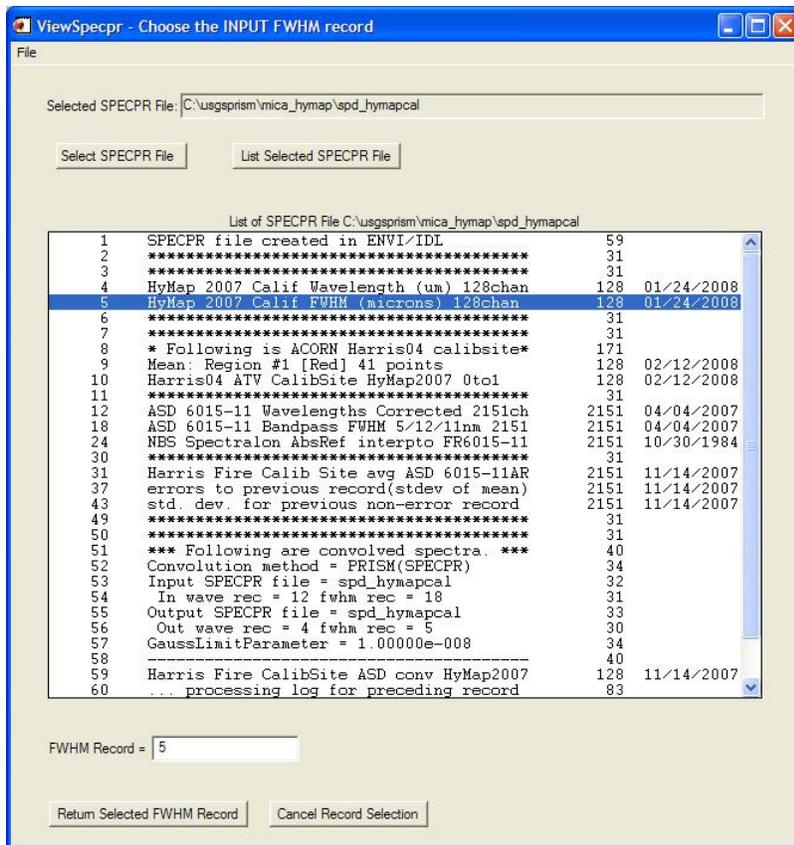


Figure 268. Selecting the record that contains the bandpass (FWHM) of the imaging spectrometer.

Next the user is prompted to select the record that contains the multiplier correction (fig. 269).

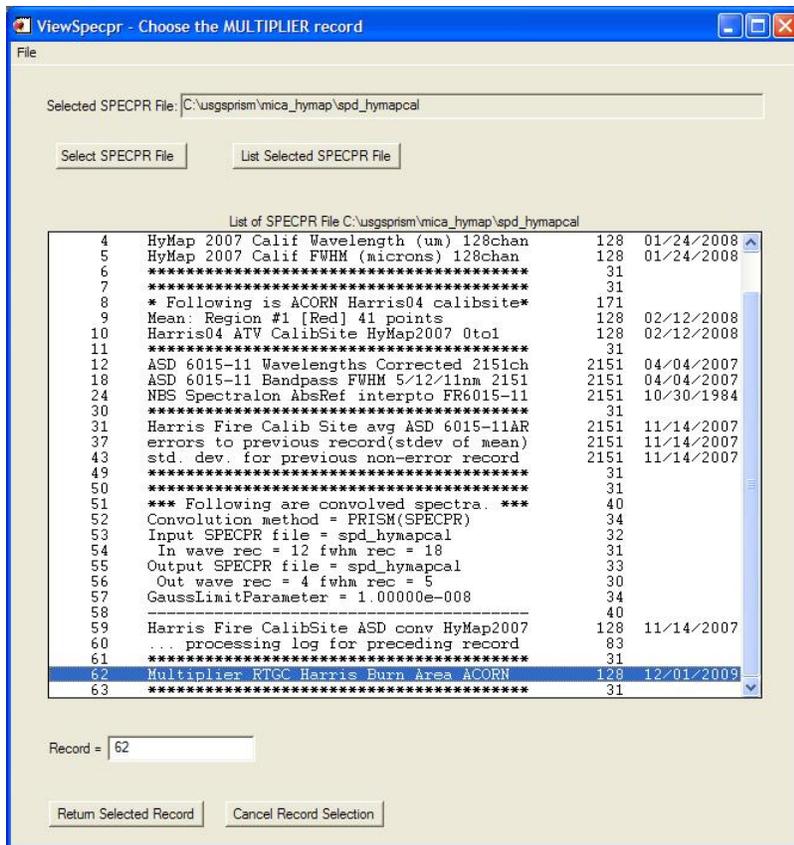


Figure 269. Selecting the record that contains the multiplier correction.

Next the user is prompted to set the filename for the output image cube (fig. 270).

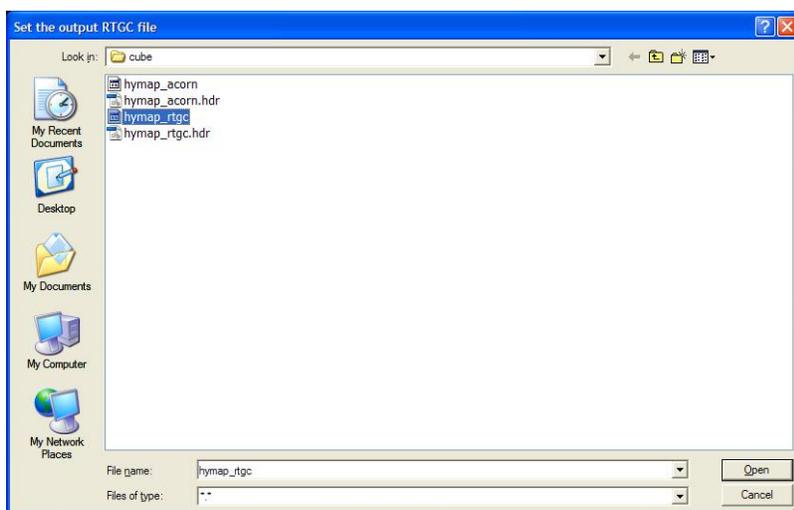


Figure 270. Setting the filename for the output image cube.

Next the user is prompted to set a scaling factor for the output image cube (fig. 271). The corrected reflectance values will be multiplied by this scale factor before storing the data in integer format.

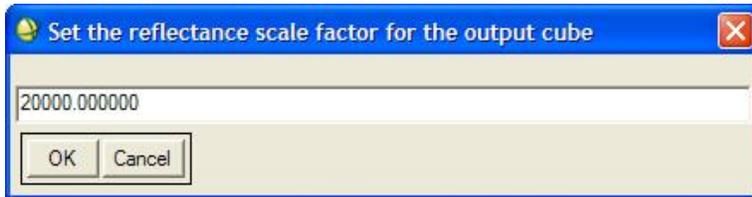


Figure 271. Setting the scale factor for the output image cube.

Next the multiplier correction is applied to the data. The output cube is created on a scan-line by scan-line basis. The output file is in BIL interleave format, with data stored as a signed 2-byte integer in PC (Intel) byte order. Before storing the data to integer, values that exceed the maximum 2-byte integer value of 32,767 are reset to this maximum value. If more than half of the channels in a pixel's spectrum have negative values, all channels in that pixel are set to a value of -1. The output file has a VICAR header, with a size, in bytes, of twice the number of samples (the x-dimension of the image cube). Once the processing is completed, a message appears, indicating the calculations are complete (fig. 272).



Figure 272. Message indicating the completion of the processing of the image cube.

Function 3.2 – Apply RTGC offset and multiplier corrections to image cube

To start the function, click on the “Image Processing” item of the “PRISM” entry of the ENVI menu bar. Select the “Apply RTGC offset and multiplier corrections to image cube” option from the list that appears (see fig. 263). The steps taken in this function are similar to those in “*Function 3.1 – Apply RTGC multiplier correction to image cube*”. However, the user is prompted to select the record containing the offset correction factor before the prompt to select the multiplier correction factor. During processing the offset correction factor is added to the atmospherically corrected data before the application of the multiplier factor.

Module 4. MICA – Material Identification and Characterization Algorithm

MICA determines the best match between a spectrum of an unknown material (or material of unknown composition) and entries in a spectral library containing reference spectra of materials of known composition. The MICA process is illustrated in figure 273 with a listing of the key inputs, analysis components, and outputs. MICA is modeled on the USGS Tetracorder algorithm (Clark and others, 2003), but with additional options for greater user control of feature weightings and identification constraints and a significantly greater ability to integrate image results with image processing and GIS software.

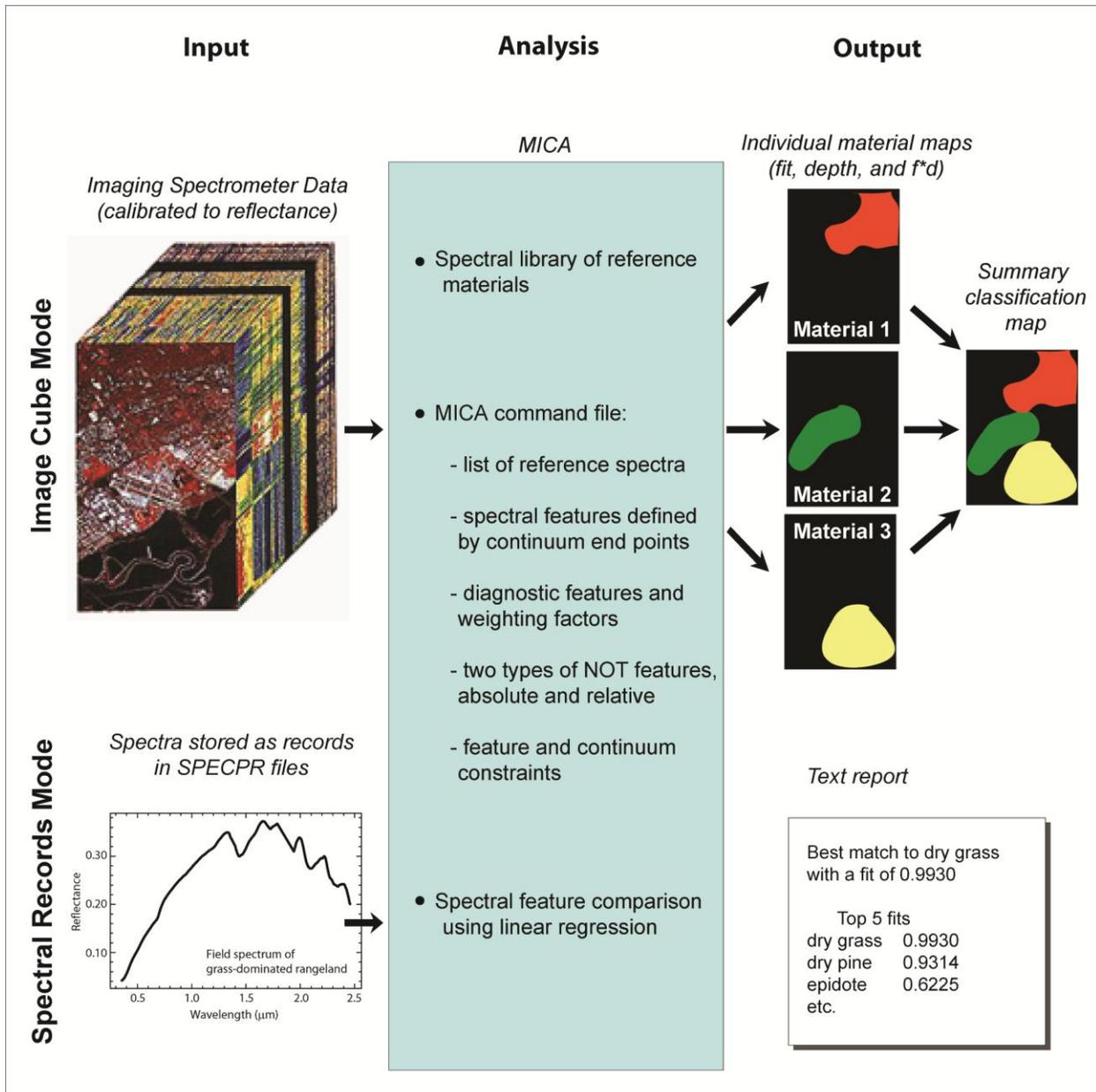


Figure 273. Processing flow and key elements of MICA, image cube analysis.

The MICA command file contains the list of reference spectra and the analysis parameters used in conducting spectral comparisons. When running MICA, the spectra being analyzed and the spectra in the reference library must have equivalent spectral characteristics, that is, either they must be measured on the same spectrometer or spectra resampled from their native spectrometer characteristics to equivalent spectral sampling and bandpass (FWHM) characteristics by interpolation (*Function 2.8*) or convolution (*Function 2.9*).

The shape of a reflectance spectrum derives, in large part, from the material's chemical composition and physical structure (see Clark, 1999). Differences in these properties lead to differences in spectral shapes. The central function of the MICA algorithm is spectral feature comparison applied to continuum-removed absorption features (*Function 1.7.1*). MICA, using the spectra of a known reference materials, can be applied to spectra of an unknown materials/compositions, measured in the laboratory, in the field, or with an imaging spectrometer, after they have been reconciled to equivalent spectral characteristics. For imaging spectrometer data, this is usually accomplished by convolving the higher resolution reference spectra to the coarser sampling and bandpass characteristics of the imaging spectrometer. The continuum-removed spectra of diagnostic features in the reference spectra and the corresponding continuum-removed features of the spectrum being analyzed are compared in linear regression. The wavelength regions for the comparisons are based on the continuum endpoints of the diagnostic features in the reference spectra. Diagnostic features are strong and (or) unique features arising from chemical bonds inherent in the reference material. PRISM uses the coefficient of determination (r^2) from the linear regression as the "fit" value, that is, a measure of the agreement between the spectra. In contrast, Tetracorder uses the linear correlation coefficient (r) as the fit value (Clark and others, 2003). The r^2 fit value ranges from 0 to 1, with better matches indicated by high fit numbers. Perfect agreement, similarity between spectral features, is indicated by a value of 1. The depth of continuum-removed features can be checked by the MICA processing (see *Function 1.7*). Features with positive depth values are termed absorption features, while those with negative depth are called emission features.

To illustrate the spectral feature comparison of a single feature, a field spectrum measured in a rangeland ecosystem covered principally by dry grass (fig. 274) is used as the spectrum of unknown composition; see the description of this spectrum in *appendix C*.

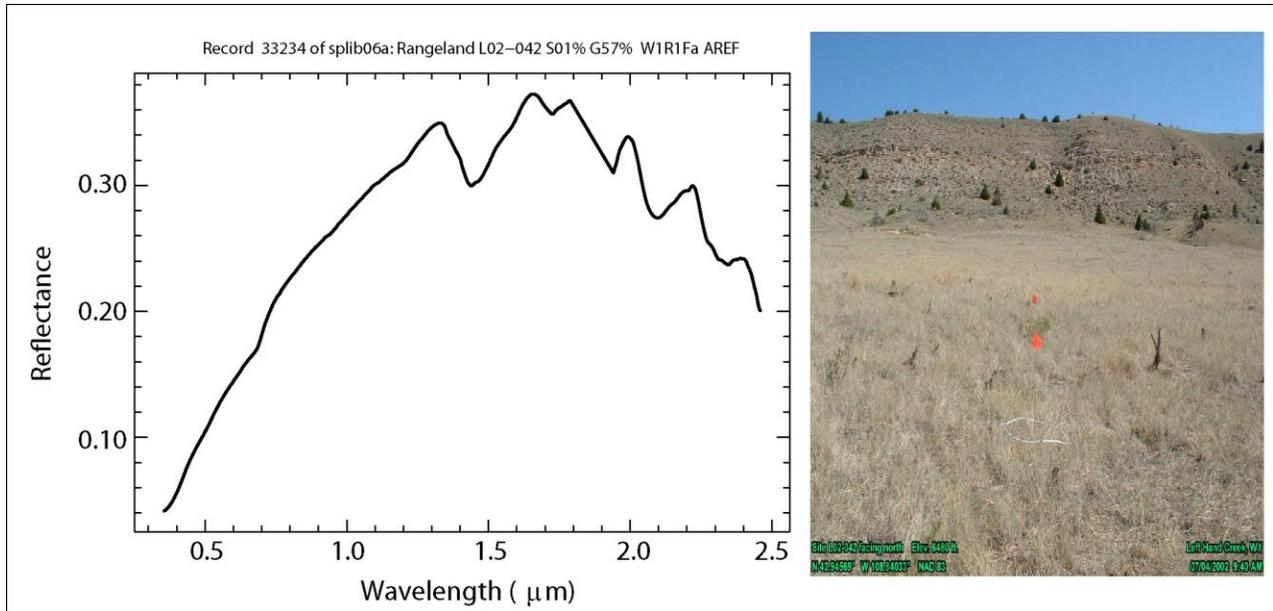


Figure 274. Reflectance spectrum and photo of an area of rangeland primarily covered by dry grass.

In figure 275, this spectrum is compared to the 2.1 μm feature in each of the laboratory measurements of dry grass and dry pine, as defined in the sample MICA command file “mica_cmds_group2_hymap2007.mcf”. This file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the command file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. Before comparison, each spectrum was convolved to equivalent sampling and bandpass (FWHM) characteristics, in this example, the HyMap imaging spectrometer (Cocks and others, 1998) as defined in the 2007 flight season. The SPECPR file containing these convolved spectra “splib06b_cvhymap07_124ch” is included with the PRISM software. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the file will be located at “C:\usgsprism\mica_hymap\” on Windows computers and at “/var/local/usgsprism/mica_hymap/” on Linux computers. In addition to the continuum-removed features, figure 275 shows the regression plots with the regression lines. The fit values for these single features are 0.9930 and 0.8798 for dry grass and dry pine, respectively. The highest fit value between these two is 0.9930, indicating the best match between the field spectrum and the lab spectra is to dry grass.

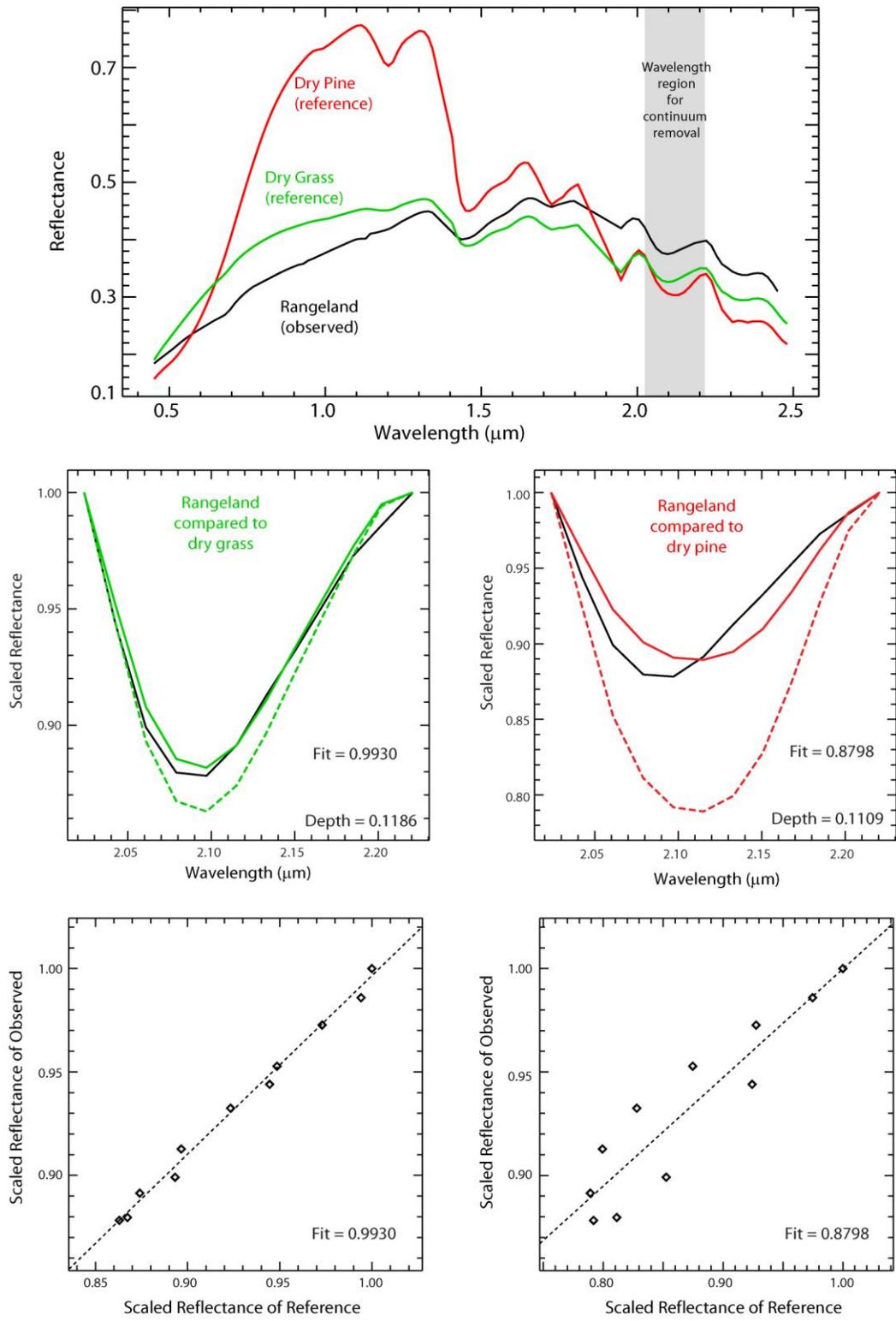


Figure 275. Spectral feature comparison of a rangeland spectrum to the principal spectral features of two reference materials.

MICA extends the spectral feature comparison concept to multiple features, allowing the user to define as many spectral features as desired for each reference spectrum listed in the command file and letting the user set the weighting factor for each feature. The weighting factors can range from 0 to 1, but the total of all weighting factors applied to the features in a reference spectrum must sum to 1, within the allowable tolerance of ± 0.001 . The sample command file in *appendix A* contains the entries for the dry grass and dry pine spectra used in this example, for which two diagnostic features are defined for each entry. Figure 276 shows the spectral feature comparison of the rangeland spectrum to the 2.1 and 2.3 μm diagnostic features of these reference spectra, including the fit values and weighting factors for each feature. A single fit value, the “weighted fit”, is calculated for each material by summing the products of the individual feature fits and their corresponding weighting factors.

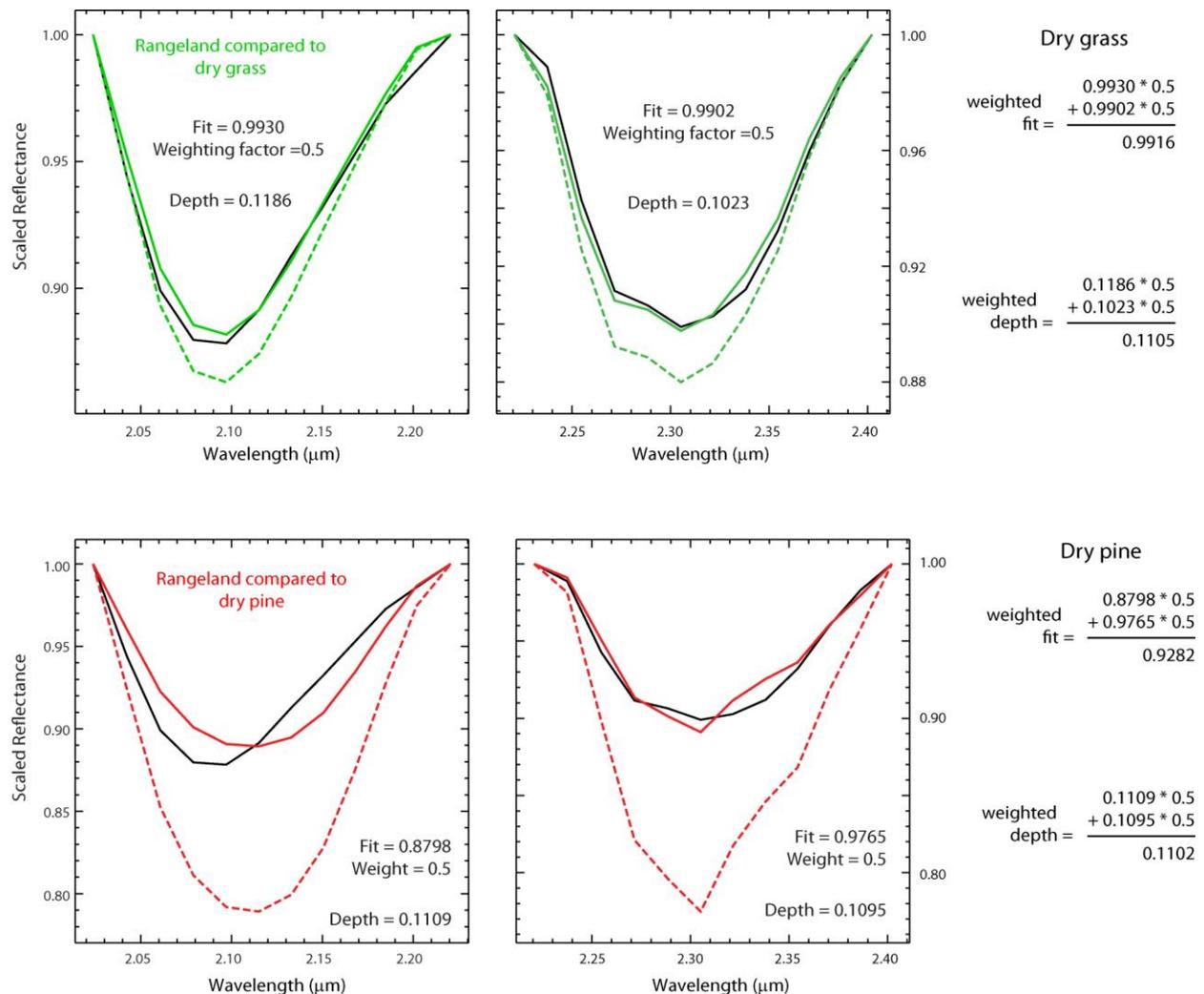


Figure 276. Spectral feature comparison of a rangeland spectrum to the diagnostic spectral features of two reference materials.

MICA arrives at an identification of the best match between the spectrum of an unknown material and the reference spectra in a MICA command file by selecting the material with the highest weighted fit value. For the rangeland example, the weighted fit values for each of the reference materials are shown in figure 276. The highest fit value between these, 0.9916, indicates the best match of the field spectrum is to the reference spectrum of dry grass. Note: in the MICA analysis of spectral records (*Function 4.2*) the fit results for all the reference materials can be reported, if desired by the user, in addition to the reporting of the material with the best fit and the five materials with the highest weighted fits, ranked in order of descending fit value.

Rather than relying solely on the fit values, MICA employs the concepts of feature and continuum constraints for each material in the command file in order to reduce false-positive identifications. Defined individually for each reference material, these constraints are criteria that must be met by the spectrum being analyzed in order to consider it as a match to the reference material. These constraints are optional and can be individually turned on and set within the command file, as desired by the user. The diagnostic feature, continuum, and weighted feature constraints are listed in table 3. Feature constraints can be defined for each individual diagnostic feature of a material and (or) for the overall weighted feature result for a material. If the value for a parameter computed using the observed spectrum exceeds a threshold for the constraint set in the command file, the material's weighted fit value is set to zero, effectively removing the material from consideration as the best match. If all the weighted fit values are zero, the MICA result for the spectrum being analyzed is "no match" to the reference spectra.

Table 3. Feature and continuum constraints.

Constraint name	Type	Description
feat_fit_min	feature	The computed fit for this feature must exceed this constraint value
feat_depth_min	feature	The computed depth of this feature must exceed this constraint value
feat_depth_max	feature	The computed depth of this feature must NOT exceed this constraint value
cont_left_min	continuum	The average scaled reflectance value for channels within the left continuum endpoint wavelength range must exceed this constraint value
cont_left_max	continuum	The average scaled reflectance value for channels within the left continuum endpoint wavelength range must NOT exceed this constraint value
cont_mid_min	continuum	The computed reflectance value at the midpoint of the continuum line must exceed this constraint value
cont_mid_max	continuum	The computed reflectance value at the midpoint of the continuum line must NOT exceed this constraint value
cont_rt_min	continuum	The average scaled reflectance value for channels within the right continuum endpoint wavelength range must exceed this constraint value
cont_rt_max	continuum	The average scaled reflectance value for channels within the right continuum endpoint wavelength range must NOT exceed the constraint value

Table 3. Feature and continuum constraints.—Continued

Constraint name	Type	Description
cont_ratio_min	continuum	The ratio of the average scaled reflectance value for channels within the right continuum endpoint wavelength range divided by the average scaled reflectance value for channels within the left continuum endpoint wavelength range must exceed this constraint value
cont_ratio_max	continuum	The ratio of the average scaled reflectance value for channels within the right continuum endpoint wavelength range divided by the average scaled reflectance value for channels within the left continuum endpoint wavelength range must NOT exceed this constraint value
weighted_fit_min	material	The total weighted fit for this material must exceed this constraint value
weighted_depth_min	material	The total weighted depth for this material must exceed this constraint value
weighted_depth_max	material	The total weighted depth for this material must NOT exceed this constraint value
weighted_fd_min	material	The total weighted fit×depth for this material must exceed this constraint value

The weighted feature constraints are the minimum acceptable weighted fit value, the acceptable range (minimum and maximum) of the weighted depth of the feature, and the minimum acceptable value of the product of the weighted fit and the weighted depth. In MICA, the scaled depth of the reference feature fitted to the observed spectrum (D_{SQref}) is evaluated against the constraints rather than the inherent band depth of the feature in the observed spectrum (from the quadratic fit, D_{Qobs} , or from the band center channel, D_{Cobs} , see *Function 1.7.1*). The fitted depth is used, as it is less subject to noise in the spectra than the depth of the observed spectrum itself; low signal-to-noise (S/N) is a potential factor that should be considered in the analysis of spectra measured in the field and by imaging spectrometers, and even by laboratory spectrometers. Although the depth of a reference emission feature is a negative value, it could contribute positively to the total weighted depth and weighted fit*depth calculations if the feature in the observed spectrum is also an emission feature. Individual weighted feature depths contribute positively to the overall weighted depth for a material if the nature of the observed feature matches the nature of the reference feature. If there is a mismatch between the natures of the reference and observed features, the feature's weighted depth will contribute negatively to the overall weighted depth of the material. For example, if a reference spectrum has both an absorption feature and an emission feature defined in the MICA command file and if the features are found in the observed spectrum as absorption and emission features, respectively, they will each contribute positively to the weighted depth calculation. If the feature in the observed spectrum is found to be the opposite type from the reference feature, for example, continuum endpoints in the MICA command file are over an absorption feature but the observed spectrum has an emission feature in these wavelengths, the depth of that feature will be subtracted in the overall weighted depth calculation for the material. In a similar manner, observed features of an opposite nature to the reference feature will apply negatively to the overall weighted fit*depth calculation for a material.

MICA attempts to reduce the impact of low S/N on spectral feature comparison by allowing continuum endpoints to be defined by a range of wavelength values. Thus, more than

one channel can fall within the specified wavelength range for one or both of the continuum endpoints. Therefore, the equation of the continuum line can be established using an average of multiple channels at either end of the continuum, where the averaging reduces the impact of noise in any single channel.

Like feature constraints, continuum constraints (see table 3) are employed to reduce false-positive identifications. Principally, thresholds on the minimum acceptable reflectance level at the endpoints or midpoint of the continuum line are employed to avoid false-positive identifications for spectra with low reflectance levels, which can also have low S/N. Such spectra can occur in poorly illuminated pixels of an imaging spectrometer dataset, arising in areas of cloud shadows or steep terrain. Constraints on the continuum reflectance levels can also be set when all available spectra for a material indicate a consistency in reflectance level, for example, the consistently low reflectance of water in the shortwave-infrared wavelengths.

In addition to reflectance levels of continua, MICA command files can be set up to check if the spectra being analyzed have a ratio of continuum endpoints that fall within an acceptable range. Minimum and maximum acceptable values of the ratio of reflectance levels of the right continuum endpoint divided by the left continuum endpoint can be specified. Again, this allows the user to set a constraint when all available spectra for a material indicate an expected trend in reflectance between continuum endpoints; for example, setting a minimum value of 1 for the ratio of the continuum endpoints means that any spectrum being analyzed must show a rise in reflectance at the continuum endpoints in order to be considered as a match to the material.

In a further step to improve material identification, MICA employs the concept of NOT features. NOT features are useful when two materials have diagnostic spectral features in similar wavelength regions but one of the materials has an additional diagnostic feature that occurs at a different wavelength position. Figure 277 shows an example of this for dry grass and the mineral calcite (see their entries in the MICA command file in *appendix A*). In this case, the MICA entry for the material with only one feature can list a NOT feature in addition to the diagnostic feature, in which case, the NOT feature is used to check that the non-aligned absorption feature of the material with two absorption features is **not** present in the unknown spectrum (above user-defined fit and depth levels). By defining the NOT feature, the material with only one feature defined will only be considered as the best match if the NOT feature is absent from the spectrum being analyzed; otherwise the fit value of the material with only one feature is zeroed out. In the example shown in figure 277, dry grass has two diagnostic features, centered near 2.1 and 2.3 μm . Calcite has only one strong diagnostic feature centered near 2.3 μm . To improve discrimination between these two materials, the entry for calcite in the MICA command file lists a NOT feature for the 2.1 μm feature of dry grass; this means that in order for the fit of the calcite spectrum to the analyzed spectrum to be considered as the best match, the spectrum being analyzed must **not** match the 2.1 μm feature of dry grass at a level that exceeds the threshold constraint on the fit of the NOT feature. If the fit is above the threshold, then the constraint on the depth of the NOT feature is checked; that is, the depth of the fitted 2.1 μm feature of dry grass to the spectrum being analyzed is compared to the depth constraint for the NOT feature. If that depth exceeds the depth threshold specified in the command file, the NOT feature is considered to be present and calcite is excluded from being a potential match by setting the weighted fit between the analyzed spectrum and calcite to zero. In other words, the definition of the NOT feature in the calcite entry in the MICA command file results in calcite being rejected as a match to any spectrum being analyzed if that spectrum has a feature at 2.1 μm that matches the dry grass feature at a level above the specified fit and depth thresholds. The user specifies

NOT features at the beginning of the MICA command file, before the reference materials; subsequently, they can be invoked as needed in the definition of reference materials (see *appendix A*).

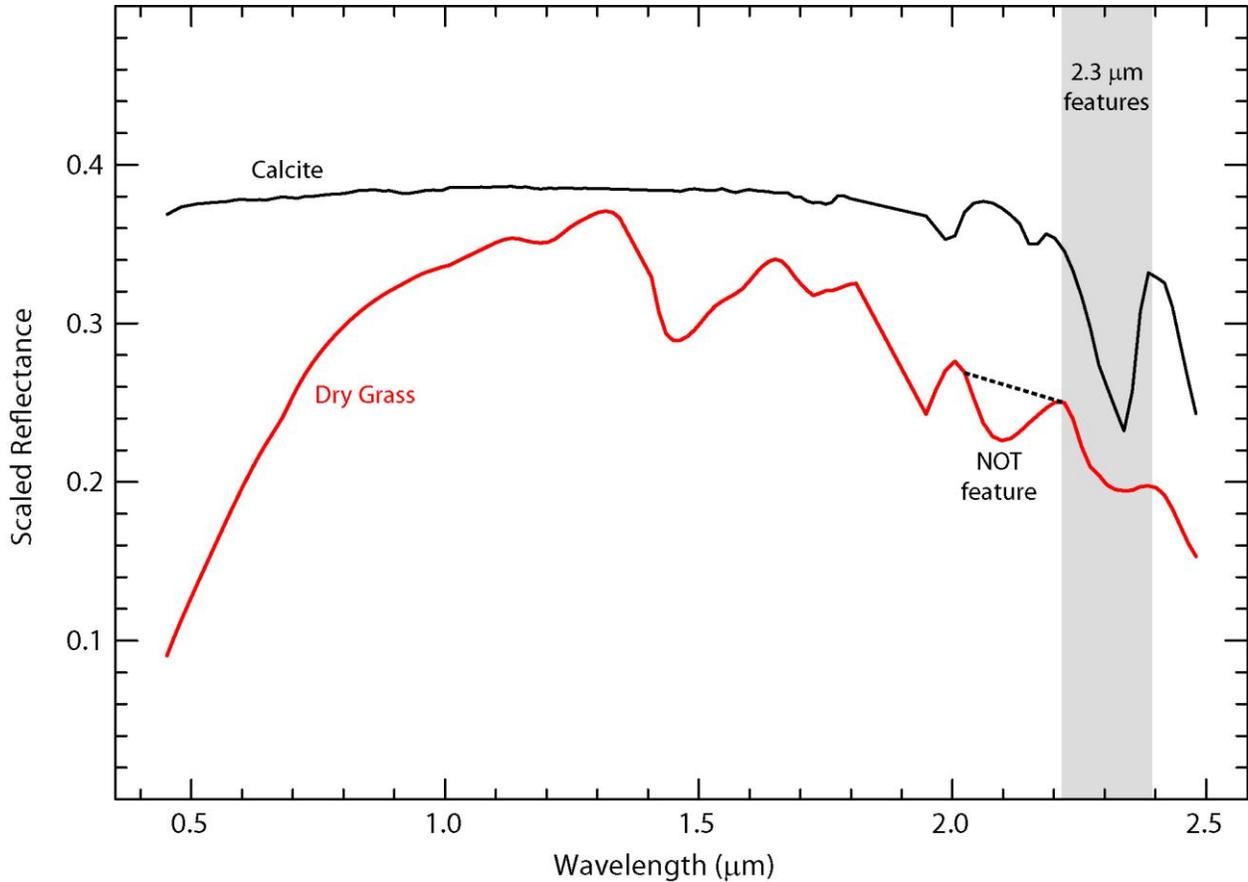


Figure 277. Absolute NOT feature.

The entry for calcite in the full sample MICA command file, in *appendix A*, specifies fit and depth thresholds for the NOT feature. This is an example of a NOT feature of the absolute type, that is, where the depth of the NOT feature is checked directly. MICA also employs the concept of NOT features of the relative type, for which the depth threshold is determined relative to the depth of another feature. Two materials, montmorillonite, with a single diagnostic feature centered near 2.2 μm , and muscovite, with a diagnostic feature centered near 2.2 μm and an additional diagnostic feature centered near 2.34 μm , are used to illustrate the concept of the relative NOT feature. Figure 278 shows the spectra of these materials.

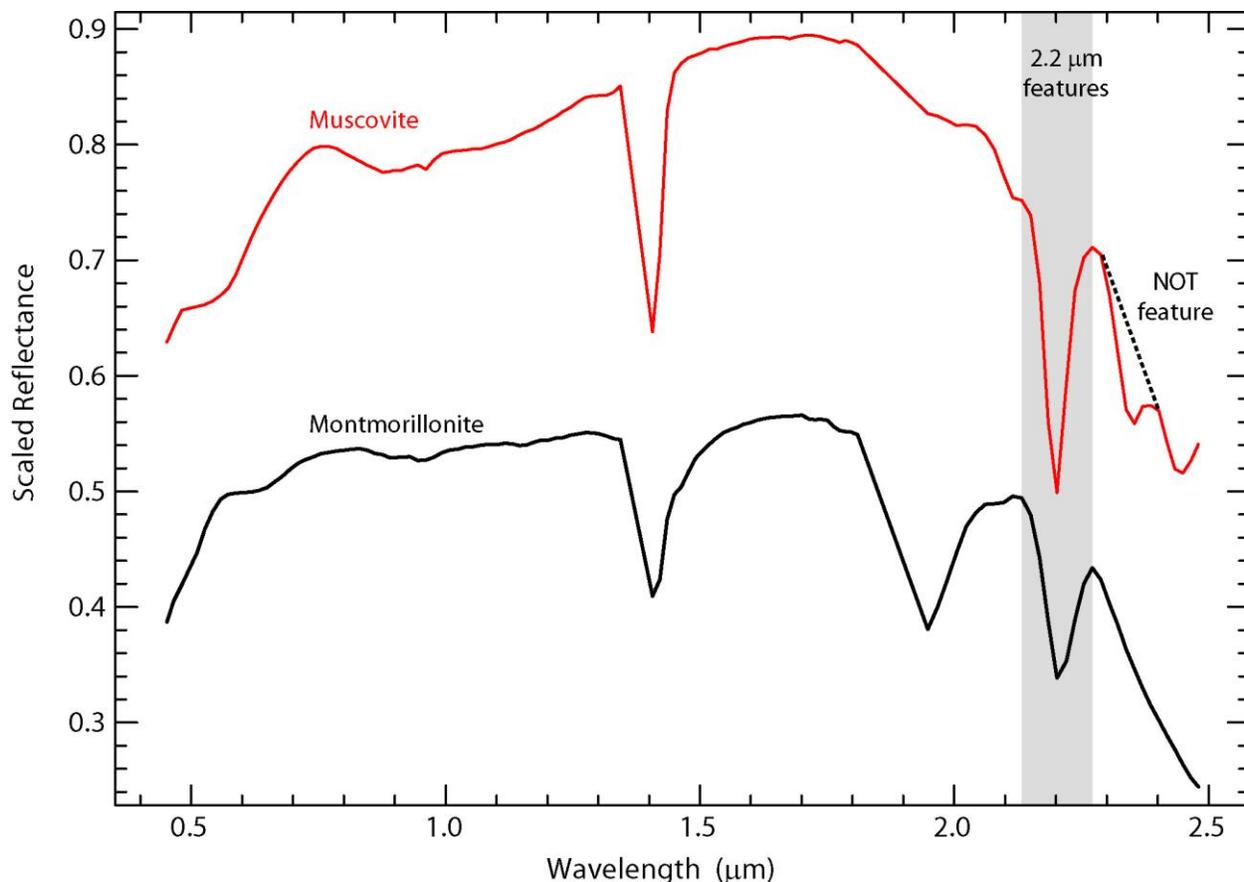


Figure 278. Relative NOT feature.

To improve discrimination between these two materials, the entry for montmorillonite in the MICA command file (see *appendix A*) lists a NOT feature for 2.34 μm feature of muscovite; this means that in order for the fit between the spectrum being analyzed and the montmorillonite spectrum to be considered as the best match, the spectrum being analyzed must **not** match the 2.34 μm feature of muscovite at a level that exceeds the NOT feature fit threshold. As for the absolute NOT feature, if such a fit is found, a secondary NOT feature constraint, in this case, on the relative depth of the NOT feature, is checked. For a relative NOT feature, the depth threshold is determined by a multiplier factor, set in the MICA command file, applied to the depth of another diagnostic feature in the NOT material, as defined in the command file. It is the scaled depth of this other feature, after being fitted to the spectrum being analyzed, to which the multiplication factor is applied, and the product of these terms becomes the depth threshold. Therefore, the depth threshold for the NOT feature is calculated relative to the depth of another feature in the spectrum of the NOT material. In the case of montmorillonite, the MICA entry specifies a NOT feature for the 2.34 μm feature of muscovite, where that NOT feature depth threshold is relative to the 2.2 μm feature of muscovite, with a multiplier factor of 0.15 (see *appendix A*).

Figure 279 shows the two continuum-removed features for muscovite, in which it is evident that for this sample of muscovite, the depth of the 2.34 μm feature exceeds the constraint

of 0.15 times the depth of the 2.2 μm feature. Stated again, for any analyzed spectrum to be a match to montmorillonite two criteria for the NOT feature must be met, as defined in the MICA command file. First, the NOT feature of muscovite, that is, the 2.34 μm feature of muscovite, cannot fit the analyzed spectrum above the NOT feature fit threshold. Second, the depth of this fitted NOT feature cannot exceed the product of the relative NOT feature multiplier and the depth of the relative feature, in this case, the 2.2 μm feature of muscovite, fitted to the analyzed spectrum. In application, the relative NOT feature checks for the presence of the NOT feature and whether its depth exceeds a threshold that scales proportionally to another feature of the NOT material, as opposed to the absolute NOT feature, which just checks for the presence of the NOT feature with a depth greater than a set threshold.

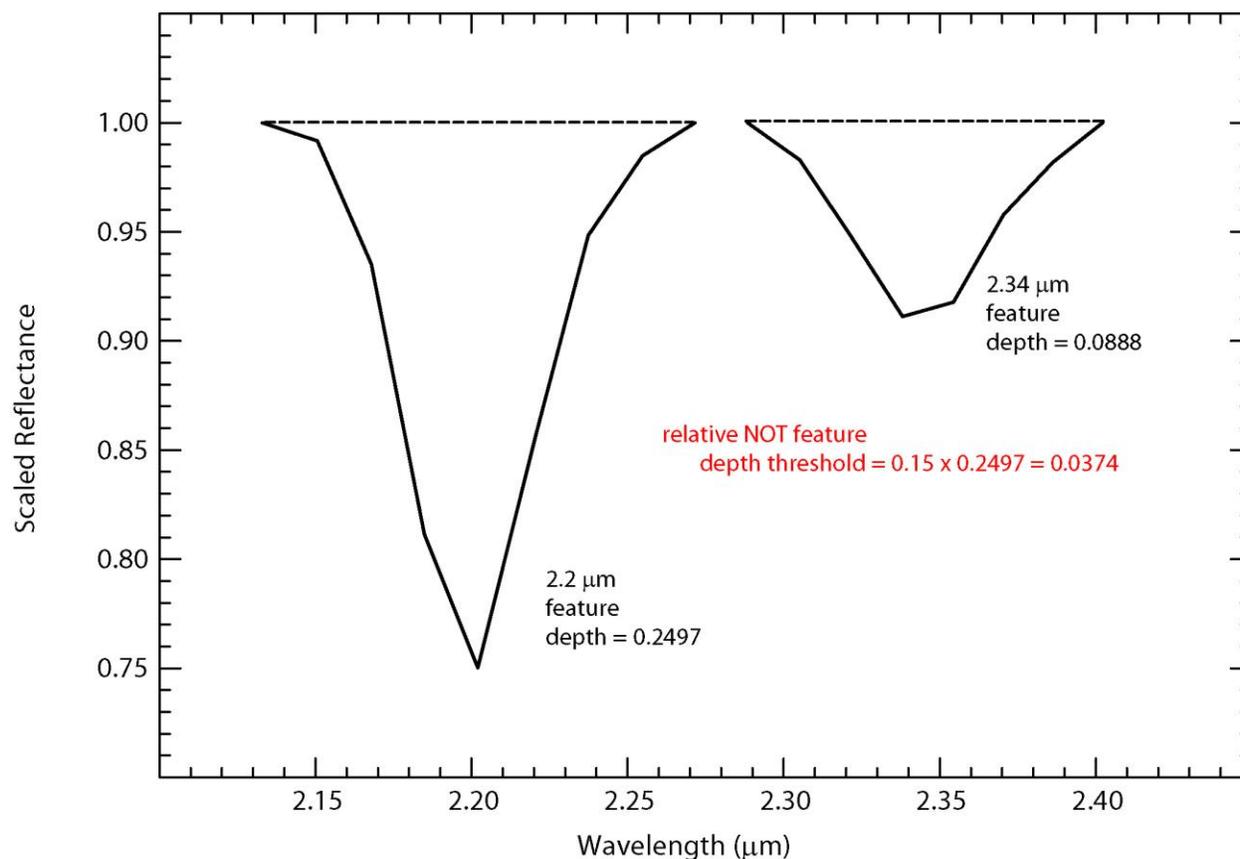


Figure 279. Diagnostic features of muscovite.

The MICA command file contains the reference material list, the diagnostic and NOT features for each reference spectrum, and the feature and continuum constraints in a rigid syntax. The file format and syntax for command file entries are described in *appendix A*, including annotations on the sample command file for diagnostic features, NOT features of the absolute type, and NOT features of the relative type. If the user does not wish to use a constraint, the user can place a value of “-99.99” in the constraints position in the command file.

The sample command file in *appendix A* was developed by the USGS to analyze a large HyMap data set covering the country of Afghanistan (Kokaly and others, in press); experience led the developers to define constraints in this command file, where appropriate. As MICA users create their own command files, it is suggested that they begin with setting as few constraints as possible; principally, the first constraints to be defined should be on minimum weighted fit values and minimum values for the reflectance levels of the midpoints of the continuum lines. These simple constraints reduce false-positive identifications but do not overly complicate the interpretation of the output from MICA and the identification of materials. Other constraints can be added as the user becomes more familiar with the concepts in MICA, the application of the algorithm, and the spectral features in the reference spectra and spectra being analyzed. As constraints are added, higher verbose levels of output from MICA are needed to see why materials are rejected as the best match, that is, to see which constraints are violated.

The user should review the setup keywords in the MICA command file (*appendix A*), in particular, the DELETED_CHANNELS keyword. The values associated with this keyword define channels in the spectrometer to be excluded during the MICA analysis. Channels that fall in wavelength regions where strong residual atmospheric contamination remains in atmospherically corrected or ground calibrated imaging spectrometer data are commonly set as deleted channels. For example, channels within the 0.71 μm oxygen absorption feature, around the water vapor features centered near 0.94, 1.13, 1.40, and 1.90 μm , and near the 2.00 μm carbon dioxide feature (Kokaly and others, 2007a). Incomplete correction for atmospheric scattering may necessitate the setting of deleted channels for wavelengths below 0.40 μm . In addition, channels at ends of spectrometer detectors sometimes suffer from poor response and low S/N and may need to be defined as deleted channels.

MICA establishes the nature of each reference feature listed in a MICA command file as an absorption or emission feature. Within the MICA command file the user can set the option to check the nature of the feature (absorption or emission) in the observed spectrum relative to the feature type of the reference. The nature of the features must match between the reference spectrum and the spectrum being analyzed. If not, the weighted fit for that material is set to zero. In other words, if a material lists an absorption feature, the analyzed spectrum must also have an absorption feature over its continuum endpoints; if the feature is instead an emission feature in the analyzed spectrum, the weighted fit value for the material is set to zero, removing the reference material from consideration as the best match to the analyzed spectrum. By default, this option is turned on. However, it is recommended that the user specify this option in the command file as a reminder to any user that this check will be performed. The user can do so by setting the value of the CHECK_SIGNS_OF_DEPTHS keyword to 1 (see *appendix A*). Note: this keyword has further implications for a reference features used to calculate the depth threshold in the invocation of a relative NOT feature; specifically, if the nature of continuum-removed feature over the endpoints of the relative feature in the spectrum being analyzed is different from the reference feature used to calculate the relative depth threshold, the NOT material is considered to be absent because the relative depth threshold cannot be established. This secondary effect of the relative NOT feature is important to remember when setting the CHECK_SIGNS_OF_DEPTHS keyword to 1. MICA allows great flexibility to the user to set both positive and negative values for depth thresholds and to set constraints on the minimum and maximum depth; therefore, advanced users may opt to turn off the check of feature types and set explicit minimum and maximum depth thresholds on each feature. The check of feature natures

can be turned off by setting the value of the CHECK_SIGNS_OF_DEPTHS keyword to zero (0) in the command file.

Another option in the MICA command file setup is to have fit values calculated, and command file fit constraints interpreted, in a manner consistent with the USGS Tetracorder algorithm. The option can be turned on by setting the value of the TETRACORDER_OPTIONS to 1 at the beginning of the command file (see *appendix A*). In comparison to the default mode of MICA, the Tetracorder option changes the interpretation of command files and the analysis of spectral records and images by forcing MICA to evaluate spectral feature comparisons using the linear correlation coefficient (r) as the measure of spectral agreement, instead of r^2 , the coefficient of determination. As a result, the fit values in the MICA command file are also interpreted as values of r , the linear correlation coefficient. If all materials in a command file listed only a single feature and no fit thresholds are specified, the two measures of fit would give the same answer for the best match. However, for multiple features with fit thresholds, the switch in the measure of fit could change the answer for the best fit, as the r^2 fit value decreases more rapidly with increasing spectral difference compared to the r value. Therefore, poorly fitted features will have more of an impact on the overall weighted fit calculation for fits computed with r^2 than with r . There are additional differences in constraint criteria caused by converting the thresholds between these two measures of fit. However, the differences have been found to be slight even for the complex sample command file in *appendix A*. The user should be keenly aware that the Tetracorder option not only affects the value of the fit that is reported in the text output file and stored in output images but also triggers the requirement that invoked NOT features are also listed as diagnostic features in reference spectra. This requirement includes the condition the continuum endpoints of the NOT feature entry match the continuum endpoints of the corresponding diagnostic feature entry. In normal mode, MICA does not require this and allows any NOT feature to be invoked without the need to have the same feature listed as a diagnostic feature of a reference material. Because of the differences in command file interpretation and the basis of value of the fit, the user needs to maintain awareness of the TETRACORDER_OPTIONS keyword in any MICA command file. The default action by PRISM is to execute MICA without the Tetracorder option. Thus, if this keyword is absent from the command line the Tetracorder options will not be used. Alternatively, the user may explicitly specify that the Tetracorder options should not be used by setting the value of the TETRACORDER_OPTIONS keyword to zero in the command file (see *appendix A*).

Generally, the structure of a MICA command file, the definitions of diagnostic absorption features, continuum constraints, and so on, are independent of the sampling and bandpass (FWHM) characteristics of a particular spectrometer. Potentially, a MICA command file can be easily altered to work with a different spectrometer by just changing the listed SPECPR files and record numbers to specify the file containing the spectra measured on or converted to the characteristics of the new spectrometer. However, in practice, spectrometers vary in their wavelength coverage and ability to resolve absorption features; therefore, command files often need to be adjusted to a particular spectrometer in order to achieve the most accurate results. In particular, the continuum endpoints should be optimized for the features in the spectra listed in the command file. In some cases, defined features may not be fully covered by the wavelength range of a different spectrometer. If the user has defined channels that should be excluded from analysis, using the DELETED_CHANNELS keyword, these must be redefined when editing a command file to apply to a different spectrometer. Therefore, while a command file can potentially be easily converted to work with data from a different spectrometer, careful attention

must be paid to the wavelength coverage of the spectrometer in order to edit the listed features to optimize the continuum endpoint ranges, remove spectral features that may be weak or absent, and add diagnostic spectral features that may be stronger or better captured by the new spectrometer.

The next two sections of this report describe the application of a sample MICA command file to analyze an imaging spectrometer image cube (*Function 4.1*) and spectral records stored in a SPECPR file (*Function 4.2*). Each section describes the steps needed to implement the function and gives brief descriptions of the output generated by MICA. Detailed descriptions of MICA output reports can be found in *appendix B*. The third MICA function, the internal check of MICA command files (*Function 4.3*), is a useful program to run when developing a command file. This function runs a MICA analysis for each reference spectrum listed in the command file. The results of the internal check show the degree of spectral similarity in the reference entries. For each entry, the other materials in the command file that are most spectrally similar, and potentially the most likely to be confused with it, are reported. If the degree of spectral similarity between two entries is high, it may be the natural result of the materials having similar chemical structure, or the materials may lack diagnostic spectral shapes over the wavelength region covered by the spectrometer, or the sensor may have an insufficient number of spectrometer channels and/or poor spectral bandpass (FWHM) characteristics. If discriminating between these entries is important, additional feature and continuum constraints may need to be developed to robustly discriminate between the materials.

Function 4.1 – Run MICA for Image Cubes

To analyze an image cube, choose the “Run MICA for Image Cubes” option from the drop-down menu that appears when you click on “MICA” under the “PRISM” menu item (fig. 280). The program flow is similar to that detailed in the *Function 1.8 – Running MICA analysis on the selected record* section of this report. MICA produces a text report, unless suppressed, and images for each reference material, showing the distribution of pixels that matched the reference material and their associated fit, depth, and fit*depth values of the match. Summary images showing the materials as differently colored classes are also produced. For details on text reports see *appendix B*.

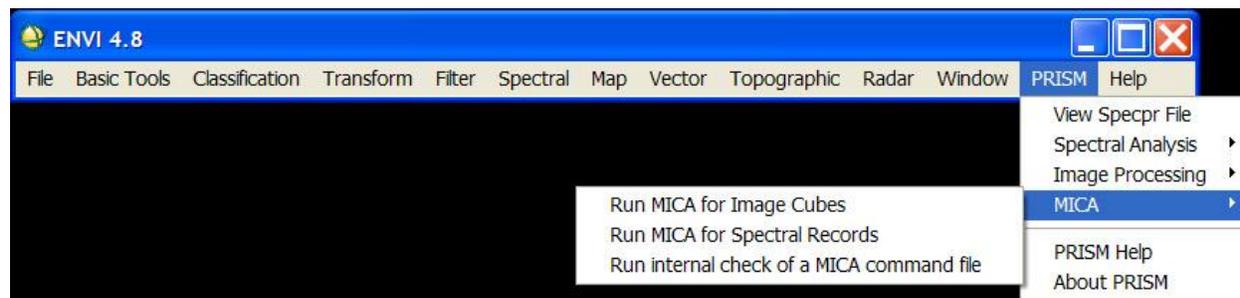


Figure 280. MICA routines.

During program execution, the following prompts are made by MICA. Prompt 1: the user is prompted to select the MICA command file (fig. 281). The sample MICA command file “mica_cmds_group2_hymap2007.mcf” is shown selected in figure 281. This

command file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file is located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. Annotations explaining the structure of the MICA command file are marked on this sample command file in *appendix A*. This command file was developed to detect the occurrences of a set of materials in the pixels of HyMap imaging spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press).

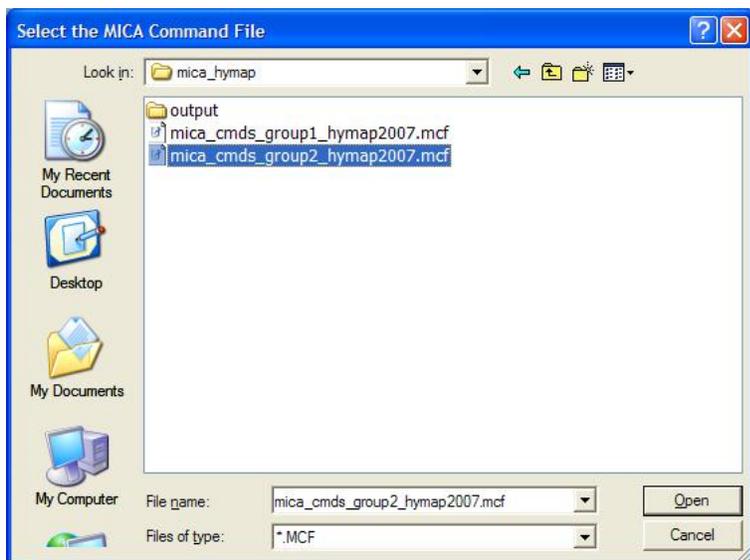


Figure 281. Selecting a MICA command file.

Prompt 2: the user is prompted to set the output directory (fig. 282). This is the directory where the results of the MICA analysis will be written, including a text file of the MICA analysis report. The user must have write permission to this directory. The name of the output text file is formed according to the following pattern, in which the term “log” is shorthand notation for logbook and indicates the file contains results from the MICA analysis as well as important information on events that occur during the program execution:

Output file = Output directory + “mica_log_imagemode_” + command file basename + “.txt”

Thus, for the example given here, the output file will be

“C:\usgsprism\mica_hymap\output\mica_log_imagemode_mica_cmds_group2_hymap2007.txt”

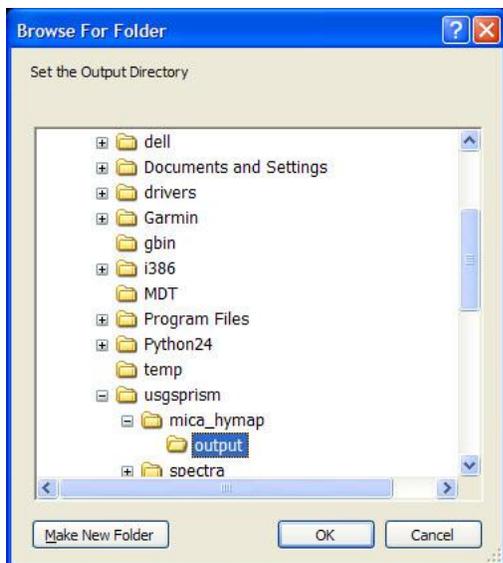


Figure 282. Selecting an output directory for MICA.

Prompt 3: the user is prompted to set the verbose level of the program output (fig. 283). The verbose level refers to the amount of information reported to the user as the image cube is processed.

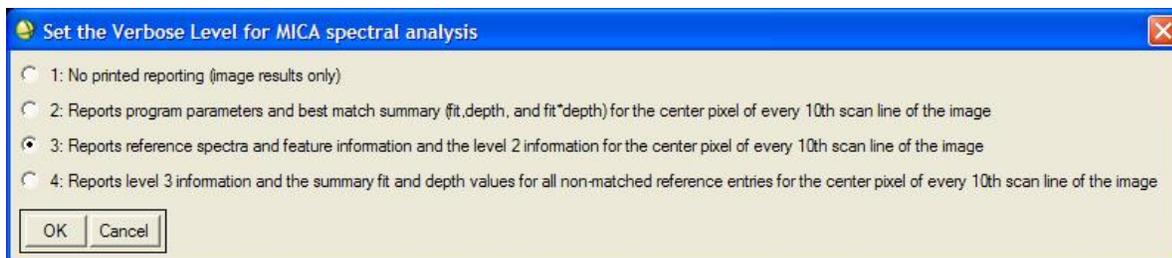


Figure 283. Setting the verbose level for MICA, image mode.

At higher verbose levels more information is reported to the user. See *appendix B* for samples and interpretation of MICA output reports at various verbose levels. At level 1, the output text report is not created, only the output images are written. If the user is running a full ENVI+IDL license, the responses to the input prompts are printed in the console window. At the next level, verbose level 2, the file containing the output text report is created and brief information on the parameters used to run MICA are written to the file. In addition, the output name of the best match and the associated weighted fit, depth, and the fit*depth values of the match are written for the center pixel of every 10th line of the image cube. Summary information on the number of matches to the reference spectra is written as well. If the user is running a full ENVI+IDL license, this information is also printed to the console window. At verbose level 3, the default level, MICA also reports information about the contents of the command file, including the reference spectra and the continuum endpoints that define the spectral features to

be analyzed. At verbose level 4, for the center pixel of every 10th line of the image cube, all fits to reference spectra (both before and after the application of constraints) are reported and the reference spectra with the top 5 fit values are ranked and reported.

Prompt 4: the user is prompted to select the image cube to process (fig. 284). After selecting the image cube, press “Open” to continue the program.

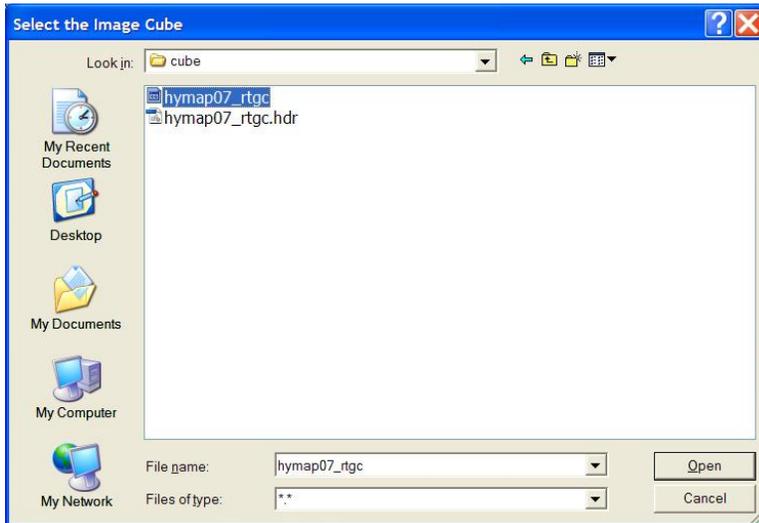


Figure 284. Selecting the spectra to analyze.

Prompt 5: if the MICA command file **does not** specify the scaling factor for the reference spectra, then the user is prompted to respond to set this value (fig. 285). The reference spectra will be divided by the scale factor to convert the spectrum to reflectance values ranging from 0 to 1. If the user selects “No” then the program execution will halt. If the scale factor for the reference spectra is set in the MICA command file then this and the next prompt (Prompt 6) will not appear.

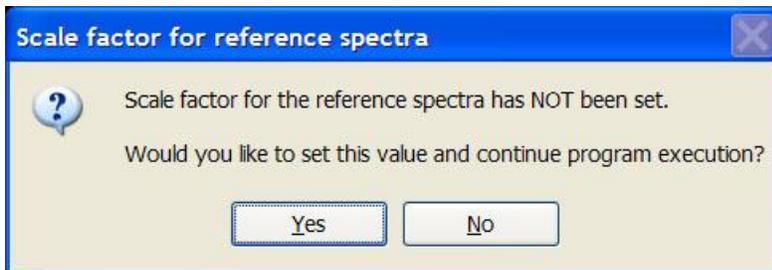


Figure 285. Prompt to set the scale factor for the reference spectra.

Prompt 6: if the user selected “Yes” to set the scale factor for the reference spectra, the user is prompted to set that value (fig. 286). If the scale factor for the reference spectra is set in the MICA command file this prompt will not appear.

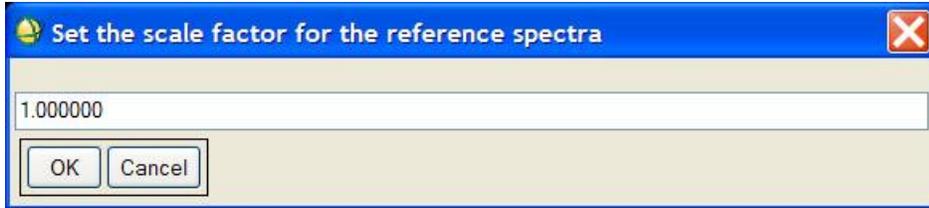


Figure 286. Setting the scale factor for the reference spectra.

Prompt 7: if the MICA command file **does not** specify the scaling factor for the observed spectra, then the user is prompted to respond in order to set this value (fig. 287). The observed spectra will be divided by the scale factor to convert it to reflectance values ranging from 0 to 1. Typically, laboratory and field spectra are collected and stored with values ranging from 0 to 1, in which case, the scale factor should be set to 1. Spectra from cubes of imaging spectrometer data are typically stored with a scaling factor of 10,000 or 20,000. If the user selects “No” then the program execution will halt. If the scale factor for the observed spectra is set in the MICA command file then this and the next prompt (Prompt 8) will not appear.



Figure 287. Prompt to set the scale factor for the observed spectra.

Prompt 8: if the user selected “Yes” to indicate a desire to set the scale factor for the observed spectra the user is prompted to set that value (fig. 288).

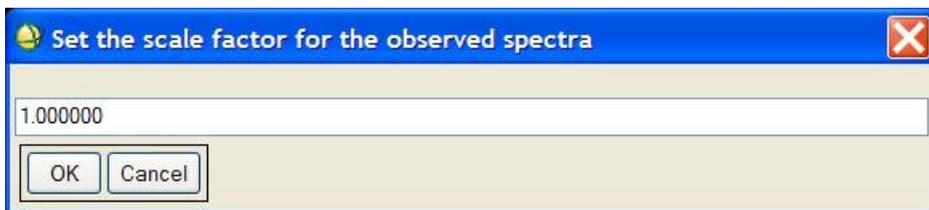


Figure 288. Setting the scale factor for the observed spectra.

Prompt 9: if the MICA command file **does** specify the scaling factor for the observed spectra, then the user is prompted whether to change this value (fig. 289). If the user selects “No” then the program execution will continue using the scale factor set in the command file (skipping prompt 10). If the scale factor for the observed spectra is not set in the MICA command file then this and the next prompt (Prompt 10) will not appear.

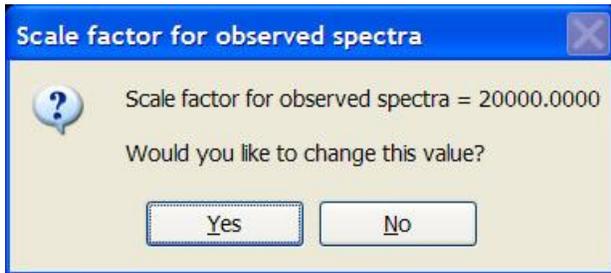


Figure 289. Prompt to change the scale factor for the observed spectrum.

Prompt 10: if the user selected “Yes” to change the scale factor for the observed spectra, the user is prompted to set that value (see fig. 290).

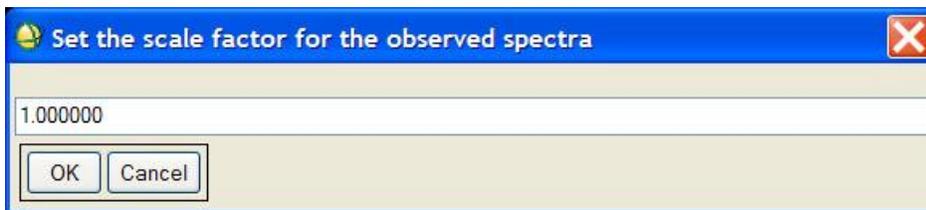


Figure 290. Setting the scale factor for the observed spectrum.

After these steps, the MICA analysis begins. The results are written to the output log file and the output images are created and will appear in the ENVI available bands window. If the user is running a full ENVI+IDL license, the output log information is also printed to the IDL console window.

Prompt 11: If the program completes successfully, a message reporting this is displayed (fig. 291). Press “OK” to dismiss the message window.



Figure 291. Confirming the successful completion of the MICA routine.

As described earlier in this section, if the user selects a verbose mode greater than 1, a text report is generated by MICA. Samples of output reports generated by the MICA image cube mode are given in *appendix B*. The text report and output images are created in the output directory selected during the MICA preprocessing steps (see prompt 2 above, fig. 282). The information in the report includes basic feedback on the selected image cube, the command file used, scale factors applied, deleted channels excluded from spectral analysis, and the user-specified value indicating non-data pixels. If a value for non-data pixels is specified, MICA will find pixels in the input cube that have all channels equal to this non-data value. MICA will produce an image of these pixels, saving it to a file with the name “image_nondata_pixels”. These pixels will be excluded from the MICA analysis. The data type of the saved image is byte and has a separate ENVI header file. A value of 0 (zero) in the image indicates a non-data pixel and a value of 1 indicates a valid data pixel. The file is compressed with GZIP compression (see ITT Visual Information Solutions, 2009, for details on the implementation of this compression in ENVI/IDL). In the basic reporting, special processing options set in the command file are identified, for example the CHECK_SIGNS_OF_DEPTHS or the TETRACORDER_OPTIONS keywords (see the discussion in the *Module 4. MICA – Material Identification and Characterization Algorithm* section of this report).

In image cube mode, MICA allows the user to create a summary image with user-controlled colors and values of classes for the reference materials. The user defined summary image, like the default summary images, is of byte data type in ENVI classification image format. No compression is applied to summary images. The user can specify this option in the command file by setting the FILE_DN_COLORS keyword to indicate a text file containing the class names, values, and colors. If the user has set this keyword, the file used and the class names, values, and colors read from this file are echoed back to the user in the MICA text report.

Following the basic information, the text report includes information on the entries in the command file and dimensions of the image cube. During the analysis of the image cube, the output name of the reference spectrum with the best fit to the central pixel of every 10th line is reported.

After the analysis is complete, the program creates the output image files using the output names specified for each material in the command file as the base of the filename. For a material, if at least one pixel was found to have its best match to the material, output images of the fit, depth, and fit*depth values are created for it, with the extensions “_fit”, “_depth”, and “_fd” added to the base output name, respectively. An output name must be specified for each reference spectrum in the command file by setting the value of the OUTPUT_NAME keyword (*appendix A*). During the MICA analysis of the image cube, if no matches of pixels were found to a reference material, the files are not created for that reference material. The names of created

files appear in the ENVI available bands list (fig. 292). Note: all georeferencing information present in the header of the input image cube is preserved in MICA output images.

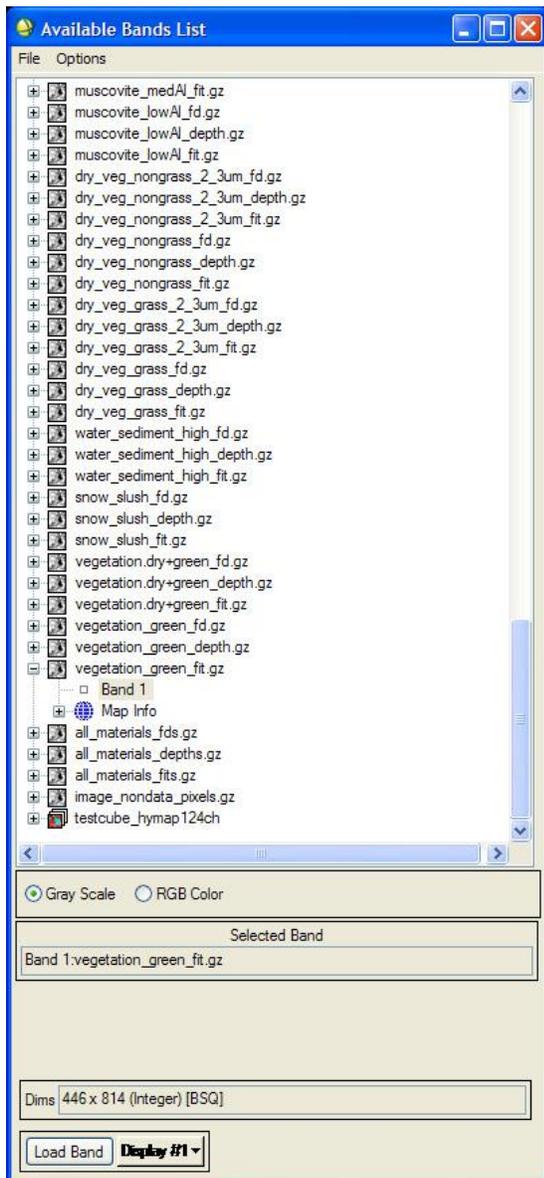


Figure 292. Available bands list following completion of MICA image cube mode.

Information on file creation/non-creation is given in the text report (see the sample reports in *appendix B*). The output image files are two-byte integer data type in PC (Intel) byte order with a VICAR header and have separate ENVI header files. The image files are compressed with GZIP compression (see ITT Visual Information Solutions, 2009, for details on the implementation of this compression in ENVI/IDL). Figure 293 shows examples of the fit, depth, and fit*depth images for the reference material calcite from the analysis of the sample HyMap data with the “mica_cmds_group2_hymap2007.mcf” command file. Fit, depth, and fit*depth values are scaled by a factor of 10,000 and converted to integers; therefore a perfect fit

of 1.0 is scaled to 10,000. The higher the value of a pixel, the brighter it is shown in the images in figure 293; thus, the brighter pixels in the fit image correspond to pixels with the better match to the reference spectrum. The brighter pixels in the depth image correspond to spectra with stronger absorption features. Greater absorption depth may be due to greater fractional coverage of the pixel by the material or a greater concentration of the substance that causes the spectral feature. Figure 294 shows the fit images for three different materials, calcite, green vegetation, and muscovite, showing how their distributions differ within the image. Figure 295 shows how the image spectra, averages of three-by-three pixel areas, which mapped as these three materials, compare to their reference spectra. To facilitate the linkage of output images with the input data and spectra used to create them, the ENVI headers of the files contain information on the input image cube, MICA command file, and reference spectrum SPECPR file, record, and title (see an example of this header information in fig. 296).

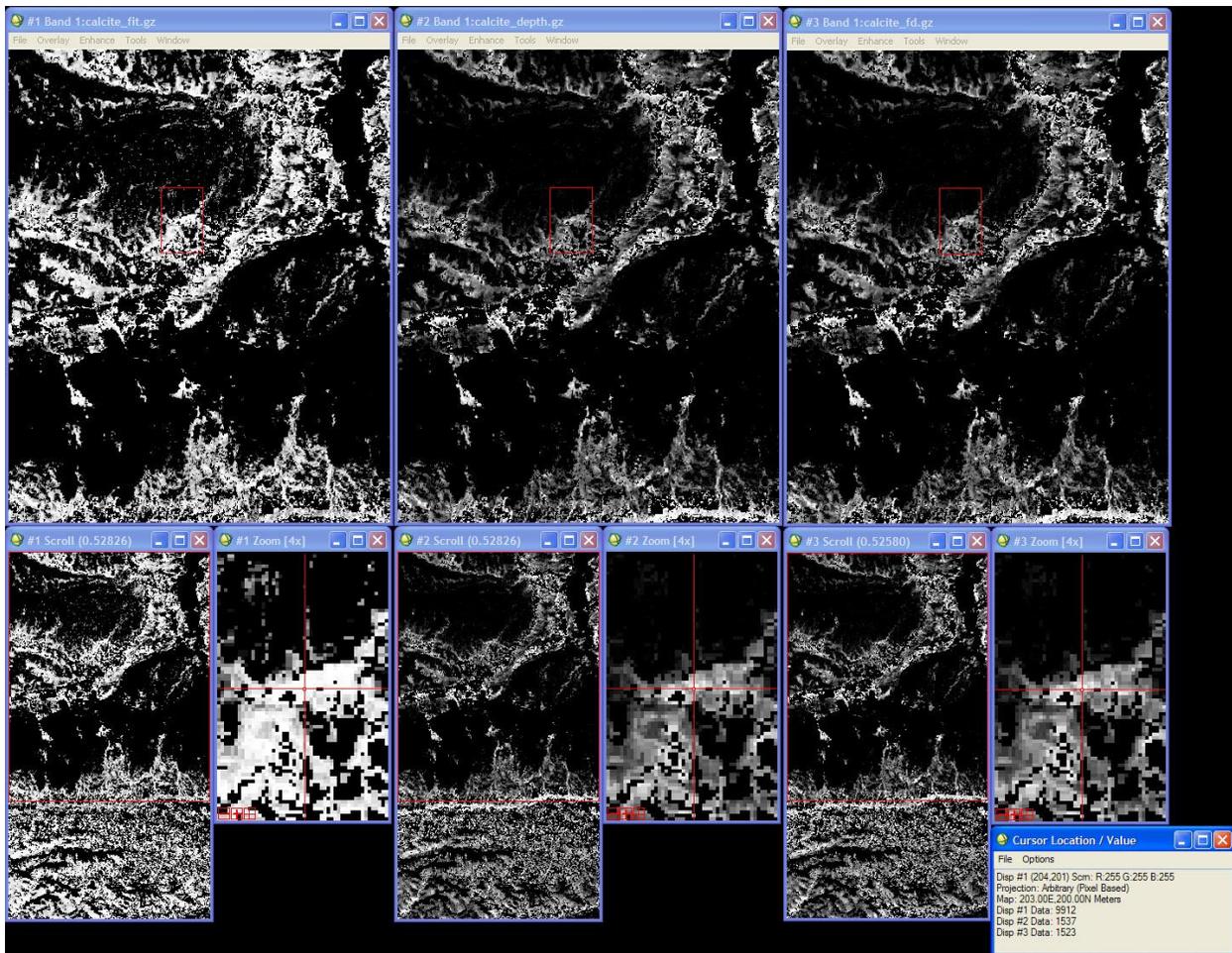


Figure 293. Calcite fit, depth, and fit*depth image from MICA image cube mode.

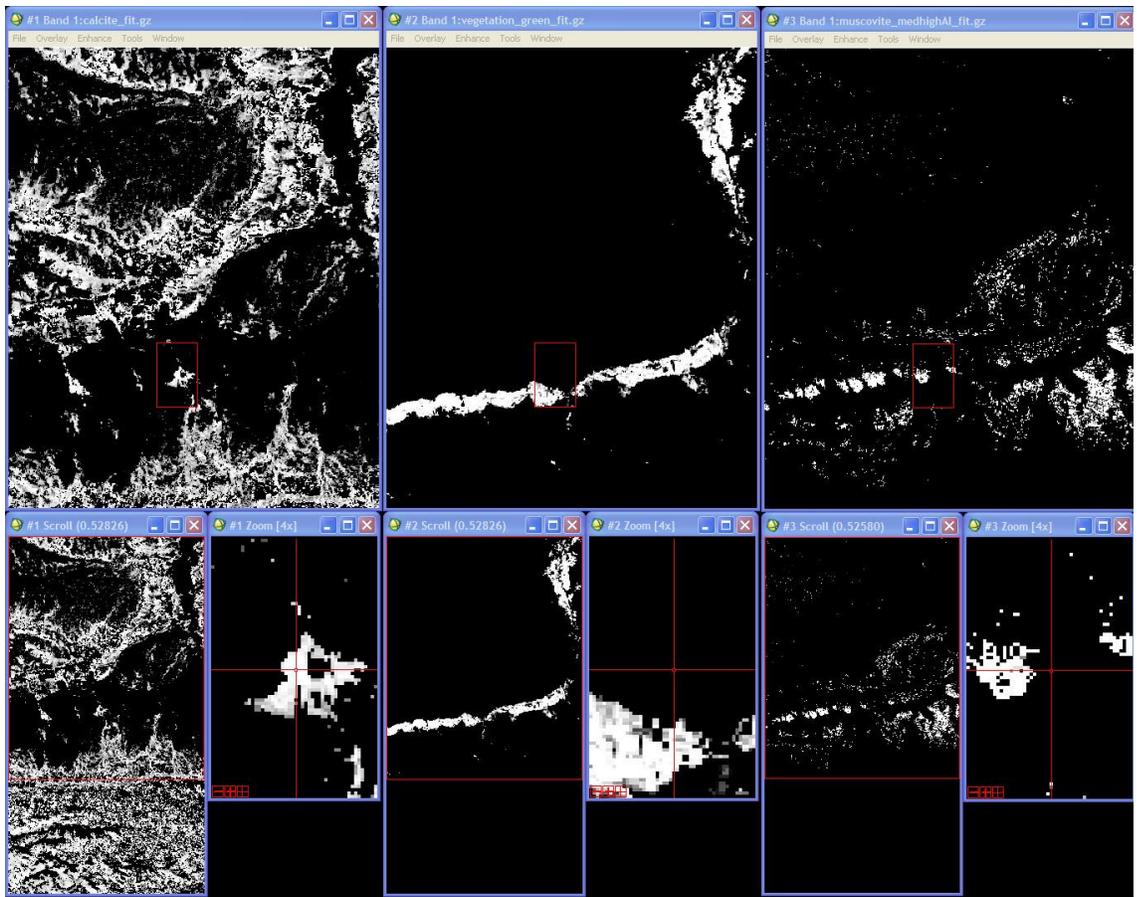


Figure 294. Fit images for calcite, green vegetation, and muscovite from MICA image cube mode.

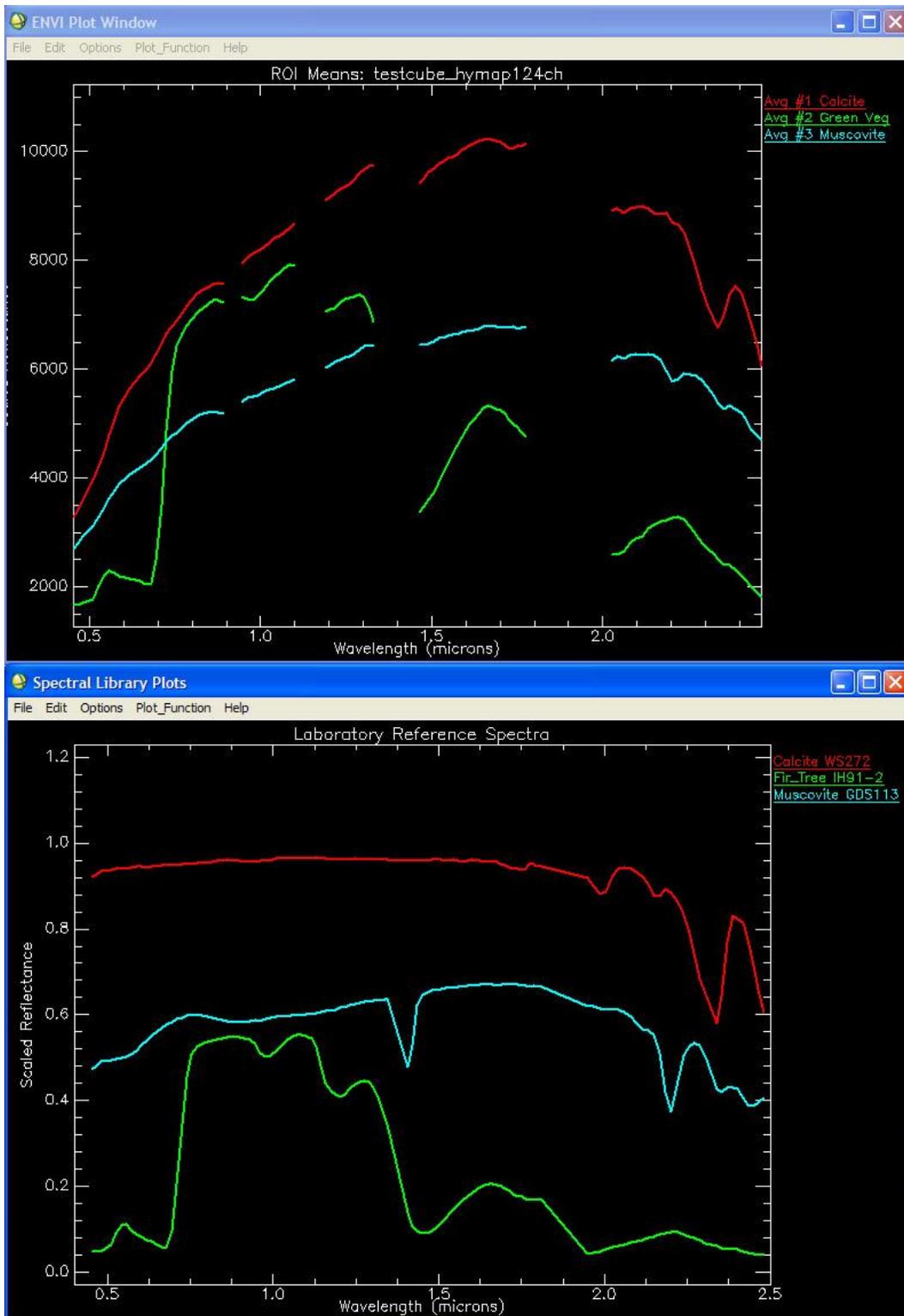


Figure 295. Image spectra (top plot) in comparison to reference spectra (bottom plot).

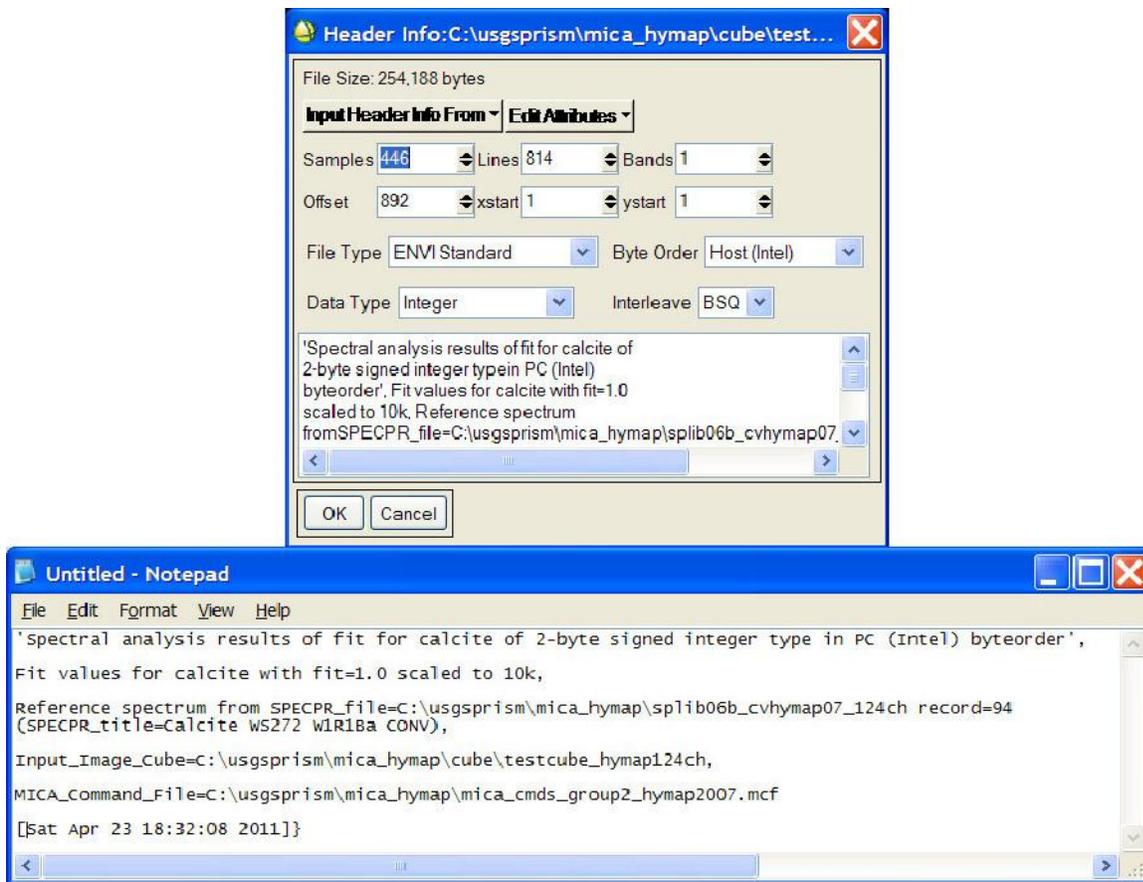


Figure 296. Example of header information stored in the ENVI header of a fit image.

For pixels that did not have a match to any of the reference materials, a special image, with the name “image_unmapped_pixels”, is created to identify them. The image data type is byte and has a separate ENVI header file. A value of 1 (one) in the image indicates a valid data pixel which was not matched to any reference spectra. The file is compressed with GZIP compression (see ITT Visual Information Solutions, 2009, for details on the implementation of this compression in ENVI/IDL).

In addition to the images of the individual materials, MICA creates an output image containing the weighted fit values for every pixel with a best match. Similarly, composite images of weighted depth and fit*depth values for the best matches are created. The composite images are named “all_materials_fits”, “all_materials_depths”, and “all_materials_fds”. Like the individual material images, these composite images are GZIP-compressed, two-byte integer files in PC (Intel) byte order with ENVI headers.

MICA creates a series of summary images to show the distributions of the mapped materials. These files, including an embedded VICAR header, are created as ENVI classification images in byte data type with separate ENVI header files. No compression is applied to these images. Each material is assigned a class value and color within the summary image, and all the pixels that were identified as the best match to the material are coded with those values and colors. The first summary images that are created are assigned values and colors based on their order of listing in the MICA command file. The first material listed is assigned a class value of

one, the second a class value of two, and so on. A standard set of 11 colors, red, green, blue, yellow, cyan, magenta, orange, pink, dark green, brown, and light purple, is assigned to the first 11 materials listed in the command file, respectively. The next 11 materials are assigned similar color values, but with their intensities multiplied by a factor of 0.85 to reduce their brightness. Each subsequent block of 11 mapped materials is assigned colors in a similar manner with factors to further reduce their brightness. The class containing unmapped pixels is assigned the value of zero and given a color of black. The filename of “mica_class_allmaterials_defaultindex” is given to the summary image resulting from this assignment of class values and colors. Figure 297 shows this image for the HyMap sample image used in this example. In this image both non-data pixels and valid image pixels in which no material was matched to a reference entry (in other words, unmapped pixels) are given the same class value of zero and class color of black. Non-data pixels are those with all channels equal to the value of the NODATA_VALUE_IMAGE keyword set in the MICA command file (see *appendix A*). If this keyword is set, MICA will differentiate between unmapped pixels and non-data pixels by writing another summary image with the non-data pixels assigned a color of dark gray and given a class value equal to the number of reference materials plus one; for example, if there are 60 reference materials, the non-data class is given a value of 61. The file is named “mica_class_allmaterials_defaultindex_withnondataclass”.

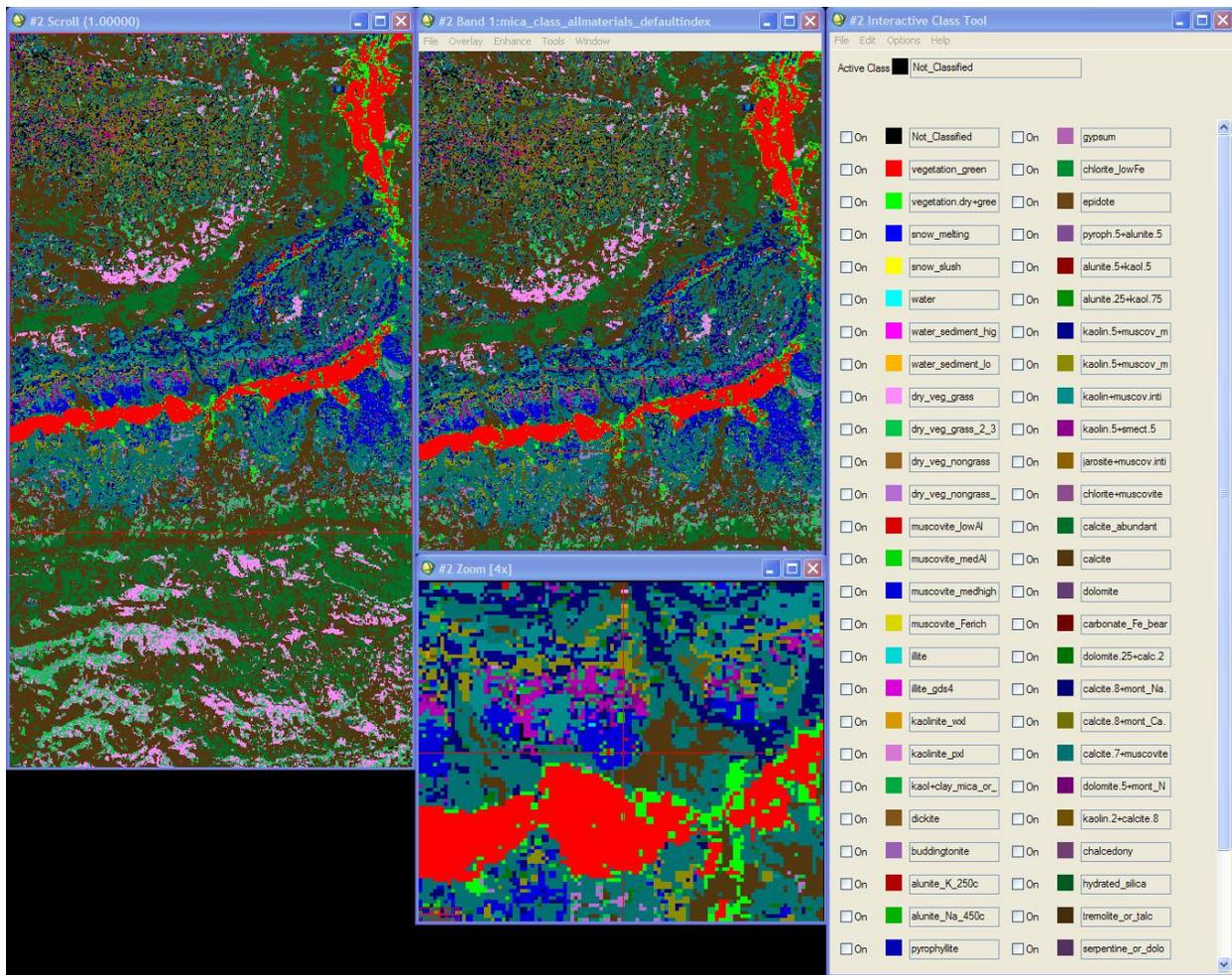


Figure 297. MICA summary image “mica_class_allmaterials_defaultindex” from MICA image cube mode.

Because ENVI only allows one background value, or “see-thru” value, when mosaicing images, the file with the grouped non-data and unmapped image pixels is useful when mosaicing the MICA summary images produced from overlapping image cubes. As with the individual material images, the ENVI headers of the summary images include information on the input image cube and the MICA command file used to produce them (fig. 298). As described previously, the summary images include an embedded VICAR header, the size of which will vary depending on the numbers of bytes needed to store the VICAR information relative to the number of samples in the image. The header size, in bytes, will be an integer multiple of the number of samples, in the example in figure 298, the number of header bytes is $4 * 446 = 3122$ bytes.

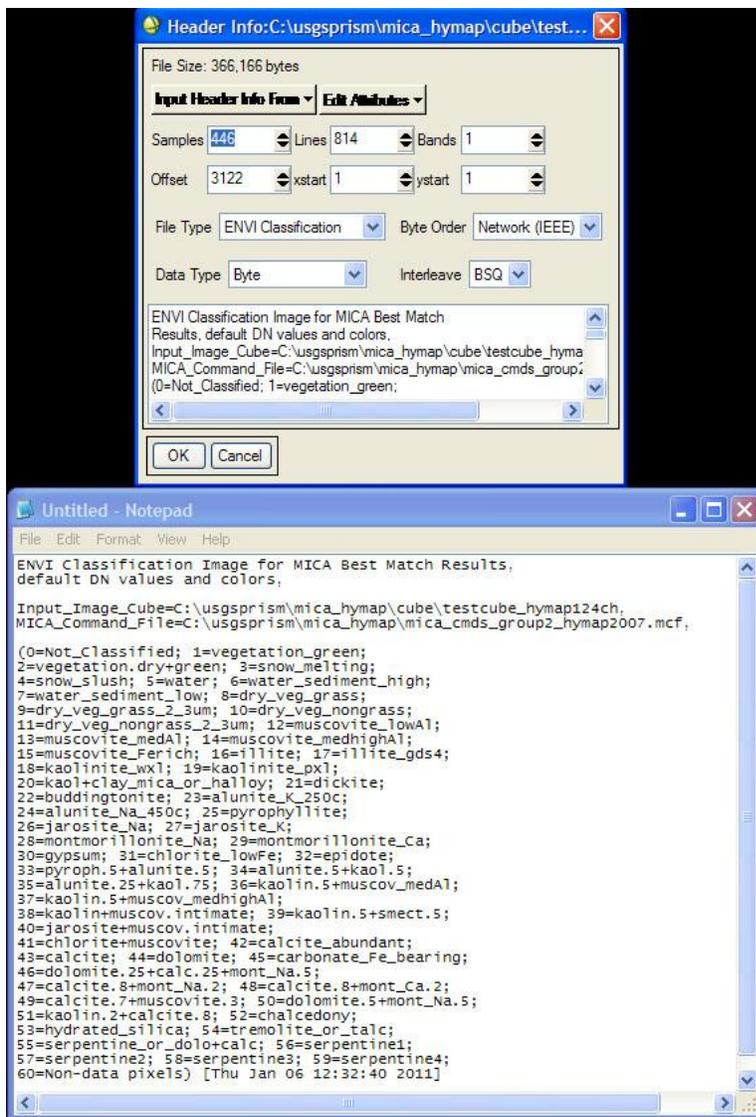


Figure 298. ENVI header information for MICA summary image “mica_class_allmaterials_defaultindex_withnondataclass”.

MICA also produces summary images with values and colors assigned according to the number of pixels that mapped in the individual material images. The materials are ranked in descending order based on the number of pixels for which they were found to be the best match. Materials that did not have any pixels mapped as the best match are excluded from this summary image. The material with the highest number of mapped pixels is assigned a class value of 1; the material with the second highest number of pixels is given a class value of 2, and so on. Again, a standard set of 11 colors, red, green, blue, yellow, cyan, magenta, orange, pink, dark green, brown, and light purple, is used and assigned to the materials with the top 11 pixel counts. The next block of 11 materials, ranked by descending pixel counts, is assigned the similar color values, but with their intensities reduced by a multiplication factor of 0.85. Each subsequent block of 11 mapped materials, ranked by pixel counts, is assigned colors in a similar manner

with factors to further reduce their brightness. The class containing unmapped pixels is assigned the value of zero and given a color of black. The summary image is created with the name “mica_class_mappedmaterials_rankedbypixelcount”. Figure 299 shows this image for the HyMap sample image used in this example. Non-data pixels are those with all channels equal to the value of the NODATA_VALUE_IMAGE keyword set in the MICA command file. If this keyword is set, MICA will differentiate between unmapped pixels and non-data pixels by writing another summary image with a separate class for non-data pixels, named “mica_class_mappedmaterials_rankedbypixelcount_withnondataclass”. Because some materials are not matched to any pixels as the best match, the total number of classes can be less than the number of reference materials listed in the MICA command file; therefore, the non-data class is assigned a value equal to the number of mapped classes plus one. Note: in these summary images, a material’s class value is based on the number of pixels mapped in the image; thus, a material’s class value in “rankedbypixelcount” images can be different in each image analyzed.

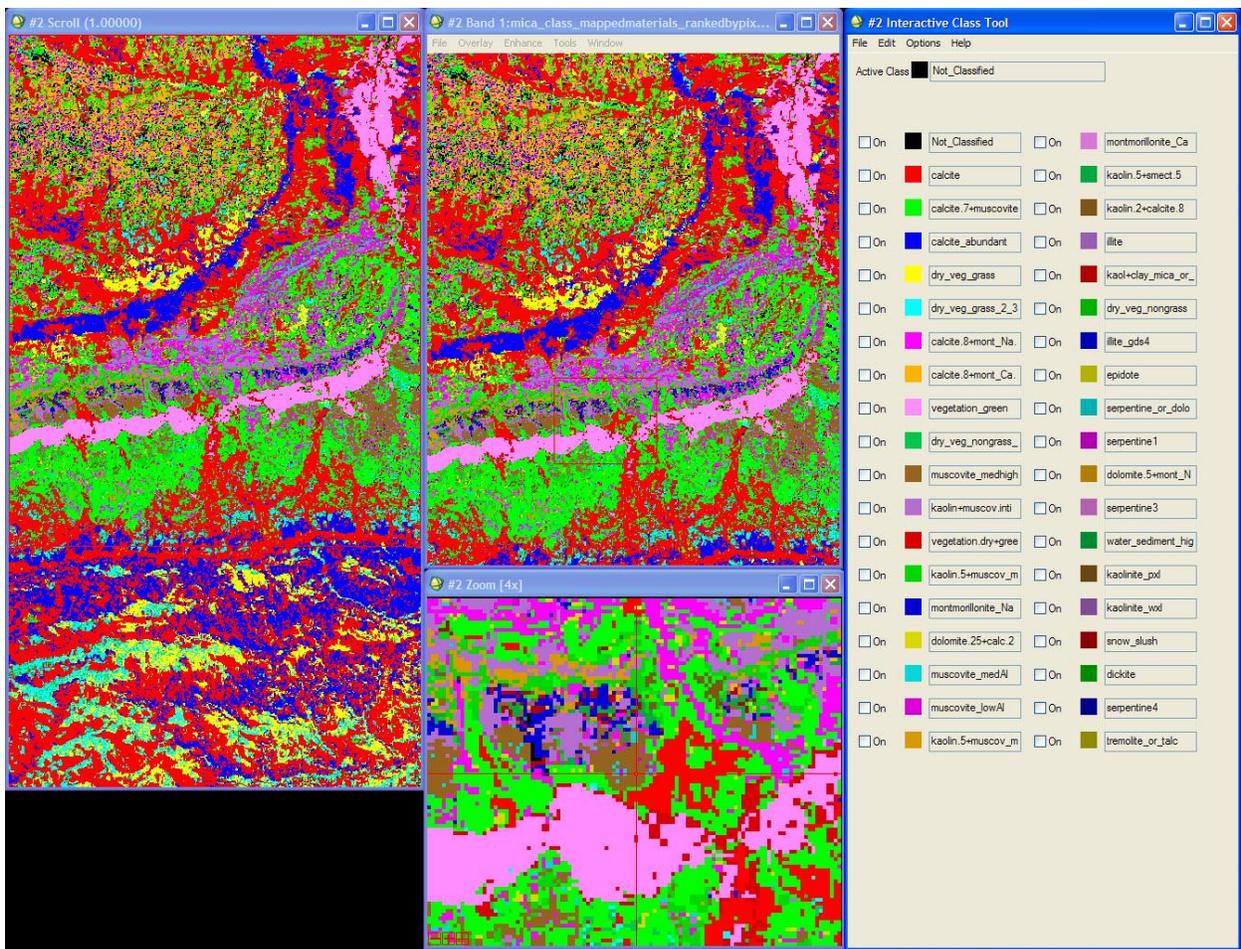


Figure 299. MICA summary image “mica_class_mappedmaterials_rankedbypixelcount” from MICA image cube mode.

MICA allows the user the option to define the class values and colors that are assigned to each reference material. This specification is made in the class values and colors file; the name of this file is defined by the value of the FILE_DN_COLORS keyword set in the MICA command file (see *appendix A*). The format of this file is shown in *appendix E*. Through this file, the user can assign a specific color scheme to the materials. The output file with the user assigned class values and colors is named “mica_class_allmaterials_userindex”. Figure 300 shows this image for the HyMap sample image used in this example. If the NODATA_VALUE_IMAGE keyword is set in the command file, MICA will differentiate between unmapped pixels and non-data pixels by writing a second summary image with a separate class for non-data pixels, named “mica_class_allmaterials_userindex_withnondataclass”. In the class values and colors file, two or more entries can be assigned the same color. In this manner, several reference spectra for the same type of material, for example, kaolinite clays, can be included in the command file, where these entries may have similar, yet slightly different spectra based on subtle chemical, or in this case, mineralogical, differences, and the pixels that match them can be colored the same in the summary images. Subsequently, the user can decide if the spectral quality of the analyzed image supports the differentiation of the two classes and they can be given distinct colors. The sample class values and colors file contains several instances of this as evidenced by multiple classes with the same color as seen in the Interactive Class Tool window in the right side of figure 300.

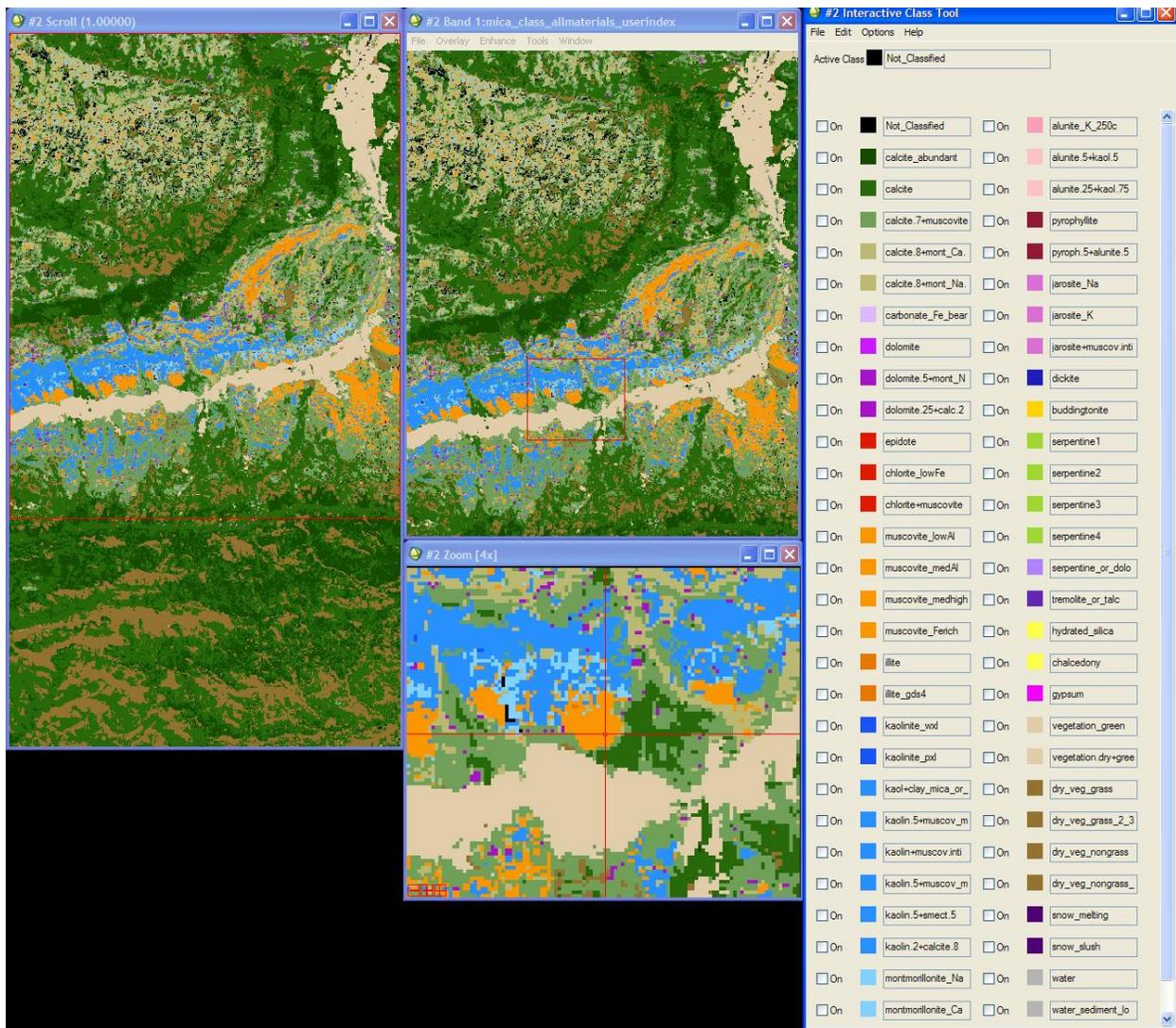


Figure 300. MICA summary image “mica_class_allmaterials_userindex” from MICA image cube mode.

Within ENVI, the summary images, fit images, and input image cube can be linked (using the “Link Display” option from the drop-down list under the “Tools” menu item on the image menu bar). Linking images is helpful when examining the MICA material maps. With the images linked, the fit value of the material match for a pixel can be easily displayed (using the “Cursor Location/Value” option from the drop-down list under the “Tools” menu item on the image menu bar) along with the corresponding pixel spectrum (using the “Z profile (spectrum)...” option from the drop-down list that appears when you click on the “Profiles” item found under the “Tools” entry on the image menu bar). Alternatively, the user can directly overlay the summary material maps on the image cube (by choosing the “Classification” item from the drop-down list under the “Overlay” menu item on the image menu bar). Figure 301 shows an example of this overlay, along with the linked fit image for calcite. With the classification overlaid, the user can change the class colors, if desired, by pressing the “Options”

item on the menu bar of the “Interactive Class Tool” window and choosing the “Edit class colors/names...” item from the list that appears.

The summary images created during the MICA processing are the least conservative indication of material identification that can be produced from the MICA results, only moderated by any weighted fit thresholds in the MICA command file. More conservative maps can be produced by subsequently developing thresholds on fit, depth, or fit*depth values for each of the materials. Masks derived from these thresholds can be applied to the summary images. It is suggested that the user examine the summary material identification images in relation to fit, depth, and fit*depth values, and pixel spectra to assess whether any such refinements are needed. If consistent thresholds are found for materials produced from a specific command file, the user may incorporate them into that command file in the form of weighted fit, depth, or fit*depth thresholds for each material, if desired. See *appendix A* for an example MICA command file and *appendix B* for samples of MICA output reports with interpretive annotations.

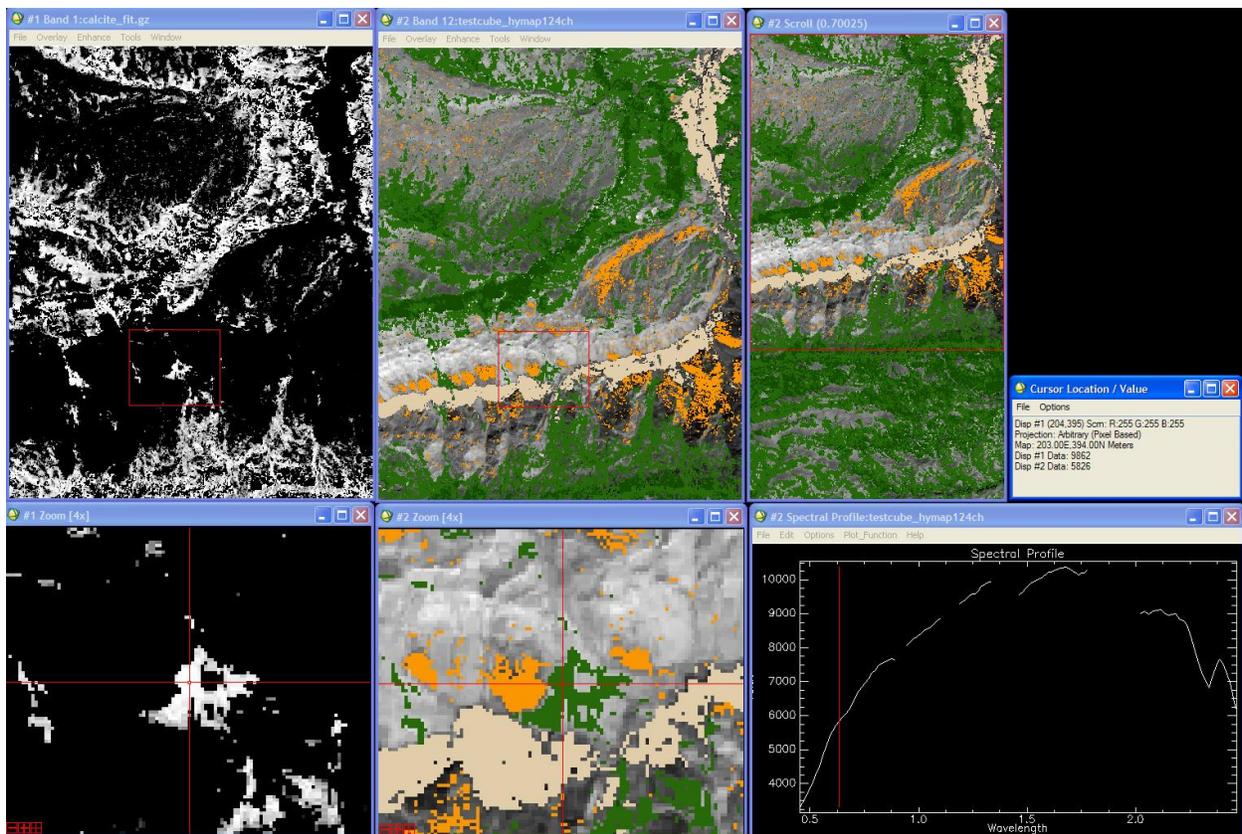


Figure 301. Overlaying the classification image (center) on the MICA image cube, with linked fit image for calcite (left) and Z-profile window (bottom right) showing the reflectance spectrum of the selected pixel. The 0.9862 fit value for the selected pixel is shown in the Cursor Location / Value window (center right) as the value for Disp#1 Data.

Function 4.2 – Run MICA for Spectral Records

To analyze spectra stored as records in a SPECPR file, choose the “Run MICA for Spectral Records” option from the drop-down menu that appears when you click on “MICA” under the “PRISM” menu item (see fig. 280). The program flow is similar to that detailed in Section “*Function 1.8 – Running MICA analysis on the selected record.*” of this report.

During program execution, the following prompts are made by MICA.

Prompt 1: the user is prompted to select the MICA command file (fig. 302). The example MICA command file “mica_cmds_group2_hymap2007.mcf” is shown selected in figure 302. This command file is included with the PRISM software distribution. If step 3 of the installation instructions was followed (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. Annotations explaining the structure of the MICA command file are marked on this example command file in *appendix A*. This command file was developed to detect the occurrences of a set of materials in HyMap imaging spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press).

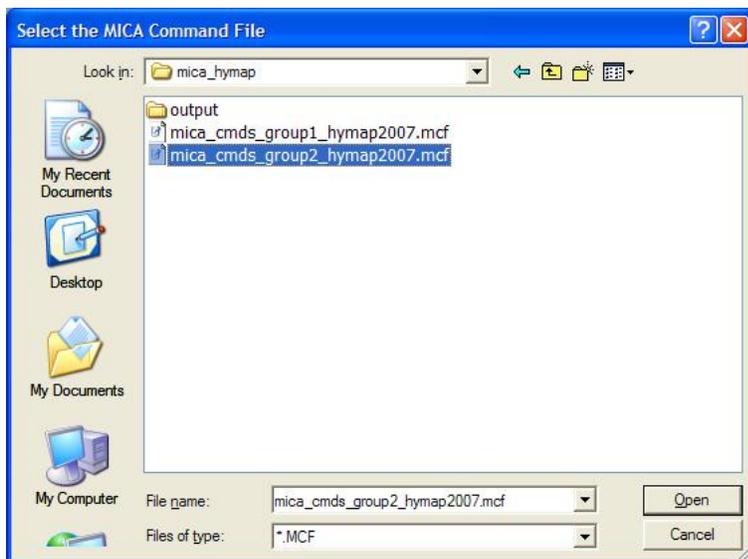


Figure 302. Selecting a MICA command file.

Prompt 2: the user is prompted to set the output directory (fig. 303). This is the directory where the results of the MICA analysis will be written, including a text file of the MICA analysis results for the selected record(s). The user must have write permission to this directory. This output text file is formed according to the following pattern, in which the term “log” is shorthand notation for logbook and indicates the file contains results from the MICA analysis as well as important information on events that occur during the program execution:

Output file = Output directory + “mica_log_spectrummode_” + command file + “.txt”

Thus, for the example given here, the output file will be

“C:\usgsprism\mica_hymap\output\mica_log_spectrummode_mica_cmds_group2_hymap2007.txt”

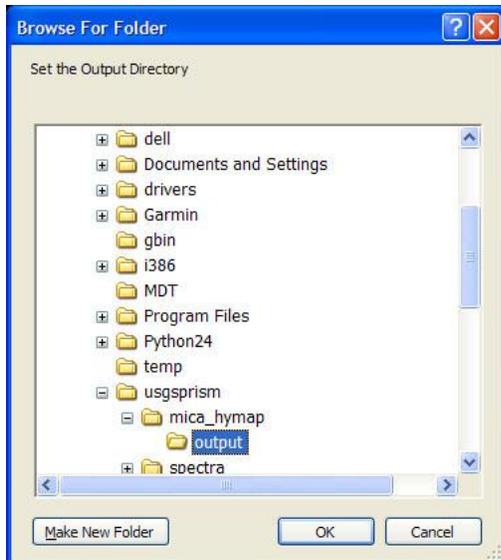


Figure 303. Selecting an output directory for MICA.

Prompt 3: the user is prompted to set the verbose level of the program output (fig. 304). The verbose level refers to the amount of information reported to the user as the spectrum is processed. A higher numbered verbose level means more information is reported, adding information to that reported at the previous level. See *appendix B* for samples and explanations of MICA output at various verbose levels. At the basic verbose level of 1, a single line of text is printed that indicates which one, if any, of the reference spectra was found to be the best match to the selected record and the fit number of that comparison. The fit value ranges from 0 to 1, with better matches indicated by high fit numbers and perfect agreement indicated by a value of 1. At the next level, verbose level 2, the output file also contains some information on the parameters used to run MICA, the weighted band depth and the fit*depth values of the match, and information on the SPECPR file, record number, and title for the analyzed spectral record and the matching reference spectrum. At verbose level 3, MICA also reports information about the contents of the MICA command file, including the reference spectra and the continuum endpoints that define the spectral features to be analyzed. Also at verbose level 3, the output file reports the fit results for all reference spectra. In addition, the reference spectra with the top 5 fit values are ranked and reported. At verbose level 4, the output file contains detailed information on the fit and depth values for each spectral feature. Also, the calculated values of feature and continuum parameters are reported along with the threshold values for these parameters that were set in the MICA command file. If a threshold was not set in the command file, the output file will show a value of -99.99 for that constraint. Summary reports describing whether spectral features passed or failed constraints are also given. A table reporting the weighted fit, depth, and fit*depth values is given along with threshold values for these parameters that were set in the MICA command file. If a threshold was not set in the command file, the output file will show a

value of -99.99 for that constraint. Verbose level 5 adds reporting from some subroutines of MICA. In addition, PostScript plots are created which show the comparison of the spectrum of the selected record to reference spectra for each diagnostic and NOT feature listed in the command file.

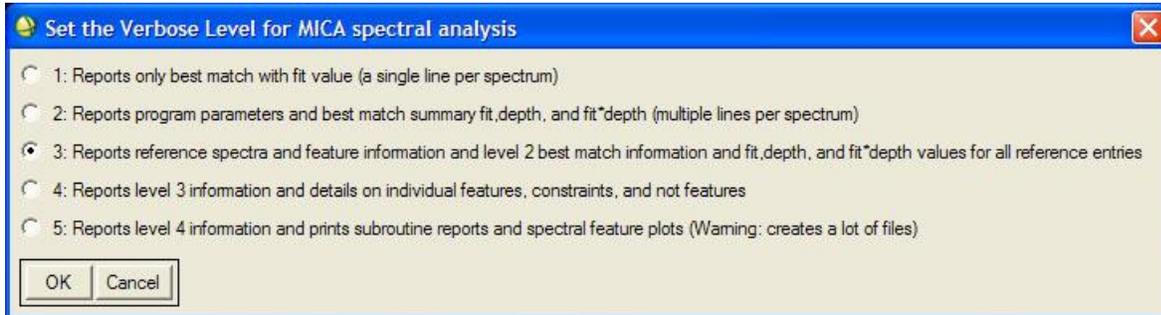


Figure 304. Setting the verbose level for MICA spectral records mode.

Prompt 4: the user is prompted to select the SPECPR file and records that contain the spectra to analyze. A window appears that allows the user to set and read the input SPECPR file (fig. 305).

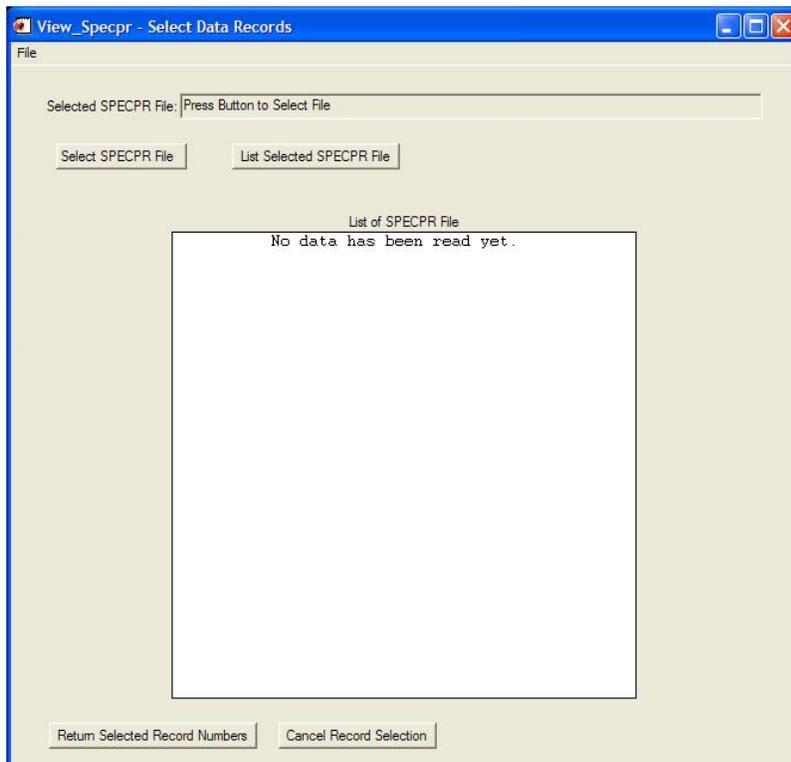


Figure 305. Selecting the spectra to analyze.

To set the SPECPR file, click on the “Select SPECPR File” button at the top left of the window. A dialog window appears allowing the user to select the SPECPR file (fig. 306). In this example, the file “splib06b_cvhymap07_124ch” is used. This SPECPR file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. Click the “Open” button after choosing the file.

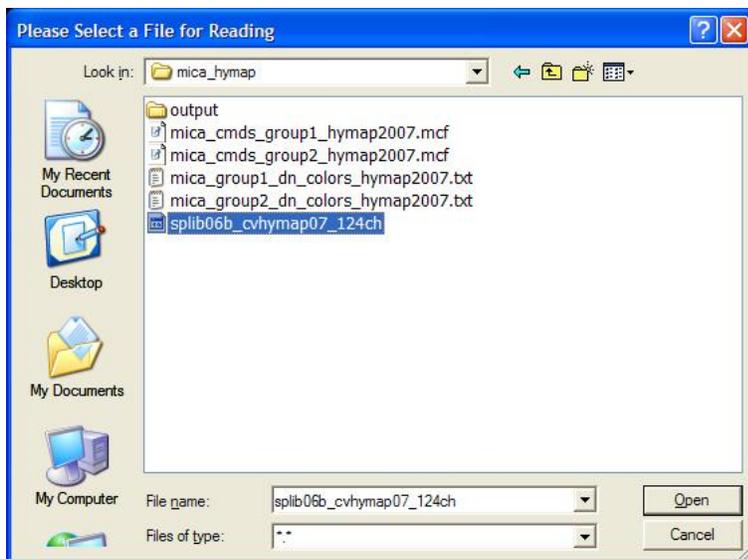


Figure 306. Selecting the SPECPR file.

To show the contents of the file and to select the records to analyze, click on the “List Selected SPECPR File” button near the top of the record selection window (see fig. 305). After pressing the button, the contents of the SPECPR file are displayed (fig. 307).

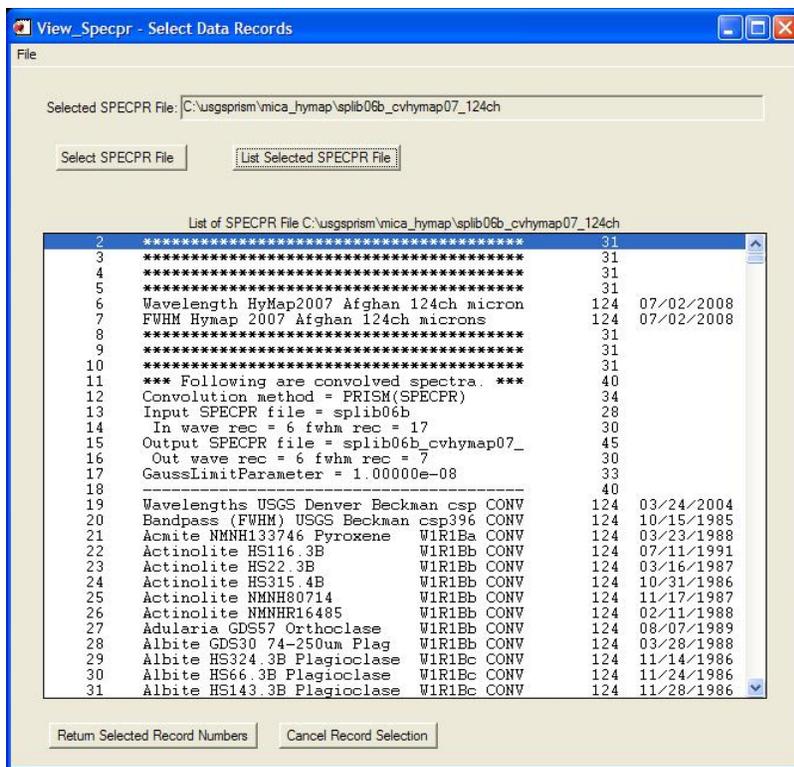


Figure 307. Listing the contents of a SPECPR file for selecting records to analyze with MICA.

The user may scroll down to the desired record using the scroll bar on the right. A single record may be selected by left-clicking on the record, or multiple records selected by choosing the first, holding the “Ctrl” (control) button, and clicking on additional records. The user may scroll up or down the list before choosing additional records. A block of records may be selected by choosing the record at one end of the desired block and then holding the Shift button and selecting the record at the other end. The user may scroll up or down the list before choosing the other end of the record block. Make sure to choose records with the same number of channels as the spectra in the MICA command file, otherwise the program will report an error and halt execution when it starts analyzing the records.

Prompt 5: if the MICA command file **does not** specify the scaling factor for the reference spectra, then the user is prompted to respond to set this value (fig. 308). The reference spectra will be divided by the scale factor to convert the spectrum to reflectance values ranging from 0 to 1. If the user selects “No” then the program execution will halt. If the scale factor for the reference spectra is set in the MICA command file then this and the next prompt (Prompt 6) will not appear.

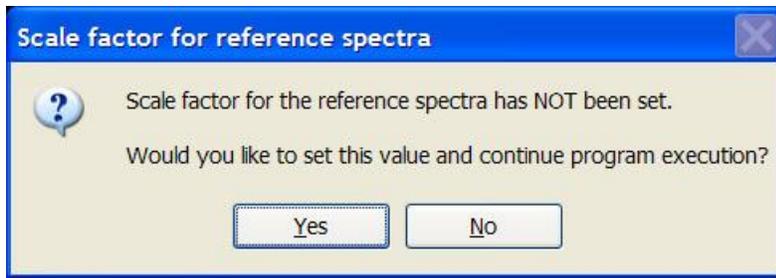


Figure 308. Prompt to set the scale factor for the reference spectra.

Prompt 6: if the user selected “Yes”, wishing to set the scale factor for the reference spectra, then the user is prompted to set that value (fig. 309). If the scale factor for the reference spectra is set in the MICA command file this prompt will not appear.

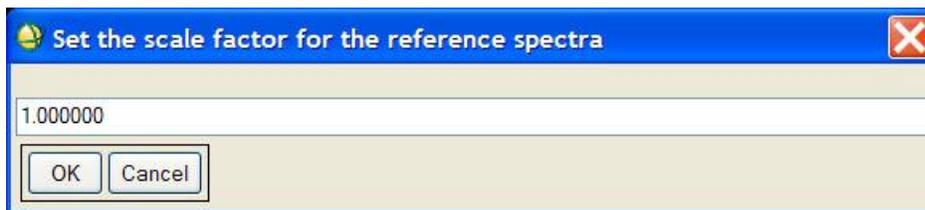


Figure 309. Setting the scale factor for the reference spectra.

Prompt 7: if the MICA command file **does NOT** specify the scaling factor for the observed spectra, then the user is prompted to respond if wishing to set this value (fig. 310). The observed spectra will be divided by the scale factor to convert it to reflectance values ranging from 0 to 1. Typically, laboratory and field spectra are collected and stored with values ranging from 0 to 1, in which case, the scale factor should be set to 1. Spectra from cubes of imaging spectrometer data are typically stored with a scaling factor of 10,000 or 20,000. If the user selects “No” then the program execution will halt. If the scale factor for the observed spectra is set in the MICA command file then this and the next prompt (Prompt 8) will not appear.



Figure 310. Prompt to set the scale factor for the observed spectra.

Prompt 8: if the user selected “Yes”, wishing to set the scale factor for the observed spectra, the user is prompted to set that value (fig. 311).

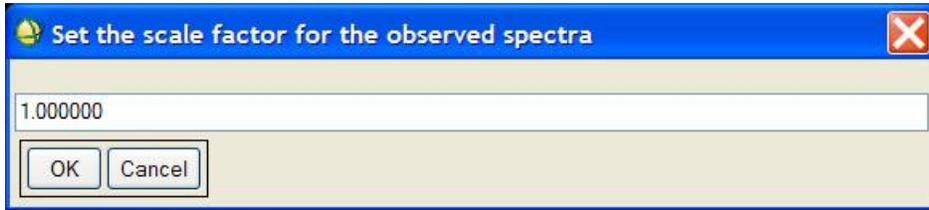


Figure 311. Setting the scale factor for the observed spectra.

Prompt 9: if the MICA command file **does** specify the scaling factor for the observed spectra, then the user is prompted to respond if wishing to change this value (fig. 312). If the user selects “No” then the program execution will continue, using the scale factor set in the command file. If the scale factor for the observed spectra is not set in the MICA command file then this and the next prompt will not appear (Prompt 10).

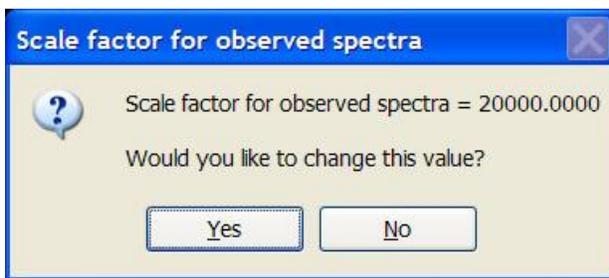


Figure 312. Prompt to change the scale factor for the observed spectrum.

Prompt 10: if the user selected “Yes”, wishing to set the scale factor for the observed spectra, then the user is prompted to set that value (fig. 313).

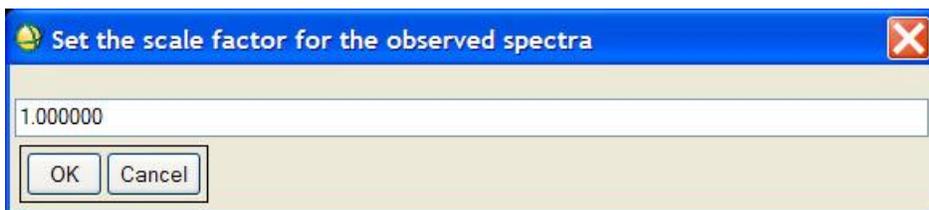


Figure 313. Setting the scale factor for the observed spectra.

After these steps, the MICA analysis begins. The results are written to the output log file. If the user is running a full ENVI+IDL license, the results are also printed to the IDL console

window. If the program completes successfully, a message reporting this is displayed (fig. 314). Press “OK” to dismiss the message window.

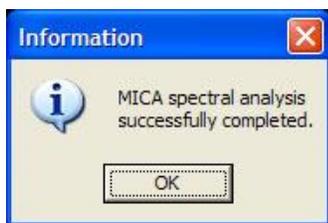


Figure 314. Confirming the successful completion of the MICA routine.

A window containing the text report of the MICA results is also displayed (for example, the bottom of a text report is shown in fig. 315). The reference spectrum that had the best match to the analyzed spectrum is shown at the end of the report. If a verbose level greater than 3 was selected, as described above, the reference materials with the five highest fit values are listed before reporting the best match. These are shown under the heading “TOP 5 FITS” and are ranked in descending order of fit value. If for all the reference spectra, the observed spectrum did not meet a constraint in the MICA command file (see the feature and continuum constraints described in *Function 4*), a “no match” result is reported.

Depending on the verbose level, as described above, additional reporting may be made. Additional details on the output from MICA are given in *appendix B*. Further information on MICA can be found in the “*Module 4. MICA – Material Identification and Characterization Algorithm*” section of this report. *Appendix A* explains the format and syntax of MICA command files and includes the sample command file with explanatory comments.

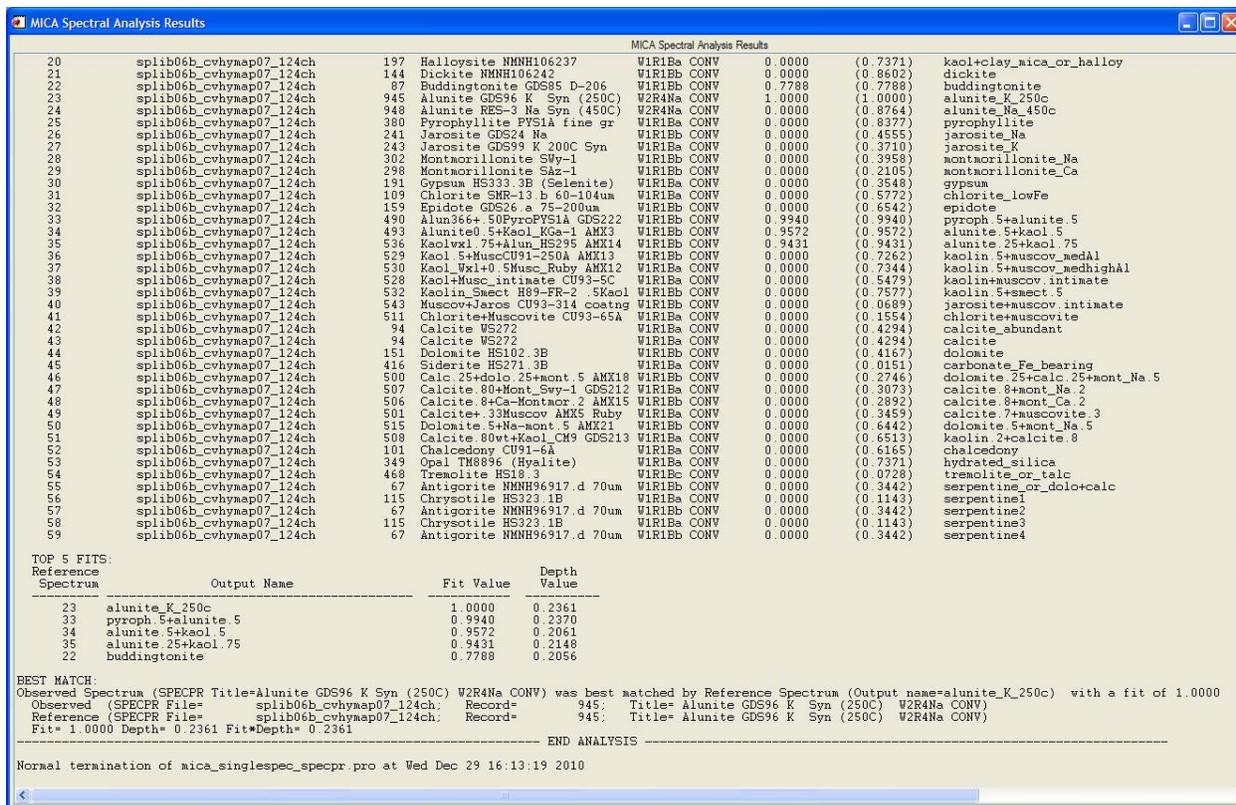


Figure 315. Text report of the MICA results.

Function 4.3 – Run internal check of a MICA command file

This function provides a convenient way to check the integrity of a MICA command file by analyzing all reference spectra listed in the command file. If the command file is set up properly, the best match to a reference spectrum should be that same spectrum. Additionally, the continuum-removed diagnostic and NOT features are plotted to PostScript files, so that the user can examine the continuum endpoint ranges to see if they capture the desired spectrometer channels. Furthermore, a file that contains the top 5 fits for each spectrum is written, so that the user can see which reference entries have the greatest spectral similarity (for example, how close are the fits between the spectra of the materials that are listed in the command file).

To run this function, choose the “Run internal check of a MICA command file” option from the drop-down menu that appears when you click on “MICA” under the “PRISM” menu item (see fig. 280). During program execution, the following prompts are made by MICA.

Prompt 1: the user is prompted to select the MICA command file. The example MICA command file “mica_cmds_group2_hymap2007.mcf” is shown in figure 316. This command file is included with the PRISM software distribution. If step 3 of the installation instructions was followed (see the “Installation of Software” section of this report), this file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. Annotations explaining the structure of the MICA command file are marked on this example command file in *appendix A*. This command file was developed to detect the occurrences of a set of materials in HyMap imaging

spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press).

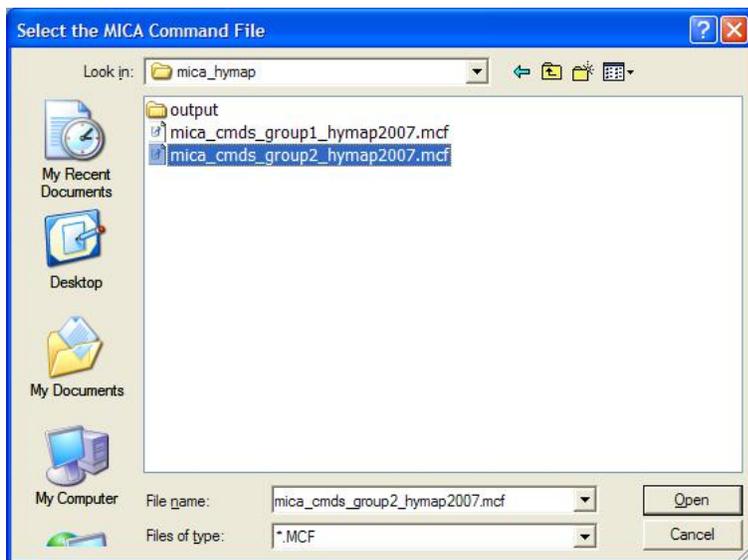


Figure 316. Selecting a MICA command file.

Prompt 2: the user is prompted to set the output directory (fig. 317). This is the directory where the results of the MICA analysis will be written, including a text file of the MICA internal check. The user must have write permission to this directory.

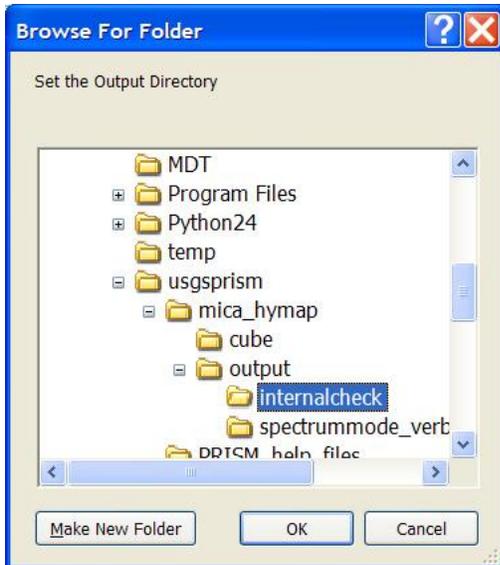


Figure 317. Selecting an output directory for MICA.

The output text file is formed according to the following pattern, in which the term “log” is shorthand notation for logbook and indicates the file contains results from the MICA analysis as well as important information on events that occur during the program execution:

Output file = Output directory + “mica_log_internalcheck_” + command file + “.txt”

Thus, for the example given here, the full output log file will be

“C:\usgsprism\mica_hymap\output\mica_log_internalcheck_mica_cmds_group2_hymap2007.txt”

In addition, a text file containing just the top 5 fits for each reference spectrum is created, with the following construction:

File = Output directory+“mica_log_internalcheck_summarytop5fits”+command file+“.txt”

Thus, for the example given here, the output file for the top 5 fits will be

“C:\usgsprism\mica_hymap\output\internalcheck\mica_log_internalcheck_summarytop5fits_mica_cmds_group2_hymap2007.txt”

Furthermore, a text file, containing a summary matrix of the all the fits, is created. This file is suitable for reading into a spreadsheet. The file name is formed with the following construction:

File = Output directory+“mica_log_internalcheck_summarymatrix”+command file+“.txt”

Thus, for the example given here, the output log file will be

“C:\usgsprism\mica_hymap\output\internalcheck\mica_log_internalcheck_summarymatrix_mica_cmds_group2_hymap2007.txt”

PostScript plots of the continuum-removed diagnostic and NOT features for each material are also written to the output directory.

The “top 5 fits” file of the internal check should be examined to make sure that each reference spectrum has a fit of 1 with itself. If that is not the case, there is an error in the command file and the user should closely examine the analysis results for that spectrum in the full output log file. The top fits also give an indication of the spectral similarity between entries in the command file. If the quality of analyzed spectra is not optimum, high similarity between two spectra, in the internal check, means a greater likelihood the MICA results could be confused between the two reference entries. The user should examine the PostScript plots of continuum-removed spectra generated by the internal check to make sure the optimum channels are captured in the left and right continuum endpoint ranges. Example output from the MICA internal check is given in *appendix B*.

Release Notes

October 2011. Original release to public of PRISM version 1.0. The PRISM save file was compiled in ENVI4.8/IDL8.0 within a 64-bit version of the Windows 7 operating system and tested on Red Hat Linux and Apple OSX 10.6 computers running ENVI+IDL. PRISM v. 1.0 was also found to operate correctly on runtime installations of ENVI4.8. Full functionality in PRISM requires installation of the iTools component of IDL.

Known issues/bugs:

- If the user has opened a large number of iPlot windows (approx. more than 10), they may not all automatically disappear when exiting ViewSPECPR.
- Opening more than one continuum removal window can lead to unstable behavior in the interface GUI windows and may crash the program; specifically, plots will only update in the last GUI to be opened or ENVI may crash.
- Automatic endpoint selection will not adjust endpoints for emission features. Instead, it will try to find the closest absorption feature.
- If the user enters any text in the text box when writing a SPECPR text record (*Function 1.9.1*) then it will be written to the SPECPR file, even if the user tries to cancel the widget by pressing the “close” button (the “X” in the top right corner of the widget).

Acknowledgments

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Appendix A. The MICA Command File

This appendix describes the format and syntax of MICA command files. MICA command files are text files. The filename should have a “.mcf” extension at the end of the name. Generally, each line of the file starts with a keyword in uppercase followed by a colon, for example “KEYWORD:”. After the keyword, one or more values are listed, separated from the keyword and each other by at least one space. A comment line can be inserted anywhere in the command file by putting a semicolon as the first character of the line of text. The main sections of the command file are:

- 1) setup keywords
- 2) wavelengths keyword
- 3) aliases
- 4) definitions of NOT features
- 5) definitions of spectra of reference materials

The setup keywords are optional parameters that control the way MICA processes reference spectra, spectral records, and image cubes. They are listed in table A1, along with the number of values required to follow the keywords and descriptions of the types of these values and their effect. They do not need to be listed in any particular order, but should be listed before the wavelengths keyword.

Table A1. Optional setup keywords and values in the MICA command file.

Keyword	# values	Description
CHECK_SIGNS_OF_DEPTHS	1	Integer. Allowable values following this keyword are 0 or 1. If set to 1, option turned on, MICA will ascertain the nature of each feature (absorption or emission) of a reference material and require the continuum-removed feature in the spectrum being analyzed to have the same nature. Features with positive depth values are absorption features, while those with negative depth are emission features. If the nature of any feature does not match, the weighted fit value of the material will be set to 0, removing the material from consideration as the best match to the spectrum being analyzed. If set to 0, turned off, MICA will not check the nature of features. If not set explicitly in the command file, the default value for the keyword is 1 (turned on).
TETRACORDER_OPTIONS	1	Integer. Allowable values following this keyword are 0 or 1. If set to 1, option turned on, MICA changes the interpretation of command files and the analysis of spectral records and images to evaluate spectral feature comparisons using the linear correlation coefficient (r) as the measure of spectral agreement, instead of r^2 , the coefficient of determination. As a result, the fit constraints in the MICA command file are also interpreted as values of r . The switch in the measure of fit also changes the value of the fit that is reported. In addition, when the Tetracorder option is turned on, NOT features are required to be diagnostic features of a listed reference material, including the requirement that the continuum endpoints of the NOT feature entry matches the continuum endpoints of the corresponding diagnostic feature entry. If not set explicitly in the command file, the default value for the keyword is 0 (turned off).
FILE_DN_COLORS	1	String. The value following this keyword is the filename (including full directory path) of the class values and colors file. There should not be any spaces in the filename. The contents of the file define the class values and colors that are assigned to each reference material. The format of this file is shown in <i>appendix E</i> . By using this keyword, the user can assign a specific color scheme to materials in the summary image. The output file with the user assigned class values and colors is named "mica_class_allmaterials_userindex". If the NODATA_VALUE_IMAGE keyword is set, as well, then the output file "mica_class_allmaterials_userindex_withnondataclass" will also be created. In the spectral records mode of MICA, this keyword has no effect.
SCALEFACTOR_REFERENCE	1	Integer or floating point. The value following this keyword is the scale factor applied to all reference spectra and all spectra containing NOT features. Spectra are divided by this value. If not set in the command file, the user will be prompted to set the value during the MICA processing.

Table A1. Optional setup keywords and values in the MICA command file.—Continued

Keyword	# values	Description
SCALEFACTOR_OBSERVED	1	Integer or floating point. The value following this keyword is the scale factor applied to all observed spectra, that is, spectra being analyzed, both spectral records and image cube spectra. Spectra are divided by this value. If not set in the command file, the user will be prompted to set the value during the MICA processing.
NODATA_VALUE_IMAGE	1	Integer or floating point. The value following this keyword indicates non-data pixels in the input image (before application of the value of the SCALEFACTOR_OBSERVED keyword). Stated another way, pixels in the image cube with all channels equal to this value are defined as non-data pixels. If this keyword is set, MICA will differentiate between unmapped pixels and non-data pixels by writing additional summary images including the non-data pixels as a separate class. The non-data class is assigned a color of dark gray and given a class value equal to the number of reference materials plus one, for example, if there are 60 reference materials, the non-data class is given a value of 61. The files containing this class will have “_withnondataclass” appended to the end of the filename for the default and ranked by pixel summary images. If the FILE_DN_COLORS keyword is set, then a user indexed summary image with the non-data class will also be produced. In the spectral records mode of MICA, this keyword has no effect.
DELETED_CHANNELS	≥1	One or more integer values, each separated by a comma. The allowable range of each value is 1 to the number of spectrometer channels, but values should not be repeated. The indicated spectrometer channels will be excluded from the MICA analysis. Channels that fall in wavelength regions where strong residual atmospheric contamination remains in atmospherically corrected or ground calibrated imaging spectrometer data are commonly set as deleted channels. In addition, channels at ends of spectrometer detectors sometimes suffer from poor response and low S/N and may need to be defined as deleted channels. Omitting this keyword results in all channels being used in MICA calculations.

The following text shows the syntax for these keywords in the command file.

```

; comment lines are indicated by a semicolon as the first character
;
CHECK_SIGNS_OF_DEPTHS: integer_value
TETRACORDER_OPTIONS: integer_value
FILE_DN_COLORS: string_value
SCALEFACTOR_REFERENCE: numeric_value
SCALEFACTOR_OBSERVED: numeric_value
NODATA_VALUE_IMAGE: numeric_value
DELETED_CHANNELS: integer,integer,integer

```

The following text shows this section extracted from the sample command file “mica_cmds_group2_hymap2007.mcf”. This command file is included with the PRISM software distribution. If step 3 of the installation instructions was followed (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. This command file was developed to detect the occurrences of a set of materials in HyMap imaging

spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press).

```
; comment lines are indicated by a semicolon as the first character
;
CHECK_SIGNS_OF_DEPTHS: 1
TETRACORDER_OPTIONS: 0
FILE_DN_COLORS: C:\usgsprism\mica_hymap\mica_colors_group2_hymap2007.txt
SCALEFACTOR_REFERENCE: 1.0
SCALEFACTOR_OBSERVED: 20000.
NODATA_VALUE_IMAGE: -1
DELETED_CHANNELS: 30,31,32,44,45,46,47,48,60,61,62,63,64,90,91,92,93,94,95,96,124
```

The next section of the MICA command file defines the wavelength positions of the channels in the spectrometer. The reference spectra and spectra being analyzed must have all been collected with the same spectrometer characteristics, wavelength, and bandpass (FWHM), or have been converted to these characteristics by interpolation (see *Function 1.9.7*) or convolution (see *Function 1.9.8*). The keyword WAVELENGTHS must be followed by two values. The first value to follow is a string of characters indicating the SPECPR filename with the record that contains the wavelength values for the spectrometer channels. This filename must include the full directory path to the file and it cannot contain a space. The second value is the record number within the specified SPECPR file that contains the wavelength values for the spectrometer channels. This value is required to be an integer number that matches a data record within the SPECPR file. The first value must be separated from the keyword by at least one space. Similarly, there must be at least one space between the two values. There cannot be any trailing spaces, after the second value, or the MICA program is likely to misinterpret the command file and either halt execution with a warning or simply stop working.

The following text shows the syntax for this keyword in the command file.

```
WAVELENGTHS: string_value integer_value
```

The following text shows this line extracted from the sample command file.

```
WAVELENGTHS: C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch 6
```

The next section of the MICA command file allows the user to set aliases for values that will be repeatedly used in the command file. Subsequently, when the alias is encountered in the command file the value of the alias keyword will be substituted in place of the alias name. This lets the user set commonly used values, such as overall weighted fit thresholds or depth thresholds in one place at the beginning of the command file, where they can be easily changed. This section of the command file must begin with the NUM_ALIAS keyword, followed by an integer number indicating the number of aliases that will be defined by the following lines in the command file. The lines that define the aliases start with the ALIAS keyword, which is followed by two values. The number of lines with the ALIAS keyword must equal the number following the NUM_ALIAS keyword. As with all keywords, a space must separate each keyword from the following value(s). For the ALIAS keyword, the first value is a character string enclosed in square brackets. This is the name of the alias. The second is the substitution value of the alias and can be a string, integer, or floating point value. The two values must be separated by at least one space and neither can contain a space. Wherever the alias name, including the square brackets, appears in the command file, the alias substitution value will replace it during the parsing of the command file by MICA. The following text shows the syntax for this section of the command file.

```
NUM_ALIAS: integer_value
ALIAS: [string_value_in_square_brackets] string_or_numeric_value
```

The following text shows this section extracted from the sample command file.

```
NUM_ALIAS: 16
ALIAS: [splib06b_cvhymap] C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
ALIAS: [MINFIT] 0.5750
ALIAS: [MINFIT_NOTFEAT] 0.6400
ALIAS: [MINFIT_SERP2] 0.6400
ALIAS: [MINFIT_SERP3AND4] 0.5000
ALIAS: [MINDEPTH_SINGLEFEAT] 0.0050
ALIAS: [MINDEPTH] 0.0100
ALIAS: [MINDEPTH_SERP_TREM] 0.0350
ALIAS: [MINDEPTH_DOLO_MIXES] 0.0250
ALIAS: [MINDEPTH_ALUNITE] 0.0300
ALIAS: [MINDEPTH_ALUNITE_MIXES] 0.0700
ALIAS: [MINDEPTH_MUSC_KAOLJARO_MIXES] 0.0500
ALIAS: [MINDEPTH_KAOL_SMECT_MIX] 0.0300
ALIAS: [MINDEPTH_BUDDINGTONITE] 0.0250
ALIAS: [MINDEPTH_DICKITE] 0.0500
ALIAS: [MIN_REFL_MID] 0.0400
```

The NUM_ALIAS keyword must be defined in the command file. If the user does not want to set any aliases, the value of the NUM_ALIAS keyword can be set to zero (0); in which case, no lines with the ALIAS keyword should be present in the command file. Consequently, no alias names, in square brackets, should appear anywhere in the command file or the MICA processing is likely to halt or hang and, furthermore, the ENVI session could stop working.

The next section of the command file defines the NOT features that could be invoked in the definitions of the detection rules for the spectra of reference materials. For additional details on NOT features, see the discussion in *Module 4*. This section of the command file begins with the NUM_NOT_FEATURES keyword, which is followed by an integer number indicating the number of NOT features that will be defined by subsequent lines in the command file. Three lines are required to define each NOT feature, as described in table A2. The number of NOT features defined must equal the number following the NUM_NOT_FEATURES keyword. If the user does not want to set any NOT features, the user can set the value of the NUM_NOT_FEATURES keyword to zero (0); in which case, NOT features should not be defined in the command file. Consequently, NOT features should not be invoked anywhere in the command file. Alternatively, the user can omit setting the NUM_NOT_FEATURES keyword, instead of setting it to zero explicitly.

The command file does not need to invoke all of the NOT features listed. In fact, the command file does not need to invoke any of the NOT features, if they are not desired. The following text shows generic syntax for this section of the command file.

```
NUM_NOT_FEATURES: integer_value
NOT_FEATURE_ID: integer_value
NOT_FEATURE_SPECPR_RECORD: string_value integer_value
CONTINUUM_ENDPTS: value1 value2 value3 value4
```

The following text shows the NOT feature definition portion of the sample command file.

```
; Setup Not Features
;
NUM_NOT_FEATURES: 12
;
;...Not material title = "Fir_Tree IH91-2          W1R1Ba CONV" Feature=1
NOT_FEATURE_ID: 1
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymap] 588
CONTINUUM_ENDPTS: 0.5220 0.5520 0.7370 0.7670
;
;...Not material title = "Muscovite GDS113 Ruby      W1R1Bb CONV" Feature=2
NOT_FEATURE_ID: 2
```

```

NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 308
CONTINUUM_ENDPTS: 2.2770 2.3100 2.3860 2.4150
;
;...Not material title = "Alunite GDS96 K Syn (250C) W2R4Na CONV" Feature=2
NOT_FEATURE_ID: 3
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 945
CONTINUUM_ENDPTS: 1.443 1.464 1.50000 1.5243
;
;...Not material title = "Alunite RES-3 Na Syn (450C) W2R4Na CONV" Feature=2
NOT_FEATURE_ID: 4
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 948
CONTINUUM_ENDPTS: 1.4630 1.4797 1.5150 1.5459
;
;...Not material title = "Gypsum HS333.3B (Selenite) W1R1Ba CONV" Feature=2
NOT_FEATURE_ID: 5
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 191
CONTINUUM_ENDPTS: 1.5000 1.5200 1.5800 1.6000
;
;...Not material title = "Chlorite+Muscovite CU93-65A W1R1Ba CONV" Feature=1
NOT_FEATURE_ID: 6
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 511
CONTINUUM_ENDPTS: 0.7818 0.8142 1.2767 1.3200
;
;...Not material title = "Epidote GDS26.a 75-200um W1R1Bb CONV" Feature=1
NOT_FEATURE_ID: 7
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 159
CONTINUUM_ENDPTS: 2.2080 2.2280 2.2680 2.2900
;
;...Not material title = "Grass_Golden_Dry GDS480 W1R1Fa CONV" Feature=2.1 micron
NOT_FEATURE_ID: 8
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 812
CONTINUUM_ENDPTS: 2.0200 2.0600 2.1980 2.2280
;
;...Not material title = "Lodgepole-Pine LP-Needles-3 W1R1Fa CONV" Feature=2.1 micron
NOT_FEATURE_ID: 9
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 831
CONTINUUM_ENDPTS: 2.0200 2.0600 2.1980 2.2280
;
;...Not material title = "Grass_Golden_Dry GDS480 W1R1Fa CONV" Feature=2.3 micron
NOT_FEATURE_ID: 10
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 812
CONTINUUM_ENDPTS: 2.2100 2.2400 2.380 2.4150
;
;...Not material title = "Lodgepole-Pine LP-Needles-3 W1R1Fa CONV" Feature=2.3 micron
NOT_FEATURE_ID: 11
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 831
CONTINUUM_ENDPTS: 2.2100 2.2400 2.390 2.4190
;
;...Not material title = "Calcite WS272 W1R1Ba CONV" Feature=2.15 micron
NOT_FEATURE_ID: 12
NOT_FEATURE_SPECPR_RECORD: [splib06b_cvhymp] 94
CONTINUUM_ENDPTS: 2.0900 2.1200 2.1800 2.2050

```

Table A2. Keywords and values required to define NOT features in the MICA command file.

Keyword	# values	Description
NOT_FEATURE_ID	1	Integer. Allowed values for this keyword range from 1 to the number of NOT features specified by the NUM_NOT_FEATURES keyword. In the entries for the reference spectra, the NOT features are invoked by specifying a NOT_FEATURE_ID number.
NOT_FEATURE_SPECPR_RECORD	2	String value and integer value. The first value to follow is a string of characters indicating the SPECPR filename with the data record that contains the spectrum with the NOT feature. This filename includes the full directory path to the file and it cannot contain a space. The second value is the record number within the specified SPECPR file that contains the spectrum with the NOT feature. This value is required to be an integer number that matches a data record within the SPECPR file. The data record must have the same number of channels as the wavelength data specified by the WAVELENGTHS keywords. The first value must be separated from the keyword by at least one space. Similarly, there must be at least one space between the first and second values. There cannot be any trailing spaces, that is, spaces after the second value, or the MICA program is likely to misinterpret the command file and either halt execution with a warning or simply stop working.
NOT_FEATURE_CONTINUUM_ENDPTS	4	Four numeric values each separated by a space. The first two values specify the wavelength range for the left continuum endpoint of the NOT feature. The third and fourth values specify the wavelength range for the right continuum endpoint of the NOT feature. MICA will search the channels of the spectrometer to determine which of them fall within these endpoint ranges. The reflectance and wavelength values of channels within each range will be averaged and used to establish the equation of the continuum line. Every channel in the continuum endpoint ranges and all the channels between them will be divided by the corresponding values of the continuum line in the computation of the continuum-removed spectrum. At least one channel, that is not a deleted channel, must fall within the endpoint ranges.

If the TETRACORDER_OPTIONS keyword is turned on, then a NOT feature used as relative NOT feature in the definition of detection rules for reference spectra must have the exact continuum endpoints as a diagnostic feature in one of the reference spectra listed subsequently in the command file.

The main section of the MICA command file lists the spectra of reference materials, the continuum endpoints of their diagnostic features, weighting factors applied to the fit values of these features, and constraints on feature values and continuum values. The entry for each reference spectrum can also invoke one or more of the previously defined NOT features, if desired. This section of the MICA command file starts with a line specifying the number of

reference spectra, using the NUM_REFERENCE_ENTRIES keyword. Following that line, each reference spectrum and its detection rules are defined. The first three lines of each reference entry sets up the spectrum of the reference material, defining values for the REFERENCE_SPECPR_RECORD, OUTPUT_NAME, and NUM_FEATURES keywords. Subsequent lines define the diagnostic spectral features, NOT features, and constraint thresholds. The general syntax of the reference entry keywords is given below, with the material setup parameters shown in black at the beginning of the reference entry block, the diagnostic feature keywords shown in red, followed by the absolute NOT feature keywords shown in green, the relative NOT feature keywords shown in blue, the weighted feature constraints following in black, and finishing with the keyword END_REFERENCE_ENTRY, which is required at the end of each block of keywords for a reference material.

```
NUM_REFERENCE_ENTRIES: integer_value
;
REFERENCE_SPECPR_RECORD: string_value integer_value
OUTPUT_NAME: string_value
NUM_FEATURES: integer_value integer_value
FEATURE_TYPE: string_value
FEATURE_WEIGHT: numeric_value
CONTINUUM_ENDPTS: value1 value2 value3 value4
CONTINUUM_CONSTRAINTS: eight_numeric_values_separated_by_at_least_one_space
FIT_CONSTRAINTS: numeric_value
DEPTH_CONSTRAINTS: numeric_value numeric_value
FEATURE_TYPE: string_value
NOT_FEATURE_ID: integer_value
NOT_FEATURE_FIT_CONSTRAINTS: numeric_value
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: numeric_value
FEATURE_TYPE: string_value
NOT_FEATURE_ID: integer_value
NOT_FEATURE_FIT_CONSTRAINTS: numeric_value
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: integer_value numeric_value
WEIGHTED_FIT_DEPTH_CONSTRAINTS: four_numeric_values_separated_by_at_least_one_space
END_REFERENCE_ENTRY:
```

The feature setup section is required and at least one diagnostic feature needs to be defined for each reference spectrum. Listing of additional diagnostic features is optional. Also optional are absolute NOT features and relative NOT features. The command line with the WEIGHTED_FIT_DEPTH_CONSTRAINTS needs to be present, though constraint values do not have to be set. In fact, all constraint values are optional. If the user does not wish to set them, the user can use put a value of -99.99 in the position of the constraint value and MICA will ignore the checking of this constraint. Tables A3–A5 describe the values for the feature setup, diagnostic feature, and NOT feature keywords, respectively.

Table A3. Keywords and values required to set up a spectrum of a reference material.

Keyword	# values	Description
NUM_REFERENCE_ENTRIES	1	Integer. Must equal the number of reference materials, that is, the number of reference spectra listed subsequently in the command file. This keyword is defined only once in the command file, after the setup of the NOT features and directly preceding the listing of the reference spectra.
REFERENCE_SPECPR_RECORD	2	String value and integer value. The first value to follow is a string of characters indicating the SPECPR filename with the data record that contains the spectrum with the diagnostic feature(s). This filename includes the full directory path to the file and it cannot contain a space. The second value is the record number within the specified SPECPR file that contains the spectrum with the diagnostic feature(s). This value is required to be an integer number that matches a data record within the SPECPR file. The data record must have the same number of channels as the wavelength record specified by the WAVELENGTHS keywords. The first value must be separated from the keyword by at least one space. Similarly, there must be at least one space between the first and second values. There cannot be any trailing spaces, after the second value, or the MICA program is likely to misinterpret the command file and either halt execution with a warning or simply stop working. Reference spectra and spectra containing NOT features are not required to come from the same SPECPR file. Any number of SPECPR files can be used, as required.
OUTPUT_NAME	1	String of characters. The value of this keyword is used in reporting the best match and interim results during the MICA processing, for the reference material. The value cannot contain a space. In MICA image cube mode, output images for fit, depth, and fit*depth will be produced showing the pixels that matched this reference material, with filenames formed by adding “_fit”, “_depth”, and “_fd” extensions to the value of the OUTPUT_NAME keyword. The files are written to the output directory defined interactively by the user when running MICA in image cube mode. In the summary images, the class name for pixels that were matched to the reference entry is given the value of the OUTPUT_NAME keyword. Output names need to be unique, that is, two reference materials cannot use the same output name.
NUM_FEATURES	2	Two integer values separated by one or more spaces. The first value is the number of diagnostic features that will be defined in the keywords to follow for this reference spectrum. It must be greater than or equal to one (1). The second value is the number of NOT features that will be invoked in the keywords to follow for this reference spectrum. It must be greater than or equal to zero (0).

Table A4. Keywords and values required to define diagnostic features in the MICA command file.

Keyword	# values	Description
FEATURE_TYPE	1	String. The only allowed values for this keyword are “Diagnostic” and “Not”. This value must be set to “Diagnostic” in order to define a diagnostic feature in the reference spectrum.
FEATURE_WEIGHT	1	Numeric value ranging from 0 to 1. The sum of all weighting factors for the diagnostic features defined for a reference spectrum must sum to 1, within the allowable tolerance of 0.001.
CONTINUUM_ENDPTS	4	Four numeric values each separated by at least one space. The first two values specify the wavelength range for the left continuum endpoint of the diagnostic feature. The third and fourth values specify the wavelength range for the right continuum endpoint of the diagnostic feature. MICA will search the channels of the spectrometer to determine which of them fall within these endpoint ranges. The reflectance and wavelength values of channels within each range will be averaged and used to establish the equation of the continuum line. Every channel in the continuum endpoint ranges and all the channels between them will be divided by the corresponding values of the continuum line in the computation of the continuum-removed spectrum. At least one channel, that is not a deleted channel, must fall within the endpoint ranges. The continuum-removed feature calculated using the analyzed spectrum is compared to the feature in the reference spectrum
CONTINUUM_CONSTRAINTS	8	Eight numeric values each separated by at least one space. These values, in order, are: the minimum required value for the reflectance level of the left continuum endpoint, the maximum allowed reflectance value for the left continuum endpoint, the minimum required value for the computed reflectance level of the midpoint of the continuum line, the maximum allowed value for the computed reflectance level of the midpoint of the continuum line, the minimum required value for the reflectance level of the right continuum endpoint, the maximum allowed reflectance value for the right continuum endpoint, the minimum required value for the ratio of the averaged reflectance value for channels within the right continuum endpoint wavelength range divided by the averaged reflectance value for channels within the left continuum endpoint wavelength range, and the maximum allowed value for this ratio of continuum endpoints.

Table A4. Keywords and values required to define diagnostic features in the MICA command file.—
Continued

Keyword	# values	Description
CONTINUUM_CONSTRAINTS— continued	8	Reflectance level thresholds are expected to fall in the range from 0 to 1. The spectrum being analyzed, after being divided by the value of the SCALEFACTOR_OBSERVED keyword, is used to calculate the values to compare with these defined thresholds. If any of the calculated values violate a constraint, then the weighted fit value of the reference material will be set to zero, removing it from consideration as the best match to the spectrum being analyzed. Table 3 in the <i>Module 4</i> section of this user's guide explains the use of these values during the MICA processing. If the user does not wish to set a constraint, a value of -99.99 should be placed in the position of the constraint value and MICA will ignore the checking of this constraint. Constraints are not required to be set; all constraints can be ignored, set equal to -99.99, if desired.
FIT_CONSTRAINTS	1	Numeric value ranging from 0 to 1. The value set for the keyword is the minimum required fit for this diagnostic feature. The fit value is calculated from the spectral feature comparison of the continuum-removed feature in the reference spectrum with the continuum-removed feature in the spectrum being analyzed. In MICA, this fit value is the coefficient of determination, r^2 , which results from the linear regression of the continuum-removed spectra (see <i>Function 1.7.1</i> for additional details). However, setting the TETRACORDER_OPTIONS keyword to 1 changes the measure of fit to the linear correlation coefficient, r . If the user does not wish to set the constraint, a value of -99.99 should be placed in the position of the constraint value and MICA will ignore the checking of this constraint. The constraint is not required to be set. If it is set and the calculated fit value violates the constraint, then the weighted fit value of the reference material will be set to zero, removing it from consideration as the best match to the spectrum being analyzed.

Table A4. Keywords and values required to define diagnostic features in the MICA command file.—
Continued

Keyword	# values	Description
DEPTH_CONSTRAINTS	2	Two numeric values, separated by at least one space. These can be positive or negative numbers. Positive depth thresholds are consistent with absorption features, while negative depths are reported for emission features. The first value is the minimum required depth value for this diagnostic feature. The second is the maximum allowed depth for the diagnostic feature. The depth compared to these thresholds comes from the reference spectral feature scaled to the spectrum being analyzed. It is the depth calculated using a quadratic function fitted to the three channels at the center of the feature, that is, the band minimum channel and one channel on either side (D_{SQref}) that is compared (see <i>Function 1.7.1</i> for additional details). If the user does not wish to set a constraint, a value of -99.99 should be placed in the position of the constraint value and MICA will ignore the checking of it. Constraints are not required to be set; all constraints can be ignored, set equal to -99.99, if desired. If either or both are set, and the calculated depth value violates the defined constraints, then the weighted fit value of the reference material will be set to zero, removing it from consideration as the best match to the spectrum being analyzed.

Table A5. Keywords and values required to invoke NOT features in the MICA command file.—Continued

Keyword	# values	Description
FEATURE_TYPE	1	String. The only allowed values for this keyword are “Diagnostic” and “Not”. This value must be set to “Not” in order to invoke a NOT feature.
NOT_FEATURE_ID	1	Allowable values are from 1 to the number of NOT features defined previously, at the beginning of the command file. Of those listed at the beginning of the command file, the NOT feature invoked for the reference material is the one with the NOT_FEATURE_ID number that matches the value of the keyword set here.
NOT_FEATURE_FIT_CONSTRAINTS	1	Numeric value ranging from 0 to 1. The value set for the keyword is the minimum required fit value for this diagnostic feature. The fit value is calculated from the spectral feature comparison of the continuum-removed NOT feature defined by the NOT_FEATURE_ID keyword with the continuum-removed feature in the spectrum being analyzed. In MICA, this fit value is the coefficient of determination, r^2 , that results from the linear regression of the continuum-removed spectra (see <i>Function 1.7.1</i> for additional details). However, setting the TETRACORDER_OPTIONS keyword to 1 changes the measure of fit to the linear correlation coefficient, r . Both absolute NOT features and relative NOT features require this line in the command file. If the user does not wish to set the fit constraint, a value of -99.99 should be placed in the position of the constraint value and MICA will ignore the checking of this constraint. However, the constraint should be set; otherwise, any fit value could result in the determination that this NOT feature has been found in the spectrum being analyzed. If the fit value for the NOT feature does exceed the value of this keyword and the depth of the feature meets the NOT feature depth constraints, the NOT feature is considered to be present in the spectrum being analyzed, and the weighted fit of the reference spectrum that invoked the NOT feature will be set to zero, removing it from consideration as the best match to the spectrum being analyzed.

Table A5. Keywords and values required to invoke NOT features in the MICA command file.—Continued

Keyword	# values	Description
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS	1	<p>Numeric value, it can be positive or negative. Either this keyword is specified for a NOT feature or the relative NOT feature depth constraint keyword is specified; they cannot both be listed for the same NOT feature invocation. The value set for the keyword is the minimum required depth for this NOT feature. The depth which is compared to this threshold value comes from the invoked NOT feature scaled to the continuum-removed feature in the spectrum being analyzed. It is the scaled depth calculated using a quadratic function fitted to the three channels at the center of the feature, that is, the band minimum channel and one channel on either side, which is used (see <i>Function 1.7.1</i> for additional details). This depth is termed D_{SQnot}. If the user does not wish to set a constraint, a value of -99.99 should be placed in the position of the constraint value and MICA will ignore the checking of this constraint. However, the constraint should be set, otherwise, any depth value could result in the determination that this NOT feature has been found in the spectrum being analyzed. For an absolute NOT feature to be found to be present in the spectrum being analyzed the NOT feature fit threshold must be met and $D_{SQnot} > \text{absolute_depth_threshold}$. If the absolute NOT feature is found to be present, the weighted fit of the material that invoked the NOT feature is set to zero, removing it from consideration as the best match to the spectrum being analyzed.</p>
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS	2	<p>Integer value followed by numeric value, separated from one another by at least one space. Either this keyword is specified for a NOT feature or the absolute NOT feature depth constraint keyword is specified; they cannot both be listed for the same NOT feature invocation. The first value, the relative feature id number, specifies the relative feature in the spectrum of the invoked NOT feature that will be used in the establishment of the minimum depth threshold. This relative feature is one of the diagnostic features of the reference spectrum that matches the spectrum of the invoked NOT feature. The match between the invoked NOT spectrum and the reference spectrum is determined by MICA as the reference spectrum that has the same SPECPR file and record, specified by its REFERENCE_SPECPR_RECORD keyword, as the NOT_FEATURE_SPECPR_RECORD keyword values of the invoked NOT feature. The relative feature id number specifies which diagnostic feature of the matching reference spectrum should be used, where the diagnostic features are numbered, starting from one, in the order they occur after the feature setup keywords.</p>

Table A5. Keywords and values required to invoke NOT features in the MICA command file.—Continued

Keyword	# values	Description
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS— continued	2	<p>For example, if the relative feature id number of the NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS keyword is 1, then the first diagnostic feature of the reference spectrum matched to the invoked NOT spectrum is used; if it is 2, the second diagnostic feature is used, and so forth. This relative feature is scaled to the continuum-removed feature in the spectrum being analyzed and the quadratic fit to the three band center channels is used to calculate the depth ($D_{SQrelative}$). The second value of this keyword is the multiplication factor to apply to the calculated $D_{SQrelative}$, the product of these two terms is the depth threshold against which to evaluate the depth of the NOT feature. The depth of the NOT feature comes from the invoked NOT feature scaled to the continuum-removed feature in the spectrum being analyzed. It is the scaled depth calculated using a quadratic function fitted to the three channels at the center of the feature, that is, the band minimum channel and one channel on either side that is used. This depth is termed D_{SQnot}. For a relative NOT feature to be found to be present in the spectrum being analyzed:</p> $D_{SQnot} > D_{SQrelative} * multiplier_factor$ <p>If the relative NOT feature is found to be present, the weighted fit of the material that invoked the NOT feature is set to zero, removing it from consideration as the best match to the spectrum being analyzed.</p>

The weighted feature keyword, WEIGHTED_FIT_DEPTH_CONSTRAINTS, is followed by four numeric values, each separated by at least one space. These values, in order, are the minimum required weighted fit, minimum required weighted depth, maximum allowable weighted depth, and the minimum required weighted fit*depth. Additional details on these values are given in table A6. The final line of each reference material entry is the keyword END_REFERENCE_ENTRY. This keyword must be present at the end of the reference material entry and has no following values.

Table A6. Values for the WEIGHTED_FIT_DEPTH_CONSTRAINTS keyword in the MICA command file.

Value	Description
Minimum weighted fit	Numeric value, ranging from 0 to 1. The summation of the diagnostic feature fit values multiplied by their feature weighting factors must be greater than the value following this keyword. Otherwise, the weighted fit value for the material will be set to zero, removing the material from consideration as the best fit to the spectrum being analyzed. See <i>appendix B</i> for a sample calculation.
Minimum weighted depth	Numeric value. The summation of the diagnostic feature depth values multiplied by their weighting factors must be greater than this keyword value. Otherwise, the weighted fit value for the material is set to zero, removing the material from consideration as the best fit to the spectrum being analyzed. Special treatment dependent on the nature of the feature (absorption or emission) is made to sum the depths. Absorption feature depths are added together with the absolute value of the depth of emission features (which inherently have negative depths). Thus, all features contribute positively to the weighted depth value that is compared to this keyword value, as long as they have the expected nature, that is, as long as the spectrum being analyzed has an absorption feature where the diagnostic feature is an absorption feature and an emission feature where the diagnostic feature is an emission feature. If the nature of a feature is opposite of the expected, the depth of the feature is multiplied by its weighting factor and by -1. Thus, if an absorption feature is expected, but the observed spectrum has an emission feature, the weighted depth of that feature contributes negatively to the overall weighted depth for the material. See <i>appendix B</i> for a sample calculation.
Maximum weighted depth	Numeric value. The summation of the diagnostic feature depth values multiplied by their feature weighting factors must be less than this keyword value. Otherwise, the weighted fit value for the material is set to zero, removing the material from consideration as the best fit to the spectrum being analyzed. If a reference material has both absorption and emission features defined, special treatment is done to sum the depths. Absorption feature depths are added together with the absolute value of emission features (which inherently have negative depths). Thus, all features contribute positively to the weighted depth value that is compared to this keyword value, as long as they have the expected nature, that is, as long as the spectrum being analyzed has an absorption feature where the diagnostic feature is an absorption feature and an emission feature where the diagnostic feature is an emission feature. If the nature of a feature is opposite of the expected, the depth of the feature is multiplied by its weighting factor and by -1. Thus, if an absorption feature is expected, but the observed spectrum has an emission feature, the weighted depth of that feature contributes negatively to the overall weighted depth for the material. See <i>appendix B</i> for a sample calculation.

Table A6. Values for the WEIGHTED_FIT_DEPTH_CONSTRAINTS keyword in the MICA command file.—Continued

Value	Description
Minimum weighted fit*depth	Numeric value, ranging from 0 to 1. The summation of the diagnostic feature fit*depth values multiplied by their weighting factors must be greater than this keyword value. Otherwise, the weighted fit value for the material is set to zero, removing the material from consideration as the best fit to the spectrum being analyzed. As with the weighted depth. Special treatment is done to sum the fit*depths. Absorption feature fit*depth values are added together with the absolute values of the fit*depth emission features (which inherently have negative depths). Thus, all features contribute positively to the weighted fit*depth value that is compared to this keyword value, as long as they have the expected nature, that is, as long as the spectrum being analyzed has an absorption feature where the diagnostic feature is an absorption feature and an emission feature where the diagnostic feature is an emission feature. If the nature of a feature is opposite of the expected, the depth of the feature is multiplied by its weighting factor and by -1. Thus, if an absorption feature is expected, but the observed spectrum has an emission feature, the weighted fit*depth of that feature contributes negatively to the overall weighted fit*depth for the material. See <i>appendix B</i> for a sample calculation.

The following text shows an example reference material entry section extracted from the sample command file, with the same color codes as the generic entry; note: some alias names are present, as indicated by the square brackets.

```

REFERENCE_SPECPR_RECORD: [splib06b_cvhymap] 94
OUTPUT_NAME: calcite_abundant
NUM_FEATURES: 2 4
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.0000
CONTINUUM_ENDPTS: 2.1780 2.2080 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.0000
CONTINUUM_ENDPTS: 2.0900 2.1200 2.1800 2.2050
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 6
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 7
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.0800
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]

```

```
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS:  0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID:  9
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS:  0.0200
WEIGHTED FIT DEPTH CONSTRAINTS:  [MINFIT]  [MINDEPTH] -99.99  0.0000
END_REFERENCE_ENTRY:
```

The command file must end with the END_CMDFILE keyword, which is not followed by any values, as shown below.

```
END_CMDFILE:
```

The following pages show the sample MICA command file “mica_cmds_group2_hymap2007.mcf”. This command file was developed to detect the occurrences of a set of materials in the pixels of HyMap imaging spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press). This command file is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. Annotations explaining the structure of the MICA command file are marked on the listing of the sample command file.

```

;-----
;
; MICA Command File
;
; 2-micron minerals, clays, carbonates, sulfates, etc., Version 9
; Optimized for HyMap 2007 124 channels
;-----
;
;
;-----
;
; FILE_DN_COLORS: C:\usgsprism\mica_hymap\mica_colors_group2_hymap2007.txt
;
; SCALEFACTOR_OBSERVED: 20000.
;
; SCALEFACTOR_REFERENCE: 1.0
;
; NODATA_VALUE_IMAGE: -1
;
; CHECK_SIGNS_OF_DEPTHS: 1
;
; TETRACORDER_OPTIONS: 0
;
; WAVELENGTHS: C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch 6
; DELETED_CHANNELS: 30,31,32,44,45,46,47,48,60,61,62,63,64,90,91,92,93,94,95,96,124
;
; Setup Aliases
;
; NUM_ALIASES: 16
; ALIAS: [splib06b_cvhymap] C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
; ALIAS: [MINFIT] 0.5750
; ALIAS: [MINFIT_NOTFEAT] 0.6400
; ALIAS: [MINFIT_SERP2] 0.6400
; ALIAS: [MINFIT_SERP3AND4] 0.5000
; ALIAS: [MINDEPTH_SINGLEFEAT] 0.0050
; ALIAS: [MINDEPTH] 0.0100
; ALIAS: [MINDEPTH_SERP_TREM] 0.0350
; ALIAS: [MINDEPTH_DOLO_MIXES] 0.0250
; ALIAS: [MINDEPTH_ALUNITE] 0.0300
; ALIAS: [MINDEPTH_ALUNITE_MIXES] 0.0700
; ALIAS: [MINDEPTH_MUSC_KAOLJARO_MIXES] 0.0500
; ALIAS: [MINDEPTH_KAOL_SMECT_MIX] 0.0300
; ALIAS: [MINDEPTH_BUDDINGTONITE] 0.0250
; ALIAS: [MINDEPTH_DICKITE] 0.050
; ALIAS: [MIN_REFL_MID] 0.0400
;
; Setup Not Features
;
; NUM_NOT_FEATURES: 12
;
; .....Not material title = "Fir Tree IH91-2" WIR1Ba CONV" Feature=1
; NOT_FEATURE_ID: 1
; NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 588
; CONTINUUM_ENDPTS: 0.5220 0.5520 0.7370 0.7670
;
;-----

```

Lines with a semi-colon ";" at the beginning are comment lines and ignored when the command file is parsed.

Optional

Optional, but the program will prompt the user to define the value.

Optional, the default is ON.

Optional, the default is OFF.

Optional when processing image cube as long as wavelengths are set in the ENVI header, otherwise it is required to be set.

Optional

Optional

Optional, not features only need to be defined if the user intends to use them in material entries.

Command file contains lines with this syntax
KEYWORD: value1 value2 ...
In this case the keyword indicates the parameter value contains the file that indicates the color to assign to each material in the output "userindex" classification image.

Observed spectra will be divided by this value.

Reference spectra will be divided by this value.

Pixels of non-data will have this value in all channels. If not set, all pixels will be processed.

A value of 1 indicates that the depth of an observed spectral feature must have the same sign (negative or positive) as the reference feature in order to be a match. If the reference feature is an absorption feature, the observed feature must be one as well. And, if the reference feature is an emission feature, the observed feature must be one as well. A value of 0 turns this OFF.

A value of 1 turns Tetracorder processing options ON, a value of 0 (zero) turns them OFF.

Deleted channels are channels that will not be used in the spectral analysis. They are separated by a comma ",".

These two values indicate the SPECPR file and record number that contain the wavelengths to the spectra listed in the command file.

Alias lines have this syntax
ALIAS: [alias] value
In the command file, whenever the alias appears, the value will be substituted. In this example, when [splib06b_cvhymap] appears, the value of "C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch" will be substituted. This is an easy way to define values that are repeatedly used in the command file.

This value indicates the number of aliases listed below.

This value indicates the number of not features listed below.

This value is a unique identifier for this not feature, it can be used in reference material entries to invoke this feature.

Right Continuum Range.

Left Continuum Range.

The channels that fall within these first two wavelength values will be used to define the left continuum endpoint. The wavelength values of the channels will be averaged and used as the X-value. The reflectance values will be averaged and used as the Y-value. These X,Y values will be used with those computed from the right continuum range in order to define the continuum line, that is they will be used to compute the slope and offset of the line that connects them with the average wavelength and reflectance values of the channels that fall within the right continuum range.

These two values indicate the SPECPR file and record number that define the spectrum which contains the not feature.

```

;.....Not material title = "Muscovite GDS113 Ruby W1R1Bb CONV" Feature=2
NOT_FEATURE_ID: 2
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 308
CONTINUUM_ENDPTS: 2.2770 2.3100 2.3860 2.4150
;
;.....Not material title = "Alunite GDS96 K Syn (250C) W2R4Na CONV" Feature=2
NOT_FEATURE_ID: 3
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 945
CONTINUUM_ENDPTS: 1.443 1.464 1.50000 1.5243
;
;.....Not material title = "Alunite RES-3 Na Syn (450C) W2R4Na CONV" Feature=2
NOT_FEATURE_ID: 4
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 948
CONTINUUM_ENDPTS: 1.4630 1.4797 1.5150 1.5459
;
;.....Not material title = "Gypsum HS333.3B (Selenite) W1R1Ba CONV" Feature=2
NOT_FEATURE_ID: 5
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 191
CONTINUUM_ENDPTS: 1.5000 1.5200 1.5800 1.6000
;
;.....Not material title = "Chlorite+Muscovite CU93-65A W1R1Ba CONV" Feature=1
NOT_FEATURE_ID: 6
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 511
CONTINUUM_ENDPTS: 0.7818 0.8142 1.2767 1.3200
;
;.....Not material title = "Epidote GDS26.a 75-200um W1R1Bb CONV" Feature=1
NOT_FEATURE_ID: 7
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 159
CONTINUUM_ENDPTS: 2.2080 2.2280 2.2680 2.2900
;
;.....Not material title = "Grass_Golden_Dry GDS480 W1R1Fa CONV" Feature=2.1 micron
NOT_FEATURE_ID: 8
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 812
CONTINUUM_ENDPTS: 2.0200 2.0600 2.1980 2.2280
;
;.....Not material title = "Lodgepole-Pine LP-Needles-3 W1R1Fa CONV" Feature=2.1 micron
NOT_FEATURE_ID: 9
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 831
CONTINUUM_ENDPTS: 2.0200 2.0600 2.1980 2.2280
;
;.....Not material title = "Grass_Golden_Dry GDS480 W1R1Fa CONV" Feature=2.3 micron
NOT_FEATURE_ID: 10
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 812
CONTINUUM_ENDPTS: 2.2100 2.2400 2.380 2.4150
;
;.....Not material title = "Lodgepole-Pine LP-Needles-3 W1R1Fa CONV" Feature=2.3 micron
NOT_FEATURE_ID: 11
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 831

```

```

CONTINUUM_ENDPTS: 2.2100 2.2400 2.390 2.4190
;
;.....Not material title = "Calcite WS272" W1R1Ba CONV" Feature=2.15 micron
NOT_FEATURE_ID: 12
NOT_FEATURE_SPECPR_RECORD:[splib06b_cvhymap] 94
CONTINUUM_ENDPTS: 2.0900 2.1200 2.1800 2.2050
;
;
; Setup Reference Materials and Spectral Features
;
;

```

Lines that are needed at the start of each material entry.

Lines that are needed for each diagnostic feature.

Lines that are needed at the end of each material entry.

```

;.....Material SPECPR Title = "Fir_Tree IH91-2" W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 588
OUTPUT_NAME: vegetation_green
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.8500
CONTINUUM_ENDPTS: 0.5220 0.5520 0.7370 0.7670
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 0.9000 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.0500
CONTINUUM_ENDPTS: 0.8700 0.9000 1.0630 1.0930
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.1000 1.1310 1.2650 1.2900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.200 -99.99 0.0000
END_REFERENCE_ENTRY:
;

```

This value indicates the number of reference materials listed in the command file.

These two values indicate the SPECPR file and record number that define the spectrum that is the spectrum for this reference material.

This value indicates the name that will be used in reporting results. If an observed spectrum matches this material's spectrum, it is reported using this name. For image cube analysis, this name will be used as the class name for the pixels that are identified as matching this reference material. This name will also be used as the base filename for the fit, depth and fit*depth images for this reference material.

These two values indicate the number of diagnostic and NOT features, respectively, for this material. At least one diagnostic feature must be defined.

The feature weight. The fit and depth values for the feature will be multiplied by this value. The sum of all feature weights for a material must equal 1, within a small tolerance.

Left Continuum Range, see the earlier comment on the NOT feature continuum range.

Right Continuum Range.

Reflectance level constraints on the mid-point of the continuum line. The reflectance value of the point must be greater than the first value and less than the second value. A value of -99.99 means the constraint will not be checked.

Reflectance level constraints on the left continuum end point. The reflectance value of the point must be greater than the first value and less than the second value. A value of -99.99 means the constraint will not be checked.

Reflectance level constraints on the right continuum end point. The reflectance value of the point must be greater than the first value and less than the second value. A value of -99.99 means the constraint will not be checked.

Constraints on the ratio of the reflectance of the right continuum end point to the left. The ratio must be greater than the first value and less than the second value. A value of -99.99 means the constraint will not be checked.

The feature fit constraint. The fit value for the feature must be greater than the given threshold value. A value of -99.99 means the constraint will not be checked.

The feature depth constraints. The depth value for the feature must be greater than the first value and less than the second. A value of -99.99 means the constraint will not be checked. NOTE: it is the fitted depth that will be checked, that is, the depth of the reference feature fitted to the observed spectrum, not the depth of the observed feature itself.

The material weighted-fit constraint. The total fit value for the feature (that is the sum of the weighted-fit of each diagnostic feature) must be greater than the given threshold value. A value of -99.99 means the constraint will not be checked.

The material weighted-depth constraint. The total depth value for the feature (that is, the sum of the weighted-depth of each diagnostic feature) must be greater than the first value and less than the second. A value of -99.99 means the constraint will not be checked.

The material weighted-fit*depth constraint. The total fit*depth value for the feature (that is the sum of the weighted-fit*depth of each diagnostic feature) must be greater than the given threshold value. A value of -99.99 means the constraint will not be checked.

```

;
;.....Material SPECPR Title = "Grass_dry.7+.3green   AMX30 W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 602
OUTPUT_NAME: vegetation.dry+green
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7000
CONTINUUM_ENDPTS: 0.5220 0.5520 0.7450 0.7750
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 0.9000 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.0800 1.1310 1.2650 1.2900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.0700 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2000
CONTINUUM_ENDPTS: 2.2050 2.2400 2.3850 2.4160
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.0700 -99.99 0.0000
END_REFERENCE_ENTRY:
;
;.....Material SPECPR Title = "Melting_snow mSnw1a   W1R1Fa CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 690
OUTPUT_NAME: snow_melting
NUM_FEATURES: 2 1
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.3500
CONTINUUM_ENDPTS: 0.9020 0.9460 1.0800 1.1100
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.0800 0.7000 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.6500
CONTINUUM_ENDPTS: 1.0990 1.1780 1.3150 1.3450
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 0.9091
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 1
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.5000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.0500 -99.99 0.0000
END_REFERENCE_ENTRY:
;
;.....Material SPECPR Title = "Melting_snow mSnw9 (slush) W1R1Fa CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 698
OUTPUT_NAME: snow_slush
NUM_FEATURES: 2 1
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.3500

```

Lines that are needed for each NOT feature (of absolute depth type).

This value indicates which NOT feature to use (the number will be matched to a NOT_FEATURE_ID listed at the start of the command file).

The NOT feature fit constraint. The fit value for the NOT feature must be greater than this threshold value in order for the NOT feature to be considered present. In this example, the threshold is aliased to "MINFIT_NOTFEAT", which is set to a value of 0.64 at the beginning of the command file.

The NOT feature depth constraint. The calculated depth of the NOT feature must be greater than the given threshold in order to be considered present. In this material, the keyword "NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS" is used indicating the absolute depth of the feature should be examined. See comments later in the command file for an example of a relative NOT feature

```

CONTINUUM_ENDPTS: 0.8700 0.9200 1.0800 1.1100
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] 0.5000 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.6500
CONTINUUM_ENDPTS: 1.0800 1.1300 1.3150 1.3450
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.0300 -99.99 -99.99 -99.99 -99.99 0.9091
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 1
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.5000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.0500 -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Seawater_Coast_Ch1 SW1 W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 566
OUTPUT_NAME: water
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 0.5300 0.5850 2.1900 2.2800
CONTINUUM_CONSTRAINTS: 0.0000 0.1900 -99.99 -99.99 0.0000 0.0800 -99.99 1.0000
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 0.4290 0.4590 0.6100 0.6400
CONTINUUM_CONSTRAINTS: 0.0000 0.1400 -99.99 -99.99 0.0000 0.1400 -99.99 1.5000
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.0300 -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Water+Montmor SWy-2+5.01g/l W1R1Fa CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 704
OUTPUT_NAME: water_sediment_high
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.8000
CONTINUUM_ENDPTS: 0.8700 0.9130 1.0550 1.0850
CONTINUUM_CONSTRAINTS: 0.0000 0.2800 -99.99 -99.99 0.0000 0.2400 -99.99 1.1000
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99

```

```

FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 0.6920 0.7220 0.7920 0.8220
CONTINUUM_CONSTRAINTS: 0.0000 0.4200 -99.99 -99.99 0.0000 0.3500 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 0.7300 0.7600 0.8340 0.8640
CONTINUUM_CONSTRAINTS: 0.0000 0.3200 -99.99 -99.99 0.0000 0.3200 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.0300 -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Water+Montmor SWy-2+0.5g/l W1R1Fa CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 701
OUTPUT_NAME: water_sediment_low
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.8000
CONTINUUM_ENDPTS: 0.8700 0.9110 1.0520 1.0820
CONTINUUM_CONSTRAINTS: 0.0000 0.1400 -99.99 -99.99 0.0000 0.1200 -99.99 1.1000
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 0.7300 0.7600 0.8340 0.8640
CONTINUUM_CONSTRAINTS: 0.0000 0.1400 -99.99 -99.99 0.0000 0.1400 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 0.6800 0.7100 0.7960 0.8260
CONTINUUM_CONSTRAINTS: 0.0000 0.1800 -99.99 -99.99 0.0000 0.1500 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] 0.0300 -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Grass_Golden_Dry GDS480 W1R1Fa CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 812
OUTPUT_NAME: dry_veg_grass
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.50

```

```

CONTINUUM_ENDPTS: 2.0200 2.0600 2.1980 2.2280
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.50
CONTINUUM_ENDPTS: 2.2100 2.2400 2.380 2.4150
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Grass_Golden_Dry GDS480 W1R1Fa CONV"
2.3 micron
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 812
OUTPUT_NAME: dry_veg_grass_2_3um
NUM_FEATURES: 1 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.00
CONTINUUM_ENDPTS: 2.2100 2.2400 2.380 2.4150
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Lodgepole-Pine LP-Needles-3 W1R1Fa CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 831
OUTPUT_NAME: dry_veg_nongrass
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.50
CONTINUUM_ENDPTS: 2.0200 2.0600 2.1980 2.2280
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.50
CONTINUUM_ENDPTS: 2.2100 2.2400 2.390 2.4190
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;

```

```

;
;.....Material SPECPR Title = "Lodgepole-Pine LP-Needles-3 W1R1Fa CONV"
2.3 micron
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 831
OUTPUT_NAME: dry_veg_nongrass_2_3um
NUM_FEATURES: 1 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.00
CONTINUUM_ENDPTS: 2.2100 2.2400 2.390 2.4190
CONTINUUM_CONSTRAINTS: -99.99 -99.99 0.1000 -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: [MINDEPTH_SINGLEFEAT] -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Muscovite CU93-1 low-Al Phyl W2R4Nb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 965
OUTPUT_NAME: muscovite_lowAl
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7500
CONTINUUM_ENDPTS: 2.1300 2.1565 2.2658 2.2900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2500
CONTINUUM_ENDPTS: 2.2872 2.3052 2.3953 2.4200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Muscovite-medlowAl CU91-250A W1R1Fb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 674
OUTPUT_NAME: muscovite_medAl
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7500
CONTINUUM_ENDPTS: 2.1284 2.1510 2.2500 2.2872
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2500

```

```

CONTINUUM_ENDPTS: 2.2782 2.2984 2.3874 2.4200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Muscovite GDS113 Ruby W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 308
OUTPUT_NAME: muscovite_medhighAl
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7500
CONTINUUM_ENDPTS: 2.1180 2.1510 2.2670 2.2960
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2500
CONTINUUM_ENDPTS: 2.2770 2.3100 2.3860 2.4150
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Muscovite GDS116 Tanzania W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 310
OUTPUT_NAME: muscovite_Fe-rich
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7500
CONTINUUM_ENDPTS: 2.1280 2.1580 2.2770 2.3060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2500
CONTINUUM_ENDPTS: 2.2870 2.3060 2.4050 2.4350
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;

```

```

;.....Material SPECPR Title = "Illite IMt-1.b <2um      W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 236
OUTPUT_NAME: illite
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7500
CONTINUUM_ENDPTS: 2.1170 2.1570 2.2660 2.3000
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2500
CONTINUUM_ENDPTS: 2.2800 2.3060 2.3850 2.4150
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Illite GDS4 (Marblehead)      W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 232
OUTPUT_NAME: illite_gds4
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.7500
CONTINUUM_ENDPTS: 2.1250 2.1550 2.2660 2.3000
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.2500
CONTINUUM_ENDPTS: 2.2750 2.3060 2.3850 2.4150
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Kaolinite CM9      W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 252
OUTPUT_NAME: kaolinite_wx1
NUM_FEATURES: 1 3
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0780 2.1080 2.2370 2.2670

```

```

CONTINUUM_CONSTRAINTS:  -99.99  -99.99  [MIN_REFL_MID]  -99.99  -99.99  -99.99  -99.99  -99.99
FIT_CONSTRAINTS:  -99.99
DEPTH_CONSTRAINTS:  -99.99  -99.99
FEATURE_TYPE:  Not
NOT_FEATURE_ID:  2
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS:  1  0.2200
FEATURE_TYPE:  Not
NOT_FEATURE_ID:  3
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS:  1  0.3000
FEATURE_TYPE:  Not
NOT_FEATURE_ID:  4
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS:  1  0.3000
WEIGHTED_FIT_DEPTH_CONSTRAINTS:  [MINFIT]  [MINDEPTH]  -99.99  0.0000
END_REFERENCE_ENTRY:
;
;

```

```

;.....Material SPECPR Title = "Kaolinite KGa-2 (px1)          WIR1Bb CONV"

```

```

REFERENCE_SPECPR_RECORD:[splib06b_cvhymap]  255
OUTPUT_NAME:  kaolinite_px1
NUM_FEATURES:  1  3
FEATURE_TYPE:  Diagnostic
FEATURE_WEIGHT:  1.000
CONTINUUM_ENDPTS:  2.0790  2.1100  2.2400  2.2750
CONTINUUM_CONSTRAINTS:  -99.99  -99.99  [MIN_REFL_MID]  -99.99  -99.99  -99.99  -99.99  -99.99
FIT_CONSTRAINTS:  -99.99
DEPTH_CONSTRAINTS:  -99.99  -99.99
FEATURE_TYPE:  Not
NOT_FEATURE_ID:  2
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS:  1  0.2200
FEATURE_TYPE:  Not
NOT_FEATURE_ID:  3
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS:  1  0.3000
FEATURE_TYPE:  Not
NOT_FEATURE_ID:  4
NOT_FEATURE_FIT_CONSTRAINTS:  [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS:  1  0.3000
WEIGHTED_FIT_DEPTH_CONSTRAINTS:  [MINFIT]  [MINDEPTH]  -99.99  0.0000
END_REFERENCE_ENTRY:
;
;

```

Lines that are needed for each NOT feature.

This value indicates which NOT feature to use (the number will be matched to a NOT_FEATURE_ID listed at the start of the command file). In this case, NOT feature 2 indicates the muscovite feature spanning the wavelength range from 2.2770 to 2.4150 micrometers.

The NOT feature fit constraint. The fit value for the NOT feature must be greater than the given threshold in order for the NOT feature to be considered present.

The NOT feature depth constraint. In this material, the keyword "NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS" is used indicating the depth threshold value is relative to one of the reference material's features. See comments earlier in the command file for an example of an absolute NOT feature. For a relative NOT feature depth constraint, the first parameter given is the diagnostic feature of the material to use in calculating the depth constraint, in this case it is diagnostic feature 1, that is, the first diagnostic feature of the muscovite (muscovite_medhighAl). The second parameter, 0.22, is the multiplier that will be applied to the depth of that diagnostic feature. In this example, the depth of the fitted NOT feature (the second feature of muscovite fitted to the observed spectrum) must be greater than the depth of muscovite's first diagnostic feature (fitted to the observed spectrum) multiplied by 0.22. NOTE: it is the fitted depths that are used, that is, the depths of the features in the NOT material that have been scaled to the observed spectrum. Thus, the value of the depth threshold changes with each observed spectrum that is analyzed.

```

;.....Material SPECPR Title = "Halloysite NMNH106237        WIR1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap]  197
OUTPUT_NAME:  kaolin+clay_mica_or_halloysite
NUM_FEATURES:  1  3
FEATURE_TYPE:  Diagnostic
FEATURE_WEIGHT:  1.000
CONTINUUM_ENDPTS:  2.0780  2.1080  2.2500  2.2870
CONTINUUM_CONSTRAINTS:  -99.99  -99.99  [MIN_REFL_MID]  -99.99  -99.99  -99.99  -99.99  -99.99
FIT_CONSTRAINTS:  -99.99
DEPTH_CONSTRAINTS:  -99.99  -99.99

```

```

NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.3000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.3000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Dickite NMNH106242      W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 144
OUTPUT_NAME: kaol_possible_alunite_or_dickite
NUM_FEATURES: 1 3
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0580 2.0880 2.2370 2.2670
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 2
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_DICKITE] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Buddingtonite GDS85 D-206      W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 87
OUTPUT_NAME: buddingtonite
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0540 2.0860 2.2770 2.3060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99

```

```

FEATURE_TYPE: Not
NOT_FEATURE_ID: 10
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0500
FEATURE_TYPE: Not
NOT_FEATURE_ID: 11
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0500
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_BUDDINGTONITE] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Buddingtnt+Na-Mont CU93-260B W2R4Nb CONV"
;
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 973
OUTPUT_NAME: buddingtonite+montmorillonite
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0540 2.0860 2.2770 2.3060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 10
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0500
FEATURE_TYPE: Not
NOT_FEATURE_ID: 11
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0500
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_BUDDINGTONITE] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Alunite GDS96 K Syn (250C) W2R4Na CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 945
OUTPUT_NAME: alunite_K_250c
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 2.0282 2.0650 2.2350 2.2600
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.443 1.464 1.50000 1.5243
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99

```

```

WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_ALUNITE] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Alunite RES-3 Na Syn (450C) W2R4Na CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 948
OUTPUT_NAME: alunite_Na_450c
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 2.0282 2.0650 2.2350 2.2600
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.4630 1.4797 1.5150 1.5459
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_ALUNITE] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Pyrophyllite PYS1A fine gr W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 380
OUTPUT_NAME: pyrophyllite
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0900 2.1280 2.2100 2.2400
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: 0.02 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Jarosite GDS24 Na W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 241
OUTPUT_NAME: jarosite_Na
NUM_FEATURES: 1 0
FEATURE_TYPE: Diagnostic

```

```

FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0690 2.0990 2.3270 2.3570
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Jarosite GDS99 K 200C Syn W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 243
OUTPUT_NAME: jarosite_K
NUM_FEATURES: 1 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0690 2.0990 2.3270 2.3570
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Montmorillonite SWy-1 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 302
OUTPUT_NAME: montmorillonite_Na
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1180 2.1550 2.2500 2.2870
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 2
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.1500
FEATURE_TYPE: Not
NOT_FEATURE_ID: 5
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Montmorillonite SAz-1 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 298
OUTPUT_NAME: montmorillonite_Ca
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000

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CONTINUUM_ENDPTS: 2.1480 2.1780 2.2500 2.2870
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 2
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.1500
FEATURE_TYPE: Not
NOT_FEATURE_ID: 5
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Gypsum HS333.3B (Selenite) W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 191
OUTPUT_NAME: gypsum
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.3333
CONTINUUM_ENDPTS: 2.0750 2.1000 2.2900 2.3250
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.3333
CONTINUUM_ENDPTS: 1.5000 1.5200 1.5800 1.6000
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: 0.8000
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.3334
CONTINUUM_ENDPTS: 1.6800 1.7100 1.7650 1.7850
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: 0.8000
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Chlorite SMR-13.b 60-104um W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 109
OUTPUT_NAME: chlorite_lowFe
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.6000
CONTINUUM_ENDPTS: 2.1600 2.1900 2.4040 2.4400
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99

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DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 2.1880 2.2180 2.2580 2.2900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.3000
CONTINUUM_ENDPTS: 0.5120 0.5420 1.6960 1.7260
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED FIT DEPTH CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Epidote GDS26.a 75-200um W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 159
OUTPUT_NAME: epidote
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 2.2080 2.2280 2.2680 2.2900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 2.2200 2.2400 2.4040 2.4350
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED FIT DEPTH CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Alun366+.50PyroPYS1A GDS222 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 490
OUTPUT_NAME: pyrophyllite.5+alunite.5
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 2.0780 2.0990 2.2280 2.2580
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.4400 1.4700 1.5050 1.5300
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99

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FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.2530 2.2830 2.3440 2.3740
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_ALUNITE_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Alunite0.5+Kaol_KGa-1 AMX3 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 493
OUTPUT_NAME: alunite.5+kaolinite.5
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 2.0680 2.0990 2.2300 2.2680
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.4400 1.470 1.5050 1.5240
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.2680 2.2980 2.3400 2.3700
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_ALUNITE_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Kaolwx1.75+Alun_HS295 AMX14 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 536
OUTPUT_NAME: alunite.25+kaolinite.75
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.9000
CONTINUUM_ENDPTS: 2.0680 2.0990 2.2300 2.2680
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 1.4400 1.4700 1.5050 1.5240

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CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.2680 2.2980 2.3400 2.3700
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED FIT DEPTH CONSTRAINTS: [MINFIT] [MINDEPTH_ALUNITE_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Kaol.5+MuscCU91-250A AMX13 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 529
OUTPUT_NAME: kaolin.5+muscovite_medAl
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1080 2.1380 2.2480 2.2780
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.2650 2.2950 2.3900 2.4200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED FIT DEPTH CONSTRAINTS: [MINFIT] [MINDEPTH_MUSC_KAOLJARO_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Kaol_Wx1+0.5Musc_Ruby AMX12 W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 530
OUTPUT_NAME: kaolin.5+muscovite_medhighAl
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1050 2.1350 2.2480 2.2780
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99

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FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.2650 2.2950 2.3900 2.4200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_MUSC_KAOLJARO_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Kaol+Musc_intimate CU93-5C W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 528
OUTPUT_NAME: kaolin+muscovite_mix_intimate
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1050 2.1380 2.2530 2.2870
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.2650 2.2950 2.3900 2.4200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_MUSC_KAOLJARO_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Kaolin_Smect H89-FR-2 .5Kaol W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 532
OUTPUT_NAME: kaolin.5+smectite.5
NUM_FEATURES: 1 4
FEATURE_TYPE: Diagnostic

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FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.0980 2.1350 2.2500 2.2870
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 2
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 3
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 4
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 5
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.2000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_KAOL_SMECT_MIX] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Muscov+Jaros CU93-314 coatng W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 543
OUTPUT_NAME: jarosite+muscovite_mix_intimate
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.1130 2.1460 2.2940 2.3260
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.3040 2.3260 2.3630 2.3940
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 0.7060 0.7380 1.2860 1.3200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_MUSC_KAOLJARO_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;

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;.....Material SPECPR Title = "Chlorite+Muscovite CU93-65A W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 511
OUTPUT_NAME: chlorite+muscovite
NUM_FEATURES: 3 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.4500
CONTINUUM_ENDPTS: 0.7818 0.8142 1.2767 1.3200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 0.4000 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.4500
CONTINUUM_ENDPTS: 2.1236 2.1574 2.2745 2.3072
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.1000
CONTINUUM_ENDPTS: 2.2750 2.3100 2.3824 2.4149
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calcite WS272 W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 94
OUTPUT_NAME: calcite_abundant
NUM_FEATURES: 2 4
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.0000
CONTINUUM_ENDPTS: 2.1780 2.2080 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.0000
CONTINUUM_ENDPTS: 2.0900 2.1200 2.1800 2.2050
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 6
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 7
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.0800
FEATURE_TYPE: Not

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NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calcite WS272" W1R1Ba CONV"
;
; Feature weight set very slightly above 1.0 in order
; to have this supersede "calcite_abundant" when
; the 2.15 micron calcite feature is not present
;
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 94
OUTPUT_NAME: calcite
NUM_FEATURES: 1 5
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000001
CONTINUUM_ENDPTS: 2.1780 2.2080 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 12
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0015
FEATURE_TYPE: Not
NOT_FEATURE_ID: 6
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.2000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 7
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.0800
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Dolomite HS102.3B" W1R1Bb CONV"

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REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 151
OUTPUT_NAME: dolomite
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1580 2.1880 2.3570 2.3870
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 1.2000
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Siderite HS271.3B W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 416
OUTPUT_NAME: carbonate_Fe_bearing
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.500
CONTINUUM_ENDPTS: 2.1980 2.2280 2.3860 2.4160
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.500
CONTINUUM_ENDPTS: 0.7560 0.7850 1.6750 1.7050
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calc.25+dolo.25+mont.5 AMX18 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 500
OUTPUT_NAME: dolomite.25+calcite.25+mont_Na.5
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.2350 2.2700 2.3700 2.4000
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99

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FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.1300 2.1600 2.2480 2.2780
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_DOLO_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calcite.80+Mont_Swy-1 GDS212 W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 507
OUTPUT_NAME: calcite.8+montmorillonite_Na.2
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.2480 2.2780 2.3760 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.1300 2.1550 2.2500 2.2770
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calcite.8+Ca-Montmor.2 AMX15 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 506
OUTPUT_NAME: calcite.8+montmorillonite_Ca.2
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.1590 2.1850 2.2500 2.2770
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.2580 2.2900 2.3670 2.3950

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CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calcite+.33Muscov AMX5 Ruby W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 501
OUTPUT_NAME: calcite.7+muscovite.3
NUM_FEATURES: 2 1
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.2270 2.2570 2.3760 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.1300 2.1580 2.2270 2.2570
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 7
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.0800
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Dolomite.5+Na-mont.5 AMX21 W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 515
OUTPUT_NAME: dolomite.5+montmorillonite_Na.5
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000
CONTINUUM_ENDPTS: 2.1400 2.1700 2.2480 2.2780
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.5000

```

```

CONTINUUM_ENDPTS: 2.2350 2.2700 2.3500 2.3850
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_DOLO_MIXES] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Calcite.80wt+Kaol_CM9 GDS213 W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 508
OUTPUT_NAME: kaolin.2+calcite.8
NUM_FEATURES: 2 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.500
CONTINUUM_ENDPTS: 2.1070 2.1400 2.2290 2.2580
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.500
CONTINUUM_ENDPTS: 2.2290 2.2580 2.3900 2.4200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Chalcedony CU91-6A W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 101
OUTPUT_NAME: chalcedony
NUM_FEATURES: 1 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1190 2.1550 2.3580 2.3900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Opal TM8896 (Hyalite) W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 349
OUTPUT_NAME: hydrated_silica
NUM_FEATURES: 1 0
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1160 2.1550 2.3700 2.3900
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99

```

```

DEPTH_CONSTRAINTS: -99.99 -99.99
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Tremolite HS18.3          W1R1Bc CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 468
OUTPUT_NAME: tremolite_or_talc
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.2200 2.2500 2.3240 2.3550
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.3240 2.3550 2.4050 2.4350
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.6000
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_RELATIVE_DEPTH_CONSTRAINTS: 1 0.6000
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_SERP_TREM] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Anitgorite NMNH96917.d 70um W1R1Bb CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 67
OUTPUT_NAME: serpentine_or_dolomite+calcite
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1780 2.2028 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.020

```

```

WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_SERP_TREM] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Chrysotile HS323.1B W1R1Ba CONV"
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 115
OUTPUT_NAME: serpentine1
NUM_FEATURES: 1 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000
CONTINUUM_ENDPTS: 2.1780 2.2028 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.020
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_SERP_TREM] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Anitgorite NMNH96917.d 70um W1R1Bb CONV"
;
; Total feature weight set very slightly above 1.0 in order
; to have this supersede "serpentine_or_dolo+calc" when
; the 1 micron iron-bearing mineral feature is present
;
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 67
OUTPUT_NAME: serpentine2
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.00
CONTINUUM_ENDPTS: 0.8100 0.8400 1.300 1.3200
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: [MINFIT_SERP2]
DEPTH_CONSTRAINTS: 0.002 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000001
CONTINUUM_ENDPTS: 2.1780 2.2028 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200

```

```

FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.020
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_SERP_TREM] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Chrysotile HS323.1B W1R1Ba CONV"
;
; Total feature weight set very slightly above 1.0 in order
; to have this supersede "serpentine1" when
; the 2.115 micron serpentine feature is present
;
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 115
OUTPUT_NAME: serpentine3
NUM_FEATURES: 2 2
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000001
CONTINUUM_ENDPTS: 2.1780 2.2028 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.0600 2.0800 2.1650 2.1850
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: [MINFIT_SERP3AND4]
DEPTH_CONSTRAINTS: 0.002 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.020
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_SERP_TREM] -99.99 0.0000
END_REFERENCE_ENTRY:
;
;
;.....Material SPECPR Title = "Anitgorite NMNH96917.d 70um W1R1Bb CONV"
;
; Total feature weight set very slightly above 1.0 in order
; to have this supersede "serpentine_or_dolo+calc" and
; "serpentine2" when the 2.115 micron serpentine
; feature is present
;
REFERENCE_SPECPR_RECORD:[splib06b_cvhymap] 67
OUTPUT_NAME: serpentine4
NUM_FEATURES: 2 2

```

```

FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 1.000002
CONTINUUM_ENDPTS: 2.1780 2.2028 2.3770 2.4060
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: -99.99
DEPTH_CONSTRAINTS: -99.99 -99.99
FEATURE_TYPE: Diagnostic
FEATURE_WEIGHT: 0.000
CONTINUUM_ENDPTS: 2.0600 2.0800 2.1650 2.1850
CONTINUUM_CONSTRAINTS: -99.99 -99.99 [MIN_REFL_MID] -99.99 -99.99 -99.99 -99.99 -99.99
FIT_CONSTRAINTS: [MINFIT_SERP3AND4]
DEPTH_CONSTRAINTS: 0.002 -99.99
FEATURE_TYPE: Not
NOT_FEATURE_ID: 8
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.0200
FEATURE_TYPE: Not
NOT_FEATURE_ID: 9
NOT_FEATURE_FIT_CONSTRAINTS: [MINFIT_NOTFEAT]
NOT_FEATURE_ABSOLUTE_DEPTH_CONSTRAINTS: 0.020
WEIGHTED_FIT_DEPTH_CONSTRAINTS: [MINFIT] [MINDEPTH_SERP_TREM] -99.99 0.0000
END_REFERENCE_ENTRY:
;
END_CMDFILE: ← This line must be present, indicating the end of the command file.

```

Appendix B. MICA output reports

This appendix contains output reports at different verbose levels from MICA analysis of spectra. Examples of analyses of spectra stored as records in a SPECPR file and in imaging spectrometer image cubes are shown in this appendix. In these examples, the command file in *appendix A*, for minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region and for HyMap spectra, is used to analyze the spectra. This command file “mica_cmds_group2_hymap2007.mcf” is included with the PRISM software distribution. If step 3 of the installation instructions was followed (see the “*Installation of Software*” section of this report), this file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers. This command file was developed to detect the occurrences of a set of materials in HyMap imaging spectrometer data. The reference materials are primarily minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region, along with other common surface cover such as water, snow, and vegetation. This command file was used to detect and map these materials in a large HyMap dataset covering the country of Afghanistan (Kokaly and others, in press).

In this appendix, example output results for spectral records are presented first. Spectra from four field sites, collected using an ASD field spectrometer and then convolved to HyMap spectral characteristics (based on HyMap’s characteristics for the 2007 data collection season), were used to generate this example output from “*Function 4.2 – Run MICA for Spectral Records*”. These spectra and photos of the field sites are shown in figures B1-B4. These spectra are in USGS Spectral Library splib06a (Clark and others, 2007), which is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then this file will be located in “C:\usgsprism\spectra\splib06\” on Windows computers and in “/var/local/usgsprism/spectra/splib06/” on Linux computers. The DESCRIPT pages for these spectra, containing detailed description of the vegetation covering the areas where these spectra were collected, are in *appendix C*.

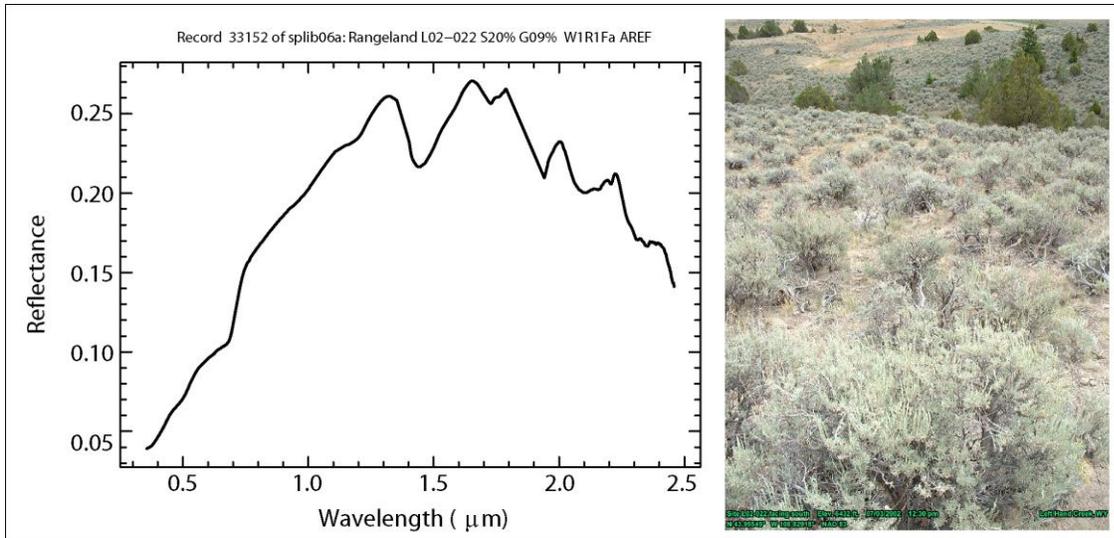


Figure B1. Photo and reflectance spectrum of example spectrum 1, field measurement of reflectance from an area of rangeland, primarily covered by shrub and tree species.

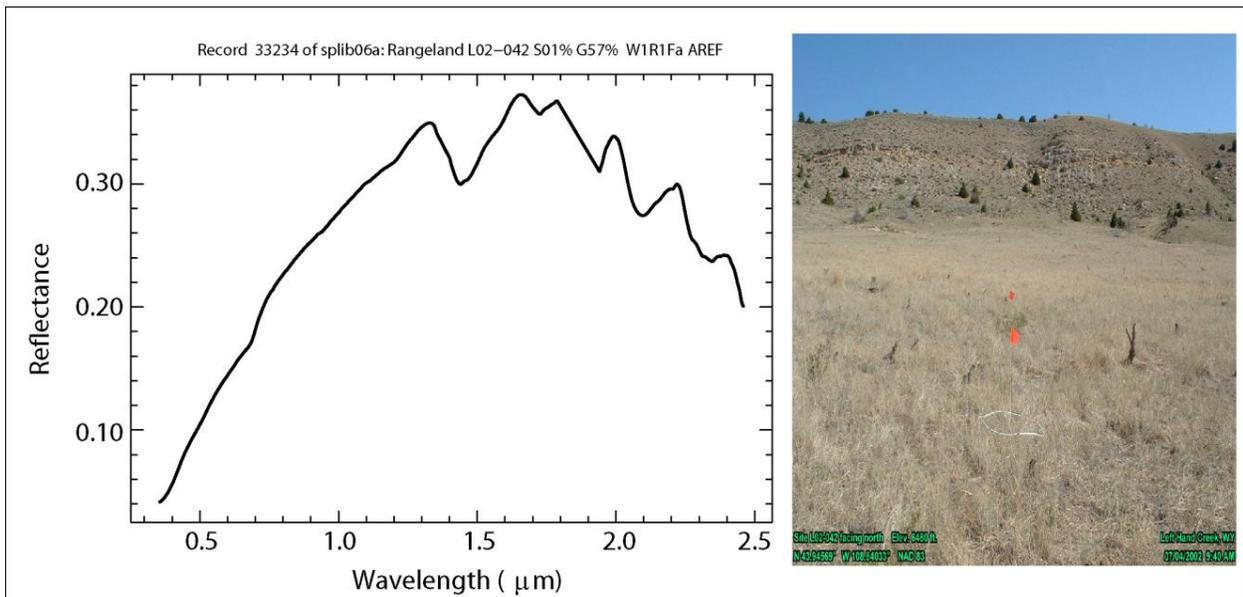


Figure B2. Photo and reflectance spectrum of example spectrum 2, field measurement of reflectance from an area of rangeland, primarily covered by dry grass.

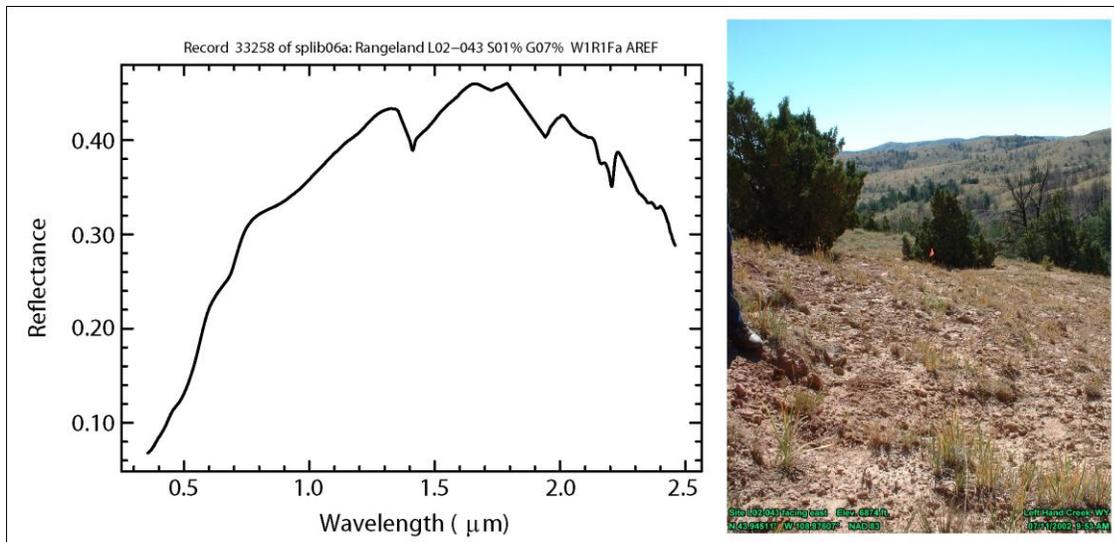


Figure B3. Photo and reflectance spectrum of example spectrum 3, field measurement of reflectance from an area of rangeland, primarily exposed soil.

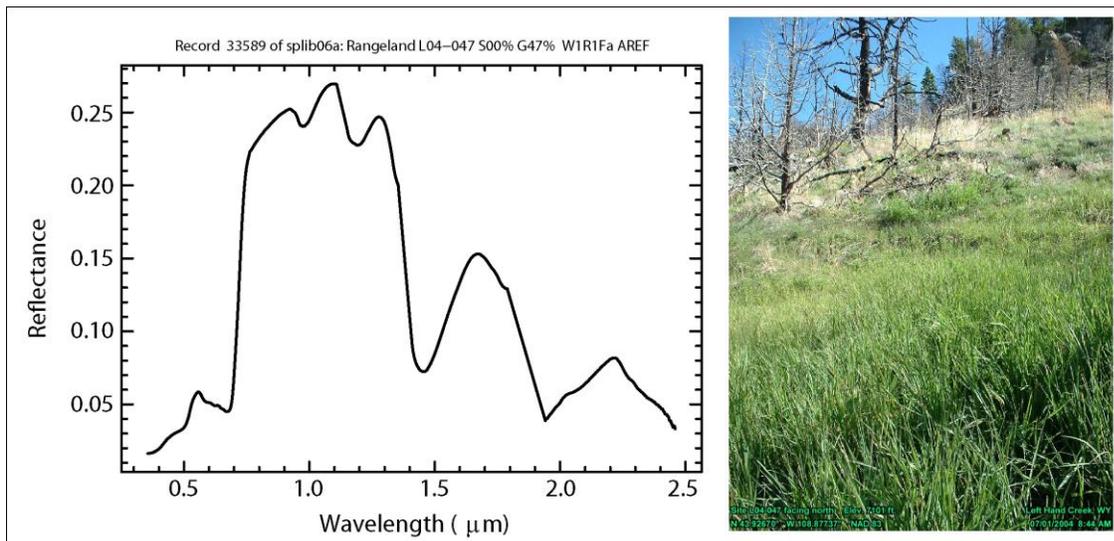


Figure B4. Photo and reflectance spectrum of example spectrum 4, field measurement of reflectance from an area of rangeland, primarily green grass.

The following pages show the output of “*Function 4.2 – Run MICA for Spectral Records*” applied to the four example spectra at verbose levels 1-4. Comments on the reported values are marked on the output report. The uncommented text reports are also included the compressed archive file that contains the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this

report), then the files will be located in “C:\usgsprism\mica_hymap\output\” on Windows computers and in “/var/local/usgsprism/mica_hymap/output/” on Linux computers.

Output report for verbose level 1. *“Function 4.2 – Run MICA for Spectral Records”*

At verbose level 1, the MICA output is a single line per spectrum analyzed. This line contains the SPECPR title of the spectrum analyzed, the output name of the best match reference spectrum, and the fit number of the best match.

The uncommented text report for this verbose level is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the *“Installation of Software”* section of this report), then the report will be located at *“C:\usgsprism\mica_hymap\output\ mica_log_spectrummode_mica_cmds_group2_hymap2007_verbose1.txt”* on Windows computers. On Linux computers, the file will be found in the *“/var/local/usgsprism/mica_hymap/output/”* directory.

```
Observed Spectrum (SPECPR Title=Rangeland L02-022 S20% G09%) best matched by Reference (Output name=dry_veg_nongrass_2_3um) with fit 0.9814
Observed Spectrum (SPECPR Title=Rangeland L02-042 S01% G57%) best matched by Reference (Output name=dry_veg_grass_2_3um) with fit 0.9939
Observed Spectrum (SPECPR Title=Rangeland L02-043 S01% G07%) best matched by Reference (Output name=kaolin.2+calcite.8) with fit 0.9245
Observed Spectrum (SPECPR Title=Rangeland L04-047 S00% G47%) best matched by Reference (Output name=vegetation_green) with fit 0.9950
```

Output report for verbose level 2. “Function 4.2 – Run MICA for Spectral Records”

At verbose level 2, the MICA output contains additional reporting on the options used in the processing of the spectra, which is given before the analysis results. Greater detail on each analyzed spectrum (observed spectrum) is reported, including the SPECPR title, record number, and SPECPR file. These details are also reported for the best match spectrum. In addition to the fit value of the best match, the depth and fit*depth values are also reported.

The uncommented text report for this verbose level is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the report will be located at “C:\usgsprism\mica_hymap\output\ mica_log_spectrummode_mica_cmds_group2_hymap2007_verbose2.txt” on Windows computers. On Linux computers, the file will be found in the “/var/local/usgsprism/mica_hymap/output/” directory.

Starting mica_singlespec_specpr.pro at Sat Apr 23 17:16:30 2011

Command Line Arguments:

LOG FILE = C:\usgsprism\mica_hymap\output\mica_log_spectrummode_mica_cmds_group2_hymap2007.txt
VERBOSE_LEVEL = 2
DELETED_CHANNELS = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124

Command File Parameters:

Wavelength SPECPR file = C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
Wavelength SPECPR record = 6
Deleted Channels found = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124
Number of Good Channels = 103
Scale factor for reference spectra = 1.0000000
Scale factor for observed spectra = 20000.000

Reporting on options used to process the spectra, set within the MICA command file or interactively by the user.

* Changing scale factor for observed spectra (from user interface) = 1.0000000

Observed Spectrum (SPECPR Title=Rangeland L02-022 S20% G09% W1R1Fa CONV) was best matched by Reference Spectrum (Output name=dry_veg_nongrass_2_3um) with a fit of 0.9814
Observed (SPECPR File= splib06b_cvhymap07_124ch; Record= 905; Title= Rangeland L02-022 S20% G09% W1R1Fa CONV)
Reference (SPECPR File= splib06b_cvhymap07_124ch; Record= 831; Title= Lodgepole-Pine LP-Needles-3 W1R1Fa CONV)
Fit= 0.9814 Depth= 0.0986 Fit*Depth= 0.0968

Observed Spectrum (SPECPR Title=Rangeland L02-042 S01% G57% W1R1Fa CONV) was best matched by Reference Spectrum (Output name=dry_veg_grass_2_3um) with a fit of 0.9939
Observed (SPECPR File= splib06b_cvhymap07_124ch; Record= 908; Title= Rangeland L02-042 S01% G57% W1R1Fa CONV)
Reference (SPECPR File= splib06b_cvhymap07_124ch; Record= 812; Title= Grass_Golden_Dry GDS480 W1R1Fa CONV)
Fit= 0.9939 Depth= 0.0954 Fit*Depth= 0.0948

Observed Spectrum (SPECPR Title=Rangeland L02-043 S01% G07% W1R1Fa CONV) was best matched by Reference Spectrum (Output name=kaolin.2+calcite.8) with a fit of 0.9245
Observed (SPECPR File= splib06b_cvhymap07_124ch; Record= 909; Title= Rangeland L02-043 S01% G07% W1R1Fa CONV)
Reference (SPECPR File= splib06b_cvhymap07_124ch; Record= 508; Title= Calcite.80wt+Kaol_CM9 GDS213 W1R1Ba CONV)
Fit= 0.9245 Depth= 0.0491 Fit*Depth= 0.0453

Observed Spectrum (SPECPR Title=Rangeland L04-047 S00% G47% W1R1Fa CONV) was best matched by Reference Spectrum (Output name=vegetation_green) with a fit of 0.9950
Observed (SPECPR File= splib06b_cvhymap07_124ch; Record= 921; Title= Rangeland L04-047 S00% G47% W1R1Fa CONV)
Reference (SPECPR File= splib06b_cvhymap07_124ch; Record= 588; Title= Fir_Tree IH91-2 W1R1Ba CONV)
Fit= 0.9950 Depth= 0.6074 Fit*Depth= 0.6041

Additional details on input (observed spectrum) and best match reference spectrum, including fit value, depth value and fit*depth value.

Normal termination of mica_singlespec_specpr.pro at Sat Apr 23 17:16:42 2011

Output report for verbose level 3. “Function 4.2 – Run MICA for Spectral Records”

At verbose level 3, the MICA output contains greater detail on the reference entries (also called reference spectra and reference materials) in the command file, including a table showing their SPECPR filename, record number, and record title along with their output name. Each reference entry (reference spectrum) is assigned a unique identification number. The output name listed for each reference spectrum in the command file is used as both a shorthand way to identify the reference spectra and a way to identify the material detected. The number of diagnostic features in each reference entry is reported. The number of NOT features invoked by each reference spectrum is also reported.

A report on the diagnostic features in each reference entry is given, showing the wavelength ranges of the left and right continuum endpoints as specified in the command file. In addition, the program reports which spectrometer channel(s) fall into those ranges; thus, the program identifies which channels are used to compute the continuum line of each feature. Also reported are the associated wavelengths of the spectrometer channels found in the continuum endpoint ranges. The type of each diagnostic feature is reported (absorption or emission).

A report on the NOT features invoked in each reference entry is given. For each instance that a NOT feature is invoked, the reference entry (SPECPR file/record/title) that invokes a NOT feature is reported along with the ID number of the NOT feature invoked, its type (absorption or emission), its depth threshold type (absolute or relative), and its SPECPR file/record/title.

Greater detail than verbose level 2 is given for the analysis of each observed spectrum, which includes a table showing the final computed fit values of the observed spectrum compared to each reference material (reference spectrum). A column containing the final fit values is reported, in which some fits may be zero because one or more continuum, feature, or weighted fit/depth constraints were violated or a NOT feature was found. Also, a column reporting the weighted fit values is reported; these are the fit values before any constraints or NOT features are checked. These columns allow the user to see all the material fit values and see which materials were not considered as matches to the observed spectrum because a constraint was violated or a NOT feature was found. Below the table containing all the fit values, a report on the reference materials (reference spectra) with the top 5 fit values is printed, with the fit values ranked and the reference material (reference spectrum) reported from high to low fit values. At the end of the MICA analysis of the observed spectrum, the detailed report of the best match spectrum, as described in the output report for verbose level 2, is given.

The uncommented text report for this verbose level is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the report will be located at “C:\usgsprism\mica_hymap\output\ mica_log_spectrummode_mica_cmds_group2_hymap2007_verbose3.txt” on Windows computers. On Linux computers, the file will be found in the “/var/local/usgsprism/mica_hymap/output/” directory.

Starting mica_singlespec_specpr.pro at Thu Dec 03 09:56:57 2009

Command Line Arguments:

LOG FILE = C:\usgsprism\mica_hymap\output\mica_log_spectrummode_mica_cmds_group2_hymap2007.txt
 VERBOSE_LEVEL = 3
 DELETED_CHANNELS = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124

Command File Parameters:

Wavelength SPECPR file = C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
 Wavelength SPECPR record = 6
 Deleted Channels found = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124
 Number of Good Channels = 103
 Scalefactor for reference spectra = 1.0000000
 Scalefactor for observed spectra = 20000.000

* Changing Scalefactor for observed spectra (from user interface) = 1.0000000

COMMAND FILE REFERENCE ENTRIES:

Reference Spectrum	Reference SPECPR File	SPECPR Record	SPECPR Title	Output Name	# of Features	# of Not Features
1	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	vegetation_green	3	0
2	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	vegetation.dry+green	3	0
3	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	snow_melting	2	1
4	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	snow_slush	2	1
5	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	566	Seawater_Coast_Ch1 SW1 W1R1Ba CONV	water	2	0
6	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	704	Water+Montmor SWy-2+5.01g/l W1R1Fa CONV	water_sediment_high	3	0
7	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	701	Water+Montmor SWy-2+0.5g/l W1R1Fa CONV	water_sediment_low	3	0
8	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	dry_veg_grass	2	0
9	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	dry_veg_grass_2_3um	1	0
10	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	dry_veg_nongrass	2	0
11	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	dry_veg_nongrass_2_3um	1	0
12	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	965	Muscovite CU93-1 low-Al Phyl W2R4Nb CONV	muscovite_lowAl	2	0
13	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	674	Muscovite-medlowAl CU91-250A W1R1Fb CONV	muscovite_medAl	2	0
14	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	308	Muscovite GDS113 Ruby W1R1Bb CONV	muscovite_medhighAl	2	0
15	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	310	Muscovite GDS116 Tanzania W1R1Ba CONV	muscovite_Ferich	2	0
16	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	236	Illite IMT-1.b <2um W1R1Ba CONV	illite	2	0
17	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	232	Illite GDS4 (Marblehead) W1R1Bb CONV	illite_gds4	2	0
18	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	252	Kaolinite CM9 W1R1Bb CONV	kaolinite_wxl	1	3
19	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	255	Kaolinite KGa-2 (pxl) W1R1Bb CONV	kaolinite_pxl	1	3
20	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	197	Halloysite NMNH106237 W1R1Ba CONV	kaol+clay_mica_or_halloy	1	3
21	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	144	Dickite NMNH106242 W1R1Bb CONV	dickite	1	3
22	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	87	Buddingtonite GDS85 D-206 W1R1Bb CONV	buddingtonite	1	2
23	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	973	Buddingtnt+Na-Mont CU93-260B W2R4Nb CONV	buddingtonite+montmorillonite	1	2
24	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	945	Alunite GDS96 K Syn (250C) W2R4Na CONV	alunite_K_250c	2	0
25	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	948	Alunite RES-3 Na Syn (450C) W2R4Na CONV	alunite_Na_450c	2	0

The number of NOT features invoked by each reference entry is reported

The number of diagnostic features in each reference entry is reported

The output name is used in the reporting to identify the reference spectrum.

An identification (ID) number is assigned to each reference entry (reference spectrum).

26	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	pyrophyllite	1	2
27	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	jarosite_Na	1	0
28	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	jarosite_K	1	0
29	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	montmorillonite_Na	1	2
30	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	montmorillonite_Ca	1	2
31	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	gypsum	3	0
32	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	chlorite_lowFe	3	0
33	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	epidote	2	0
34	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	pyrophyllite.5+alunite.5	3	0
35	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	alunite.5+kaolinite.5	3	0
36	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	alunite.25+kaolinite.75	3	0
37	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	kaolin.5+muscovite_medAl	2	2
38	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	530	Kaol Wx1+0.5Musc_Ruby AMX12	W1R1Ba	CONV	kaolin.5+muscovite_medhighAl	2	2
39	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	kaolin+muscovite_mix_intimate	2	2
40	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	kaolin.5+smectite.5	1	4
41	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	543	Muscov+Jaros CU93-314 coatng	W1R1Bb	CONV	jarosite+muscovite_mix_intimat	3	0
42	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	chlorite+muscovite	3	0
43	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	94	Calcite WS272	W1R1Ba	CONV	calcite_abundant	2	4
44	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	94	Calcite WS272	W1R1Ba	CONV	calcite	1	5
45	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	dolomite	1	2
46	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	carbonate_Fe_bearing	2	0
47	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	dolomite.25+calcite.25+mont_Na	2	0
48	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	calcite.8+montmorillonite_Na.2	2	2
49	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	calcite.8+montmorillonite_Ca.2	2	2
50	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	calcite.7+muscovite.3	2	1
51	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	dolomite.5+montmorillonite_Na.	2	0
52	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	kaolin.2+calcite.8	2	0
53	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	101	Chalcedony CU91-6A	W1R1Ba	CONV	chalcedony	1	0
54	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba	CONV	hydrated_silica	1	0
55	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	468	Tremolite HS18.3	W1R1Bc	CONV	tremolite_or_talc	2	2
56	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	serpentine_or_dolomite+calcite	1	2
57	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	serpentine1	1	2
58	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	serpentine2	2	2
59	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	serpentine3	2	2
60	C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	serpentine4	2	2

The last line of the reference entry listing shows the total number of reference spectra listed in the command file.

The wavelength range of the left continuum endpoint, as specified in the command file.

The wavelength range of the right continuum endpoint, as specified in the command file.

The wavelength range of the spectrometer channels that fall into the continuum ranges.

DIAGNOSTIC FEATURE ENTRIES:				Command File		Command File		Spectrometer Matched		Spectrometer Matched		Spectrometer Matched		Spectrometer Matched		Emission
Reference Feature Spectrum	Feature Number	Count	SPECPR File/Record/Title	Left Continuum Range WaveMin to WaveMax	Right Continuum Range WaveMin to WaveMax	Left Continuum Range ChanMin to ChanMax	Right Continuum Range ChanMin to ChanMax	Left Continuum Range WaveMin to WaveMax	Right Continuum Range WaveMin to WaveMax	Left Continuum Range ChanMin to ChanMax	Right Continuum Range ChanMin to ChanMax	Left Continuum Range WaveMin to WaveMax	Right Continuum Range WaveMin to WaveMax	Left Continuum Range ChanMin to ChanMax	Right Continuum Range ChanMin to ChanMax	Feature
1	1	1		0.5220 to 0.5520	0.7370 to 0.7670	5 to 6	19 to 20	0.5266 to 0.5420	0.7400 to 0.7551	5 to 6	19 to 20	0.5266 to 0.5420	0.7400 to 0.7551	5 to 6	19 to 20	no
1	2	2		0.8700 to 0.9000	1.0630 to 1.0930	28 to 30	41 to 42	0.8762 to 0.8976	1.0703 to 1.0854	28 to 30	41 to 42	0.8762 to 0.8976	1.0703 to 1.0854	28 to 30	41 to 42	no
1	3	3		1.1000 to 1.1310	1.2650 to 1.2900	43 to 45	55 to 56	1.1005 to 1.1303	1.2743 to 1.2882	43 to 45	55 to 56	1.1005 to 1.1303	1.2743 to 1.2882	43 to 45	55 to 56	no
2	1	4		0.5220 to 0.5520	0.7450 to 0.7750	5 to 6	20 to 21	0.5266 to 0.5420	0.7551 to 0.7702	5 to 6	20 to 21	0.5266 to 0.5420	0.7551 to 0.7702	5 to 6	20 to 21	no
2	2	5		1.0800 to 1.1310	1.2650 to 1.2900	42 to 45	55 to 56	1.0854 to 1.1303	1.2743 to 1.2882	42 to 45	55 to 56	1.0854 to 1.1303	1.2743 to 1.2882	42 to 45	55 to 56	no
2	3	6		2.2050 to 2.2400	2.3850 to 2.4160	108 to 109	118 to 119	2.2207 to 2.2374	2.3863 to 2.4022	108 to 109	118 to 119	2.2207 to 2.2374	2.3863 to 2.4022	108 to 109	118 to 119	no
3	1	7		0.9020 to 0.9460	1.0800 to 1.1100	31 to 33	42 to 43	0.9136 to 0.9455	1.0854 to 1.1005	31 to 33	42 to 43	0.9136 to 0.9455	1.0854 to 1.1005	31 to 33	42 to 43	no
3	2	8		1.0990 to 1.1780	1.3150 to 1.3450	43 to 48	58 to 60	1.1005 to 1.1742	1.3162 to 1.3436	43 to 48	58 to 60	1.1005 to 1.1742	1.3162 to 1.3436	43 to 48	58 to 60	no
4	1	9		0.8700 to 0.9200	1.0800 to 1.1100	28 to 31	42 to 43	0.8762 to 0.9136	1.0854 to 1.1005	28 to 31	42 to 43	0.8762 to 0.9136	1.0854 to 1.1005	28 to 31	42 to 43	no
4	2	10		1.0800 to 1.1300	1.3150 to 1.3450	42 to 44	58 to 60	1.0854 to 1.1155	1.3162 to 1.3436	42 to 44	58 to 60	1.0854 to 1.1155	1.3162 to 1.3436	42 to 44	58 to 60	no
5	1	11		0.5300 to 0.5850	2.1900 to 2.2800	6 to 8	107 to 111	0.5420 to 0.5723	2.2020 to 2.2716	6 to 8	107 to 111	0.5420 to 0.5723	2.2020 to 2.2716	6 to 8	107 to 111	no
5	2	12		0.4290 to 0.4590	0.6100 to 0.6400	1 to 1	11 to 12	0.4520 to 0.4520	0.6186 to 0.6337	1 to 1	11 to 12	0.4520 to 0.4520	0.6186 to 0.6337	1 to 1	11 to 12	YES
6	1	13		0.8700 to 0.9130	1.0550 to 1.0850	28 to 30	40 to 41	0.8762 to 0.8976	1.0553 to 1.0703	28 to 30	40 to 41	0.8762 to 0.8976	1.0553 to 1.0703	28 to 30	40 to 41	no
6	2	14		0.6920 to 0.7220	0.7920 to 0.8220	16 to 17	23 to 24	0.6946 to 0.7098	0.8004 to 0.8156	16 to 17	23 to 24	0.6946 to 0.7098	0.8004 to 0.8156	16 to 17	23 to 24	no
6	3	15		0.7300 to 0.7600	0.8340 to 0.8640	19 to 20	26 to 27	0.7400 to 0.7551	0.8459 to 0.8610	19 to 20	26 to 27	0.7400 to 0.7551	0.8459 to 0.8610	19 to 20	26 to 27	YES
7	1	16		0.8700 to 0.9110	1.0520 to 1.0820	28 to 30	40 to 41	0.8762 to 0.8976	1.0553 to 1.0703	28 to 30	40 to 41	0.8762 to 0.8976	1.0553 to 1.0703	28 to 30	40 to 41	no
7	2	17		0.7300 to 0.7600	0.8340 to 0.8640	19 to 20	26 to 27	0.7400 to 0.7551	0.8459 to 0.8610	19 to 20	26 to 27	0.7400 to 0.7551	0.8459 to 0.8610	19 to 20	26 to 27	YES
7	3	18		0.6800 to 0.7100	0.7960 to 0.8260	16 to 17	23 to 24	0.6946 to 0.7098	0.8004 to 0.8156	16 to 17	23 to 24	0.6946 to 0.7098	0.8004 to 0.8156	16 to 17	23 to 24	no
8	1	19		2.0200 to 2.0600	2.1980 to 2.2280	97 to 98	107 to 108	2.0238 to 2.0424	2.2020 to 2.2207	97 to 98	107 to 108	2.0238 to 2.0424	2.2020 to 2.2207	97 to 98	107 to 108	no
8	2	20		2.2100 to 2.2400	2.3800 to 2.4150	108 to 109	118 to 119	2.2207 to 2.2374	2.3863 to 2.4022	108 to 109	118 to 119	2.2207 to 2.2374	2.3863 to 2.4022	108 to 109	118 to 119	no
9	1	21		2.2100 to 2.2400	2.3800 to 2.4150	108 to 109	118 to 119	2.2207 to 2.2374	2.3863 to 2.4022	108 to 109	118 to 119	2.2207 to 2.2374	2.3863 to 2.4022	108 to 109	118 to 119	no
10	1	22		2.0200 to 2.0600	2.1980 to 2.2280	97 to 98	107 to 108	2.0238 to 2.0424	2.2020 to 2.2207	97 to 98	107 to 108	2.0238 to 2.0424	2.2020 to 2.2207	97 to 98	107 to 108	no
10	2	23		2.2100 to 2.2400	2.3900 to 2.4190	108 to 109	119 to 120	2.2207 to 2.2374	2.4022 to 2.4182	108 to 109	119 to 120	2.2207 to 2.2374	2.4022 to 2.4182	108 to 109	119 to 120	no
11	1	24		2.2100 to 2.2400	2.3900 to 2.4190	108 to 109	119 to 120	2.2207 to 2.2374	2.4022 to 2.4182	108 to 109	119 to 120	2.2207 to 2.2374	2.4022 to 2.4182	108 to 109	119 to 120	no
12	1	25		2.1300 to 2.1565	2.2658 to 2.2900	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	no
12	2	26		2.2872 to 2.3052	2.3953 to 2.4200	112 to 113	119 to 120	2.2884 to 2.3052	2.4022 to 2.4182	112 to 113	119 to 120	2.2884 to 2.3052	2.4022 to 2.4182	112 to 113	119 to 120	no
13	1	27		2.1284 to 2.1510	2.2500 to 2.2872	103 to 104	110 to 111	2.1329 to 2.1506	2.2548 to 2.2716	103 to 104	110 to 111	2.1329 to 2.1506	2.2548 to 2.2716	103 to 104	110 to 111	no
13	2	28		2.2782 to 2.2984	2.3874 to 2.4200	112 to 112	119 to 120	2.2884 to 2.2884	2.4022 to 2.4182	112 to 112	119 to 120	2.2884 to 2.2884	2.4022 to 2.4182	112 to 112	119 to 120	no
14	1	29		2.1180 to 2.1510	2.2670 to 2.2960	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	no
14	2	30		2.2770 to 2.3100	2.3860 to 2.4150	112 to 113	118 to 119	2.2884 to 2.3052	2.3863 to 2.4022	112 to 113	118 to 119	2.2884 to 2.3052	2.3863 to 2.4022	112 to 113	118 to 119	no
15	1	31		2.1280 to 2.1580	2.2770 to 2.3060	103 to 104	112 to 113	2.1329 to 2.1506	2.2884 to 2.3052	103 to 104	112 to 113	2.1329 to 2.1506	2.2884 to 2.3052	103 to 104	112 to 113	no
15	2	32		2.2870 to 2.3060	2.4050 to 2.4350	112 to 113	120 to 121	2.2884 to 2.3052	2.4182 to 2.4339	112 to 113	120 to 121	2.2884 to 2.3052	2.4182 to 2.4339	112 to 113	120 to 121	no
16	1	33		2.1170 to 2.1570	2.2660 to 2.3000	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	no
16	2	34		2.2800 to 2.3060	2.3850 to 2.4150	112 to 113	118 to 119	2.2884 to 2.3052	2.3863 to 2.4022	112 to 113	118 to 119	2.2884 to 2.3052	2.3863 to 2.4022	112 to 113	118 to 119	no
17	1	35		2.1250 to 2.1550	2.2660 to 2.3000	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	2.1329 to 2.1506	2.2716 to 2.2884	103 to 104	111 to 112	no
17	2	36		2.2750 to 2.3060	2.3850 to 2.4150	112 to 113	118 to 119	2.2884 to 2.3052	2.3863 to 2.4022	112 to 113	118 to 119	2.2884 to 2.3052	2.3863 to 2.4022	112 to 113	118 to 119	no
18	1	37		2.0780 to 2.1080	2.2370 to 2.2670	100 to 101	109 to 110	2.0790 to 2.0971	2.2374 to 2.2548	100 to 101	109 to 110	2.0790 to 2.0971	2.2374 to 2.2548	100 to 101	109 to 110	no
19	1	38		2.0790 to 2.1100	2.2400 to 2.2750	100 to 101	110 to 111	2.0790 to 2.0971	2.2548 to 2.2716	100 to 101	110 to 111	2.0790 to 2.0971	2.2548 to 2.2716	100 to 101	110 to 111	no
20	1	39		2.0780 to 2.1080	2.2500 to 2.2870	100 to 101	110 to 111	2.0790 to 2.0971	2.2548 to 2.2716	100 to 101	110 to 111	2.0790 to 2.0971	2.2548 to 2.2716	100 to 101	110 to 111	no

Values for the three features of reference entry 1 are circled.

These values not shown in this appendix in order to fit the report onto this page. The values not depicted here correspond to each Reference Spectrum's SPECPR filename, record number and title.

The spectrometer channel(s) which fall into the wavelength range of the left continuum endpoint.

The spectrometer channel(s) which fall into the wavelength range of the right continuum endpoint.

If the feature is an absorption feature, this column will have a value of no.

21	1	40	2.0580 to	2.0880	2.2370 to	2.2670	99 to	100	109 to	110	2.0608 to	2.0790	2.2374 to	2.2548	no
22	1	41	2.0540 to	2.0860	2.2770 to	2.3060	99 to	100	112 to	113	2.0608 to	2.0790	2.2884 to	2.3052	no
23	1	42	2.0540 to	2.0860	2.2770 to	2.3060	99 to	100	112 to	113	2.0608 to	2.0790	2.2884 to	2.3052	no
24	1	43	2.0282 to	2.0650	2.2350 to	2.2600	98 to	99	109 to	110	2.0424 to	2.0608	2.2374 to	2.2548	no
24	2	44	1.4430 to	1.4640	1.5000 to	1.5243	64 to	65	68 to	69	1.4497 to	1.4637	1.5054 to	1.5191	no
25	1	45	2.0282 to	2.0650	2.2350 to	2.2600	98 to	99	109 to	110	2.0424 to	2.0608	2.2374 to	2.2548	no
25	2	46	1.4630 to	1.4797	1.5150 to	1.5459	65 to	66	69 to	70	1.4637 to	1.4778	1.5191 to	1.5327	no
26	1	47	2.0900 to	2.1280	2.2100 to	2.2400	101 to	102	108 to	109	2.0971 to	2.1151	2.2207 to	2.2374	no
27	1	48	2.0690 to	2.0990	2.3270 to	2.3570	100 to	101	115 to	116	2.0790 to	2.0971	2.3381 to	2.3544	no
28	1	49	2.0690 to	2.0990	2.3270 to	2.3570	100 to	101	115 to	116	2.0790 to	2.0971	2.3381 to	2.3544	no
29	1	50	2.1180 to	2.1550	2.2500 to	2.2870	103 to	104	110 to	111	2.1329 to	2.1506	2.2548 to	2.2716	no
30	1	51	2.1480 to	2.1780	2.2500 to	2.2870	104 to	105	110 to	111	2.1506 to	2.1679	2.2548 to	2.2716	no
31	1	52	2.0750 to	2.1000	2.2900 to	2.3250	100 to	101	113 to	114	2.0790 to	2.0971	2.3052 to	2.3215	no
31	2	53	1.5000 to	1.5200	1.5800 to	1.6000	68 to	69	74 to	75	1.5054 to	1.5191	1.5859 to	1.5990	no
31	3	54	1.6800 to	1.7100	1.7650 to	1.7850	82 to	83	89 to	89	1.6885 to	1.7010	1.7743 to	1.7743	no
32	1	55	2.1600 to	2.1900	2.4040 to	2.4400	105 to	106	120 to	121	2.1679 to	2.1849	2.4182 to	2.4339	no
32	2	56	2.1880 to	2.2180	2.2580 to	2.2900	107 to	107	111 to	112	2.2020 to	2.2020	2.2716 to	2.2884	no
32	3	57	0.5120 to	0.5420	1.6960 to	1.7260	5 to	6	83 to	85	0.5266 to	0.5420	1.7010 to	1.7258	no
33	1	58	2.2080 to	2.2280	2.2680 to	2.2900	108 to	108	111 to	112	2.2207 to	2.2207	2.2716 to	2.2884	no
33	2	59	2.2200 to	2.2400	2.4040 to	2.4350	108 to	109	120 to	121	2.2207 to	2.2374	2.4182 to	2.4339	no
34	1	60	2.0780 to	2.0990	2.2280 to	2.2580	100 to	101	109 to	110	2.0790 to	2.0971	2.2374 to	2.2548	no
34	2	61	1.4400 to	1.4700	1.5050 to	1.5300	64 to	65	68 to	69	1.4497 to	1.4637	1.5054 to	1.5191	no
34	3	62	2.2530 to	2.2830	2.3440 to	2.3740	110 to	111	116 to	117	2.2548 to	2.2716	2.3544 to	2.3705	no
35	1	63	2.0680 to	2.0990	2.2300 to	2.2680	100 to	101	109 to	110	2.0790 to	2.0971	2.2374 to	2.2548	no
35	2	64	1.4400 to	1.4700	1.5050 to	1.5240	64 to	65	68 to	69	1.4497 to	1.4637	1.5054 to	1.5191	no
35	3	65	2.2680 to	2.2980	2.3400 to	2.3700	111 to	112	116 to	116	2.2716 to	2.2884	2.3544 to	2.3544	no
36	1	66	2.0680 to	2.0990	2.2300 to	2.2680	100 to	101	109 to	110	2.0790 to	2.0971	2.2374 to	2.2548	no
36	2	67	1.4400 to	1.4700	1.5050 to	1.5240	64 to	65	68 to	69	1.4497 to	1.4637	1.5054 to	1.5191	no
36	3	68	2.2680 to	2.2980	2.3400 to	2.3700	111 to	112	116 to	116	2.2716 to	2.2884	2.3544 to	2.3544	no
37	1	69	2.1080 to	2.1380	2.2480 to	2.2780	102 to	103	110 to	111	2.1151 to	2.1329	2.2548 to	2.2716	no
37	2	70	2.2650 to	2.2950	2.3900 to	2.4200	111 to	112	119 to	120	2.2716 to	2.2884	2.4022 to	2.4182	no
38	1	71	2.1050 to	2.1350	2.2480 to	2.2780	102 to	103	110 to	111	2.1151 to	2.1329	2.2548 to	2.2716	no
38	2	72	2.2650 to	2.2950	2.3900 to	2.4200	111 to	112	119 to	120	2.2716 to	2.2884	2.4022 to	2.4182	no
39	1	73	2.1050 to	2.1380	2.2530 to	2.2870	102 to	103	110 to	111	2.1151 to	2.1329	2.2548 to	2.2716	no
39	2	74	2.2650 to	2.2950	2.3900 to	2.4200	111 to	112	119 to	120	2.2716 to	2.2884	2.4022 to	2.4182	no
40	1	75	2.0980 to	2.1350	2.2500 to	2.2870	102 to	103	110 to	111	2.1151 to	2.1329	2.2548 to	2.2716	no
41	1	76	2.1130 to	2.1460	2.2940 to	2.3260	102 to	103	113 to	114	2.1151 to	2.1329	2.3052 to	2.3215	no
41	2	77	2.3040 to	2.3260	2.3630 to	2.3940	113 to	114	117 to	118	2.3052 to	2.3215	2.3705 to	2.3863	no
41	3	78	0.7060 to	0.7380	1.2860 to	1.3200	17 to	18	56 to	58	0.7098 to	0.7250	1.2882 to	1.3162	no
42	1	79	0.7818 to	0.8142	1.2767 to	1.3200	22 to	23	56 to	58	0.7852 to	0.8004	1.2882 to	1.3162	no
42	2	80	2.1236 to	2.1574	2.2745 to	2.3072	103 to	104	112 to	113	2.1329 to	2.1506	2.2884 to	2.3052	no
42	3	81	2.2750 to	2.3100	2.3824 to	2.4149	112 to	113	118 to	119	2.2884 to	2.3052	2.3863 to	2.4022	no
43	1	82	2.1780 to	2.2080	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
43	2	83	2.0900 to	2.1200	2.1800 to	2.2050	101 to	102	106 to	107	2.0971 to	2.1151	2.1849 to	2.2020	no
44	1	84	2.1780 to	2.2080	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
45	1	85	2.1580 to	2.1880	2.3570 to	2.3870	105 to	106	117 to	118	2.1679 to	2.1849	2.3705 to	2.3863	no
46	1	86	2.1980 to	2.2280	2.3860 to	2.4160	107 to	108	118 to	119	2.2020 to	2.2207	2.3863 to	2.4022	no
46	2	87	0.7560 to	0.7850	1.6750 to	1.7050	21 to	21	81 to	83	0.7702 to	0.7702	1.6759 to	1.7010	no
47	1	88	2.2350 to	2.2700	2.3700 to	2.4000	109 to	110	117 to	118	2.2374 to	2.2548	2.3705 to	2.3863	no
47	2	89	2.1300 to	2.1600	2.2480 to	2.2780	103 to	104	110 to	111	2.1329 to	2.1506	2.2548 to	2.2716	no
48	1	90	2.2480 to	2.2780	2.3760 to	2.4060	110 to	111	118 to	119	2.2548 to	2.2716	2.3863 to	2.4022	no
48	2	91	2.1300 to	2.1550	2.2500 to	2.2770	103 to	104	110 to	111	2.1329 to	2.1506	2.2548 to	2.2716	no
49	1	92	2.1590 to	2.1850	2.2500 to	2.2770	105 to	106	110 to	111	2.1679 to	2.1849	2.2548 to	2.2716	no
49	2	93	2.2580 to	2.2900	2.3670 to	2.3950	111 to	112	117 to	118	2.2716 to	2.2884	2.3705 to	2.3863	no
50	1	94	2.2270 to	2.2570	2.3760 to	2.4060	109 to	110	118 to	119	2.2374 to	2.2548	2.3863 to	2.4022	no
50	2	95	2.1300 to	2.1580	2.2270 to	2.2570	103 to	104	109 to	110	2.1329 to	2.1506	2.2374 to	2.2548	no
51	1	96	2.1400 to	2.1700	2.2480 to	2.2780	104 to	105	110 to	111	2.1506 to	2.1679	2.2548 to	2.2716	no

51	2	97	2.2350 to	2.2700	2.3500 to	2.3850	109 to	110	116 to	117	2.2374 to	2.2548	2.3544 to	2.3705	no
52	1	98	2.1070 to	2.1400	2.2290 to	2.2580	102 to	103	109 to	110	2.1151 to	2.1329	2.2374 to	2.2548	no
52	2	99	2.2290 to	2.2580	2.3900 to	2.4200	109 to	110	119 to	120	2.2374 to	2.2548	2.4022 to	2.4182	no
53	1	100	2.1190 to	2.1550	2.3580 to	2.3900	103 to	104	117 to	118	2.1329 to	2.1506	2.3705 to	2.3863	no
54	1	101	2.1160 to	2.1550	2.3700 to	2.3900	103 to	104	117 to	118	2.1329 to	2.1506	2.3705 to	2.3863	no
55	1	102	2.2200 to	2.2500	2.3240 to	2.3550	108 to	109	115 to	116	2.2207 to	2.2374	2.3381 to	2.3544	no
55	2	103	2.3240 to	2.3550	2.4050 to	2.4350	115 to	116	120 to	121	2.3381 to	2.3544	2.4182 to	2.4339	no
56	1	104	2.1780 to	2.2028	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
57	1	105	2.1780 to	2.2028	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
58	1	106	0.8100 to	0.8400	1.3000 to	1.3200	24 to	25	57 to	58	0.8156 to	0.8306	1.3021 to	1.3162	no
58	2	107	2.1780 to	2.2028	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
59	1	108	2.1780 to	2.2028	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
59	2	109	2.0600 to	2.0800	2.1650 to	2.1850	99 to	100	105 to	106	2.0608 to	2.0790	2.1679 to	2.1849	no
60	1	110	2.1780 to	2.2028	2.3770 to	2.4060	106 to	107	118 to	119	2.1849 to	2.2020	2.3863 to	2.4022	no
60	2	111	2.0600 to	2.0800	2.1650 to	2.1850	99 to	100	105 to	106	2.0608 to	2.0790	2.1679 to	2.1849	no

The total number of diagnostic features listed in the command file.

The identification number (ID #) of the NOT feature invoked. In the command file, each NOT feature listed has a unique ID number

The method of determining the depth threshold constraint for the NOT feature, either based on the exact value in the command file (absolute) or by multiplying the value in the command file by the depth value of another of the NOT material's diagnostic features (relative).

COMMAND FILE NOT FEATURE REFERENCE ENTRIES:

Not #	Refer. #	Reference SPECPR Filename	Reference SPECPR Rec	Reference SPECPR Title	Not Feat. ID #	NOT Feature Type	Depth Check Type	NOT Feature SPECPR File	NOT Feature SPECPR Rec	NOT Feature SPECPR Title
1	3	splib06b_cvhymp07_124ch	690	Melting_snow mSnlw1a	1	Absorption	Absolute	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2
2	4	splib06b_cvhymp07_124ch	698	Melting_snow mSnlw9 (slush)	1	Absorption	Absolute	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2
3	18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby
4	18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)
5	18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)
6	19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (pxl)	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby
7	19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (pxl)	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)
8	19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (pxl)	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)
9	20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby
10	20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)
11	20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)
12	21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby
13	21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)
14	21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)
15	22	splib06b_cvhymp07_124ch	87	Buddingtonite GDS85 D-206	10	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480
16	22	splib06b_cvhymp07_124ch	87	Buddingtonite GDS85 D-206	11	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3
17	23	splib06b_cvhymp07_124ch	973	Buddingtnt+Na-Mont CU93-260B	10	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480
18	23	splib06b_cvhymp07_124ch	973	Buddingtnt+Na-Mont CU93-260B	11	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3
19	26	splib06b_cvhymp07_124ch	380	Pyrophyllite FYS1A fine gr	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)
20	26	splib06b_cvhymp07_124ch	380	Pyrophyllite FYS1A fine gr	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)

The SPECPR filename, record number, and title of the reference entry (material) that has invoked the NOT feature.

The SPECPR filename, record number, and title of the NOT feature invoked.

The identification number of the reference entry (material) that has invoked the NOT feature.

Reference entry with identification number 19 (Kaolinite KGa-2) invokes three NOT features.

A counter tracking the number of times a NOT feature is invoked.

21	29	splib06b_cvhymp07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV
22	29	splib06b_cvhymp07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	5	Absorption	Relative	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV
23	30	splib06b_cvhymp07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV
24	30	splib06b_cvhymp07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	5	Absorption	Relative	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV
25	37	splib06b_cvhymp07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV
26	37	splib06b_cvhymp07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV
27	38	splib06b_cvhymp07_124ch	530	Kaol_Wx1+0.5Musc_Ruby AMX12	W1R1Ba	CONV	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV
28	38	splib06b_cvhymp07_124ch	530	Kaol_Wx1+0.5Musc_Ruby AMX12	W1R1Ba	CONV	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV
29	39	splib06b_cvhymp07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV
30	39	splib06b_cvhymp07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV
31	40	splib06b_cvhymp07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	2	Absorption	Relative	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV
32	40	splib06b_cvhymp07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	3	Absorption	Relative	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV
33	40	splib06b_cvhymp07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	4	Absorption	Relative	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV
34	40	splib06b_cvhymp07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	5	Absorption	Relative	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV
35	43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	6	Absorption	Absolute	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV
36	43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	7	Absorption	Relative	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV
37	43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
38	43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
39	44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	12	Absorption	Absolute	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV
40	44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	6	Absorption	Absolute	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV
41	44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	7	Absorption	Relative	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV
42	44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
43	44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
44	45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
45	45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
46	48	splib06b_cvhymp07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
47	48	splib06b_cvhymp07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
48	49	splib06b_cvhymp07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
49	49	splib06b_cvhymp07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
50	50	splib06b_cvhymp07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	7	Absorption	Relative	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV
51	55	splib06b_cvhymp07_124ch	468	Tremolite HS18.3	W1R1Bc	CONV	8	Absorption	Relative	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
52	55	splib06b_cvhymp07_124ch	468	Tremolite HS18.3	W1R1Bc	CONV	9	Absorption	Relative	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
53	56	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
54	56	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
55	57	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
56	57	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
57	58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
58	58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
59	59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
60	59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV
61	60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	8	Absorption	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV
62	60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	9	Absorption	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV

This line marks the beginning of a block of text reporting on the analysis of an input spectrum (observed spectrum).

The input spectrum (observed spectrum) being analyzed, its SPECPR filename, record number and title are reported.

```
----- STARTING ANALYSIS -----
SPECPR file, record Analyzed: C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch, 905 (SPECPR title = Rangeland L02-022 S20% G09% W1R1Fa CONV)
Command file used: C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
Total number of reference spectra = 60
Total number of reference features = 111
Total number of listed NOT features = 12
Total number of references to NOT features = 60
```

Information on the command file being used to analyze the spectrum.

This column contains the “weighted fits”, that is the summation of the individual diagnostic feature fits multiplied by the weighting factors specified in the command file.

Following this line, the final fit values from the comparison of the input spectrum (observed spectrum) to each reference material (reference spectrum) are reported. These values are the “final weighted fits”, that is the summation of the individual diagnostic feature fits multiplied by the weighting factors specified in the command file.

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Final Fit Value	(Fit before) (constraints)	Output Name
1	splib06b_cvhymap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	0.0000	{0.9013}	vegetation_green
2	splib06b_cvhymap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	0.9529	{0.9529}	vegetation.dry+green
3	splib06b_cvhymap07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	0.0000	{0.3286}	snow_melting
4	splib06b_cvhymap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	0.0000	{0.4622}	snow_slush
5	splib06b_cvhymap07_124ch	566	Seawater_Coast_Ch1 SW1 W1R1Ba CONV	0.0000	{0.5326}	water
6	splib06b_cvhymap07_124ch	704	Water+Montmor SWy-2+5.01g/1 W1R1Fa CONV	0.0000	{0.8776}	water_sediment_high
7	splib06b_cvhymap07_124ch	701	Water+Montmor SWy-2+0.5g/1 W1R1Fa CONV	0.0000	{0.8578}	water_sediment_low
8	splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	0.9663	{0.9663}	dry_veg_grass
9	splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	0.9639	{0.9639}	dry_veg_grass_2_3um
10	splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	0.9647	{0.9647}	dry_veg_nongrass
11	splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	0.9814	{0.9814}	dry_veg_nongrass_2_3um
12	splib06b_cvhymap07_124ch	965	Muscovite CU93-1 low-Al Phyl W2R4Nb CONV	0.0000	{0.6754}	muscovite_lowAl
13	splib06b_cvhymap07_124ch	674	Muscovite-medlowAl CU91-250A W1R1Fb CONV	0.0000	{0.5771}	muscovite_medAl
14	splib06b_cvhymap07_124ch	308	Muscovite GDS113 Ruby W1R1Bb CONV	0.0000	{0.4812}	muscovite_medhighAl
15	splib06b_cvhymap07_124ch	310	Muscovite GDS116 Tanzania W1R1Ba CONV	0.0000	{0.6538}	muscovite_Fe-rich
16	splib06b_cvhymap07_124ch	236	Illite IMt-1.b <2um W1R1Ba CONV	0.0000	{0.8727}	illite
17	splib06b_cvhymap07_124ch	232	Illite GDS4 (Marblehead) W1R1Bb CONV	0.0000	{0.9019}	illite_gds4
18	splib06b_cvhymap07_124ch	252	Kaolinite CM9 W1R1Bb CONV	0.0000	{0.2829}	kaolinite_wx1
19	splib06b_cvhymap07_124ch	255	Kaolinite KGa-2 (pxl) W1R1Bb CONV	0.0000	{0.3819}	kaolinite_pxl

The identification (ID) number of the reference entry (reference material).

The SPECPR filename, record number, and title of the reference entry (material).

This column contains the final fit values of each reference material after checking its constraints. If any constraint was violated, the calculated weighted fit (in the column to the right) was zeroed. The **highest** fit value in this column determines the **best match** to the observed spectrum.

20	splib06b_cvhyomap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	0.0000	(0.5011)	kaolin+clay_mica_or_halloysite
21	splib06b_cvhyomap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	0.0000	(0.2665)	kaol_possible_alunite_or_dicki
22	splib06b_cvhyomap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	0.0000	(0.0319)	buddingtonite
23	splib06b_cvhyomap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb	CONV	0.0000	(0.1422)	buddingtonite+montmorillonite
24	splib06b_cvhyomap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	0.0000	(0.0332)	alunite_K_250c
25	splib06b_cvhyomap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	0.0000	(0.1719)	alunite_Na_450c
26	splib06b_cvhyomap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	0.0000	(0.0070)	pyrophyllite
27	splib06b_cvhyomap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	0.0000	(0.2712)	jarosite_Na
28	splib06b_cvhyomap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	0.0000	(0.3224)	jarosite_K
29	splib06b_cvhyomap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	0.0000	(0.7261)	montmorillonite_Na
30	splib06b_cvhyomap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	0.0000	(0.7681)	montmorillonite_Ca
31	splib06b_cvhyomap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	0.0000	(0.7086)	gypsum
32	splib06b_cvhyomap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	0.0000	(0.4571)	chlorite_lowFe
33	splib06b_cvhyomap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	0.0000	(0.6299)	epidote
34	splib06b_cvhyomap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	0.0000	(0.1227)	pyrophyllite.5+alunite.5
35	splib06b_cvhyomap07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	0.0000	(0.2648)	alunite.5+kaolinite.5
36	splib06b_cvhyomap07_124ch	536	Kaolwxl.75+Alun_HS295 AMX14	W1R1Bb	CONV	0.0000	(0.2610)	alunite.25+kaolinite.75
37	splib06b_cvhyomap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	0.0000	(0.4697)	kaolin.5+muscovite_medAl
38	splib06b_cvhyomap07_124ch	530	Kaol_Wxl+0.5Musc_Ruby AMX12	W1R1Ba	CONV	0.0000	(0.3886)	kaolin.5+muscovite_medhighAl
39	splib06b_cvhyomap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	0.0000	(0.6233)	kaolin+muscovite_mix_intimate
40	splib06b_cvhyomap07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	0.0000	(0.4139)	kaolin.5+smectite.5
41	splib06b_cvhyomap07_124ch	543	Muscov+Jaros CU93-314 coatng	W1R1Bb	CONV	0.0000	(0.5001)	jarosite+muscovite_mix_intimat
42	splib06b_cvhyomap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	0.0000	(0.2241)	chlorite+muscovite
43	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.7213)	calcite_abundant
44	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.7213)	calcite
45	splib06b_cvhyomap07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	0.0000	(0.3356)	dolomite
46	splib06b_cvhyomap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	0.0000	(0.6679)	carbonate_Fe_bearing
47	splib06b_cvhyomap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	0.0000	(0.5488)	dolomite.25+calcite.25+mont_Na
48	splib06b_cvhyomap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	0.0000	(0.6087)	calcite.8+montmorillonite_Na.2
49	splib06b_cvhyomap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	0.0000	(0.7722)	calcite.8+montmorillonite_Ca.2
50	splib06b_cvhyomap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	0.0000	(0.4216)	calcite.7+muscovite.3
51	splib06b_cvhyomap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	0.0000	(0.5201)	dolomite.5+montmorillonite_Na.
52	splib06b_cvhyomap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	0.0000	(0.4644)	kaolin.2+calcite.8
53	splib06b_cvhyomap07_124ch	101	Chalcedony CU91-6A	W1R1Ba	CONV	0.0000	(0.4225)	chalcedony
54	splib06b_cvhyomap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba	CONV	0.0000	(0.3638)	hydrated_silica
55	splib06b_cvhyomap07_124ch	468	Tremolite HS18.3	W1R1Bc	CONV	0.0000	(0.7610)	tremolite_or_talc
56	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.6159)	serpentine_or_dolomite+calcite
57	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	0.0000	(0.4893)	serpentine1
58	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.6159)	serpentine2

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59      splib06b_cvhymp07_124ch      115  Chrysotile HS323.1B      W1R1Ba CONV      0.0000      (0.4893)      serpentine3
60      splib06b_cvhymp07_124ch      67   Antigorite NMNH96917.d 70um W1R1Bb CONV      0.0000      (0.6159)      serpentine4

```

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
11	dry_veg_nongrass_2_3um	0.9814	0.0986
8	dry_veg_grass	0.9663	0.0791
10	dry_veg_nongrass	0.9647	0.0841
9	dry_veg_grass_2_3um	0.9639	0.0861
2	vegetation.dry+green	0.9529	0.1417

The materials with the five highest fit values. On each line, the ID number of the reference material (reference spectrum) and its output name are given with the final fit value and associated depth value.

Details of the best match are reported.

BEST MATCH:

```

Observed Spectrum (SPECPR Title=Rangeland L02-022 S20% G09% W1R1Fa CONV) was best matched by Reference Spectrum (Output name=dry_veg_nongrass_2_3um) with a fit of 0.9814
Observed (SPECPR File= splib06b_cvhymp07_124ch; Record= 905; Title= Rangeland L02-022 S20% G09% W1R1Fa CONV)
Reference (SPECPR File= splib06b_cvhymp07_124ch; Record= 831; Title= Lodgepole-Pine LP-Needles-3 W1R1Fa CONV)
Fit= 0.9814 Depth= 0.0986 Fit*Depth= 0.0968

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----- END ANALYSIS -----

This line marks the beginning of the block of text reporting on the analysis of the next input spectrum (observed spectrum).

This line marks the end of the block of text reporting on the analysis of the first input spectrum (observed spectrum).

----- STARTING ANALYSIS -----

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SPECPR file,record Analyzed: C:\usgsprism\mica_hymap\splib06b_cvhymp07_124ch, 908 (SPECPR title = Rangeland L02-042 S01% G57% W1R1Fa CONV)
Command file used: C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
Total number of reference spectra = 60
Total number of reference features = 111
Total number of listed NOT features = 12
Total number of references to NOT features = 62

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FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Final Fit Value	(Fit before) (constraints)	Output Name
1	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	0.0000	(0.8085)	vegetation_green
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	0.0000	(0.8977)	vegetation.dry+green
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	0.0000	(0.2229)	snow_melting

4	splib06b_cvhyomap07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Fa	CONV	0.0000	(0.2364)	snow_slush
5	splib06b_cvhyomap07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba	CONV	0.0000	(0.5627)	water
6	splib06b_cvhyomap07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa	CONV	0.0000	(0.6911)	water_sediment_high
7	splib06b_cvhyomap07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa	CONV	0.0000	(0.7159)	water_sediment_low
8	splib06b_cvhyomap07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV	0.9931	(0.9931)	dry_veg_grass
9	splib06b_cvhyomap07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV	0.9939	(0.9939)	dry_veg_grass_2_3um
10	splib06b_cvhyomap07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	0.9320	(0.9320)	dry_veg_nongrass
11	splib06b_cvhyomap07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	0.9735	(0.9735)	dry_veg_nongrass_2_3um
12	splib06b_cvhyomap07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb	CONV	0.0000	(0.7268)	muscovite_lowAl
13	splib06b_cvhyomap07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb	CONV	0.0000	(0.6802)	muscovite_medAl
14	splib06b_cvhyomap07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV	0.0000	(0.6178)	muscovite_medhighAl
15	splib06b_cvhyomap07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba	CONV	0.0000	(0.6730)	muscovite_Fe-rich
16	splib06b_cvhyomap07_124ch	236	Illite IMT-1.b <2um	W1R1Ba	CONV	0.0000	(0.8874)	illite
17	splib06b_cvhyomap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	0.0000	(0.8996)	illite_gds4
18	splib06b_cvhyomap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	0.0000	(0.5925)	kaolinite_wxl
19	splib06b_cvhyomap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	0.0000	(0.5971)	kaolinite_pxl
20	splib06b_cvhyomap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	0.0000	(0.6998)	kaolin+clay_mica_or_halloysite
21	splib06b_cvhyomap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	0.0000	(0.5387)	kaol_possible_alunite_or_dicki
22	splib06b_cvhyomap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	0.0000	(0.0741)	buddingtonite
23	splib06b_cvhyomap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb	CONV	0.0000	(0.2469)	buddingtonite+montmorillonite
24	splib06b_cvhyomap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	0.0000	(0.1346)	alunite_K_250c
25	splib06b_cvhyomap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	0.0000	(0.2979)	alunite_Na_450c
26	splib06b_cvhyomap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	0.0000	(0.2881)	pyrophyllite
27	splib06b_cvhyomap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	0.0000	(0.1811)	jarosite_Na
28	splib06b_cvhyomap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	0.0000	(0.2422)	jarosite_K
29	splib06b_cvhyomap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	0.0000	(0.8411)	montmorillonite_Na
30	splib06b_cvhyomap07_124ch	298	Montmorillonite SAZ-1	W1R1Bb	CONV	0.0000	(0.8199)	montmorillonite_Ca
31	splib06b_cvhyomap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	0.0000	(0.6754)	gypsum
32	splib06b_cvhyomap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	0.0000	(0.5557)	chlorite_lowFe
33	splib06b_cvhyomap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	0.6216	(0.6216)	epidote
34	splib06b_cvhyomap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	0.0000	(0.3566)	pyrophyllite.5+alunite.5
35	splib06b_cvhyomap07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	0.0000	(0.5574)	alunite.5+kaolinite.5
36	splib06b_cvhyomap07_124ch	536	Kaolwxl.75+Alun_HS295 AMX14	W1R1Bb	CONV	0.0000	(0.5561)	alunite.25+kaolinite.75
37	splib06b_cvhyomap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	0.0000	(0.6643)	kaolin.5+muscovite_medAl
38	splib06b_cvhyomap07_124ch	530	Kaol_Wxl+0.5Musc_Ruby AMX12	W1R1Ba	CONV	0.0000	(0.5775)	kaolin.5+muscovite_medhighAl
39	splib06b_cvhyomap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	0.0000	(0.7736)	kaolin+muscovite_mix_intimate
40	splib06b_cvhyomap07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	0.0000	(0.6059)	kaolin.5+smectite.5
41	splib06b_cvhyomap07_124ch	543	Muscov+Jaros CU93-314 coatng	W1R1Bb	CONV	0.0000	(0.5712)	jarosite+muscovite_mix_intimat
42	splib06b_cvhyomap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	0.0000	(0.3356)	chlorite+muscovite
43	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.7909)	calcite_abundant
44	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.7909)	calcite
45	splib06b_cvhyomap07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	0.0000	(0.4872)	dolomite
46	splib06b_cvhyomap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	0.0000	(0.6660)	carbonate_Fe_bearing
47	splib06b_cvhyomap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	0.0000	(0.6190)	dolomite.25+calcite.25+mont_Na
48	splib06b_cvhyomap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	0.0000	(0.7069)	calcite.8+montmorillonite_Na.2
49	splib06b_cvhyomap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	0.0000	(0.8781)	calcite.8+montmorillonite_Ca.2
50	splib06b_cvhyomap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	0.0000	(0.5181)	calcite.7+muscovite.3
51	splib06b_cvhyomap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	0.0000	(0.5882)	dolomite.5+montmorillonite_Na.
52	splib06b_cvhyomap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	0.0000	(0.5837)	kaolin.2+calcite.8
53	splib06b_cvhyomap07_124ch	101	Chalcedony CU91-6A	W1R1Ba	CONV	0.0000	(0.3291)	chalcedony
54	splib06b_cvhyomap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba	CONV	0.0000	(0.2521)	hydrated_silica

55	splib06b_cvhyomap07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	0.0000	(0.6332)	tremolite_or_talc
56	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.0000	(0.7102)	serpentine_or_dolomite+calcite
57	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	0.0000	(0.5415)	serpentine1
58	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.0000	(0.7102)	serpentine2
59	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	0.0000	(0.5415)	serpentine3
60	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.0000	(0.7102)	serpentine4

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
9	dry_veg_grass_2_3um	0.9939	0.0954
8	dry_veg_grass	0.9931	0.0996
11	dry_veg_nongrass_2_3um	0.9735	0.1064
10	dry_veg_nongrass	0.9320	0.1011
33	epidote	0.6216	0.0851

BEST MATCH:

Observed (SPECPR Title=Rangeland L02-042 S01% G57% W1R1Fa CONV) was best matched by Reference (Output name=dry_veg_grass_2_3um) with a fit of 0.9939
 Observed (SPECPR File= splib06b_cvhyomap07_124ch; Record= 908; Title= Rangeland L02-042 S01% G57% W1R1Fa CONV)
 Reference (SPECPR File= splib06b_cvhyomap07_124ch; Record= 812; Title= Grass_Golden_Dry GDS480 W1R1Fa CONV)
 Fit= 0.9939 Depth= 0.0954 Fit*Depth= 0.0948

----- END ANALYSIS -----

----- STARTING ANALYSIS -----

SPECPR file, record Analyzed: C:\usgsprism\mica_hymap\splib06b_cvhyomap07_124ch, 909 (SPECPR title = Rangeland L02-043 S01% G07% W1R1Fa CONV)
 Command file used: C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
 Total number of reference spectra = 60
 Total number of reference features = 111
 Total number of listed NOT features = 12
 Total number of references to NOT features = 62

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Final Fit Value	(Fit before) (constraints)	Output Name
1	splib06b_cvhyomap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	0.0000	(0.1561)	vegetation_green
2	splib06b_cvhyomap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	0.0000	(0.1069)	vegetation.dry+green
3	splib06b_cvhyomap07_124ch	690	Melting_snow mSnlwla W1R1Fa CONV	0.0000	(0.3755)	snow_melting
4	splib06b_cvhyomap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	0.0000	(0.5666)	snow_slush
5	splib06b_cvhyomap07_124ch	566	Seawater_Coast_Ch1 SW1 W1R1Ba CONV	0.0000	(0.6646)	water
6	splib06b_cvhyomap07_124ch	704	Water+Montmor SWy-2+5.01g/l W1R1Fa CONV	0.0000	(0.8632)	water_sediment_high
7	splib06b_cvhyomap07_124ch	701	Water+Montmor SWy-2+0.5g/l W1R1Fa CONV	0.0000	(0.8731)	water_sediment_low
8	splib06b_cvhyomap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	0.0000	(0.1519)	dry_veg_grass
9	splib06b_cvhyomap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	0.0000	(0.2232)	dry_veg_grass_2_3um
10	splib06b_cvhyomap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	0.0000	(0.1724)	dry_veg_nongrass
11	splib06b_cvhyomap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	0.0000	(0.2936)	dry_veg_nongrass_2_3um
12	splib06b_cvhyomap07_124ch	965	Muscovite CU93-1 low-Al Phyl W2R4Nb CONV	0.0000	(0.2111)	muscovite_lowAl
13	splib06b_cvhyomap07_124ch	674	Muscovite-medlowAl CU91-250A W1R1Fb CONV	0.0000	(0.5244)	muscovite_medAl
14	splib06b_cvhyomap07_124ch	308	Muscovite GDS113 Ruby W1R1Bb CONV	0.0000	(0.5106)	muscovite_medhighAl
15	splib06b_cvhyomap07_124ch	310	Muscovite GDS116 Tanzania W1R1Ba CONV	0.0000	(0.0187)	muscovite_Fe-rich

16	splib06b_cvhyomap07_124ch	236	Illite IMt-1.b <2um	W1R1Ba	CONV	0.0000	(0.2176)	illite
17	splib06b_cvhyomap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	0.0000	(0.2015)	illite_gds4
18	splib06b_cvhyomap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	0.0000	(0.8691)	kaolinite_wxl
19	splib06b_cvhyomap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	0.0000	(0.8216)	kaolinite_pxl
20	splib06b_cvhyomap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	0.0000	(0.7671)	kaolin+clay_mica_or_halloysite
21	splib06b_cvhyomap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	0.0000	(0.8661)	kaol_possible_alunite_or_dicki
22	splib06b_cvhyomap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	0.0000	(0.0567)	buddingtonite
23	splib06b_cvhyomap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb	CONV	0.0000	(0.2150)	buddingtonite+montmorillonite
24	splib06b_cvhyomap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	0.0000	(0.5150)	alunite_K_250c
25	splib06b_cvhyomap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	0.6294	(0.6294)	alunite_Na_450c
26	splib06b_cvhyomap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	0.0000	(0.3039)	pyrophyllite
27	splib06b_cvhyomap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	0.0000	(0.3161)	jarosite_Na
28	splib06b_cvhyomap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	0.0000	(0.1755)	jarosite_K
29	splib06b_cvhyomap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	0.0000	(0.2907)	montmorillonite_Na
30	splib06b_cvhyomap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	0.0000	(0.0009)	montmorillonite_Ca
31	splib06b_cvhyomap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	0.0000	(0.4705)	gypsum
32	splib06b_cvhyomap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	0.0000	(0.3388)	chlorite_lowFe
33	splib06b_cvhyomap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	0.0000	(0.3431)	epidote
34	splib06b_cvhyomap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	0.0000	(0.4963)	pyrophyllite.5+alunite.5
35	splib06b_cvhyomap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb	CONV	0.0000	(0.7272)	alunite.5+kaolinite.5
36	splib06b_cvhyomap07_124ch	536	Kaolwxl.75+Alun_HS295 AMX14	W1R1Bb	CONV	0.0000	(0.7500)	alunite.25+kaolinite.75
37	splib06b_cvhyomap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	0.6993	(0.6993)	kaolin.5+muscovite_medAl
38	splib06b_cvhyomap07_124ch	530	Kaol_Wxl+0.5Musc_Ruby AMX12	W1R1Ba	CONV	0.7567	(0.7567)	kaolin.5+muscovite_medhighAl
39	splib06b_cvhyomap07_124ch	528	Kaol+Musc intimate CU93-5C	W1R1Ba	CONV	0.0000	(0.4961)	kaolin+muscovite_mix_intimate
40	splib06b_cvhyomap07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	0.0000	(0.7394)	kaolin.5+smectite.5
41	splib06b_cvhyomap07_124ch	543	Muscov+Jaros CU93-314 coatng	W1R1Bb	CONV	0.0000	(0.0128)	jarosite+muscovite_mix_intimat
42	splib06b_cvhyomap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	0.0000	(0.3078)	chlorite+muscovite
43	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.0340)	calcite_abundant
44	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.0340)	calcite
45	splib06b_cvhyomap07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	0.0000	(0.0534)	dolomite
46	splib06b_cvhyomap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	0.0000	(0.2698)	carbonate_Fe_bearing
47	splib06b_cvhyomap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	0.6890	(0.6890)	dolomite.25+calcite.25+mont_Na
48	splib06b_cvhyomap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	0.0000	(0.5357)	calcite.8+montmorillonite_Na.2
49	splib06b_cvhyomap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	0.0000	(0.4362)	calcite.8+montmorillonite_Ca.2
50	splib06b_cvhyomap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	0.8738	(0.8738)	calcite.7+muscovite.3
51	splib06b_cvhyomap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	0.6278	(0.6278)	dolomite.5+montmorillonite_Na.
52	splib06b_cvhyomap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	0.9245	(0.9245)	kaolin.2+calcite.8
53	splib06b_cvhyomap07_124ch	101	Chalcedony CU91-6A	W1R1Ba	CONV	0.0000	(0.1158)	chalcedony
54	splib06b_cvhyomap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba	CONV	0.0000	(0.2443)	hydrated_silica
55	splib06b_cvhyomap07_124ch	468	Tremolite HS18.3	W1R1Bc	CONV	0.0000	(0.0758)	tremolite_or_talc
56	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.0017)	serpentine_or_dolomite+calcite
57	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	0.0000	(0.0347)	serpentine1
58	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.0017)	serpentine2
59	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	0.0000	(0.0347)	serpentine3
60	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.0017)	serpentine4

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
52	kaolin.2+calcite.8	0.9245	0.0491

50	calcite.7+muscovite.3	0.8738	0.0506
38	kaolin.5+muscovite_medhighAl	0.7567	0.0636
37	kaolin.5+muscovite_medAl	0.6993	0.0602
47	dolomite.25+calcite.25+mont_Na.5	0.6890	0.0380

BEST MATCH:

Observed (SPECPR Title=Rangeland L02-043 S01% G07% W1R1Fa CONV) was best matched by Reference (Output name=kaolin.2+calcite.8) with a fit of 0.9245
 Observed (SPECPR File= splib06b_cvhyamap07_124ch; Record= 909; Title= Rangeland L02-043 S01% G07% W1R1Fa CONV)
 Reference (SPECPR File= splib06b_cvhyamap07_124ch; Record= 508; Title= Calcite.80wt+Kaol_CM9 GDS213 W1R1Ba CONV)
 Fit= 0.9245 Depth= 0.0491 Fit*Depth= 0.0453

----- END ANALYSIS -----

----- STARTING ANALYSIS -----

SPECPR file,record Analyzed: C:\usgsprism\mica_hymap\splib06b_cvhyamap07_124ch, 921 (SPECPR title = Rangeland L04-047 S00% G47% W1R1Fa CONV)
 Command file used: C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
 Total number of reference spectra = 60
 Total number of reference features = 111
 Total number of listed NOT features = 12
 Total number of references to NOT features = 62

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Final Fit Value	(Fit before) (constraints)	Output Name
1	splib06b_cvhyamap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	0.9950	(0.9950)	vegetation_green
2	splib06b_cvhyamap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	0.9419	(0.9419)	vegetation.dry+green
3	splib06b_cvhyamap07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	0.0000	(0.1974)	snow_melting
4	splib06b_cvhyamap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	0.0000	(0.3553)	snow_slush
5	splib06b_cvhyamap07_124ch	566	Seawater_Coast_Ch1 SW1 W1R1Ba CONV	0.0000	(0.6434)	water
6	splib06b_cvhyamap07_124ch	704	Water+Montmor SWy-2+5.01g/l W1R1Fa CONV	0.0000	(0.8710)	water_sediment_high
7	splib06b_cvhyamap07_124ch	701	Water+Montmor SWy-2+0.5g/l W1R1Fa CONV	0.0000	(0.8533)	water_sediment_low
8	splib06b_cvhyamap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	0.0000	(0.7481)	dry_veg_grass
9	splib06b_cvhyamap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	0.0000	(0.9406)	dry_veg_grass_2_3um
10	splib06b_cvhyamap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	0.0000	(0.6147)	dry_veg_nongrass
11	splib06b_cvhyamap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	0.0000	(0.9261)	dry_veg_nongrass_2_3um
12	splib06b_cvhyamap07_124ch	965	Muscovite CU93-1 low-Al Phyl W2R4Nb CONV	0.0000	(0.7330)	muscovite_lowAl
13	splib06b_cvhyamap07_124ch	674	Muscovite-medlowAl CU91-250A W1R1Fb CONV	0.0000	(0.7540)	muscovite_medAl
14	splib06b_cvhyamap07_124ch	308	Muscovite GDS113 Ruby W1R1Bb CONV	0.0000	(0.6751)	muscovite_medhighAl
15	splib06b_cvhyamap07_124ch	310	Muscovite GDS116 Tanzania W1R1Ba CONV	0.0000	(0.6515)	muscovite_Fe-rich
16	splib06b_cvhyamap07_124ch	236	Illite IMT-1.b <2um W1R1Ba CONV	0.0000	(0.8906)	illite
17	splib06b_cvhyamap07_124ch	232	Illite GDS4 (Marblehead) W1R1Bb CONV	0.0000	(0.8739)	illite_gds4
18	splib06b_cvhyamap07_124ch	252	Kaolinite CM9 W1R1Bb CONV	0.0000	(0.7918)	kaolinite_wxl
19	splib06b_cvhyamap07_124ch	255	Kaolinite KGa-2 (pxl) W1R1Bb CONV	0.0000	(0.7398)	kaolinite_pxl
20	splib06b_cvhyamap07_124ch	197	Halloysite NMNH106237 W1R1Ba CONV	0.0000	(0.7960)	kaolin+clay_mica_or_halloysite
21	splib06b_cvhyamap07_124ch	144	Dickite NMNH106242 W1R1Bb CONV	0.0000	(0.7938)	kaol_possible_alunite_or_dicki
22	splib06b_cvhyamap07_124ch	87	Buddingtonite GDS85 D-206 W1R1Bb CONV	0.0000	(0.2630)	buddingtonite
23	splib06b_cvhyamap07_124ch	973	Buddingtnt+Na-Mont CU93-260B W2R4Nb CONV	0.0000	(0.4734)	buddingtonite+montmorillonite
24	splib06b_cvhyamap07_124ch	945	Alunite GDS96 K Syn (250C) W2R4Na CONV	0.0000	(0.6471)	alunite_K_250c
25	splib06b_cvhyamap07_124ch	948	Alunite RES-3 Na Syn (450C) W2R4Na CONV	0.0000	(0.8207)	alunite_Na_450c
26	splib06b_cvhyamap07_124ch	380	Pyrophyllite PYS1A fine gr W1R1Ba CONV	0.0000	(0.3973)	pyrophyllite
27	splib06b_cvhyamap07_124ch	241	Jarosite GDS24 Na W1R1Bb CONV	0.0000	(0.4020)	jarosite_Na

28	splib06b_cvhyomap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba CONV	0.0000	(0.4807)	jarosite_K
29	splib06b_cvhyomap07_124ch	302	Montmorillonite SWy-1	W1R1Bb CONV	0.0000	(0.8988)	montmorillonite_Na
30	splib06b_cvhyomap07_124ch	298	Montmorillonite SAZ-1	W1R1Bb CONV	0.0000	(0.7938)	montmorillonite_Ca
31	splib06b_cvhyomap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba CONV	0.0000	(0.6323)	gypsum
32	splib06b_cvhyomap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba CONV	0.0000	(0.2550)	chlorite_lowFe
33	splib06b_cvhyomap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb CONV	0.6356	(0.6356)	epidote
34	splib06b_cvhyomap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb CONV	0.0000	(0.5836)	pyrophyllite.5+alunite.5
35	splib06b_cvhyomap07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb CONV	0.0000	(0.7709)	alunite.5+kaolinite.5
36	splib06b_cvhyomap07_124ch	536	Kaolwxl.75+Alun_HS295 AMX14	W1R1Bb CONV	0.0000	(0.7558)	alunite.25+kaolinite.75
37	splib06b_cvhyomap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb CONV	0.0000	(0.7816)	kaolin.5+muscovite_medAl
38	splib06b_cvhyomap07_124ch	530	Kaol_Wxl+0.5Musc_Ruby AMX12	W1R1Ba CONV	0.0000	(0.7016)	kaolin.5+muscovite_medhighAl
39	splib06b_cvhyomap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba CONV	0.0000	(0.8444)	kaolin+muscovite_mix_intimate
40	splib06b_cvhyomap07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb CONV	0.0000	(0.7306)	kaolin.5+smectite.5
41	splib06b_cvhyomap07_124ch	543	Muscov+Jaros CU93-314 coatng	W1R1Bb CONV	0.0000	(0.5594)	jarosite+muscovite_mix_intimat
42	splib06b_cvhyomap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba CONV	0.0000	(0.4587)	chlorite+muscovite
43	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba CONV	0.0000	(0.1962)	calcite_abundant
44	splib06b_cvhyomap07_124ch	94	Calcite WS272	W1R1Ba CONV	0.0000	(0.1962)	calcite
45	splib06b_cvhyomap07_124ch	151	Dolomite HS102.3B	W1R1Bb CONV	0.0000	(0.0001)	dolomite
46	splib06b_cvhyomap07_124ch	416	Siderite HS271.3B	W1R1Ba CONV	0.0000	(0.4642)	carbonate_Fe_bearing
47	splib06b_cvhyomap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb CONV	0.0000	(0.7005)	dolomite.25+calcite.25+mont_Na
48	splib06b_cvhyomap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV	0.0000	(0.8021)	calcite.8+montmorillonite_Na.2
49	splib06b_cvhyomap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb CONV	0.0000	(0.9094)	calcite.8+montmorillonite_Ca.2
50	splib06b_cvhyomap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba CONV	0.0000	(0.6523)	calcite.7+muscovite.3
51	splib06b_cvhyomap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb CONV	0.0000	(0.6584)	dolomite.5+montmorillonite_Na.
52	splib06b_cvhyomap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba CONV	0.0000	(0.7033)	kaolin.2+calcite.8
53	splib06b_cvhyomap07_124ch	101	Chalcedony CU91-6A	W1R1Ba CONV	0.0000	(0.9061)	chalcedony
54	splib06b_cvhyomap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba CONV	0.0000	(0.8217)	hydrated_silica
55	splib06b_cvhyomap07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	0.0000	(0.5836)	tremolite_or_talc
56	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.0000	(0.1107)	serpentine_or_dolomite+calcite
57	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	0.0000	(0.1619)	serpentine1
58	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.0000	(0.1107)	serpentine2
59	splib06b_cvhyomap07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	0.0000	(0.1619)	serpentine3
60	splib06b_cvhyomap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.0000	(0.1107)	serpentine4

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
1	vegetation_green	0.9950	0.6074
2	vegetation.dry+green	0.9419	0.5212
33	epidote	0.6356	0.0503

Remaining fits are zero.

Remaining fits are zero.

BEST MATCH:

Observed (SPECPR Title=Rangeland L04-047 S00% G47% W1R1Fa CONV) was best matched by Reference (Output name=vegetation_green) with a fit of 0.9950

Observed (SPECPR File= splib06b_cvhyomap07_124ch; Record= 921; Title= Rangeland L04-047 S00% G47% W1R1Fa CONV)

Reference (SPECPR File= splib06b_cvhyomap07_124ch; Record= 588; Title= Fir_Tree IH91-2 W1R1Ba CONV)

Fit= 0.9950 Depth= 0.6074 Fit*Depth= 0.6041

----- END ANALYSIS -----

Normal termination of mica_singlespec_specpr.pro at Sat Apr 23 17:19:47 2011

Output report for verbose level 4. “Function 4.2 – Run MICA for Spectral Records”

At verbose level 4, the MICA output contains great detail in its reporting on the analysis of each observed spectrum. A table showing the results of the linear regression of the analyzed spectrum (observed spectrum) with reference features (all diagnostic and NOT features) is printed. This table shows the fit and depth values of each comparison along with the feature weight of each diagnostic feature in a material. For NOT features, the depth threshold type (absolute or relative) is reported, along with the SPECPR file/record/title of the NOT feature. If a reference material invokes a “relative” NOT feature then the material’s diagnostic feature number to use as the relative feature is reported. The column labeled “Ref. Spectrum Feature # for rel. depth” (reference spectrum feature number for the relative depth) indicates which of the diagnostic features of the reference spectrum invoking the NOT feature is to be used in calculating the depth threshold for the NOT feature. Also reported is the multiplier factor to apply to the relative depth. For an example calculation, see the annotation in the report below.

A table for the continuum values of diagnostic features is printed next. For each diagnostic feature of a reference material, the analyzed spectrum’s left continuum endpoint reflectance level, the reflectance value of the midpoint of the continuum line, the right continuum endpoint reflectance level, and the ratio of the right to the left continuum reflectance values are reported, along with the constraints on them (the minimum and maximum acceptable values set in the command file). An entry of -99.99 for any of the constraint values indicates that a constraint value was not set in the command file and that the constraint will not be checked. This table lets the user check how the values calculated from the observed spectrum compare to the constraints listed in the command file.

Next, a table for the diagnostic feature fits and depths is printed. For each diagnostic feature of a reference material, the observed spectrum’s fit to the feature and the depth of the reference feature scaled to the observed spectrum are reported, along with the constraints on them (the minimum and maximum acceptable values set in the command file). An entry of -99.99 for any of the constraint values indicates that a constraint value was not set in the command file and that the constraint will not be checked. This table lets the user check how the values calculated from the observed spectrum compare to the constraints listed in the command file.

Next, a table for the NOT feature fits and depths is printed. For each NOT feature of a reference material, the observed spectrum’s fit to the NOT feature and the depth of the NOT feature scaled to the observed spectrum are reported, along with the constraints on them (the threshold values, as set in the command file for “absolute” NOT features or as computed using the relative depth multiplier set in the command file and the depth of the relative feature).

Next, constraint reports are printed. First, a table of the constraint results for diagnostic features is printed. This table includes the fit, depth, left continuum endpoint, midpoint of the continuum line, right continuum endpoint, and ratio of the left to right continuum endpoints. In addition, a column reporting a check of the match between the reference feature type (absorption or emission) and the type of the continuum-removed feature (absorption or emission) for the observed spectrum is included. This check makes sure that if the NOT feature is an absorption feature then the continuum removal over its endpoints for the observed spectrum also produces an absorption feature and not an emission feature. The label at the top of the column is “Depth Sign” because absorption features have positive depth values and emission features have negative depth values. Thus, the results of a check to make sure the depths of the reference and observed spectral features have the same sign (+/-) is shown. This check is performed if the user has turned on either the “TETRACORDER_OPTIONS” or “CHECK_SIGNS_OF_DEPTH” keyword in the command file (see *appendix A*). An entry of “N/A” in the columns of the constraint results indicates that no value was set for the constraint in the command file and, thus, it was

not checked and will not be used in the final judgment of whether the feature has passed all constraints. The final column of the table is the summary judgment of the constraints for each feature. If the observed spectrum has failed to meet any of the individual constraints, then the final judgment for the feature will be “Fail” as well. For a reference material (reference spectrum) to be matched to the observed spectrum, all of its features must pass their continuum constraints, otherwise the final fit value of the material will be set to zero before the highest fit value is determined, thus eliminating the material from being selected as the best match.

Next, summary results for the NOT features are reported. If the fit and depth values of the NOT feature do not meet the constraints on their values, they are marked as “Fail”. Also, since MICA compares the absolute values of the depths of features to the constraints, a column checking that the continuum-removed feature in the observed spectrum is the same type of feature as the NOT feature is printed. That is, if the NOT feature is an absorption feature (which has a positive value for depth), then the continuum removal of the observed spectrum must also result in an absorption feature (which will have a positive value for depth). If the depth threshold is determined using a relative NOT threshold calculation, a column checking that the relative feature and the same continuum-removed feature in the observed spectrum are the equivalent type of feature (for example, both are absorption features, that is, the depths of both have a positive value) will be printed. The final judgment on a NOT feature is “present” if all the constraints are passed. If a NOT feature is detected as being present, then the reference entry (reference material) that invoked the NOT feature will be rejected as a match to the observed spectrum. The logic of the NOT feature, in contrast to diagnostic features, is that the reference material (reference spectrum) cannot match the observed spectrum if the NOT feature is present. The presence of the NOT feature indicates that the observed spectrum is likely to match a material other than the reference material (reference spectrum) that invoked the NOT feature.

Next, the summary values of the weighted fit, weighted depth, and weighted fit*depth are reported. For each reference spectrum (reference material) the weighted fit value is the summation of the individual diagnostic feature fit values multiplied by the weighting factors set in the command file. In the same way, the weighted depth and weighted fit*depth are determined. These values are reported along with constraints on them that were set in the command file. NOTE: in the depth calculation, the absolute values of the depths are multiplied by the weighting factors (reported earlier). This is so that both absorption and emission features contribute positively to the weighted depth. Another factor is considered, the feature in the observed spectrum must be of the same type (absorption or emission) as the reference feature. If they are the same type, the depth value for the feature will contribute positively to the final weighted depth value, otherwise it will be multiplied by -1, and when added with the other depths, it reduces the overall depth value. In the annotated output below, an example calculation of the weighted depth is shown for a material that has both absorption and emission diagnostic features.

Next, a summary table for the constraints on weighted fit, depth, and fit*depth is printed. For each reference material (reference spectrum), if all of these constraints are passed, then the reference material remains in consideration for the “best match” to the observed spectrum. If any constraint is failed, then the weighted fit value will be zeroed so that the material is not considered as the best match to the observed spectrum.

Next, the weighted fit values are given. The first fit column shows the “final fit” which is determined after adjusting the weighted fits (the second fit column) based on the feature and material constraints. For each reference material (reference spectrum), if all of its constraints are passed, then the reference material remains in consideration as the “best match” to the observed spectrum. The best match is found in this first fit column as the highest weighted fit value (non-zero). If any diagnostic feature constraint is failed (either a continuum constraint or a fit, depth, or depth sign constraint), a NOT feature is found to be present, or the material’s weighted fit/depth constraints are violated, then the weighted fit value will be

zeroed (in this first fit column) before the highest fit value is selected, thus removing the material from consideration as the best match to the observed spectrum.

Below the table containing all the fit values, a report on the reference materials (reference spectra) with the top 5 fit values is printed, with the fit values ranked and the reference material (reference spectrum) with the highest fit value reported first. At the end of the MICA analysis of the observed spectrum, the detailed report of the best match spectrum, as described in the output report for verbose level 2, is given.

The uncommented text report for this verbose level is included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the report will be located at “C:\usgsprism\mica_hymap\output\ mica_log_spectrummode_mica_cmds_group2_hymap2007_verbose4.txt” on Windows computers. On Linux computers, the file will be found in the “/var/local/usgsprism/mica_hymap/output/” directory. For brevity, only the output of the first observed spectrum (Rangeland L02-022) is shown in this appendix.

Starting mica_singlespec_specpr.pro at Sat Apr 23 17:23:27 2011

Command Line Arguments:

LOG FILE = C:\usgsprism\mica_hymap\output\mica_log_spectrummode_mica_cmds_group2_hymap2007.txt
VERBOSE_LEVEL = 4
DELETED_CHANNELS = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124

Command File Parameters:

Wavelength SPECPR file = C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
Wavelength SPECPR record = 6
Deleted Channels found = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124
Number of Good Channels = 103
Scale factor for reference spectra = 1.0000000
Scale factor for observed spectra = 20000.000

* Changing scale factor for observed spectra (from user interface) = 1.0000000

COMMAND FILE REFERENCE ENTRIES:

This block of reporting is the same as verbose level 3 of the MICA spectral records mode.

DIAGNOSTIC FEATURE ENTRIES:

This block of reporting is the same as verbose level 3 of the MICA spectral records mode.

COMMAND FILE NOT FEATURE REFERENCE ENTRIES:

This block of reporting is the same as verbose level 3 of the MICA spectral records mode.

This line marks the beginning of a block of text reporting on the analysis of an input spectrum (observed spectrum).

The input spectrum (observed spectrum) being analyzed, its SPECPR filename, record number and title are reported.

```
----- STARTING ANALYSIS -----
SPECPR file,record Analyzed:  C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch, 905 (SPECPR title = Rangeland L02-022 S20% G09% W1R1Fa CONV)
Command file used:           C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
Total number of reference spectra      =      60
Total number of reference features     =     111
Total number of listed NOT features    =      12
Total number of references to NOT features =      62
```

Following this line, the feature comparison results for each feature (diagnostic and NOT features) of the reference spectra (reference materials) are reported. For diagnostic features, the fit and depth values for the fit of the reference spectra to the observed spectrum are given, along with the feature's weighting factor specified in the command file.

FEATURE ANALYSIS RESULTS:

Refer. #	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Feature Type	Feat. #	Fit	Depth	Weight	NOT Feature Depth Type
1	splib06b_cvhymap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	diagnostic	1	0.8852	0.1593	0.8500	
1	splib06b_cvhymap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	diagnostic	2	0.9851	0.0138	0.0500	
1	splib06b_cvhymap07_124ch	588	Fir_Tree IH91-2 W1R1Ba CONV	diagnostic	3	0.9966	0.0288	0.1000	
2	splib06b_cvhymap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	diagnostic	1	0.9509	0.1749	0.7000	
2	splib06b_cvhymap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	diagnostic	2	0.9938	0.0286	0.1000	
2	splib06b_cvhymap07_124ch	602	Grass_dry.7+.3green AMX30 W1R1Ba CONV	diagnostic	3	0.9393	0.0823	0.2000	
3	splib06b_cvhymap07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	diagnostic	1	0.4623	0.0067	0.3500	
3	splib06b_cvhymap07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	diagnostic	2	0.2566	0.0152	0.6500	
3	splib06b_cvhymap07_124ch	690	Melting_snow mSnw1a W1R1Fa CONV	not	1	0.8852	0.1593		Absolute
4	splib06b_cvhymap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	diagnostic	1	0.8753	0.0126	0.3500	
4	splib06b_cvhymap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	diagnostic	2	0.2398	0.0129	0.6500	
4	splib06b_cvhymap07_124ch	698	Melting_snow mSnw9 (slush) W1R1Fa CONV	not	1	0.8852	0.1593		Absolute
5	splib06b_cvhymap07_124ch	566	Seawater_Coast_Ch1 SW1 W1R1Ba CONV	diagnostic	1	0.5082	-0.6653	0.9000	
5	splib06b_cvhymap07_124ch	566	Seawater_Coast_Ch1 SW1 W1R1Ba CONV	diagnostic	2	0.7522	-0.0515	0.1000	
6	splib06b_cvhymap07_124ch	704	Water+Montmor SWy-2+5.01g/l W1R1Fa CONV	diagnostic	1	0.9611	0.0116	0.8000	
6	splib06b_cvhymap07_124ch	704	Water+Montmor SWy-2+5.01g/l W1R1Fa CONV	diagnostic	2	0.8634	-0.0914	0.1000	
6	splib06b_cvhymap07_124ch	704	Water+Montmor SWy-2+5.01g/l W1R1Fa CONV	diagnostic	3	0.2229	-0.0111	0.1000	
7	splib06b_cvhymap07_124ch	701	Water+Montmor SWy-2+0.5g/l W1R1Fa CONV	diagnostic	1	0.9383	0.0114	0.8000	
7	splib06b_cvhymap07_124ch	701	Water+Montmor SWy-2+0.5g/l W1R1Fa CONV	diagnostic	2	0.1596	-0.0095	0.1000	
7	splib06b_cvhymap07_124ch	701	Water+Montmor SWy-2+0.5g/l W1R1Fa CONV	diagnostic	3	0.9115	-0.0914	0.1000	
8	splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	diagnostic	1	0.9687	0.0722	0.5000	
8	splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	diagnostic	2	0.9639	0.0861	0.5000	
9	splib06b_cvhymap07_124ch	812	Grass_Golden_Dry GDS480 W1R1Fa CONV	diagnostic	1	0.9639	0.0861	1.0000	
10	splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	diagnostic	1	0.9481	0.0695	0.5000	
10	splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3 W1R1Fa CONV	diagnostic	2	0.9814	0.0986	0.5000	

The three features of reference material 3 are circled.

Not feature reporting shown on next page.

This page is a duplicate of the previous, with the reporting on the NOT features shown here.

```
----- STARTING ANALYSIS -----
SPECPR file,record Analyzed: C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch, 905 (SPECPR title = Rangeland L02-022 S20% G09% W1R1Fa CONV)
Command file used: C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
Total number of reference spectra = 60
Total number of reference features = 111
Total number of listed NOT features = 12
Total number of references to NOT features = 62
```

Following this line, the feature comparison results for each feature (diagnostic and NOT features) of the reference spectra (reference materials) are reported. For NOT features, the fit and depth values for the least-squares fit of the NOT spectrum to the observed spectrum are given. For depth thresholds determined in a relative sense, the reference feature to be used to determine the threshold is reported along with the multiplier factor to apply (from the command file).

FEATURE ANALYSIS RESULTS:

Refer. #	Ref. SPECPR file/rec/title	Feature Type	Feat. #	Fit	Depth	Weight	NOT Feature Depth Type	NOT Feature SPECPR File	NOT Feature SPECPR Rec	NOT Feature SPECPR Title	Ref. Spectrum Feature # for rel. depth	Multiplier for rel. depth
1		diagnostic	1	0.8852	0.1593	0.8500						
1		diagnostic	2	0.9851	0.0138	0.0500						
1		diagnostic	3	0.9966	0.0288	0.1000						
2		diagnostic	1	0.9509	0.1749	0.7000						
2		diagnostic	2	0.9938	0.0286	0.1000						
2		diagnostic	3	0.9393	0.0823	0.2000						
3		diagnostic	1	0.4623	0.0067	0.3500						
3		diagnostic	2	0.2566	0.0152	0.6500						
3		not	1	0.8852	0.1593		Absolute	splib06b_cvhymap07_124ch	588 Fir_Tree IH91-2	W1R1Ba CONV		
4		diagnostic	1	0.8753	0.0126	0.3500						
4		diagnostic	2	0.2398	0.0129	0.6500						
4		not	1	0.8852	0.1593		Absolute	splib06b_cvhymap07_124ch	588 Fir_Tree IH91-2	W1R1Ba CONV		
5		diagnostic	1	0.5082	-0.6653	0.9000						
5		diagnostic	2	0.7522	-0.0515	0.1000						
6		diagnostic	1	0.9611	0.0116	0.8000						
6		diagnostic	2	0.8634	-0.0914	0.1000						
6		diagnostic	3	0.2229	-0.0111	0.1000						
7		diagnostic	1	0.9383	0.0114	0.8000						
7		diagnostic	2	0.1596	-0.0095	0.1000						
7		diagnostic	3	0.9115	-0.0914	0.1000						
8		diagnostic	1	0.9687	0.0722	0.5000						
8		diagnostic	2	0.9639	0.0861	0.5000						
9		diagnostic	1	0.9639	0.0861	1.0000						
10		diagnostic	1	0.9481	0.0695	0.5000						
10		diagnostic	2	0.9814	0.0986	0.5000						

The three features of reference material 3 are circled.

These values reported on previous page.

11	splib06b_cvhymap07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	diagnostic	1	0.9814	0.0986	1.0000	
12	splib06b_cvhymap07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb	CONV	diagnostic	1	0.7646	-0.0999	0.7500	
12	splib06b_cvhymap07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb	CONV	diagnostic	2	0.4075	0.0181	0.2500	
13	splib06b_cvhymap07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb	CONV	diagnostic	1	0.5928	-0.0736	0.7500	
13	splib06b_cvhymap07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb	CONV	diagnostic	2	0.5298	0.0237	0.2500	
14	splib06b_cvhymap07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV	diagnostic	1	0.3993	-0.0744	0.7500	
14	splib06b_cvhymap07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV	diagnostic	2	0.7270	0.0237	0.2500	
15	splib06b_cvhymap07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba	CONV	diagnostic	1	0.8701	-0.1114	0.7500	
15	splib06b_cvhymap07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba	CONV	diagnostic	2	0.0049	0.0029	0.2500	
16	splib06b_cvhymap07_124ch	236	Illite IMT-1.b <2um	W1R1Ba	CONV	diagnostic	1	0.9137	-0.1015	0.7500	
16	splib06b_cvhymap07_124ch	236	Illite IMT-1.b <2um	W1R1Ba	CONV	diagnostic	2	0.7499	0.0232	0.2500	
17	splib06b_cvhymap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	diagnostic	1	0.9443	-0.1055	0.7500	
17	splib06b_cvhymap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	diagnostic	2	0.7747	0.0242	0.2500	
18	splib06b_cvhymap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	diagnostic	1	0.2829	-0.0282	1.0000	
18	splib06b_cvhymap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	not	1	0.7270	0.0237		Relative
18	splib06b_cvhymap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	not	2	0.2235	0.0029		Relative
18	splib06b_cvhymap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	not	3	0.8045	0.0053		Relative
19	splib06b_cvhymap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	diagnostic	1	0.3819	-0.0598	1.0000	
19	splib06b_cvhymap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	not	1	0.7270	0.0237		Relative
19	splib06b_cvhymap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	not	2	0.2235	0.0029		Relative
19	splib06b_cvhymap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	not	3	0.8045	0.0053		Relative
20	splib06b_cvhymap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	diagnostic	1	0.5011	-0.0733	1.0000	
20	splib06b_cvhymap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	not	1	0.7270	0.0237		Relative
20	splib06b_cvhymap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	not	2	0.2235	0.0029		Relative
20	splib06b_cvhymap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	not	3	0.8045	0.0053		Relative
21	splib06b_cvhymap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	diagnostic	1	0.2665	-0.0283	1.0000	
21	splib06b_cvhymap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	not	1	0.7270	0.0237		Relative
21	splib06b_cvhymap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	not	2	0.2235	0.0029		Relative
21	splib06b_cvhymap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	not	3	0.8045	0.0053		Relative
22	splib06b_cvhymap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	diagnostic	1	0.0319	-0.0237	1.0000	
22	splib06b_cvhymap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	not	1	0.9639	0.0861		Absolute
22	splib06b_cvhymap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	not	2	0.9814	0.0986		Absolute
23	splib06b_cvhymap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb	CONV	diagnostic	1	0.1422	-0.0426	1.0000	
23	splib06b_cvhymap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb	CONV	not	1	0.9639	0.0861		Absolute
23	splib06b_cvhymap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb	CONV	not	2	0.9814	0.0986		Absolute
24	splib06b_cvhymap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	diagnostic	1	0.0120	-0.0074	0.9000	
24	splib06b_cvhymap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	diagnostic	2	0.2235	0.0029	0.1000	
25	splib06b_cvhymap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	diagnostic	1	0.1016	-0.0225	0.9000	
25	splib06b_cvhymap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	diagnostic	2	0.8045	0.0053	0.1000	
26	splib06b_cvhymap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	diagnostic	1	0.0070	0.0015	1.0000	
26	splib06b_cvhymap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	not	1	0.2235	0.0029		Relative
26	splib06b_cvhymap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	not	2	0.8045	0.0053		Relative
27	splib06b_cvhymap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	diagnostic	1	0.2712	-0.0819	1.0000	
28	splib06b_cvhymap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	diagnostic	1	0.3224	-0.0883	1.0000	
29	splib06b_cvhymap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	diagnostic	1	0.7261	-0.0801	1.0000	
29	splib06b_cvhymap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	not	1	0.7270	0.0237		Relative
29	splib06b_cvhymap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	not	2	0.7626	-0.0049		Relative
30	splib06b_cvhymap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	diagnostic	1	0.7681	-0.0806	1.0000	
30	splib06b_cvhymap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	not	1	0.7270	0.0237		Relative
30	splib06b_cvhymap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	not	2	0.7626	-0.0049		Relative
31	splib06b_cvhymap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	1	0.8442	-0.1331	0.3333	
31	splib06b_cvhymap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	2	0.7626	-0.0049	0.3333	
31	splib06b_cvhymap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	3	0.5191	0.0177	0.3334	
32	splib06b_cvhymap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	1	0.3225	0.0545	0.6000	
32	splib06b_cvhymap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	2	0.5051	-0.0423	0.1000	
32	splib06b_cvhymap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	3	0.7102	-0.3737	0.3000	
33	splib06b_cvhymap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	diagnostic	1	0.0653	-0.0062	0.1000	
33	splib06b_cvhymap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	diagnostic	2	0.6926	0.0865	0.9000	

The four features of reference material 18 are circled.



NOT feature reporting shown on next page.

58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d	70um	W1R1Bb	CONV	not	1	0.9687	0.0722	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry	GDS480	W1R1Fa	CONV	
58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d	70um	W1R1Bb	CONV	not	2	0.9481	0.0695	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine	LP-Needles-3	W1R1Fa	CONV	
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B		W1R1Ba	CONV	diagnostic	1	0.4893	0.0791	1.0000							
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B		W1R1Ba	CONV	diagnostic	2	0.7925	0.0259	0.0000							
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B		W1R1Ba	CONV	not	1	0.9687	0.0722	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry	GDS480	W1R1Fa	CONV	
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B		W1R1Ba	CONV	not	2	0.9481	0.0695	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine	LP-Needles-3	W1R1Fa	CONV	
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d	70um	W1R1Bb	CONV	diagnostic	1	0.4159	0.0859	1.0000							
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d	70um	W1R1Bb	CONV	diagnostic	2	0.7978	0.0262	0.0000							
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d	70um	W1R1Bb	CONV	not	1	0.9687	0.0722	Absolute	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry	GDS480	W1R1Fa	CONV	
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d	70um	W1R1Bb	CONV	not	2	0.9481	0.0695	Absolute	splib06b_cvhymp07_124ch	831	Lodgepole-Pine	LP-Needles-3	W1R1Fa	CONV	

Following this line, the results for the observed spectrum's feature continuum constraints are reported. For each specified feature of a reference material, the observed spectrum's left continuum endpoint reflectance level, the reflectance value of the midpoint of the continuum line, the right continuum endpoint reflectance level, and the ratio of the right to the left continuum reflectance values are reported, along with the constraints on them (the minimum and maximum acceptable values set in the command file).

The computed left continuum endpoint reflectance value, and the min/max allowable values as set in the command file.

The computed continuum midpoint reflectance value, and the min/max allowable values as set in the command file.

The computed right continuum endpoint reflectance value, and the min/max allowable values as set in the command file.

The computed ratio of the right continuum endpoint reflectance value to the left, and the min/max allowable values as set in the command file.

CONSTRAINT ANALYSIS:

CONSTRAINT ANALYSIS - CONTINUUM_CONSTRAINTS:

Ref. #	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Feature Type	Feat. #	Refl. Left Ct.	Min Left Ct.	Max Left Ct.	Refl. Mid Ct.	Min Mid Ct.	Max Mid Ct.	Refl. Right Ct.	Min Right Ct.	Max Right Ct.	Rt/Lt Ct. Ratio	Min Ratio	Max Ratio	
1	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	W1R1Ba CONV	diagnostic	1	0.0818	-99.9900	-99.9900	0.1170	0.0400	-99.9900	0.1521	-99.9900	-99.9900	1.8583	0.9000	-99.9900
1	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	W1R1Ba CONV	diagnostic	2	0.1829	-99.9900	-99.9900	0.2015	0.1000	-99.9900	0.2202	-99.9900	-99.9900	1.2040	-99.9900	-99.9900
1	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	W1R1Ba CONV	diagnostic	3	0.2248	-99.9900	-99.9900	0.2405	0.1000	-99.9900	0.2562	-99.9900	-99.9900	1.1397	-99.9900	-99.9900
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green	AMX30 W1R1Ba CONV	diagnostic	1	0.0818	-99.9900	-99.9900	0.1199	0.0400	-99.9900	0.1580	-99.9900	-99.9900	1.9301	0.9000	-99.9900
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green	AMX30 W1R1Ba CONV	diagnostic	2	0.2233	-99.9900	-99.9900	0.2398	0.0700	-99.9900	0.2562	-99.9900	-99.9900	1.1474	-99.9900	-99.9900
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green	AMX30 W1R1Ba CONV	diagnostic	3	0.2087	-99.9900	-99.9900	0.1883	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.8050	-99.9900	-99.9900
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnw1a	W1R1Fa CONV	diagnostic	1	0.1936	-99.9900	-99.9900	0.2085	0.0800	0.7000	0.2233	-99.9900	-99.9900	1.1533	-99.9900	-99.9900
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnw1a	W1R1Fa CONV	diagnostic	2	0.2248	-99.9900	-99.9900	0.2428	0.0400	-99.9900	0.2607	-99.9900	-99.9900	1.1599	-99.9900	0.9091
4	splib06b_cvhymp07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Fa CONV	diagnostic	1	0.1829	-99.9900	-99.9900	0.2031	0.0400	0.5000	0.2233	-99.9900	-99.9900	1.2210	-99.9900	-99.9900
4	splib06b_cvhymp07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Fa CONV	diagnostic	2	0.2233	-99.9900	-99.9900	0.2420	0.0300	-99.9900	0.2607	-99.9900	-99.9900	1.1676	-99.9900	0.9091
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba CONV	diagnostic	1	8.815e-002	0.000e+000	1.900e-001	1.445e-001	-9.999e+001	-9.999e+001	2.008e-001	0.000e+000	8.000e-002	2.278e+000	-9.999e+001	1.000e+000
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba CONV	diagnostic	2	6.131e-002	0.000e+000	1.400e-001	8.031e-002	-9.999e+001	-9.999e+001	9.931e-002	0.000e+000	1.400e-001	1.620e+000	-9.999e+001	1.500e+000
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa CONV	diagnostic	1	1.829e-001	0.000e+000	2.800e-001	1.999e-001	-9.999e+001	-9.999e+001	2.169e-001	0.000e+000	2.400e-001	1.186e+000	-9.999e+001	1.100e+000
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa CONV	diagnostic	2	1.196e-001	0.000e+000	4.200e-001	1.439e-001	-9.999e+001	-9.999e+001	1.681e-001	0.000e+000	3.500e-001	1.405e+000	-9.999e+001	-9.999e+001
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa CONV	diagnostic	3	1.521e-001	0.000e+000	3.200e-001	1.647e-001	-9.999e+001	-9.999e+001	1.772e-001	0.000e+000	3.200e-001	1.165e+000	-9.999e+001	-9.999e+001
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa CONV	diagnostic	1	1.829e-001	0.000e+000	1.400e-001	1.999e-001	-9.999e+001	-9.999e+001	2.169e-001	0.000e+000	1.200e-001	1.186e+000	-9.999e+001	1.100e+000
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa CONV	diagnostic	2	1.521e-001	0.000e+000	1.400e-001	1.647e-001	-9.999e+001	-9.999e+001	1.772e-001	0.000e+000	1.400e-001	1.165e+000	-9.999e+001	-9.999e+001
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa CONV	diagnostic	3	1.196e-001	0.000e+000	1.800e-001	1.439e-001	-9.999e+001	-9.999e+001	1.681e-001	0.000e+000	1.500e-001	1.405e+000	-9.999e+001	-9.999e+001
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa CONV	diagnostic	1	0.2205	-99.9900	-99.9900	0.2146	0.1000	-99.9900	0.2088	-99.9900	-99.9900	0.9472	-99.9900	-99.9900
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa CONV	diagnostic	2	0.2087	-99.9900	-99.9900	0.1883	0.1000	-99.9900	0.1680	-99.9900	-99.9900	0.8050	-99.9900	-99.9900
9	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa CONV	diagnostic	1	0.2087	-99.9900	-99.9900	0.1883	0.1000	-99.9900	0.1680	-99.9900	-99.9900	0.8050	-99.9900	-99.9900
10	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa CONV	diagnostic	1	0.2205	-99.9900	-99.9900	0.2146	0.1000	-99.9900	0.2088	-99.9900	-99.9900	0.9472	-99.9900	-99.9900
10	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa CONV	diagnostic	2	0.2087	-99.9900	-99.9900	0.1872	0.1000	-99.9900	0.1658	-99.9900	-99.9900	0.7946	-99.9900	-99.9900
11	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa CONV	diagnostic	1	0.2087	-99.9900	-99.9900	0.1872	0.1000	-99.9900	0.1658	-99.9900	-99.9900	0.7946	-99.9900	-99.9900
12	splib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R1Nb CONV	diagnostic	1	0.2024	-99.9900	-99.9900	0.1918	0.0400	-99.9900	0.1813	-99.9900	-99.9900	0.8960	-99.9900	-99.9900
13	splib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R1Nb CONV	diagnostic	2	0.1754	-99.9900	-99.9900	0.1706	0.0400	-99.9900	0.1658	-99.9900	-99.9900	0.9454	-99.9900	-99.9900
13	splib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb CONV	diagnostic	1	0.2024	-99.9900	-99.9900	0.1960	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9371	-99.9900	-99.9900
13	splib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb CONV	diagnostic	2	0.1783	-99.9900	-99.9900	0.1721	0.0400	-99.9900	0.1658	-99.9900	-99.9900	0.9300	-99.9900	-99.9900
14	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb CONV	diagnostic	1	0.2024	-99.9900	-99.9900	0.1918	0.0400	-99.9900	0.1813	-99.9900	-99.9900	0.8960	-99.9900	-99.9900
14	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb CONV	diagnostic	2	0.1754	-99.9900	-99.9900	0.1717	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.9577	-99.9900	-99.9900
15	splib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba CONV	diagnostic	1	0.2024	-99.9900	-99.9900	0.1889	0.0400	-99.9900	0.1754	-99.9900	-99.9900	0.8668	-99.9900	-99.9900
15	splib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba CONV	diagnostic	2	0.1754	-99.9900	-99.9900	0.1678	0.0400	-99.9900	0.1602	-99.9900	-99.9900	0.9134	-99.9900	-99.9900
16	splib06b_cvhymp07_124ch	236	Illite IMT-1.b <2um	W1R1Ba CONV	diagnostic	1	0.2024	-99.9900	-99.9900	0.1918	0.0400	-99.9900	0.1813	-99.9900	-99.9900	0.8960	-99.9900	-99.9900
16	splib06b_cvhymp07_124ch	236	Illite IMT-1.b <2um	W1R1Ba CONV	diagnostic	2	0.1754	-99.9900	-99.9900	0.1717	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.9577	-99.9900	-99.9900
17	splib06b_cvhymp07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb CONV	diagnostic	1	0.2024	-99.9900	-99.9900	0.1918	0.0400	-99.9900	0.1813	-99.9900	-99.9900	0.8960	-99.9900	-99.9900
17	splib06b_cvhymp07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb CONV	diagnostic	2	0.1754	-99.9900	-99.9900	0.1717	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.9577	-99.9900	-99.9900
18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	W1R1Bb CONV	diagnostic	1	0.2017	-99.9900	-99.9900	0.2013	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9965	-99.9900	-99.9900
19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (px1)	W1R1Bb CONV	diagnostic	1	0.2017	-99.9900	-99.9900	0.1957	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9403	-99.9900	-99.9900
20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	W1R1Ba CONV	diagnostic	1	0.2017	-99.9900	-99.9900	0.1957	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9403	-99.9900	-99.9900
21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	W1R1Bb CONV	diagnostic	1	0.2049	-99.9900	-99.9900	0.2029	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9808	-99.9900	-99.9900
22	splib06b_cvhymp07_124ch	87	Buckinghamite GDS6 D-206	W1R1Bb CONV	diagnostic	1	0.2049	-99.9900	-99.9900	0.1902	0.0400	-99.9900	0.1754	-99.9900	-99.9900	0.8560	-99.9900	-99.9900
23	splib06b_cvhymp07_124ch	973	Buddingtonite Na-Mont C993-260B	W2R1Nb CONV	diagnostic	1	0.2049	-99.9900	-99.9900	0.1902	0.0400	-99.9900	0.1754	-99.9900	-99.9900	0.8560	-99.9900	-99.9900
24	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R1Na CONV	diagnostic	1	0.2114	-99.9900	-99.9900	0.2062	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9509	-99.9900	-99.9900
24	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R1Na CONV	diagnostic	2	0.2189	-99.9900	-99.9900	0.2261	0.0400	-99.9900	0.2333	-99.9900	-99.9900	1.0658	-99.9900	-99.9900
25	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C															

26	sp1lb06b_cvhyamap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba CONV diagnostic	1	0.2008	-99.9900	-99.9900	0.2047	0.0400	-99.9900	0.2087	-99.9900	-99.9900	1.0391	-99.9900	-99.9900
27	sp1lb06b_cvhyamap07_124ch	241	Jarosite GDS24 Na	W1R1Bb CONV diagnostic	1	0.2017	-99.9900	-99.9900	0.1849	0.0400	-99.9900	0.1681	-99.9900	-99.9900	0.8337	-99.9900	-99.9900
28	sp1lb06b_cvhyamap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba CONV diagnostic	1	0.2017	-99.9900	-99.9900	0.1849	0.0400	-99.9900	0.1681	-99.9900	-99.9900	0.8337	-99.9900	-99.9900
29	sp1lb06b_cvhyamap07_124ch	302	Montmorillonite SWy-1	W1R1Bb CONV diagnostic	1	0.2024	-99.9900	-99.9900	0.1960	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9371	-99.9900	-99.9900
30	sp1lb06b_cvhyamap07_124ch	298	Montmorillonite SAz-1	W1R1Bb CONV diagnostic	1	0.2033	-99.9900	-99.9900	0.1965	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9327	-99.9900	-99.9900
31	sp1lb06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba CONV diagnostic	1	0.2017	-99.9900	-99.9900	0.1867	0.0400	-99.9900	0.1717	-99.9900	-99.9900	0.8513	-99.9900	-99.9900
31	sp1lb06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba CONV diagnostic	2	0.2333	-99.9900	-99.9900	0.2447	0.0400	-99.9900	0.2561	-99.9900	-99.9900	1.0978	-99.9900	-99.9900
32	sp1lb06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba CONV diagnostic	3	0.2637	-99.9900	-99.9900	0.2633	0.0400	-99.9900	0.2630	-99.9900	-99.9900	0.9972	-99.9900	-99.9900
31	sp1lb06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba CONV diagnostic	1	0.2057	-99.9900	-99.9900	0.1829	0.0400	-99.9900	0.1602	-99.9900	-99.9900	0.7790	-99.9900	-99.9900
32	sp1lb06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba CONV diagnostic	2	0.2073	-99.9900	-99.9900	0.1943	0.0400	-99.9900	0.1813	-99.9900	-99.9900	0.8748	-99.9900	-99.9900
32	sp1lb06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba CONV diagnostic	3	0.0818	-99.9900	-99.9900	0.1706	0.0400	-99.9900	0.2593	-99.9900	-99.9900	3.1682	-99.9900	-99.9900
31	sp1lb06b_cvhyamap07_124ch	159	Spidote GDS26.a 75-200um	W1R1Bb CONV diagnostic	1	0.2103	-99.9900	-99.9900	0.1958	0.0400	-99.9900	0.1813	-99.9900	-99.9900	0.8620	-99.9900	-99.9900
33	sp1lb06b_cvhyamap07_124ch	159	Spidote GDS26.a 75-200um	W1R1Bb CONV diagnostic	2	0.2087	-99.9900	-99.9900	0.1844	0.0400	-99.9900	0.1602	-99.9900	-99.9900	0.7678	-99.9900	-99.9900
34	sp1lb06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb CONV diagnostic	1	0.2017	-99.9900	-99.9900	0.2013	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9965	-99.9900	-99.9900
34	sp1lb06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb CONV diagnostic	2	0.2189	-99.9900	-99.9900	0.2261	0.0400	-99.9900	0.2333	-99.9900	-99.9900	1.0658	-99.9900	-99.9900
34	sp1lb06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb CONV diagnostic	3	0.1896	-99.9900	-99.9900	0.1790	0.0400	-99.9900	0.1683	-99.9900	-99.9900	0.8875	-99.9900	-99.9900
35	sp1lb06b_cvhyamap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb CONV diagnostic	1	0.2017	-99.9900	-99.9900	0.2013	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9965	-99.9900	-99.9900
35	sp1lb06b_cvhyamap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb CONV diagnostic	2	0.2189	-99.9900	-99.9900	0.2261	0.0400	-99.9900	0.2333	-99.9900	-99.9900	1.0658	-99.9900	-99.9900
35	sp1lb06b_cvhyamap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb CONV diagnostic	3	0.1813	-99.9900	-99.9900	0.1744	0.0400	-99.9900	0.1676	-99.9900	-99.9900	0.9242	-99.9900	-99.9900
36	sp1lb06b_cvhyamap07_124ch	536	Kaolxkl.75+Alun_HS295 AMX14	W1R1Bb CONV diagnostic	1	0.2017	-99.9900	-99.9900	0.2013	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9965	-99.9900	-99.9900
36	sp1lb06b_cvhyamap07_124ch	536	Kaolxkl.75+Alun_HS295 AMX14	W1R1Bb CONV diagnostic	2	0.2189	-99.9900	-99.9900	0.2261	0.0400	-99.9900	0.2333	-99.9900	-99.9900	1.0658	-99.9900	-99.9900
36	sp1lb06b_cvhyamap07_124ch	536	Kaolxkl.75+Alun_HS295 AMX14	W1R1Bb CONV diagnostic	3	0.1813	-99.9900	-99.9900	0.1744	0.0400	-99.9900	0.1676	-99.9900	-99.9900	0.9242	-99.9900	-99.9900
37	sp1lb06b_cvhyamap07_124ch	529	Kaol.5+MuscU91-250A AMX13	W1R1Bb CONV diagnostic	1	0.2016	-99.9900	-99.9900	0.1956	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9407	-99.9900	-99.9900
37	sp1lb06b_cvhyamap07_124ch	529	Kaol.5+MuscU91-250A AMX13	W1R1Bb CONV diagnostic	2	0.1813	-99.9900	-99.9900	0.1736	0.0400	-99.9900	0.1658	-99.9900	-99.9900	0.9146	-99.9900	-99.9900
38	sp1lb06b_cvhyamap07_124ch	530	Kaol Wxl+0.5Musc Ruby AMX12	W1R1Ba CONV diagnostic	1	0.2016	-99.9900	-99.9900	0.1956	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9407	-99.9900	-99.9900
39	sp1lb06b_cvhyamap07_124ch	530	Kaol Wxl+0.5Musc Ruby AMX12	W1R1Ba CONV diagnostic	2	0.1813	-99.9900	-99.9900	0.1736	0.0400	-99.9900	0.1658	-99.9900	-99.9900	0.9146	-99.9900	-99.9900
39	sp1lb06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba CONV diagnostic	1	0.2016	-99.9900	-99.9900	0.1956	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9407	-99.9900	-99.9900
39	sp1lb06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba CONV diagnostic	2	0.1813	-99.9900	-99.9900	0.1736	0.0400	-99.9900	0.1658	-99.9900	-99.9900	0.9146	-99.9900	-99.9900
40	sp1lb06b_cvhyamap07_124ch	532	Kaolin_Smect H89-FR-2.5Kaol	W1R1Bb CONV diagnostic	1	0.2016	-99.9900	-99.9900	0.1956	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9407	-99.9900	-99.9900
41	sp1lb06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb CONV diagnostic	1	0.2016	-99.9900	-99.9900	0.1866	0.0400	-99.9900	0.1717	-99.9900	-99.9900	0.8516	-99.9900	-99.9900
41	sp1lb06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb CONV diagnostic	2	0.1717	-99.9900	-99.9900	0.1702	0.0400	-99.9900	0.1687	-99.9900	-99.9900	0.9826	-99.9900	-99.9900
41	sp1lb06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb CONV diagnostic	3	0.1321	-99.9900	-99.9900	0.1957	0.0400	-99.9900	0.2594	-99.9900	-99.9900	1.9634	-99.9900	-99.9900
42	sp1lb06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba CONV diagnostic	1	0.1650	-99.9900	-99.9900	0.2122	0.0400	-99.9900	0.2594	-99.9900	-99.9900	1.5719	0.4000	-99.9900
42	sp1lb06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba CONV diagnostic	2	0.2024	-99.9900	-99.9900	0.1869	0.0400	-99.9900	0.1754	-99.9900	-99.9900	0.8668	-99.9900	-99.9900
42	sp1lb06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba CONV diagnostic	3	0.1754	-99.9900	-99.9900	0.1717	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.9577	-99.9900	-99.9900
43	sp1lb06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV diagnostic	1	0.2072	-99.9900	-99.9900	0.1876	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.8106	-99.9900	-99.9900
43	sp1lb06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV diagnostic	2	0.2008	-99.9900	-99.9900	0.2040	0.0400	-99.9900	0.2072	-99.9900	-99.9900	1.0319	-99.9900	-99.9900
44	sp1lb06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV diagnostic	1	0.2072	-99.9900	-99.9900	0.1876	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.8106	-99.9900	-99.9900
45	sp1lb06b_cvhyamap07_124ch	151	Dolomite HS102.3B	W1R1Bb CONV diagnostic	1	0.2057	-99.9900	-99.9900	0.1872	0.0400	-99.9900	0.1687	-99.9900	-99.9900	0.8202	-99.9900	1.2000
46	sp1lb06b_cvhyamap07_124ch	416	Siderite HS271.3B	W1R1Ba CONV diagnostic	1	0.2088	-99.9900	-99.9900	0.1884	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.8045	-99.9900	-99.9900
46	sp1lb06b_cvhyamap07_124ch	416	Siderite HS271.3B	W1R1Ba CONV diagnostic	2	0.1604	-99.9900	-99.9900	0.2128	0.0400	-99.9900	0.2652	-99.9900	-99.9900	1.6535	-99.9900	-99.9900
47	sp1lb06b_cvhyamap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb CONV diagnostic	1	0.2010	-99.9900	-99.9900	0.1848	0.0400	-99.9900	0.1687	-99.9900	-99.9900	0.8394	-99.9900	-99.9900
47	sp1lb06b_cvhyamap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb CONV diagnostic	2	0.2024	-99.9900	-99.9900	0.1960	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9371	-99.9900	-99.9900
48	sp1lb06b_cvhyamap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV diagnostic	1	0.1896	-99.9900	-99.9900	0.1788	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.8858	-99.9900	-99.9900
48	sp1lb06b_cvhyamap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV diagnostic	2	0.2024	-99.9900	-99.9900	0.1960	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9371	-99.9900	-99.9900
49	sp1lb06b_cvhyamap07_124ch	506	Calcite.8+Ca-Montsor.2 AMX15	W1R1Bb CONV diagnostic	1	0.2057	-99.9900	-99.9900	0.1977	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9220	-99.9900	-99.9900
49	sp1lb06b_cvhyamap07_124ch	506	Calcite.8+Ca-Montsor.2 AMX15	W1R1Bb CONV diagnostic	2	0.1813	-99.9900	-99.9900	0.1750	0.0400	-99.9900	0.1687	-99.9900	-99.9900	0.9304	-99.9900	-99.9900
50	sp1lb06b_cvhyamap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba CONV diagnostic	1	0.2010	-99.9900	-99.9900	0.1845	0.0400	-99.9900	0.1680	-99.9900	-99.9900	0.8359	-99.9900	-99.9900
50	sp1lb06b_cvhyamap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba CONV diagnostic	2	0.2024	-99.9900	-99.9900	0.2017	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9931	-99.9900	-99.9900
51	sp1lb06b_cvhyamap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb CONV diagnostic	1	0.2033	-99.9900	-99.9900	0.1965	0.0400	-99.9900	0.1896	-99.9900	-99.9900	0.9327	-99.9900	-99.9900
51	sp1lb06b_cvhyamap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb CONV diagnostic	2	0.2010	-99.9900	-99.9900	0.1846	0.0400	-99.9900	0.1683	-99.9900	-99.9900	0.8374	-99.9900	-99.9900
52	sp1lb06b_cvhyamap07_124ch	508	Calcite.80wt+Kaol CM9 GDS213	W1R1Ba CONV diagnostic	1	0.2016	-99.9900	-99.9900	0.2013	0.0400	-99.9900	0.2010	-99.9900	-99.9900	0.9969	-99.9900	-99.9900
53	sp1lb06b_cvhyamap07_124ch	508	Calcite.80wt+Kaol CM9 GDS213	W1R1Ba CONV diagnostic	2	0.2010	-99.9900	-99.9900	0.1834	0.0400	-99.9900	0.1658	-99.9900	-99.9900	0.8251	-99.9900	-99.9900
53	sp1lb06b_cvhyamap07_124ch	101	Chalcedony CU91-6A	W1R1Ba CONV diagnostic	1	0.2024	-99.9900	-99.9900	0.1855	0.0400	-99.9900	0.1687	-99.9900	-99.9900	0.8336	-99.9900	-99.9900
54	sp1lb06b_cvhyamap07_124ch	349	Opal T#8896 (Hyallite)	W1R1Ba CONV diagnostic	1	0.2024	-99.9900	-99.9900	0.1855	0.0400	-99.9900	0.1687	-99.9900	-99.9900	0.8336	-99.9900	-99.9900
55	sp1lb06b_cvhyamap07_124ch	468	Tremolite HS18.3	W1R1Bc CONV diagnostic	1	0.2087	-99.9900	-99.9900	0.1884	0.0400	-99.9900	0.1681	-99.9900	-99.9900	0.8057	-99.9900	-99.9900
56	sp1lb06b_cvhyamap07_124ch	468	Tremolite HS18.3	W1R1Bc CONV diagnostic	2	0.1681	-99.9900	-99.9900	0.1642	0.0400							

3	splib06b_cvhymp07_124ch	690	Melting_snow mSnlw	W1R1Fa	CONV	diagnostic	1	0.4623	-99.9900	0.0067	-99.9900	-99.9900
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnlw	W1R1Fa	CONV	diagnostic	2	0.2566	-99.9900	0.0152	-99.9900	-99.9900
4	splib06b_cvhymp07_124ch	698	Melting_snow mSln9 (slush)	W1R1Fa	CONV	diagnostic	1	0.8753	-99.9900	0.0126	-99.9900	-99.9900
4	splib06b_cvhymp07_124ch	698	Melting_snow mSln9 (slush)	W1R1Fa	CONV	diagnostic	2	0.2398	-99.9900	0.0129	-99.9900	-99.9900
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba	CONV	diagnostic	1	0.5082	-99.9900	-0.6653	-99.9900	-99.9900
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba	CONV	diagnostic	2	0.7522	-99.9900	-0.0515	-99.9900	-99.9900
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa	CONV	diagnostic	1	0.9611	-99.9900	0.0116	-99.9900	-99.9900
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa	CONV	diagnostic	2	0.8624	-99.9900	-0.0914	-99.9900	-99.9900
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Fa	CONV	diagnostic	3	0.2229	-99.9900	-0.0111	-99.9900	-99.9900
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa	CONV	diagnostic	1	0.9383	-99.9900	0.0114	-99.9900	-99.9900
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa	CONV	diagnostic	2	0.1596	-99.9900	-0.0095	-99.9900	-99.9900
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Fa	CONV	diagnostic	3	0.9115	-99.9900	-0.0914	-99.9900	-99.9900
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV	diagnostic	1	0.9687	-99.9900	0.0722	0.0050	-99.9900
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV	diagnostic	2	0.9639	-99.9900	0.0861	0.0050	-99.9900
9	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa	CONV	diagnostic	1	0.9639	-99.9900	0.0861	0.0050	-99.9900
10	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	diagnostic	1	0.9481	-99.9900	0.0695	0.0050	-99.9900
10	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	diagnostic	2	0.9814	-99.9900	0.0986	0.0050	-99.9900
11	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	diagnostic	1	0.9814	-99.9900	0.0986	0.0050	-99.9900
12	splib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb	CONV	diagnostic	1	0.7646	-99.9900	-0.0999	-99.9900	-99.9900
12	splib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb	CONV	diagnostic	2	0.4075	-99.9900	0.0181	-99.9900	-99.9900
13	splib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb	CONV	diagnostic	1	0.5928	-99.9900	-0.0736	-99.9900	-99.9900
13	splib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb	CONV	diagnostic	2	0.5298	-99.9900	0.0237	-99.9900	-99.9900
14	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV	diagnostic	1	0.3993	-99.9900	-0.0744	-99.9900	-99.9900
14	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV	diagnostic	2	0.7270	-99.9900	0.0237	-99.9900	-99.9900
15	splib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba	CONV	diagnostic	1	0.8701	-99.9900	-0.1114	-99.9900	-99.9900
15	splib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba	CONV	diagnostic	2	0.0049	-99.9900	0.0029	-99.9900	-99.9900
16	splib06b_cvhymp07_124ch	236	Illite IMT-1.b <2um	W1R1Ba	CONV	diagnostic	1	0.9137	-99.9900	-0.1015	-99.9900	-99.9900
16	splib06b_cvhymp07_124ch	236	Illite IMT-1.b <2um	W1R1Ba	CONV	diagnostic	2	0.7499	-99.9900	0.0232	-99.9900	-99.9900
17	splib06b_cvhymp07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	diagnostic	1	0.9443	-99.9900	-0.1055	-99.9900	-99.9900
17	splib06b_cvhymp07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	diagnostic	2	0.7747	-99.9900	0.0242	-99.9900	-99.9900
18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	diagnostic	1	0.2829	-99.9900	-0.0282	-99.9900	-99.9900
19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	diagnostic	1	0.3819	-99.9900	-0.0598	-99.9900	-99.9900
20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	diagnostic	1	0.5011	-99.9900	-0.0733	-99.9900	-99.9900
21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	diagnostic	1	0.2665	-99.9900	-0.0283	-99.9900	-99.9900
22	splib06b_cvhymp07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	diagnostic	1	0.0319	-99.9900	-0.0237	-99.9900	-99.9900
23	splib06b_cvhymp07_124ch	973	Buddingtonite+Na-Mont CU93-260B	W2R4Nb	CONV	diagnostic	1	0.1422	-99.9900	-0.0426	-99.9900	-99.9900
24	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	diagnostic	1	0.0120	-99.9900	-0.0074	-99.9900	-99.9900
24	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	diagnostic	2	0.2235	-99.9900	0.0029	-99.9900	-99.9900
25	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	diagnostic	1	0.1016	-99.9900	-0.0225	-99.9900	-99.9900
25	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	diagnostic	2	0.8045	-99.9900	0.0053	-99.9900	-99.9900
26	splib06b_cvhymp07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	diagnostic	1	0.0070	-99.9900	0.0015	0.0200	-99.9900
27	splib06b_cvhymp07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	diagnostic	1	0.2712	-99.9900	-0.0819	-99.9900	-99.9900
28	splib06b_cvhymp07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	diagnostic	1	0.3224	-99.9900	-0.0883	-99.9900	-99.9900
29	splib06b_cvhymp07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	diagnostic	1	0.7261	-99.9900	-0.0801	-99.9900	-99.9900
30	splib06b_cvhymp07_124ch	298	Montmorillonite SWz-1	W1R1Bb	CONV	diagnostic	1	0.7681	-99.9900	-0.0806	-99.9900	-99.9900
31	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	1	0.8442	-99.9900	-0.1331	-99.9900	-99.9900
31	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	2	0.7626	0.8000	-0.0049	-99.9900	-99.9900
31	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	3	0.5191	0.8000	0.0177	-99.9900	-99.9900
32	splib06b_cvhymp07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	1	0.3225	-99.9900	0.0545	-99.9900	-99.9900
32	splib06b_cvhymp07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	2	0.5051	-99.9900	-0.0423	-99.9900	-99.9900
32	splib06b_cvhymp07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	3	0.7102	-99.9900	-0.3737	-99.9900	-99.9900
33	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	diagnostic	1	0.0653	-99.9900	-0.0062	-99.9900	-99.9900
33	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	diagnostic	2	0.6926	-99.9900	0.0865	-99.9900	-99.9900
34	splib06b_cvhymp07_124ch	490	Alun366+50PyroPYS1A GDS222	W1R1Bb	CONV	diagnostic	1	0.0964	-99.9900	-0.0176	-99.9900	-99.9900
34	splib06b_cvhymp07_124ch	490	Alun366+50PyroPYS1A GDS222	W1R1Bb	CONV	diagnostic	2	0.3594	-99.9900	0.0038	-99.9900	-99.9900
34	splib06b_cvhymp07_124ch	490	Alun366+50PyroPYS1A GDS222	W1R1Bb	CONV	diagnostic	3	0.5266	-99.9900	0.0443	-99.9900	-99.9900
35	splib06b_cvhymp07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	diagnostic	1	0.2418	-99.9900	-0.0245	-99.9900	-99.9900
35	splib06b_cvhymp07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	diagnostic	2	0.4727	-99.9900	0.0044	-99.9900	-99.9900
35	splib06b_cvhymp07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	diagnostic	3	0.5998	-99.9900	0.0214	-99.9900	-99.9900
36	splib06b_cvhymp07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	diagnostic	1	0.2546	-99.9900	-0.0259	-99.9900	-99.9900
36	splib06b_cvhymp07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	diagnostic	2	0.3193	-99.9900	0.0036	-99.9900	-99.9900
36	splib06b_cvhymp07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	diagnostic	3	0.7280	-99.9900	0.0226	-99.9900	-99.9900
37	splib06b_cvhymp07_124ch	529	Kaol_5+MuscCU91-250A AMX13	W1R1Bb	CONV	diagnostic	1	0.4697	-99.9900	-0.0697	-99.9900	-99.9900
38	splib06b_cvhymp07_124ch	529	Kaol_5+MuscCU91-250A AMX13	W1R1Bb	CONV	diagnostic	2	0.4173	-99.9900	0.0264	-99.9900	-99.9900
38	splib06b_cvhymp07_124ch	530	Kaol Wx1+0.5Musc Ruby AMX12	W1R1Ba	CONV	diagnostic	1	0.3886	-99.9900	-0.0644	-99.9900	-99.9900
38	splib06b_cvhymp07_124ch	530	Kaol Wx1+0.5Musc Ruby AMX12	W1R1Ba	CONV	diagnostic	2	0.5135	-99.9900	0.0300	-99.9900	-99.9900
39	splib06b_cvhymp07_124ch	528	Kaol+Musc intimate CU93-5C	W1R1Ba	CONV	diagnostic	1	0.6233	-99.9900	-0.0816	-99.9900	-99.9900
39	splib06b_cvhymp07_124ch	528	Kaol+Musc intimate CU93-5C	W1R1Ba	CONV	diagnostic	2	0.3927	-99.9900	0.0268	-99.9900	-99.9900
40	splib06b_cvhymp07_124ch	532	Kaolin Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	diagnostic	1	0.4139	-99.9900	-0.0637	-99.9900	-99.9900
41	splib06b_cvhymp07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	diagnostic	1	0.8322	-99.9900	-0.1200	-99.9900	-99.9900
41	splib06b_cvhymp07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	diagnostic	2	0.5564	-99.9900	0.0095	-99.9900	-99.9900
41	splib06b_cvhymp07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	diagnostic	3	0.1679	-99.9900	-0.0515	-99.9900	-99.9900
42	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	diagnostic	1	0.0006	-99.9900	-0.0006	-99.9900	-99.9900
42	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	diagnostic	2	0.3467	-99.9900	-0.0783	-99.9900	-99.9900
42	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	diagnostic	3	0.6779	-99.9900	0.0225	-99.9900	-99.9900
43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	diagnostic	1	0.7213	-99.9900	0.0858	-99.9900	-99.9900
43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	diagnostic	2	0.7036	-99.9900	0.0082	-99.9900	-99.9900
44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba	CONV	diagnostic	1	0.7213	-99.9900	0.0858	-99.9900	-99.9900
45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	diagnostic	1	0.3356	-99.9900	0.0604	-99.9900	-99.9900
46	splib06b_cvhymp07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	diagnostic	1	0.8273	-99.9900	0.0839	-99.9900	-99.9900
46	splib06b_cvhymp07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	diagnostic	2	0.5085	-99.9900	-0.1353	-99.9900	-99.9900

43	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.0006	0.6400	-0.0006	0.2000	Absolute	sp1ib06b_cvhymp07_124ch	511 Chlorite+Muscovite CU93-65A	W1R1Ba CONV
43	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.0653	0.6400	-0.0062	0.0005	Relative	sp1ib06b_cvhymp07_124ch	159 Epidote GDS26.a 75-200um	W1R1Bb CONV
43	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
43	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
44	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.7036	0.6400	0.0082	0.0015	Absolute	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV
44	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.0006	0.6400	-0.0006	0.2000	Absolute	sp1ib06b_cvhymp07_124ch	511 Chlorite+Muscovite CU93-65A	W1R1Ba CONV
44	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.0653	0.6400	-0.0062	0.0005	Relative	sp1ib06b_cvhymp07_124ch	159 Epidote GDS26.a 75-200um	W1R1Bb CONV
44	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
44	sp1ib06b_cvhymp07_124ch	94 Calcite WS272	W1R1Ba CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
45	sp1ib06b_cvhymp07_124ch	151 Dolomite HS102.3B	W1R1Bb CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
45	sp1ib06b_cvhymp07_124ch	151 Dolomite HS102.3B	W1R1Bb CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
48	sp1ib06b_cvhymp07_124ch	507 Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
48	sp1ib06b_cvhymp07_124ch	507 Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
49	sp1ib06b_cvhymp07_124ch	506 Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
49	sp1ib06b_cvhymp07_124ch	506 Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
50	sp1ib06b_cvhymp07_124ch	501 Calcite+.33Muscov AMX5 Ruby	W1R1Ba CONV	not	0.0653	0.6400	-0.0062	0.0005	Relative	sp1ib06b_cvhymp07_124ch	159 Epidote GDS26.a 75-200um	W1R1Bb CONV
55	sp1ib06b_cvhymp07_124ch	468 Tremolite HS18.3	W1R1Bc CONV	not	0.9687	0.6400	0.0722	0.0433	Relative	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
55	sp1ib06b_cvhymp07_124ch	468 Tremolite HS18.3	W1R1Bc CONV	not	0.9481	0.6400	0.0695	0.0417	Relative	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
56	sp1ib06b_cvhymp07_124ch	67 Antigorite NMMH96917.d 70um	W1R1Bb CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
56	sp1ib06b_cvhymp07_124ch	67 Antigorite NMMH96917.d 70um	W1R1Bb CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
57	sp1ib06b_cvhymp07_124ch	115 Chrysotile HS323.1B	W1R1Ba CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
57	sp1ib06b_cvhymp07_124ch	115 Chrysotile HS323.1B	W1R1Ba CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
58	sp1ib06b_cvhymp07_124ch	67 Antigorite NMMH96917.d 70um	W1R1Bb CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
58	sp1ib06b_cvhymp07_124ch	67 Antigorite NMMH96917.d 70um	W1R1Bb CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
59	sp1ib06b_cvhymp07_124ch	115 Chrysotile HS323.1B	W1R1Ba CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
59	sp1ib06b_cvhymp07_124ch	115 Chrysotile HS323.1B	W1R1Ba CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV
60	sp1ib06b_cvhymp07_124ch	67 Antigorite NMMH96917.d 70um	W1R1Bb CONV	not	0.9687	0.6400	0.0722	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	812 Grass_Golden_Dry GDS480	W1R1Fa CONV
60	sp1ib06b_cvhymp07_124ch	67 Antigorite NMMH96917.d 70um	W1R1Bb CONV	not	0.9481	0.6400	0.0695	0.0200	Absolute	sp1ib06b_cvhymp07_124ch	831 Lodgpole-Pine LP-Needles-3	W1R1Fa CONV

Following this line, the summary results ("pass" or "fail") based on the previously reported values for the diagnostic feature constraints are reported. If any of the individual constraints was violated, then the final judgment on the feature constraints is "Fail", indicating that the feature is NOT detected because a constraint was violated.

The depth sign constraint is checked (if turned "ON" in the command file). This check makes sure that if the NOT feature is an absorption feature then the continuum removal over the endpoints for the observed spectrum also produces an absorption feature, instead of an emission feature.

CONSTRAINT RESULTS - PER FEATURE SUMMARY:

Ref. #	Reference SPECTR File	Reference SPECTR Rec	Reference SPECTR Title	Feature Type	Feat. #	Fit	Depth	Left	Mid	Right	Ratio	Depth Sign	Final Judgment on Constraint Algorithms	
1	sp1ib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
1	sp1ib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	W1R1Ba CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
1	sp1ib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	W1R1Ba CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
2	sp1ib06b_cvhymp07_124ch	602	Grass_dry_7+.3green AMX30	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
2	sp1ib06b_cvhymp07_124ch	602	Grass_dry_7+.3green AMX30	W1R1Ba CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
2	sp1ib06b_cvhymp07_124ch	602	Grass_dry_7+.3green AMX30	W1R1Ba CONV	diagnostic	3	N/A	Pass	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
3	sp1ib06b_cvhymp07_124ch	690	Melting_snow mSnw1a	W1R1Pa CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
3	sp1ib06b_cvhymp07_124ch	690	Melting_snow mSnw1a	W1R1Pa CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	Fail	This feature FAILED one or more constraints!	
4	sp1ib06b_cvhymp07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Pa CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.	
4	sp1ib06b_cvhymp07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Pa CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	Fail	This feature FAILED one or more constraints!	
5	sp1ib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba CONV	diagnostic	1	N/A	N/A	Pass	N/A	Fail	Fail	This feature FAILED one or more constraints!	
5	sp1ib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba CONV	diagnostic	2	N/A	N/A	Pass	N/A	Pass	Fail	This feature FAILED one or more constraints!	
5	sp1ib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Pa CONV	diagnostic	1	N/A	N/A	Pass	N/A	Pass	Fail	This feature FAILED one or more constraints!	
6	sp1ib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Pa CONV	diagnostic	2	N/A	N/A	Pass	N/A	Pass	N/A	Fail	This feature FAILED one or more constraints!
6	sp1ib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	W1R1Pa CONV	diagnostic	3	N/A	N/A	Pass	N/A	Pass	N/A	Pass	This feature PASSED all the constraints.
7	sp1ib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Pa CONV	diagnostic	1	N/A	N/A	Fail	N/A	Fail	Fail	This feature FAILED one or more constraints!	
7	sp1ib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Pa CONV	diagnostic	2	N/A	N/A	Fail	N/A	Fail	N/A	Pass	This feature FAILED one or more constraints!
7	sp1ib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	W1R1Pa CONV	diagnostic	3	N/A	N/A	Pass	N/A	Fail	N/A	Fail	This feature FAILED one or more constraints!
8	sp1ib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Pa CONV	diagnostic	1	N/A	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
8	sp1ib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Pa CONV	diagnostic	2	N/A	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
8	sp1ib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Pa CONV	diagnostic	3	N/A	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
9	sp1ib06b_cvhymp07_124ch	831	Lodgpole-Pine LP-Needles-3	W1R1Pa CONV	diagnostic	1	N/A	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
9	sp1ib06b_cvhymp07_124ch	831	Lodgpole-Pine LP-Needles-3	W1R1Pa CONV	diagnostic	2	N/A	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
9	sp1ib06b_cvhymp07_124ch	831	Lodgpole-Pine LP-Needles-3	W1R1Pa CONV	diagnostic	3	N/A	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
10	sp1ib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
10	sp1ib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
11	sp1ib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
11	sp1ib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
12	sp1ib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
12	sp1ib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
13	sp1ib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
13	sp1ib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.

The three features of reference material 3 are circled.

An entry of "N/A" indicates no constraint was set on this parameter.

The final judgment on a feature is "Failed", indicating that it is not detected, if one or more of the individual constraints has failed.

14	splib06b_cvhyamap07_124ch	236	Illite IMt-1.b <2um	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
14	splib06b_cvhyamap07_124ch	236	Illite IMt-1.b <2um	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
15	splib06b_cvhyamap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
15	splib06b_cvhyamap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
16	splib06b_cvhyamap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
17	splib06b_cvhyamap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
18	splib06b_cvhyamap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
19	splib06b_cvhyamap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
20	splib06b_cvhyamap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
21	splib06b_cvhyamap07_124ch	973	Buddingtont+Na-Mont CU93-260B	W2R4Nb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
22	splib06b_cvhyamap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
22	splib06b_cvhyamap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
23	splib06b_cvhyamap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
23	splib06b_cvhyamap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
24	splib06b_cvhyamap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	diagnostic	1	N/A	Fail	N/A	Pass	N/A	N/A	Pass	This feature FAILED one or more constraints!
25	splib06b_cvhyamap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
26	splib06b_cvhyamap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
27	splib06b_cvhyamap07_124ch	202	Montmorillonite SWy-1	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
28	splib06b_cvhyamap07_124ch	298	Montmorillonite SAz-1	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
29	splib06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
29	splib06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	2	Fail	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
29	splib06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	diagnostic	3	Fail	N/A	N/A	Pass	N/A	N/A	Pass	This feature FAILED one or more constraints!
30	splib06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
30	splib06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
30	splib06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
31	splib06b_cvhyamap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
31	splib06b_cvhyamap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
32	splib06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
32	splib06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
32	splib06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
33	splib06b_cvhyamap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
33	splib06b_cvhyamap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
33	splib06b_cvhyamap07_124ch	493	Alunite0.5+Kaol KGa-1 AMX3	W1R1Bb	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
34	splib06b_cvhyamap07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
34	splib06b_cvhyamap07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
34	splib06b_cvhyamap07_124ch	536	Kaolw1.75+Alun_HS295 AMX14	W1R1Bb	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
35	splib06b_cvhyamap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
35	splib06b_cvhyamap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
36	splib06b_cvhyamap07_124ch	530	Kaol Wx1+0.5Musc_Ruby AMX12	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
36	splib06b_cvhyamap07_124ch	530	Kaol Wx1+0.5Musc_Ruby AMX12	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
37	splib06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
37	splib06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
38	splib06b_cvhyamap07_124ch	532	Kaolin_Smect H89-FR-2 .5Kaol	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
39	splib06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
39	splib06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
39	splib06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
40	splib06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	Pass	Fail	This feature FAILED one or more constraints!
40	splib06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
40	splib06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
41	splib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
41	splib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
41	splib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba	CONV	diagnostic	3	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
42	splib06b_cvhyamap07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	Pass	Pass	This feature PASSED all the constraints.
43	splib06b_cvhyamap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
43	splib06b_cvhyamap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
44	splib06b_cvhyamap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
44	splib06b_cvhyamap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
45	splib06b_cvhyamap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
45	splib06b_cvhyamap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
46	splib06b_cvhyamap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
46	splib06b_cvhyamap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
47	splib06b_cvhyamap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
47	splib06b_cvhyamap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
48	splib06b_cvhyamap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
48	splib06b_cvhyamap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.
49	splib06b_cvhyamap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
49	splib06b_cvhyamap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints.

50	sp1ib06b_cvhyamap07_124ch	101	Chalcedony CU91-6A	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
51	sp1ib06b_cvhyamap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
52	sp1ib06b_cvhyamap07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
52	sp1ib06b_cvhyamap07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
53	sp1ib06b_cvhyamap07_124ch	67	Antigorite MNH96917.d 70um	W1R1Bb CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
54	sp1ib06b_cvhyamap07_124ch	115	Chrysothile HS323.1B	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
55	sp1ib06b_cvhyamap07_124ch	67	Antigorite MNH96917.d 70um	W1R1Bb CONV	diagnostic	1	Fail	Fail	N/A	Pass	N/A	N/A	Fail	This feature FAILED one or more constraints!
55	sp1ib06b_cvhyamap07_124ch	67	Antigorite MNH96917.d 70um	W1R1Bb CONV	diagnostic	2	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
56	sp1ib06b_cvhyamap07_124ch	115	Chrysothile HS323.1B	W1R1Ba CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
56	sp1ib06b_cvhyamap07_124ch	115	Chrysothile HS323.1B	W1R1Ba CONV	diagnostic	2	Pass	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
57	sp1ib06b_cvhyamap07_124ch	67	Antigorite MNH96917.d 70um	W1R1Bb CONV	diagnostic	1	N/A	N/A	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!
57	sp1ib06b_cvhyamap07_124ch	67	Antigorite MNH96917.d 70um	W1R1Bb CONV	diagnostic	2	Pass	Pass	N/A	Pass	N/A	N/A	Pass	This feature PASSED all the constraints!

Following this line, the summary results ("present" or "absent") based on the previously reported values for the NOT feature constraints are reported. If any of the individual constraints was violated, the constraint is judged as "Fail", and the final judgment on the NOT feature constraints is "absent", indicating that the observed spectrum does not have a shape that matches the NOT feature.

MICA compares the absolute values of the depths of features in the observed spectrum to the constraints (that is, an emission feature has a negative depth, but the absolute value is taken before comparing it to the constraint).

Since MICA compares the absolute values of the depths of features to the constraints, this checks that the continuum-removed feature in the observed spectrum is the same type of feature as the NOT feature, that is, if the NOT feature is an absorption feature (which has a positive value for depth), then the continuum removal of the observed spectrum must also result in an absorption feature (which will have a positive value for depth).

If the depth threshold is determined using a relative NOT threshold calculation, this checks that the relative feature and the feature in the observed spectrum are the same types of features (for example, both are absorption features, that is, the depths of both have a positive value).

CONSTRAINT RESULTS - NOT FEATURES:

The reference material (entry) that has invoked the NOT feature.

Refer. #	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Feature Type	Fit	Depth	Not Feat Sign	Rel. Feat Sign	Final Judgment on Not Feature Constraint Algorithms	
3	sp1ib06b_cvhyamap07_124ch	690	Melting_snow mSnw1a	W1R1Fa CONV	not	Pass	Fail	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec588) was absent.
4	sp1ib06b_cvhyamap07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Fa CONV	not	Pass	Fail	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec588) was absent.
18	sp1ib06b_cvhyamap07_124ch	252	Kaolinite CM9	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
18	sp1ib06b_cvhyamap07_124ch	252	Kaolinite CM9	W1R1Bb CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
18	sp1ib06b_cvhyamap07_124ch	252	Kaolinite CM9	W1R1Bb CONV	not	Pass	Fail	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
19	sp1ib06b_cvhyamap07_124ch	255	Kaolinite KGa-2 (px1)	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
19	sp1ib06b_cvhyamap07_124ch	255	Kaolinite KGa-2 (px1)	W1R1Bb CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
19	sp1ib06b_cvhyamap07_124ch	255	Kaolinite KGa-2 (px1)	W1R1Bb CONV	not	Pass	Fail	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
20	sp1ib06b_cvhyamap07_124ch	197	Halloysite MNH106237	W1R1Ba CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
20	sp1ib06b_cvhyamap07_124ch	197	Halloysite MNH106237	W1R1Ba CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
20	sp1ib06b_cvhyamap07_124ch	197	Halloysite MNH106237	W1R1Ba CONV	not	Pass	Fail	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
21	sp1ib06b_cvhyamap07_124ch	144	Dickite MNBH106242	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
21	sp1ib06b_cvhyamap07_124ch	144	Dickite MNBH106242	W1R1Bb CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
21	sp1ib06b_cvhyamap07_124ch	144	Dickite MNBH106242	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
22	sp1ib06b_cvhyamap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec812) was present!
22	sp1ib06b_cvhyamap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec831) was present!
23	sp1ib06b_cvhyamap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb CONV	not	Pass	Pass	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec812) was present!
23	sp1ib06b_cvhyamap07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb CONV	not	Pass	Pass	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec831) was present!
26	sp1ib06b_cvhyamap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
26	sp1ib06b_cvhyamap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
29	sp1ib06b_cvhyamap07_124ch	302	Montmorillonite SWy-1	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
29	sp1ib06b_cvhyamap07_124ch	302	Montmorillonite SWy-1	W1R1Bb CONV	not	Pass	Fail	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec191) was absent.
30	sp1ib06b_cvhyamap07_124ch	298	Montmorillonite SAz-1	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
30	sp1ib06b_cvhyamap07_124ch	298	Montmorillonite SAz-1	W1R1Bb CONV	not	Pass	Fail	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec191) was absent.
37	sp1ib06b_cvhyamap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
37	sp1ib06b_cvhyamap07_124ch	529	Kaol.5+MuscCU91-250A AMX13	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
38	sp1ib06b_cvhyamap07_124ch	530	Kaol_Wxl+0.5Musc_Ruby AMX12	W1R1Ba CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
38	sp1ib06b_cvhyamap07_124ch	530	Kaol_Wxl+0.5Musc_Ruby AMX12	W1R1Ba CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
39	sp1ib06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
39	sp1ib06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
40	sp1ib06b_cvhyamap07_124ch	532	Kaolin_Smect H89-FR-2.5Kaol	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec308) was absent.
40	sp1ib06b_cvhyamap07_124ch	532	Kaolin_Smect H89-FR-2.5Kaol	W1R1Bb CONV	not	Fail	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec945) was absent.
40	sp1ib06b_cvhyamap07_124ch	532	Kaolin_Smect H89-FR-2.5Kaol	W1R1Bb CONV	not	Pass	Pass	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec948) was absent.
40	sp1ib06b_cvhyamap07_124ch	532	Kaolin_Smect H89-FR-2.5Kaol	W1R1Bb CONV	not	Pass	Fail	Pass	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec191) was absent.
43	sp1ib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Fail	Fail	Fail	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec511) was absent.
43	sp1ib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Fail	Pass	Fail	Fail	The not-feature (sp1ib06b_cvhyamap07_124ch rec159) was absent.
43	sp1ib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec812) was present!
43	sp1ib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (sp1ib06b_cvhyamap07_124ch rec831) was present!

The NOT feature that was invoked.

The final judgment on a NOT feature is "present" if all the constraints are passed. If a NOT feature is detected as being present, then the reference entry (reference material) that invoked the NOT feature is considered as a non-match to the observed spectrum. The logic of the NOT feature, in contrast to diagnostic features, is that the reference spectrum cannot match the observed spectrum if the NOT feature is present. The presence of the NOT feature indicates that the observed spectrum is likely to match a material other than the reference spectrum that invoked the NOT feature. In this case, the NOT feature of "record 812 of sp1ib06b_cvhyamap07_124ch" which has a title of "Grass_Golden_Dry GDS480" was found to be present, indicating that the observed spectrum has a feature that matches "Grass_Golden_Dry GDS480". Since the reference entry for "Calcite WS272" invoked this NOT feature, the observed spectrum will not be matched to "Calcite WS272".

44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec94) was present!
44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Fail	Fail	Fail	N/A	The not-feature (splib06b_cvhymp07_124ch rec511) was absent.
44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Fail	Pass	Fail	Fail	The not-feature (splib06b_cvhymp07_124ch rec159) was absent.
44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
48	splib06b_cvhymp07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
48	splib06b_cvhymp07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
49	splib06b_cvhymp07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
49	splib06b_cvhymp07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
50	splib06b_cvhymp07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba CONV	not	Fail	Pass	Fail	Fail	The not-feature (splib06b_cvhymp07_124ch rec159) was absent.
55	splib06b_cvhymp07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	not	Pass	Pass	Pass	Pass	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
55	splib06b_cvhymp07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	not	Pass	Pass	Pass	Pass	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
56	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
56	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
57	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
57	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec812) was present!
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	not	Pass	Pass	Pass	N/A	The not-feature (splib06b_cvhymp07_124ch rec831) was present!

Following this line, the summary values for each reference spectrum's (reference material's) match to the observed spectrum are reported. For each reference spectrum (material) the weighted fit value is the summation of the individual diagnostic feature fit values multiplied by the weighting factors set in the command file. In the same way, the weighted depth and weighted fit*depth are determined. These values are reported along with constraints on them that were set in the command file.

The computed weighted fit and the minimum value needed to be reached to consider the observed spectrum a match to the reference.

The computed weighted depth and the min/max allowable values.

The computed weighted fit * depth and the minimum value needed to be reached to consider the observed spectrum a match to the reference.

CONSTRAINT ANALYSIS - WEIGHTED FITS AND DEPTHS:

The reference material (also described as the reference spectrum or reference entry).

Ref. #	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title		Fit Value	Min Fit	Depth Value	Min Depth	Max Depth	Fit*Depth	
										Value	Fit*Depth
1	splib06b_cvhymp07_124ch	588	Fir_Tree IHS1-2	W1R1Ba CONV	0.9013	0.5750	0.1390	0.2000	-99.9900	0.1234	0.0000
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green AMX30	W1R1Ba CONV	0.9529	0.5750	0.1417	0.0700	-99.9900	0.1347	0.0000
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnw1a	W1R1Fa CONV	0.3286	0.5750	0.0122	0.0500	-99.9900	0.0036	0.0000
4	splib06b_cvhymp07_124ch	698	Melting_snow mSnw9 (slush)	W1R1Fa CONV	0.4622	0.5750	0.0128	0.0500	-99.9900	0.0059	0.0000
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	W1R1Ba CONV	0.5326	0.5750	-0.5936	0.0300	-99.9900	-0.3004	0.0000
6	splib06b_cvhymp07_124ch	704	Water+Montmor Swy-2+5.01g/l	W1R1Fa CONV	0.8776	0.5750	0.0013	0.0300	-99.9900	0.0013	0.0000
7	splib06b_cvhymp07_124ch	701	Water+Montmor Swy-2+0.5g/l	W1R1Fa CONV	0.8578	0.5750	0.0009	0.0300	-99.9900	0.0003	0.0000
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa CONV	0.9663	0.5750	0.0791	0.0100	-99.9900	0.0764	0.0000
9	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	W1R1Fa CONV	0.9639	0.5750	0.0861	0.0100	-99.9900	0.0830	0.0000

Example calculation:

From previous reporting, this spectrum has three features, two absorption features and one emission feature.

The weighted values are calculated as:

$$\text{weighted fit} = (0.9611 * 0.8000) + (0.8634 * 0.1000) + (0.2229 * 0.1000) = 0.8776$$

$$\text{weighted depth} = 1 * (|0.0116| * 0.8000) + -1 * (|-0.0914| * 0.1000) + 1 * (|-0.0111| * 0.1000) = 0.0013$$

NOTE: in the depth calculation, the absolute values of the depths are multiplied by the weighting factors (reported earlier). This is so that both absorption and emission features contribute positively to the weighted depth. Another factor is considered, the feature in the observed spectrum must be of the same type (absorption or emission) as the reference feature. If they are the same type, the depth value for the feature will contribute positively to the final weighted depth value, otherwise it will be multiplied by -1, and when added with the other depths, it reduces the overall depth value. In this example, the first reference feature is an absorption feature, as is the feature in the observed spectrum (indicated by its positive depth value). The second reference feature is also an absorption feature, but the feature in the observed spectrum is not (indicated by its negative depth value). Therefore, the weighted depth of the 2nd feature is multiplied by -1 so that it reduces the overall depth. Finally, the third reference feature is an emission feature, and so is the feature in the observed spectrum (indicated by its negative depth value). This feature contributes positively to the overall weighted depth because the absolute value of its depth is taken before it is multiplied by its weighting factor.

10	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa CONV	0.9647	0.5750	0.0841	0.0100	-99.9900	0.0814	0.0000
11	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa CONV	0.9814	0.5750	0.0986	0.0100	-99.9900	0.0968	0.0000
12	splib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb CONV	0.6754	0.5750	-0.0704	0.0100	-99.9900	-0.0555	0.0000
13	splib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	W1R1Fb CONV	0.5771	0.5750	-0.0493	0.0100	-99.9900	-0.0296	0.0000
14	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb CONV	0.4812	0.5750	-0.0499	0.0100	-99.9900	-0.0180	0.0000
15	splib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba CONV	0.6538	0.5750	-0.0828	0.0100	-99.9900	-0.0727	0.0000
16	splib06b_cvhymp07_124ch	236	Illite IMT-1.b <2um	W1R1Ba CONV	0.8727	0.5750	-0.0703	0.0100	-99.9900	-0.0652	0.0000
17	splib06b_cvhymp07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb CONV	0.9019	0.5750	-0.0731	0.0100	-99.9900	-0.0700	0.0000
18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	W1R1Bb CONV	0.2829	0.5750	-0.0282	0.0100	-99.9900	-0.0080	0.0000
19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb CONV	0.3819	0.5750	-0.0598	0.0100	-99.9900	-0.0228	0.0000
20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	W1R1Ba CONV	0.5011	0.5750	-0.0733	0.0100	-99.9900	-0.0367	0.0000
21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	W1R1Bb CONV	0.2665	0.5750	-0.0283	0.0500	-99.9900	-0.0075	0.0000
22	splib06b_cvhymp07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb CONV	0.0319	0.5750	-0.0237	0.0250	-99.9900	-0.0008	0.0000
23	splib06b_cvhymp07_124ch	973	Buddingtnt+Na-Mont CU93-260B	W2R4Nb CONV	0.1422	0.5750	-0.0426	0.0250	-99.9900	-0.0061	0.0000
24	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na CONV	0.0332	0.5750	-0.0064	0.0300	-99.9900	-0.0000	0.0000
25	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na CONV	0.1719	0.5750	-0.0197	0.0300	-99.9900	-0.0016	0.0000
26	splib06b_cvhymp07_124ch	380	Pyrophyllite PYSIA fine gr	W1R1Ba CONV	0.0070	0.5750	0.0015	0.0100	-99.9900	0.0000	0.0000
27	splib06b_cvhymp07_124ch	241	Jarosite GDS24 Na	W1R1Bb CONV	0.2712	0.5750	-0.0819	0.0100	-99.9900	-0.0222	0.0000
28	splib06b_cvhymp07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba CONV	0.3224	0.5750	-0.0883	0.0100	-99.9900	-0.0285	0.0000
29	splib06b_cvhymp07_124ch	302	Montmorillonite SWy-1	W1R1Bb CONV	0.7261	0.5750	-0.0801	0.0100	-99.9900	-0.0582	0.0000
30	splib06b_cvhymp07_124ch	298	Montmorillonite SAz-1	W1R1Bb CONV	0.7681	0.5750	-0.0806	0.0100	-99.9900	-0.0619	0.0000
31	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba CONV	0.7086	0.5750	-0.0401	0.0100	-99.9900	-0.0356	0.0000
32	splib06b_cvhymp07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba CONV	0.4571	0.5750	-0.0836	0.0100	-99.9900	-0.0712	0.0000
33	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb CONV	0.6299	0.5750	0.0772	0.0100	-99.9900	0.0539	0.0000
34	splib06b_cvhymp07_124ch	490	Alun366+.50PyroPYSIA GDS222	W1R1Bb CONV	0.1227	0.5750	-0.0154	0.0700	-99.9900	-0.0014	0.0000
35	splib06b_cvhymp07_124ch	493	Alunite0.5+Kao1_KGa-1 AMX3	W1R1Bb CONV	0.2648	0.5750	-0.0216	0.0700	-99.9900	-0.0051	0.0000
36	splib06b_cvhymp07_124ch	536	Kao1wx1.75+Alun_HS295 AMX14	W1R1Bb CONV	0.2610	0.5750	-0.0230	0.0700	-99.9900	-0.0058	0.0000
37	splib06b_cvhymp07_124ch	529	Kao1.5+MuscCU91-250A AMX13	W1R1Bb CONV	0.4697	0.5750	-0.0697	0.0500	-99.9900	-0.0327	0.0000
38	splib06b_cvhymp07_124ch	530	Kao1_Wx1+0.5Musc_Ruby AMX12	W1R1Ba CONV	0.3896	0.5750	-0.0644	0.0500	-99.9900	-0.0250	0.0000
39	splib06b_cvhymp07_124ch	528	Kao1+Musc_intimate CU93-5C	W1R1Ba CONV	0.6233	0.5750	-0.0816	0.0500	-99.9900	-0.0508	0.0000
40	splib06b_cvhymp07_124ch	532	Kao1in_Smect H89-FR-2 .5Kao1	W1R1Bb CONV	0.4139	0.5750	-0.0637	0.0300	-99.9900	-0.0264	0.0000
41	splib06b_cvhymp07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb CONV	0.5001	0.5750	-0.0858	0.0500	-99.9900	-0.0543	0.0000
42	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba CONV	0.2241	0.5750	-0.0332	0.0100	-99.9900	-0.0107	0.0000
43	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	0.7213	0.5750	0.0858	0.0100	-99.9900	0.0619	0.0000
44	splib06b_cvhymp07_124ch	94	Calcite WS272	W1R1Ba CONV	0.7213	0.5750	0.0858	0.0100	-99.9900	0.0619	0.0000
45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	W1R1Bb CONV	0.3356	0.5750	0.0604	0.0100	-99.9900	0.0203	0.0000
46	splib06b_cvhymp07_124ch	416	Siderite HS271.3B	W1R1Ba CONV	0.6679	0.5750	-0.0257	0.0100	-99.9900	0.0003	0.0000
47	splib06b_cvhymp07_124ch	500	Calc.25+do1o.25+mont.5 AMX18	W1R1Bb CONV	0.5488	0.5750	-0.0019	0.0250	-99.9900	0.0051	0.0000
48	splib06b_cvhymp07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba CONV	0.6087	0.5750	-0.0127	0.0100	-99.9900	-0.0109	0.0000
49	splib06b_cvhymp07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb CONV	0.7722	0.5750	-0.0163	0.0100	-99.9900	-0.0092	0.0000
50	splib06b_cvhymp07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba CONV	0.4216	0.5750	0.0237	0.0100	-99.9900	0.0211	0.0000
51	splib06b_cvhymp07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb CONV	0.5201	0.5750	0.0001	0.0250	-99.9900	0.0063	0.0000
52	splib06b_cvhymp07_124ch	508	Calcite.80wt+Kao1_CM9 GDS213	W1R1Ba CONV	0.4644	0.5750	0.0262	0.0100	-99.9900	0.0245	0.0000
53	splib06b_cvhymp07_124ch	101	Chalcedony CU91-6A	W1R1Ba CONV	0.4225	0.5750	-0.0761	0.0100	-99.9900	-0.0321	0.0000
54	splib06b_cvhymp07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba CONV	0.3638	0.5750	-0.0723	0.0100	-99.9900	-0.0263	0.0000
55	splib06b_cvhymp07_124ch	468	Tremolite HS18.3	W1R1Bc CONV	0.7610	0.5750	0.0571	0.0350	-99.9900	0.0434	0.0000
56	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.6159	0.5750	0.0859	0.0350	-99.9900	0.0529	0.0000
57	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	0.4893	0.5750	0.0791	0.0350	-99.9900	0.0387	0.0000
58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.6159	0.5750	0.0859	0.0350	-99.9900	0.0529	0.0000
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	W1R1Ba CONV	0.4893	0.5750	0.0791	0.0350	-99.9900	0.0387	0.0000
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb CONV	0.6159	0.5750	0.0859	0.0350	-99.9900	0.0529	0.0000

Following this line, the summary results ("pass" or "fail") for the weighted fit and depth constraints are given. For each reference entry (reference material), if all of these constraints are passed, then the reference material might be considered the "best match" to the observed spectrum, if it has the highest weighted fit value. If any constraint is failed, then the weighted fit value will be zeroed so that the material is not considered as a match to the observed spectrum.

CONSTRAINT RESULTS - WEIGHTED FITS AND DEPTHS:

Reference Spectrum	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Fit Constraint	Depth Constraint	Fit*Depth Constraints
1	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	Pass	Fail	Pass
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green AMX30	Pass	Pass	Pass
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnlw1a	Fail	Fail	Pass
4	splib06b_cvhymp07_124ch	698	Melting_snow mSnlw9 (slush)	Fail	Fail	Pass
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	Fail	Fail	Fail
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	Pass	Fail	Pass
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	Pass	Fail	Pass
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	Pass	Pass	Pass
9	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	Pass	Pass	Pass

10	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	WIR1Fa CONV	Pass	Pass	Pass
11	splib06b_cvhymp07_124ch	831	Lodgepole-Pine LP-Needles-3	WIR1Fa CONV	Pass	Pass	Pass
12	splib06b_cvhymp07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb CONV	Pass	Fail	Fail
13	splib06b_cvhymp07_124ch	674	Muscovite-medlowAl CU91-250A	WIR1Eb CONV	Pass	Fail	Fail
14	splib06b_cvhymp07_124ch	308	Muscovite GDS113 Ruby	WIR1Bb CONV	Fail	Fail	Fail
15	splib06b_cvhymp07_124ch	310	Muscovite GDS116 Tanzania	WIR1Ba CONV	Pass	Fail	Fail
16	splib06b_cvhymp07_124ch	236	Illite IMT-1.b <2um	WIR1Ba CONV	Pass	Fail	Fail
17	splib06b_cvhymp07_124ch	232	Illite GDS4 (Marblehead)	WIR1Bb CONV	Pass	Fail	Fail
18	splib06b_cvhymp07_124ch	252	Kaolinite CM9	WIR1Bb CONV	Fail	Fail	Fail
19	splib06b_cvhymp07_124ch	255	Kaolinite KGa-2 (pxl)	WIR1Bb CONV	Fail	Fail	Fail
20	splib06b_cvhymp07_124ch	197	Halloysite NMNH106237	WIR1Ba CONV	Fail	Fail	Fail
21	splib06b_cvhymp07_124ch	144	Dickite NMNH106242	WIR1Bb CONV	Fail	Fail	Fail
22	splib06b_cvhymp07_124ch	87	Buddingtonite GDS85 D-206	WIR1Bb CONV	Fail	Fail	Fail
23	splib06b_cvhymp07_124ch	973	Buddingtonite+Na-Mont CU93-260B	W2R4Nb CONV	Fail	Fail	Fail
24	splib06b_cvhymp07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na CONV	Fail	Fail	Fail
25	splib06b_cvhymp07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na CONV	Fail	Fail	Fail
26	splib06b_cvhymp07_124ch	380	Pyrophyllite PYS1A fine gr	WIR1Ba CONV	Fail	Fail	Pass
27	splib06b_cvhymp07_124ch	241	Jarosite GDS24 Na	WIR1Bb CONV	Fail	Fail	Fail
28	splib06b_cvhymp07_124ch	243	Jarosite GDS99 K 200C Syn	WIR1Ba CONV	Fail	Fail	Fail
29	splib06b_cvhymp07_124ch	302	Montmorillonite SWy-1	WIR1Bb CONV	Pass	Fail	Fail
30	splib06b_cvhymp07_124ch	298	Montmorillonite SAZ-1	WIR1Bb CONV	Pass	Fail	Fail
31	splib06b_cvhymp07_124ch	191	Gypsum HS333.3B (Selenite)	WIR1Ba CONV	Pass	Fail	Fail
32	splib06b_cvhymp07_124ch	109	Chlorite SMR-13.b 60-104um	WIR1Ba CONV	Fail	Fail	Fail
33	splib06b_cvhymp07_124ch	159	Epidote GDS26.a 75-200um	WIR1Bb CONV	Pass	Pass	Pass
34	splib06b_cvhymp07_124ch	490	Alun366+.50PyroPYS1A GDS222	WIR1Bb CONV	Fail	Fail	Fail
35	splib06b_cvhymp07_124ch	493	Alunite0.5+Kao1 KGa-1 AMX3	WIR1Bb CONV	Fail	Fail	Fail
36	splib06b_cvhymp07_124ch	536	Kao1wx1.75+Alun HS295 AMX14	WIR1Bb CONV	Fail	Fail	Fail
37	splib06b_cvhymp07_124ch	529	Kao1.5+MuscCU91-250A AMX13	WIR1Bb CONV	Fail	Fail	Fail
38	splib06b_cvhymp07_124ch	530	Kao1_wx1+0.5Musc_Ruby AMX12	WIR1Ba CONV	Fail	Fail	Fail
39	splib06b_cvhymp07_124ch	528	Kao1+Musc_intimate CU93-5C	WIR1Ba CONV	Pass	Fail	Fail
40	splib06b_cvhymp07_124ch	532	Kao1in_Smect H89-FR-2 .5Kao1	WIR1Bb CONV	Fail	Fail	Fail
41	splib06b_cvhymp07_124ch	543	Muscov+Jaros CU93-314 coatng	WIR1Bb CONV	Fail	Fail	Fail
42	splib06b_cvhymp07_124ch	511	Chlorite+Muscovite CU93-65A	WIR1Ba CONV	Fail	Fail	Fail
43	splib06b_cvhymp07_124ch	94	Calcite WS272	WIR1Ba CONV	Pass	Pass	Pass
44	splib06b_cvhymp07_124ch	94	Calcite WS272	WIR1Ba CONV	Pass	Pass	Pass
45	splib06b_cvhymp07_124ch	151	Dolomite HS102.3B	WIR1Bb CONV	Fail	Pass	Pass
46	splib06b_cvhymp07_124ch	416	Siderite HS271.3B	WIR1Ba CONV	Pass	Fail	Pass
47	splib06b_cvhymp07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	WIR1Bb CONV	Fail	Fail	Pass
48	splib06b_cvhymp07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	WIR1Ba CONV	Pass	Fail	Fail
49	splib06b_cvhymp07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	WIR1Bb CONV	Pass	Fail	Fail
50	splib06b_cvhymp07_124ch	501	Calcite+.33Muscov AMX5 Ruby	WIR1Ba CONV	Fail	Pass	Pass
51	splib06b_cvhymp07_124ch	515	Dolomite.5+Na-mont.5 AMX21	WIR1Bb CONV	Fail	Fail	Pass
52	splib06b_cvhymp07_124ch	508	Calcite.80wt+Kao1 CM9 GDS213	WIR1Ba CONV	Fail	Pass	Pass
53	splib06b_cvhymp07_124ch	101	Chalcedony CU91-6A	WIR1Ba CONV	Fail	Fail	Fail
54	splib06b_cvhymp07_124ch	349	Opal TM8896 (Hyalite)	WIR1Ba CONV	Fail	Fail	Fail
55	splib06b_cvhymp07_124ch	468	Tremolite HS18.3	WIR1Bc CONV	Pass	Pass	Pass
56	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	WIR1Bb CONV	Pass	Pass	Pass
57	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	WIR1Ba CONV	Fail	Pass	Pass
58	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	WIR1Bb CONV	Pass	Pass	Pass
59	splib06b_cvhymp07_124ch	115	Chrysotile HS323.1B	WIR1Ba CONV	Fail	Pass	Pass
60	splib06b_cvhymp07_124ch	67	Antigorite NMNH96917.d 70um	WIR1Bb CONV	Pass	Pass	Pass

Following this line, the weighted fit values are given, after adjusting them based on the feature and material constraints. For each reference entry (reference material), if all of these constraints are passed, then the reference material could be the "best match" to the observed spectrum, if it has the highest weighted fit value. If any diagnostic feature constraint is failed (either a continuum constraint or a fit.depth or depth sign constraint), a NOT feature is found to be present, or the material's weighted fit/depth constraints are violated, then the weighted fit value will be zeroed before the highest fit value is selected, thus removing the material from consideration as the best match to the observed spectrum.

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Reference SPECPR File	Reference SPECPR Rec	Reference SPECPR Title	Final Fit Value	(Fit before) (constraints)	Output Name
1	splib06b_cvhymp07_124ch	588	Fir_Tree IH91-2	0.0000	(0.9013)	vegetation_green
2	splib06b_cvhymp07_124ch	602	Grass_dry.7+.3green AMX30	0.9529	(0.9529)	vegetation.dry+green
3	splib06b_cvhymp07_124ch	690	Melting_snow mSnw1a	0.0000	(0.3286)	snow_melting
4	splib06b_cvhymp07_124ch	698	Melting_snow mSnw9 (slush)	0.0000	(0.4622)	snow_slush
5	splib06b_cvhymp07_124ch	566	Seawater_Coast_Ch1 SW1	0.0000	(0.5326)	water
6	splib06b_cvhymp07_124ch	704	Water+Montmor SWy-2+5.01g/l	0.0000	(0.8776)	water_sediment_high
7	splib06b_cvhymp07_124ch	701	Water+Montmor SWy-2+0.5g/l	0.0000	(0.8578)	water_sediment_low
8	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	0.9663	(0.9663)	dry_veg_grass
9	splib06b_cvhymp07_124ch	812	Grass_Golden_Dry GDS480	0.9639	(0.9639)	dry_veg_grass_2_3um

10	splib06b_cvhyamap07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	0.9647	(0.9647)		dry_veg_nongrass
11	splib06b_cvhyamap07_124ch	831	Lodgepole-Pine LP-Needles-3	W1R1Fa	CONV	0.9814	(0.9814)		dry_veg_nongrass_2_3um
12	splib06b_cvhyamap07_124ch	965	Muscovite CU93-1 low-Al Phyl	W2R4Nb	CONV	0.0000	(0.6754)		muscovite_lowAl
13	splib06b_cvhyamap07_124ch	674	Muscovite=medlowAl CU91-250A	W1R1Fb	CONV	0.0000	(0.5771)		muscovite_medAl
14	splib06b_cvhyamap07_124ch	308	Muscovite GDS113 Ruby	W1R1Bb	CONV	0.0000	(0.4812)		muscovite_medhighAl
15	splib06b_cvhyamap07_124ch	310	Muscovite GDS116 Tanzania	W1R1Ba	CONV	0.0000	(0.6538)		muscovite_Fe-rich
16	splib06b_cvhyamap07_124ch	236	Illite IMT-1.b <2um	W1R1Ba	CONV	0.0000	(0.8727)		illite
17	splib06b_cvhyamap07_124ch	232	Illite GDS4 (Marblehead)	W1R1Bb	CONV	0.0000	(0.9019)		illite_gds4
18	splib06b_cvhyamap07_124ch	252	Kaolinite CM9	W1R1Bb	CONV	0.0000	(0.2829)		kaolinite_wx1
19	splib06b_cvhyamap07_124ch	255	Kaolinite KGa-2 (pxl)	W1R1Bb	CONV	0.0000	(0.3819)		kaolinite_pxl
20	splib06b_cvhyamap07_124ch	197	Halloysite NMNH106237	W1R1Ba	CONV	0.0000	(0.5011)		kaolin+clay_mica_or_halloysite
21	splib06b_cvhyamap07_124ch	144	Dickite NMNH106242	W1R1Bb	CONV	0.0000	(0.2665)		kaol_possible_alunite_or_dickite
22	splib06b_cvhyamap07_124ch	87	Buddingtonite GDS85 D-206	W1R1Bb	CONV	0.0000	(0.0319)		buddingtonite
23	splib06b_cvhyamap07_124ch	973	Buddingtonite+Na-Mont CU93-260B	W2R4Nb	CONV	0.0000	(0.1422)		buddingtonite+montmorillonite
24	splib06b_cvhyamap07_124ch	945	Alunite GDS96 K Syn (250C)	W2R4Na	CONV	0.0000	(0.0332)		alunite_K_250c
25	splib06b_cvhyamap07_124ch	948	Alunite RES-3 Na Syn (450C)	W2R4Na	CONV	0.0000	(0.1719)		alunite_Na_450c
26	splib06b_cvhyamap07_124ch	380	Pyrophyllite PYS1A fine gr	W1R1Ba	CONV	0.0000	(0.0070)		pyrophyllite
27	splib06b_cvhyamap07_124ch	241	Jarosite GDS24 Na	W1R1Bb	CONV	0.0000	(0.2712)		jarosite_Na
28	splib06b_cvhyamap07_124ch	243	Jarosite GDS99 K 200C Syn	W1R1Ba	CONV	0.0000	(0.3224)		jarosite_K
29	splib06b_cvhyamap07_124ch	302	Montmorillonite SWy-1	W1R1Bb	CONV	0.0000	(0.7261)		montmorillonite_Na
30	splib06b_cvhyamap07_124ch	298	Montmorillonite SAZ-1	W1R1Bb	CONV	0.0000	(0.7681)		montmorillonite_Ca
31	splib06b_cvhyamap07_124ch	191	Gypsum HS333.3B (Selenite)	W1R1Ba	CONV	0.0000	(0.7086)		gypsum
32	splib06b_cvhyamap07_124ch	109	Chlorite SMR-13.b 60-104um	W1R1Ba	CONV	0.0000	(0.4571)		chlorite_lowFe
33	splib06b_cvhyamap07_124ch	159	Epidote GDS26.a 75-200um	W1R1Bb	CONV	0.0000	(0.6299)		epidote
34	splib06b_cvhyamap07_124ch	490	Alun366+.50PyroPYS1A GDS222	W1R1Bb	CONV	0.0000	(0.1227)		pyrophyllite.5+alunite.5
35	splib06b_cvhyamap07_124ch	493	Alunite0.5+Kaol_KGa-1 AMX3	W1R1Bb	CONV	0.0000	(0.2648)		alunite.5+kaolinite.5
36	splib06b_cvhyamap07_124ch	536	Kaolwx1.75+Alun_HS295 AMX14	W1R1Bb	CONV	0.0000	(0.2610)		alunite.25+kaolinite.75
37	splib06b_cvhyamap07_124ch	529	Kaol.5+MuscovCU91-250A AMX13	W1R1Bb	CONV	0.0000	(0.4697)		kaolin.5+muscovite_medAl
38	splib06b_cvhyamap07_124ch	530	Kaol_Wx1+0.5Musc_Ruby AMX12	W1R1Ba	CONV	0.0000	(0.3886)		kaolin.5+muscovite_medhighAl
39	splib06b_cvhyamap07_124ch	528	Kaol+Musc_intimate CU93-5C	W1R1Ba	CONV	0.0000	(0.6233)		kaolin+muscovite_mix_intimate
40	splib06b_cvhyamap07_124ch	532	Kaolin_smect HS9-FR-2 .5Kaol	W1R1Bb	CONV	0.0000	(0.4139)		kaolin.5+smectite.5
41	splib06b_cvhyamap07_124ch	543	Muscov+Jaros CU93-314 coating	W1R1Bb	CONV	0.0000	(0.5001)		jarosite+muscovite_mix_intimate
42	splib06b_cvhyamap07_124ch	511	Chlorite+Muscovite CU93-65A	W1R1Ba	CONV	0.0000	(0.2241)		chlorite+muscovite
43	splib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.7213)		calcite_abundant
44	splib06b_cvhyamap07_124ch	94	Calcite WS272	W1R1Ba	CONV	0.0000	(0.7213)		calcite
45	splib06b_cvhyamap07_124ch	151	Dolomite HS102.3B	W1R1Bb	CONV	0.0000	(0.3356)		dolomite
46	splib06b_cvhyamap07_124ch	416	Siderite HS271.3B	W1R1Ba	CONV	0.0000	(0.6679)		carbonate_Fe_bearing
47	splib06b_cvhyamap07_124ch	500	Calc.25+dolo.25+mont.5 AMX18	W1R1Bb	CONV	0.0000	(0.5488)		dolomite.25+calcite.25+mont_Na.5
48	splib06b_cvhyamap07_124ch	507	Calcite.80+Mont_Swy-1 GDS212	W1R1Ba	CONV	0.0000	(0.6087)		calcite.8+montmorillonite_Na.2
49	splib06b_cvhyamap07_124ch	506	Calcite.8+Ca-Montmor.2 AMX15	W1R1Bb	CONV	0.0000	(0.7722)		calcite.8+montmorillonite_Ca.2
50	splib06b_cvhyamap07_124ch	501	Calcite+.33Muscov AMX5 Ruby	W1R1Ba	CONV	0.0000	(0.4216)		calcite.7+muscovite.3
51	splib06b_cvhyamap07_124ch	515	Dolomite.5+Na-mont.5 AMX21	W1R1Bb	CONV	0.0000	(0.5201)		dolomite.5+montmorillonite_Na.5
52	splib06b_cvhyamap07_124ch	508	Calcite.80wt+Kaol_CM9 GDS213	W1R1Ba	CONV	0.0000	(0.4644)		kaolin.2+calcite.8
53	splib06b_cvhyamap07_124ch	101	Chalcedony CU91-6A	W1R1Ba	CONV	0.0000	(0.4225)		chalcedony
54	splib06b_cvhyamap07_124ch	349	Opal TM8896 (Hyalite)	W1R1Ba	CONV	0.0000	(0.3638)		hydrated_silica
55	splib06b_cvhyamap07_124ch	468	Tremolite HS18.3	W1R1Bc	CONV	0.0000	(0.7610)		tremolite_or_talc
56	splib06b_cvhyamap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.6159)		serpentine_or_dolomite+calcite
57	splib06b_cvhyamap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	0.0000	(0.4893)		serpentine1
58	splib06b_cvhyamap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.6159)		serpentine2
59	splib06b_cvhyamap07_124ch	115	Chrysotile HS323.1B	W1R1Ba	CONV	0.0000	(0.4893)		serpentine3
60	splib06b_cvhyamap07_124ch	67	Antigorite NMNH96917.d 70um	W1R1Bb	CONV	0.0000	(0.6159)		serpentine4

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
11	dry_veg_nongrass_2_3um	0.9814	0.0986
8	dry_veg_grass	0.9663	0.0791
10	dry_veg_nongrass	0.9647	0.0841
9	dry_veg_grass_2_3um	0.9639	0.0861
2	vegetation.dry+green	0.9529	0.1417

The reference materials (reference spectra) with the five highest fit values. On each line, the ID number of the reference material (reference spectrum) and its output name are given with its final weighted fit value and associated depth value.

BEST MATCH: ← The best match is reported along with details of the observed and reference spectra, and values of the fit, depth and fit*depth.

Observed Spectrum (SPECPR Title=Rangeland L02-022 S20% G09% W1R1Fa CONV) was best matched by Reference Spectrum (Output name=dry_veg_nongrass_2_3um) with a fit of 0.9814
 Observed (SPECPR File= splib06b_cvhyamap07_124ch; Record= 905; Title= Rangeland L02-022 S20% G09% W1R1Fa CONV)
 Reference (SPECPR File= splib06b_cvhyamap07_124ch; Record= 831; Title= Lodgepole-Pine LP-Needles-3 W1R1Fa CONV)
 Fit= 0.9814 Depth= 0.0986 Fit*Depth= 0.0968

END ANALYSIS

← This line marks the end of the block of text reporting on the analysis of the first input spectrum (observed spectrum).

Output report for verbose level 5. “Function 4.2 – Run MICA for Spectral Records”

At verbose level 5, the MICA output report has all the great detail of verbose level 4 and some reporting from the subroutines called by MICA. In addition, PostScript plots of the observed spectrum compared to each reference feature (diagnostic and NOT features) are created (see examples shown in fig. B5). The plot files are created in the output directory. These plots show the continuum- removed reference features (dotted lines), the observed spectrum (solid thick lines) that has been continuum removed with the same continuum endpoint channels as the reference, and the reference feature scaled to the observed spectral feature (solid thin lines). These plots let the user visually inspect the feature comparisons. Note: if the command file contains a numerous diagnostic and NOT features and/or many observed spectra are analyzed, then many plot files will be created.

The uncommented text report and PostScript plots for this verbose level are included with the PRISM software distribution. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the files will be located in “C:\usgsprism\mica_hymap\output\spectrummode_verboselevel5\” on Windows computers. On Linux computers, the files will be found in the “/var/local/usgsprism/mica_hymap/output/” directory.

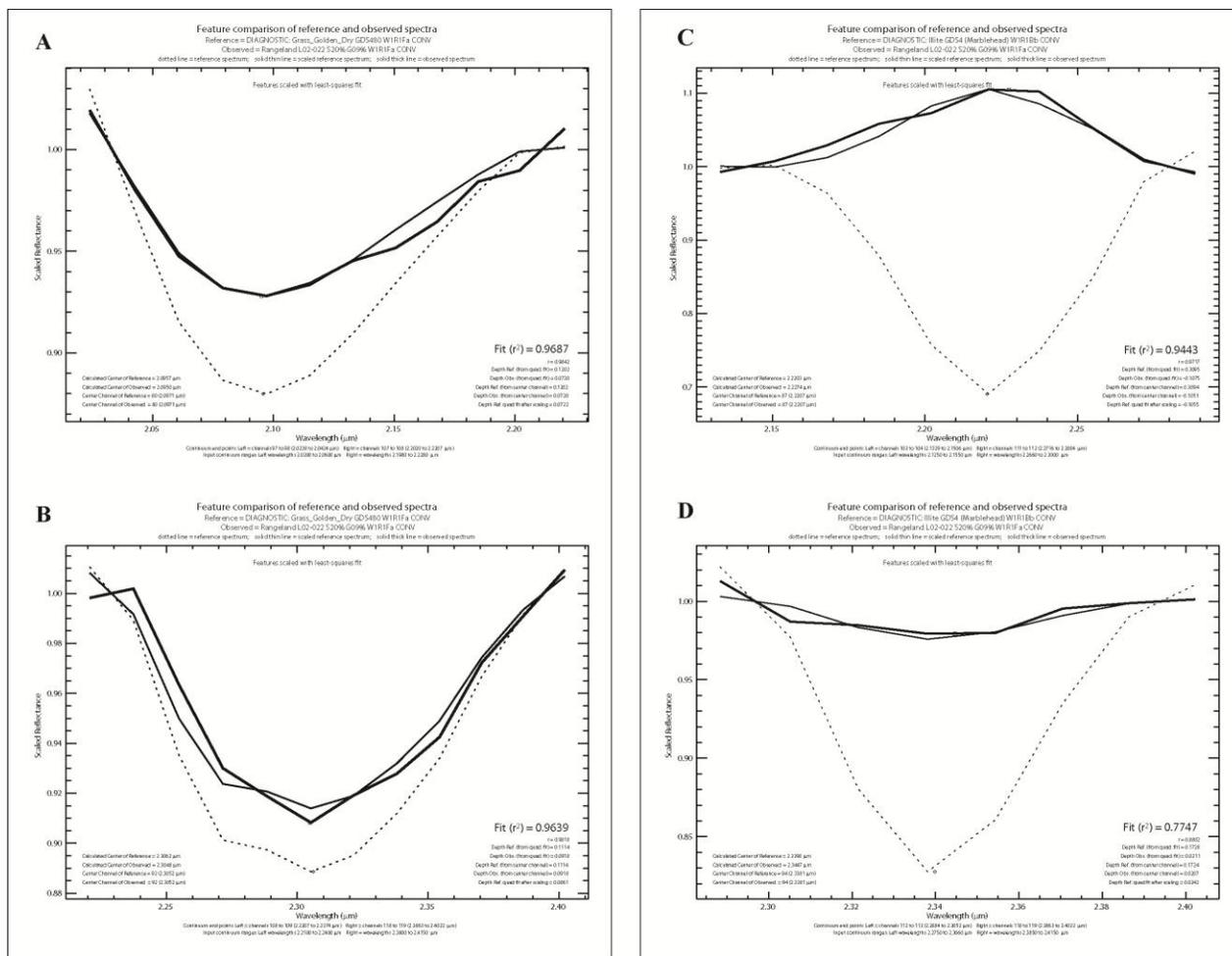


Figure B5. Plots of reference features for “Dry Golden Grass”, A and B, and “Illite”, C and D, compared to the observed spectrum. Dotted lines are the continuum-removed reference features. Solid thick lines are the continuum-removed observed spectra. Solid thin lines are the reference spectra scaled to the observed spectra.

Output report for verbose level 1. “Function 4.1 – Run MICA for Image Cubes”

This part of the appendix contains example reports for the MICA Image Cube mode, including the output reports for different verbose levels. In this example, the command file in *appendix A*, for minerals with diagnostic absorption features in the 2 to 2.5 μm wavelength region and for HyMap imaging spectrometer, is used to analyze the example image. The example image “testcube_hymap124ch” is distributed with the PRISM software. If the default directory in step 3 of the installation instructions was used, then the command file will be located in “C:\usgsprism\mica_hymap\cube\” on Windows computers and in “/var/local/usgsprism/mica_hymap/cube/” on Linux computers. The sample command file was developed to detect the occurrences of a set of materials in the pixels of HyMap imaging spectrometer data. The reference materials are primarily minerals, along with other common surface cover such as water, snow, and vegetation. For more details on the application of this command file to the large HyMap dataset covering the country of Afghanistan see Kokaly and others (in press). The command file “mica_cmds_group2_hymap2007.mcf” is distributed with the PRISM software. If the default directory in step 3 of the installation instructions was used (see the “*Installation of Software*” section of this report), then the command file will be located in “C:\usgsprism\mica_hymap\” on Windows computers and in “/var/local/usgsprism/mica_hymap/” on Linux computers.

Verbose level 1 of the MICA image cube does not produce a text report, creating only the output images.

Output report for verbose level 2. “Function 4.1 – Run MICA for Image Cubes”

The information in the report includes basic feedback on the selected image cube, the command file used, scale factors applied, deleted channels excluded from spectral analysis, and the user-specified value indicating non-data pixels. If a value for non-data pixels is specified, MICA will find all pixels in the input cube, in which all channels are set to this non-data value, produce an image of these pixels, with the name “image_nodata_pixels”, and exclude these pixels from analysis. The data type for the image of the non-data pixels is byte and has a separate ENVI header file. A value of 0 (zero) in the image indicates a non-data pixel and 1 (one) indicates a valid data pixel. The file is compressed with GZIP compression (see ITT Visual Information Solutions, 2009, for details on the implementation of this compression in ENVI/IDL). In the basic feedback, special processing options set in the command file are identified, for example the “CHECK_SIGNS_OF_DEPTHS” or the “TETRACORDER_OPTIONS” options (see the discussion of these keywords in *Module 4. MICA – Material Identification and Characterization Algorithm*).

In image cube mode, MICA allows the user to create a summary image with user controlled colors and values of classes for the reference materials. This user defined summary image, as well as the default summary images, is of byte data type in ENVI classification image format. No compression is applied to the summary images. The user can specify this option in the command file by setting the “FILE_DN_COLORS” keyword to indicate a text file containing the class names, values, and colors. If the user has set this keyword, the file used and the class names, values, and colors read from this file are echoed back to the user in the text report.

Following the basic information, the text report includes information on the entries in the command file and dimensions of the image cube. During the analysis of the image cube, the output name of the reference spectrum with the best fit to the central pixel of every 10th line is reported. After the analysis is complete, the program creates the output files using the output names specified for each material in the command file as the base of the filename. For each material, if at least one pixel was found to have its best match to the material, output images of the fit, depth, and fit*depth values are created, with the extensions “_fit”, “_depth”, and “_fd” added to the base output names, respectively. If no matches were found to the material, its output files will not be created. For pixels that did not have a match to any of the reference materials, a special image, with the name “image_unmapped_pixels”, is created to identify them. The image data type is byte and has a separate ENVI header file. A value of 1 (one) in the image indicates a valid data pixel which was not matched to any reference spectra. The file is compressed with GZIP compression (see ITT Visual Information Solutions, 2009, for details on the implementation of this compression in ENVI/IDL). All georeferencing information present in the header of the input image cube is preserved in MICA output images. Information of file creation/non-creation is given in the text report. The output fit, depth, and fit*depth image files are two-byte integer data type in PC (Intel) byte order with a VICAR header and have corresponding, separate ENVI header files. The image files are compressed with GZIP compression (see ITT Visual Information Solutions, 2009, for details on the implementation of this compression in ENVI/IDL). To facilitate tracing the relationships of output images with the input data and spectra used to create them, the ENVI headers of the files contain information on the input image cube, MICA command file, and reference spectrum SPECPR file, record, and title.

Starting mica_imagecube_array_specpr.pro at Sat Apr 23 18:26:03 2011

Operating System Type = Windows (NOT performing byteorder operations)

Command Line Options

FILE_DN_COLORS = 0
DELETED_CHANNELS = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124

Image Cube = C:\usgsprism\mica_hymap\cube\testcube_hymap124ch

Number of Bands = 124
Number of Lines = 814
Number of Samples = 446

} Image cube analyzed and dimensions

Processing Parameters:

TETRACORDER PROCESSING OPTIONS ARE TURNED OFF! FIT VALUES ARE IN TERMS OF r^2 THE COEFFICIENT OF DETERMINATION
OPTION TO CHECK THE SIGN OF THE DEPTHS IS TURNED ON!

} Special processing options

Setting wavelengths based on WAVELENGTH_SPECPR_RECORD keyword in the command file structure.

Wavelength SPECPR file = C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
Wavelength SPECPR record = 6

Deleted Channels found = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124
Number of Good Channels = 103

Deleted channels, set in the command file. These channels will be excluded from the MICA analysis.

Searching for command file keyword value for FILE_DN_COLORS...

FILE_DN_COLORS = C:\usgsprism\mica_hymap\mica_colors_group2_hymap2007.txt

class_name	class_value	red	grn	blu
calcite_abundant	1	20	75	0
calcite	2	40	105	10
calcite.7+muscovite.3	3	113	160	90
calcite.8+montmorillonite_Ca.2	4	188	185	115
calcite.8+montmorillonite_Na.2	5	188	185	115
carbonate_Fe_bearing	6	220	185	255
dolomite	7	205	25	255
dolomite.5+montmorillonite_Na.5	8	165	20	200
dolomite.25+calcite.25+mont_Na.5	9	165	20	200
epidote	10	225	25	0
chlorite_lowFe	11	225	25	0
chlorite+muscovite	12	225	25	0
muscovite_lowAl	13	250	150	0
muscovite_medAl	14	250	150	0
muscovite_medhighAl	15	250	150	0
muscovite_Fe-rich	16	250	150	0
illite	17	230	120	0
illite_gds4	18	230	120	0
kaolinite_wxl	19	25	85	245
kaolinite_pxl	20	25	85	245
kaolin+clay_mica_or_halloysite	21	40	145	255
kaolin.5+muscovite_medAl	22	40	145	255
kaolin+muscovite_mix_intimate	23	40	145	255
kaolin.5+muscovite_medhighAl	24	40	145	255
kaolin.5+smectite.5	25	40	145	255
kaolin.2+calcite.8	26	40	145	255



This block of text is reported if the FILE_DN_COLORS keyword is set in the command file. User-specified values and colors for classes are read from that file.

montmorillonite_Na	27	130	210	255
montmorillonite_Ca	28	130	210	255
alunite_Na_450c	29	250	160	185
alunite_K_250c	30	250	160	185
alunite.5+kaolinite.5	31	255	195	195
alunite.25+kaolinite.75	32	255	195	195
pyrophyllite	33	145	25	55
pyrophyllite.5+alunite.5	34	145	25	55
jarosite_Na	35	218	112	214
jarosite_K	36	218	112	214
jarosite+muscovite_mix_intimate	37	218	112	214
kaol_possible_alunite_or_dickite	38	30	30	185
buddingtonite	39	255	210	0
buddingtonite+montmorillonite	40	255	210	0
serpentine1	41	160	215	50
serpentine2	42	160	215	50
serpentine3	43	160	215	50
serpentine4	44	160	215	50
serpentine_or_dolomite+calcite	45	176	131	255
tremolite_or_talc	46	100	40	180
hydrated_silica	47	255	255	75
chalcedony	48	255	255	75
gypsum	49	240	0	255
vegetation_green	50	225	205	170
vegetation.dry+green	51	225	205	170
dry_veg_grass	52	147	115	48
dry_veg_grass_2_3um	53	147	115	48
dry_veg_nongrass	54	147	115	48
dry_veg_nongrass_2_3um	55	147	115	48
snow_melting	56	80	0	115
snow_slush	57	80	0	115
water	58	180	180	180
water_sediment_low	59	180	180	180
water_sediment_high	60	180	180	180

Number of color entries found in the file = 60

Scale factor for reference spectra (command file value) = 1.0000000
 Scale factor for observed spectra (command file value) = 20000.000

Value indicating a non-data pixel in an image cube (from command file) = -1.0000

Analyzing the first reference spectrum against the command file to test its integrity.
 ...passed the integrity check.

Reference spectra are divided by this value

Observed spectra are divided by this value

Non-data pixel value. Pixels that have all channels set to this value are identified as non-data pixels (see later portion of the output report). An output image is created for these pixels.

The syntax of the MICA command file is checked by analyzing the first reference spectrum in spectral records mode.

```
Searching for the default non-data mask file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
and associated ENVI header file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.hdr
searching for alternate ENVI header file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz.hdr
Did not find the default non-data mask file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
```

MICA searches the output directory for an existing image of the non-data pixels and the associated ENVI header file. The program searches for a file with the expected name "image_nodata_pixels.gz" that has the same dimensions (scanlines and samples) as the image being analyzed.

```
Creating a mask file for non-data pixels, mask file =
C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
Searching for non-data pixels, those with all bands = -1.00000
... processing mask file 0% complete...
... processing mask file 10% complete...
... processing mask file 20% complete...
... processing mask file 30% complete...
... processing mask file 40% complete...
... processing mask file 50% complete...
... processing mask file 60% complete...
... processing mask file 70% complete...
... processing mask file 80% complete...
... processing mask file 90% complete...
... processing mask file 100% complete...
Found number of non-data pixels = 0 which is 0.0% of all pixels.
```

If an existing image is not found, MICA detects the non-data pixels in the image cube using the previously specified non-data pixel value and creates an image of the non-data pixels and reports the number of non-data pixels that were found.

----- STARTING ANALYSIS -----

```
Image cube analyzed:C:\usgsprism\mica_hymap\cube\testcube_hymap124ch
Number of Bands = 124
Number of Lines = 814
Number of Samples = 446
```

Name and dimensions of the image cube being analyzed

```
Command file used:C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
Total number of reference spectra = 60
Total number of reference features = 111
Total number of reference NOT spectra = 12
Total number of invocations of NOT features = 62
```

Command file used, and brief summary of reference spectra and features

Beginning line by line analysis of the image cube at Mon Apr 25 12:54:15 2011

```
Input spectrum (line=10,sample=223) was best matched by calcite with a fit of 0.8521 and a depth of 0.0468 and a fit*depth of 0.0399
Input spectrum (line=20,sample=223) was best matched by calcite with a fit of 0.8174 and a depth of 0.0441 and a fit*depth of 0.0360
Input spectrum (line=30,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.6639 and a depth of 0.0179 and a fit*depth of 0.0145
Input spectrum (line=40,sample=223) was best matched by calcite with a fit of 0.8821 and a depth of 0.0415 and a fit*depth of 0.0366
Input spectrum (line=50,sample=223) was best matched by calcite with a fit of 0.8855 and a depth of 0.0419 and a fit*depth of 0.0144
Input spectrum (line=60,sample=223) was best matched by calcite.7+montmorillonite_Na.2 with a fit of 0.8551 and a depth of 0.0419 and a fit*depth of 0.0144
Input spectrum (line=70,sample=223) was best matched by dry_veg_grass with a fit of 0.9363 and a depth of 0.0474 and a fit*depth of 0.0403
Input spectrum (line=80,sample=223) NO MATCH WAS FOUND!
Input spectrum (line=90,sample=223) was best matched by calcite.8+montmorillonite_Na.2 with a fit of 0.6622 and a depth of 0.0104 and a fit*depth of 0.0156
Input spectrum (line=100,sample=223) was best matched by calcite.8+montmorillonite_Na.2 with a fit of 0.1921 and a depth of 0.0141 and a fit*depth of 0.0112
Input spectrum (line=110,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.8345 and a depth of 0.0158 and a fit*depth of 0.0132
```

During the MICA analysis, the best match is reported for the central pixel on every 10th line, including the output name of the reference spectrum, the fit, depth and fit*depth values. If no match is found, that is reported.

Input spectrum (line=120,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.7719 and a depth of 0.0147 and a fit*depth of 0.0114
 Input spectrum (line=130,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.7372 and a depth of 0.0150 and a fit*depth of 0.0111
 Input spectrum (line=140,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.6843 and a depth of 0.0132 and a fit*depth of 0.0094
 Input spectrum (line=150,sample=223) was best matched by calcite with a fit of 0.7231 and a depth of 0.0246 and a fit*depth of 0.0178
 Input spectrum (line=160,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.6386 and a depth of 0.0144 and a fit*depth of 0.0092
 Input spectrum (line=170,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.6342 and a depth of 0.0135 and a fit*depth of 0.0111
 Input spectrum (line=180,sample=223) NO MATCH WAS FOUND!
 Input spectrum (line=190,sample=223) was best matched by calcite with a fit of 0.9310 and a depth of 0.0907 and a fit*depth of 0.0844
 Input spectrum (line=200,sample=223) was best matched by calcite with a fit of 0.9579 and a depth of 0.0990 and a fit*depth of 0.0948
 Input spectrum (line=210,sample=223) was best matched by calcite with a fit of 0.9559 and a depth of 0.0986 and a fit*depth of 0.0943
 Input spectrum (line=220,sample=223) was best matched by dry_veg_grass with a fit of 0.9688 and a depth of 0.0633 and a fit*depth of 0.0612
 Input spectrum (line=230,sample=223) was best matched by calcite with a fit of 0.9139 and a depth of 0.0833 and a fit*depth of 0.0761
 Input spectrum (line=240,sample=223) was best matched by dry_veg_grass_2_3um with a fit of 0.9009 and a depth of 0.0755 and a fit*depth of 0.0680
 Input spectrum (line=250,sample=223) was best matched by calcite with a fit of 0.9531 and a depth of 0.1231 and a fit*depth of 0.1173
 Input spectrum (line=260,sample=223) was best matched by calcite with a fit of 0.9920 and a depth of 0.1790 and a fit*depth of 0.1776
 Input spectrum (line=270,sample=223) was best matched by calcite with a fit of 0.9462 and a depth of 0.0638 and a fit*depth of 0.0604
 Input spectrum (line=280,sample=223) was best matched by calcite with a fit of 0.9566 and a depth of 0.0830 and a fit*depth of 0.0794
 Input spectrum (line=290,sample=223) was best matched by calcite with a fit of 0.8339 and a depth of 0.0482 and a fit*depth of 0.0402
 Input spectrum (line=300,sample=223) NO MATCH WAS FOUND!
 Input spectrum (line=310,sample=223) was best matched by calcite with a fit of 0.9732 and a depth of 0.0955 and a fit*depth of 0.0929
 Input spectrum (line=320,sample=223) was best matched by dry_veg_grass with a fit of 0.9258 and a depth of 0.0535 and a fit*depth of 0.0493
 Input spectrum (line=330,sample=223) was best matched by kaolin+muscovite_mix_intimate with a fit of 0.9744 and a depth of 0.0829 and a fit*depth of 0.0807
 Input spectrum (line=340,sample=223) was best matched by kaolin+muscovite_mix_intimate with a fit of 0.9349 and a depth of 0.0638 and a fit*depth of 0.0597
 Input spectrum (line=350,sample=223) was best matched by muscovite_medAl with a fit of 0.9026 and a depth of 0.0495 and a fit*depth of 0.0455
 Input spectrum (line=360,sample=223) was best matched by calcite.7+muscovite.3 with a fit of 0.8747 and a depth of 0.0503 and a fit*depth of 0.0465
 Input spectrum (line=370,sample=223) was best matched by kaolin+muscovite_mix_intimate with a fit of 0.9766 and a depth of 0.0632 and a fit*depth of 0.0618
 Input spectrum (line=380,sample=223) was best matched by kaolin+clay_mica_or_halloysite with a fit of 0.9415 and a depth of 0.0325 and a fit*depth of 0.0306
 Input spectrum (line=390,sample=223) was best matched by calcite.8+montmorillonite_Na.2 with a fit of 0.9248 and a depth of 0.0432 and a fit*depth of 0.0400
 Input spectrum (line=400,sample=223) was best matched by dolomite.25+calcite.25+mont_Na.5 with a fit of 0.8724 and a depth of 0.0399 and a fit*depth of 0.0357
 Input spectrum (line=410,sample=223) was best matched by vegetation.dry+green with a fit of 0.8816 and a depth of 0.1612 and a fit*depth of 0.1462
 Input spectrum (line=420,sample=223) was best matched by calcite with a fit of 0.9379 and a depth of 0.1246 and a fit*depth of 0.1168
 Input spectrum (line=430,sample=223) was best matched by calcite with a fit of 0.8843 and a depth of 0.0915 and a fit*depth of 0.0809
 Input spectrum (line=440,sample=223) was best matched by vegetation_green with a fit of 0.8914 and a depth of 0.2097 and a fit*depth of 0.1861
 Input spectrum (line=450,sample=223) was best matched by vegetation.dry+green with a fit of 0.8595 and a depth of 0.1400 and a fit*depth of 0.1243
 Input spectrum (line=460,sample=223) was best matched by calcite with a fit of 0.9142 and a depth of 0.0753 and a fit*depth of 0.0688
 Input spectrum (line=470,sample=223) was best matched by calcite with a fit of 0.9017 and a depth of 0.0840 and a fit*depth of 0.0757
 Input spectrum (line=480,sample=223) was best matched by calcite with a fit of 0.9420 and a depth of 0.1052 and a fit*depth of 0.0991
 Input spectrum (line=490,sample=223) was best matched by calcite with a fit of 0.6683 and a depth of 0.0366 and a fit*depth of 0.0244
 Input spectrum (line=500,sample=223) was best matched by calcite with a fit of 0.8909 and a depth of 0.0926 and a fit*depth of 0.0825
 Input spectrum (line=510,sample=223) was best matched by calcite with a fit of 0.8521 and a depth of 0.0612 and a fit*depth of 0.0522
 Input spectrum (line=520,sample=223) was best matched by calcite with a fit of 0.8053 and a depth of 0.0658 and a fit*depth of 0.0530
 Input spectrum (line=530,sample=223) was best matched by calcite with a fit of 0.9321 and a depth of 0.1021 and a fit*depth of 0.0951
 Input spectrum (line=540,sample=223) was best matched by calcite with a fit of 0.9164 and a depth of 0.0730 and a fit*depth of 0.0669
 Input spectrum (line=550,sample=223) was best matched by calcite with a fit of 0.9918 and a depth of 0.2050 and a fit*depth of 0.2034
 Input spectrum (line=560,sample=223) was best matched by calcite with a fit of 0.9580 and a depth of 0.1186 and a fit*depth of 0.1137
 Input spectrum (line=570,sample=223) was best matched by calcite with a fit of 0.8199 and a depth of 0.1145 and a fit*depth of 0.0939
 Input spectrum (line=580,sample=223) was best matched by calcite_abundant with a fit of 0.9570 and a depth of 0.1390 and a fit*depth of 0.1331
 Input spectrum (line=590,sample=223) was best matched by calcite_abundant with a fit of 0.9354 and a depth of 0.1359 and a fit*depth of 0.1271
 Input spectrum (line=600,sample=223) was best matched by calcite with a fit of 0.9569 and a depth of 0.1009 and a fit*depth of 0.0966
 Input spectrum (line=610,sample=223) was best matched by calcite with a fit of 0.9621 and a depth of 0.1112 and a fit*depth of 0.1070
 Input spectrum (line=620,sample=223) was best matched by dry_veg_grass with a fit of 0.9478 and a depth of 0.0661 and a fit*depth of 0.0625
 Input spectrum (line=630,sample=223) was best matched by calcite_abundant with a fit of 0.9699 and a depth of 0.1478 and a fit*depth of 0.1433
 Input spectrum (line=640,sample=223) was best matched by calcite_abundant with a fit of 0.9654 and a depth of 0.1606 and a fit*depth of 0.1550

```

Input spectrum (line=650,sample=223) was best matched by calcite with a fit of 0.9842 and a depth of 0.1600 and a fit*depth of 0.1575
Input spectrum (line=660,sample=223) was best matched by dry_veg_grass with a fit of 0.9185 and a depth of 0.0404 and a fit*depth of 0.0370
Input spectrum (line=670,sample=223) was best matched by dry_veg_grass with a fit of 0.9757 and a depth of 0.0576 and a fit*depth of 0.0562
Input spectrum (line=680,sample=223) was best matched by dry_veg_grass with a fit of 0.9320 and a depth of 0.0556 and a fit*depth of 0.0518
Input spectrum (line=690,sample=223) was best matched by calcite with a fit of 0.9232 and a depth of 0.0739 and a fit*depth of 0.0682
Input spectrum (line=700,sample=223) was best matched by calcite with a fit of 0.8760 and a depth of 0.0566 and a fit*depth of 0.0496
Input spectrum (line=710,sample=223) was best matched by calcite with a fit of 0.9327 and a depth of 0.0851 and a fit*depth of 0.0794
Input spectrum (line=720,sample=223) was best matched by calcite with a fit of 0.9562 and a depth of 0.1176 and a fit*depth of 0.1125
Input spectrum (line=730,sample=223) was best matched by calcite with a fit of 0.9675 and a depth of 0.1317 and a fit*depth of 0.1274
Input spectrum (line=740,sample=223) was best matched by dry_veg_grass with a fit of 0.9774 and a depth of 0.0721 and a fit*depth of 0.0704
Input spectrum (line=750,sample=223) was best matched by calcite with a fit of 0.9513 and a depth of 0.1120 and a fit*depth of 0.1065
Input spectrum (line=760,sample=223) was best matched by calcite with a fit of 0.9539 and a depth of 0.1152 and a fit*depth of 0.1099
Input spectrum (line=770,sample=223) was best matched by calcite with a fit of 0.9561 and a depth of 0.0821 and a fit*depth of 0.0785
Input spectrum (line=780,sample=223) was best matched by calcite with a fit of 0.9711 and a depth of 0.1259 and a fit*depth of 0.1223
Input spectrum (line=790,sample=223) was best matched by calcite_abundant with a fit of 0.9838 and a depth of 0.1915 and a fit*depth of 0.1884
Input spectrum (line=800,sample=223) was best matched by calcite with a fit of 0.9508 and a depth of 0.1159 and a fit*depth of 0.1102
Input spectrum (line=810,sample=223) was best matched by calcite with a fit of 0.9459 and a depth of 0.1032 and a fit*depth of 0.0976

```

Finished line by line analysis at Mon Apr 25 12:59:00 2011

Elapsed time = 0 hours 4 minutes 45 seconds.

----- END ANALYSIS -----

Writing the results to ENVI files:

Output directory = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\ ← Output directory

Writing the composite all materials images to ENVI files for fit, depth and fit*depth (fd):

Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_fits.gz
Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_depths.gz
Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_fds.gz

Writing the individual material images to ENVI files (with gzip compression) for fit, depth and fit*depth (fd):

Output files for material =	vegetation_green with	14258 pixels selected as the best match were successfully written.
Output files for material =	vegetation.dry+green with	5230 pixels selected as the best match were successfully written.
Output files for material =	snow_melting with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	snow_slush with	2 pixels selected as the best match were successfully written.
Output files for material =	water with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	water_sediment_high with	26 pixels selected as the best match were successfully written.
Output files for material =	water_sediment_low with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	dry_veg_grass with	20360 pixels selected as the best match were successfully written.
Output files for material =	dry_veg_grass_2_3um with	19714 pixels selected as the best match were successfully written.
Output files for material =	dry_veg_nongrass with	274 pixels selected as the best match were successfully written.
Output files for material =	dry_veg_nongrass_2_3um with	9914 pixels selected as the best match were successfully written.
Output files for material =	muscovite_lowAl with	1917 pixels selected as the best match were successfully written.

of pixels matched to each material ↑

Output files are created for reference materials that were matched to one or more pixels. If a material did not have any pixels that were matched to it, the output fit, depth and fit*depth images are not created for it.

Output files for material =	muscovite_medAl with	2068 pixels selected as the best match were successfully written.
Output files for material =	muscovite_medhighAl with	8903 pixels selected as the best match were successfully written.
Output files for material =	muscovite_Fe-rich with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	illite with	358 pixels selected as the best match were successfully written.
Output files for material =	illite_gds4 with	67 pixels selected as the best match were successfully written.
Output files for material =	kaolinite_wx1 with	17 pixels selected as the best match were successfully written.
Output files for material =	kaolinite_px1 with	45 pixels selected as the best match were successfully written.
Output files for material =	kaolin+clay_mica_or_halloysite with	553 pixels selected as the best match were successfully written.
Output files for material =	kaol_possible_alunite_or_dickite with	3 pixels selected as the best match were successfully written.
Output files for material =	buddingtonite with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	buddingtonite+montmorillonite with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	alunite_K_250c with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	alunite_Na_450c with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	pyrophyllite with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	jarosite_Na with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	jarosite_K with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	montmorillonite_Na with	3730 pixels selected as the best match were successfully written.
Output files for material =	montmorillonite_Ca with	877 pixels selected as the best match were successfully written.
Output files for material =	gypsum with	34 pixels selected as the best match were successfully written.
Output files for material =	chlorite_lowFe with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	epidote with	64 pixels selected as the best match were successfully written.
Output files for material =	pyrophyllite.5+alunite.5 with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	alunite.5+kaolinite.5 with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	alunite.25+kaolinite.75 with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	kaolin.5+muscovite_medAl with	1319 pixels selected as the best match were successfully written.
Output files for material =	kaolin.5+muscovite_medhighAl with	2621 pixels selected as the best match were successfully written.
Output files for material =	kaolin+muscovite_mix_intimate with	5184 pixels selected as the best match were successfully written.
Output files for material =	kaolin.5+smectite.5 with	481 pixels selected as the best match were successfully written.
Output files for material =	jarosite+muscovite_mix_intimate with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	chlorite+muscovite with	3 pixels selected as the best match were successfully written.
Output files for material =	calcite_abundant with	37019 pixels selected as the best match were successfully written.
Output files for material =	calcite with	144044 pixels selected as the best match were successfully written.
Output files for material =	dolomite with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	carbonate_Fe_bearing with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	dolomite.25+calcite.25+mont_Na.5 with	4018 pixels selected as the best match were successfully written.
Output files for material =	calcite.8+montmorillonite_Na.2 with	16543 pixels selected as the best match were successfully written.
Output files for material =	calcite.8+montmorillonite_Ca.2 with	21098 pixels selected as the best match were successfully written.
Output files for material =	calcite.7+muscovite.3 with	27736 pixels selected as the best match were successfully written.
Output files for material =	dolomite.5+montmorillonite_Na.5 with	41 pixels selected as the best match were successfully written.
Output files for material =	kaolin.2+calcite.8 with	532 pixels selected as the best match were successfully written.
Output files for material =	chalcedony with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	hydrated_silica with	0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material =	tremolite_or_talc with	1 pixels selected as the best match were successfully written.
Output files for material =	serpentine_or_dolomite+calcite with	65 pixels selected as the best match were successfully written.

```

Output files for material = serpentine1 with 102 pixels selected as the best match were successfully written.
Output files for material = serpentine2 with 0 pixels selected as the best match, files were NOT written because no matches were found.
Output files for material = serpentine3 with 39 pixels selected as the best match were successfully written.
Output files for material = serpentine4 with 1 pixel selected as the best match were successfully written.

```

Creating an image of the pixels in which no materials were detected (file=image_unmapped_pixels). } Number of unmapped pixels and filename of image created for them.

```

No match was found for 13783 pixels.

```

Sorting materials by the number of pixels in which the material was detected.

```

      calcite found 144044 pixels
    calcite_abundant found 37019 pixels
  calcite.7+muscovite.3 found 27736 pixels
calcite.8+montmorillonite_Ca.2 found 21098 pixels
      dry_veg_grass found 20360 pixels
    dry_veg_grass_2_3um found 19714 pixels
calcite.8+montmorillonite_Na.2 found 16543 pixels
      vegetation_green found 14258 pixels
    dry_veg_nongrass_2_3um found 9914 pixels
      muscovite_medhighAl found 8903 pixels
    vegetation.dry+green found 5230 pixels
  kaolin+muscovite_mix_intimate found 5184 pixels
dolomite.25+calcite.25+mont_Na.5 found 4018 pixels
      montmorillonite_Na found 3730 pixels
  kaolin.5+muscovite_medhighAl found 2621 pixels
      muscovite_medAl found 2068 pixels
      muscovite_lowAl found 1917 pixels
  kaolin.5+muscovite_medAl found 1319 pixels
      montmorillonite_Ca found 877 pixels
kaolin+clay_mica_or_halloysite found 553 pixels
  kaolin.2+calcite.8 found 532 pixels
  kaolin.5+smectite.5 found 481 pixels
      illite found 358 pixels
    dry_veg_nongrass found 274 pixels
      serpentine1 found 102 pixels
      illite_gds4 found 67 pixels
serpentine_or_dolomite+calcite found 65 pixels

```

Materials ranked by number of pixels to which they were matched.

↖ # of pixels matched to each material

epidote	found	64 pixels
kaolinite_px1	found	45 pixels
dolomite.5+montmorillonite_Na.5	found	41 pixels
serpentine3	found	39 pixels
gypsum	found	34 pixels
water_sediment_high	found	26 pixels
kaolinite_wx1	found	17 pixels
kaol_possible_alunite_or_dickite	found	3 pixels
chlorite+muscovite	found	3 pixels
snow_slush	found	2 pixels
serpentine4	found	1 pixels
tremolite_or_talc	found	1 pixels
buddingtonite	found	0 pixels
chlorite_lowFe	found	0 pixels
pyrophyllite.5+alunite.5	found	0 pixels
buddingtonite+montmorillonite	found	0 pixels
alunite.5+kaolinite.5	found	0 pixels
alunite.25+kaolinite.75	found	0 pixels
jarosite_K	found	0 pixels
jarosite+muscovite_mix_intimate	found	0 pixels
alunite_K_250c	found	0 pixels
dolomite	found	0 pixels
carbonate_Fe_bearing	found	0 pixels
chalcedony	found	0 pixels
hydrated_silica	found	0 pixels
alunite_Na_450c	found	0 pixels
water_sediment_low	found	0 pixels
pyrophyllite	found	0 pixels
water	found	0 pixels
jarosite_Na	found	0 pixels
snow_melting	found	0 pixels
serpentine2	found	0 pixels
muscovite_Fe-rich	found	0 pixels

Summary classification maps produced with all materials assigned a class using default values and colors, one image with and one without the nondata class.

Creating an ENVI Classification Image for ALL materials using default DN values and colors.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_defaultindex

Creating an ENVI Classification Image for ALL materials using default DN values and colors, including the non-data pixels.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_defaultindex_withnondataclass

Summary classification maps produced with only mapped materials assigned a class using values and colors determined by the number of pixels mapped, one image with and one without the nondata class.

Creating an ENVI Classification Image for Materials with DN values and colors ranked by top-pixel counts.

Output Classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_mappedmaterials_rankedbypixelcount

Creating an ENVI Classification Image for Materials with DN values and colors ranked by top-pixel counts, including the non-data pixels.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_mappedmaterials_rankedbypixelcount_withnondataclass

Summary classification maps produced with all materials assigned a class using user-specified values and colors, one image with and one without the nondata class.

Creating an ENVI Classification Image for ALL materials using user-indexed DN values and colors.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_userindex

Creating an ENVI Classification Image for ALL materials using user-indexed DN values and colors, including the non-data pixels.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_userindex_withnondataclass

Ending mica_imagecube_array_specpr.pro at Mon Apr 25 12:59:11 2011

Elapsed time = 0 hours 5 minutes 6 seconds.

Output report for verbose level 3. “*Function 4.1 – Run MICA for Image Cubes*”

Verbose level three adds reporting on the contents of the MICA command file, including reference spectra, diagnostic and NOT features, continuum endpoint ranges, and the channels found within these ranges. Additional details on the creation of the non-data pixels are given, including the number of non-data pixels found in the image. More information is reported during the creation of the summary images, including the class value and color assigned to each material.

Starting mica_imagecube_array_specpr.pro at Mon Apr 25 13:04:40 2011

Operating System Type = Windows (NOT performing byteorder operations)

Command Line Options

FILE_DN_COLORS = 0
DELETED_CHANNELS = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124

Image Cube = C:\usgsprism\mica_hymap\cube\testcube_hymap124ch

Number of Bands = 124
Number of Lines = 814
Number of Samples = 446

Processing Parameters:

TETRACORDER PROCESSING OPTIONS ARE TURNED OFF! FIT VALUES ARE IN TERMS OF r^2 THE COEFFICIENT OF DETERMINATION

OPTION TO CHECK THE SIGN OF THE DEPTHS IS TURNED ON!

Setting wavelengths based on WAVELENGTH_SPECPR_RECORD keyword in the command file structure.

Wavelength SPECPR file = C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
Wavelength SPECPR record = 6

Deleted Channels found = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124
Number of Good Channels = 103

Searching for command file keyword value for FILE_DN_COLORS...

FILE_DN_COLORS = C:\usgsprism\mica_hymap\mica_colors_group2_hymap2007.txt

class_name	class_value	red	grn	blu
calcite_abundant	1	20	75	0
calcite	2	40	105	10

Same reporting on colors as verbose level 2

```
Scale factor for reference spectra (command file value) = 1.0000000
Scale factor for observed spectra (command file value) = 20000.000

Value indicating a non-data pixel in an image cube (from command file) = -1.0000
```

REFERENCE ENTRIES:

Same reporting on reference material spectral features as verbose level 3 of the spectral records mode of MICA.

DIAGNOSTIC FEATURE ENTRIES:

Same reporting on diagnostic features as verbose level 3 of the spectral records mode of MICA.

COMMAND FILE NOT FEATURE REFERENCE ENTRIES:

Same reporting on NOT features as verbose level 3 of the spectral records mode of MICA.

```
Analyzing the first reference spectrum against the command file to test its integrity.
...passed the integrity check.
```

```
Searching for the default non-data mask file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
and associated ENVI header file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.hdr
Opened and read a non-data mask file at the default location =
C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
with dimensions that match the input image cube.
Found 0 non-data pixels, which is 0.% of all pixels.
```

```
----- STARTING ANALYSIS -----
Image cube analyzed:C:\usgsprism\mica_hymap\cube\testcube_hymap124ch
Number of Bands = 124
Number of Lines = 814
Number of Samples = 446
Command file used:C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
Total number of reference spectra = 60
Total number of reference features = 111
Total number of reference NOT spectra = 12
Total number of invocations of NOT features = 62
```

MICA searches the output directory for an existing image of the non-data pixels and the associated ENVI header file. The program searches for a file with the expected name "image_nodata_pixels.gz" that has the same dimensions (scanlines and samples) as the image being analyzed.

If an existing image is found, MICA opens it and reports the number of non-data pixels that were found, that is, the number of pixels with the value of zero in the mask image that was opened.

Beginning line by line analysis of the image cube at Mon Apr 25 13:04:47 2011

Input spectrum (line=10,sample=223) was best matched by calcite with a fit of 0.8521 and a depth of 0.0468 and a fit*depth of 0.0399
Input spectrum (line=20,sample=223) was best matched by calcite with a fit of 0.8174 and a depth of 0.0441 and a fit*depth of 0.0360
Input spectrum (line=30,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.6639 and a depth of 0.0179 and a fit*depth of 0.0145
Input spectrum (line=40,sample=223) was best matched by calcite with a fit of 0.8821 and a depth of 0.0415 and a fit*depth of 0.0366
Input spectrum (line=50,sample=223) was best matched by calcite with a fit of 0.9825 and a depth of 0.1201 and a fit*depth of 0.1180
Input spectrum (line=60,sample=223) was best matched by calcite.7+muscovite.3 with a fit of 0.5855 and a depth of 0.0164 and a fit*depth of 0.0144
Input spectrum (line=70,sample=223) was best matched by dry_veg_grass with a fit of 0.9365 and a depth of 0.0431 and a fit*depth of 0.0403
Input spectrum (line=80,sample=223) NO MATCH WAS FOUND!
Input spectrum (line=90,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.6652 and a depth of 0.0194 and a fit*depth of 0.0156
Input spectrum (line=100,sample=223) was best matched by calcite.8+montmorillonite_Na.2 with a fit of 0.7192 and a depth of 0.0141 and a fit*depth of 0.0112
Input spectrum (line=110,sample=223) was best matched by calcite.8+montmorillonite_Ca.2 with a fit of 0.8345 and a depth of 0.0158 and a fit*depth of 0.0132

Same reporting on matches to the central pixel of every 10th line as verbose level 2 of the image cube mode of MICA.

Input spectrum (line=800,sample=223) was best matched by calcite with a fit of 0.9508 and a depth of 0.1159 and a fit*depth of 0.1102
Input spectrum (line=810,sample=223) was best matched by calcite with a fit of 0.9459 and a depth of 0.1032 and a fit*depth of 0.0976

Finished line by line analysis at Mon Apr 25 13:08:35 2011

Elapsed time = 0 hours 3 minutes 47 seconds.

----- END ANALYSIS -----

Writing the results to ENVI files:

Output directory = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\

Writing the composite all materials images to ENVI files for fit, depth and fit*depth (fd):

Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_fits.gz
Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_depths.gz
Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_fds.gz

Writing the individual material images to ENVI files (with gzip compression) for fit, depth and fit*depth (fd):

Output files for material = vegetation_green with 14258 pixels selected as the best match were successfully written.
Output files for material = vegetation.dry+green with 5230 pixels selected as the best match were successfully written.

Same reporting on creation of files for each material as verbose level 2 of the image cube mode of MICA.

Output files for material = serpentine3 with 39 pixels selected as the best match were successfully written.
Output files for material = serpentine4 with 1 pixels selected as the best match were successfully written.

Creating an image of the pixels in which no materials were detected (file=image_unmapped_pixels).

No match was found for 13783 pixels.

Sorting materials by the number of pixels in which the material was detected.

calcite found	144044 pixels
calcite_abundant found	37019 pixels

Same reporting on number of pixels detected as verbose level 2 of the image cube mode of MICA.

serpentine2 found	0 pixels
muscovite_Fe-rich found	0 pixels

Creating an ENVI Classification Image for ALL materials using default DN values and colors.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_defaultindex

In comparison, to verbose level 2 of the MICA image cube mode, verbose level 3 contains additional reporting on the files, class values, and colors used in creating the summary maps.

Starting make_envi_classification_image.pro at Mon Apr 25 13:08:43 2011

Processing the input images...

File 1 =	vegetation_green_fit.gz, found	14258 pixels with this material (3.93% of valid image pixels).
File 2 =	vegetation.dry+green_fit.gz, found	5230 pixels with this material (1.44% of valid image pixels).
File 3 =	snow_melting_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 4 =	snow_slush_fit.gz, found	2 pixels with this material (0.00% of valid image pixels).
File 5 =	water_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 6 =	water_sediment_high_fit.gz, found	26 pixels with this material (0.01% of valid image pixels).
File 7 =	water_sediment_low_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 8 =	dry_veg_grass_fit.gz, found	20360 pixels with this material (5.61% of valid image pixels).
File 9 =	dry_veg_grass_2_3um_fit.gz, found	19714 pixels with this material (5.43% of valid image pixels).
File 10 =	dry_veg_nongrass_fit.gz, found	274 pixels with this material (0.08% of valid image pixels).
File 11 =	dry_veg_nongrass_2_3um_fit.gz, found	9914 pixels with this material (2.73% of valid image pixels).
File 12 =	muscovite_lowAl_fit.gz, found	1917 pixels with this material (0.53% of valid image pixels).
File 13 =	muscovite_medAl_fit.gz, found	2068 pixels with this material (0.57% of valid image pixels).
File 14 =	muscovite_medhighAl_fit.gz, found	8903 pixels with this material (2.45% of valid image pixels).
File 15 =	muscovite_Fe-rich_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 16 =	illite_fit.gz, found	358 pixels with this material (0.10% of valid image pixels).
File 17 =	illite_gds4_fit.gz, found	67 pixels with this material (0.02% of valid image pixels).

File 18 = kaolinite_wxl_fit.gz, found 17 pixels with this material (0.00% of valid image pixels).
File 19 = kaolinite_pxl_fit.gz, found 45 pixels with this material (0.01% of valid image pixels).
File 20 = kaolin+clay_mica_or_halloysite_fit.gz, found 553 pixels with this material (0.15% of valid image pixels).
File 21 = kaol_possible_alunite_or_dickite_fit.gz, found 3 pixels with this material (0.00% of valid image pixels).
File 22 = buddingtonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 23 = buddingtonite+montmorillonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 24 = alunite_K_250c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 25 = alunite_Na_450c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 26 = pyrophyllite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 27 = jarosite_Na_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 28 = jarosite_K_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 29 = montmorillonite_Na_fit.gz, found 3730 pixels with this material (1.03% of valid image pixels).
File 30 = montmorillonite_Ca_fit.gz, found 877 pixels with this material (0.24% of valid image pixels).
File 31 = gypsum_fit.gz, found 34 pixels with this material (0.01% of valid image pixels).
File 32 = chlorite_lowFe_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 33 = epidote_fit.gz, found 64 pixels with this material (0.02% of valid image pixels).
File 34 = pyrophyllite.5+alunite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 35 = alunite.5+kaolinite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 36 = alunite.25+kaolinite.75_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 37 = kaolin.5+muscovite_medAl_fit.gz, found 1319 pixels with this material (0.36% of valid image pixels).
File 38 = kaolin.5+muscovite_medhighAl_fit.gz, found 2621 pixels with this material (0.72% of valid image pixels).
File 39 = kaolin+muscovite_mix_intimate_fit.gz, found 5184 pixels with this material (1.43% of valid image pixels).
File 40 = kaolin.5+smectite.5_fit.gz, found 481 pixels with this material (0.13% of valid image pixels).
File 41 = jarosite+muscovite_mix_intimate_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 42 = chlorite+muscovite_fit.gz, found 3 pixels with this material (0.00% of valid image pixels).
File 43 = calcite_abundant_fit.gz, found 37019 pixels with this material (10.20% of valid image pixels).
File 44 = calcite_fit.gz, found 144044 pixels with this material (39.68% of valid image pixels).
File 45 = dolomite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 46 = carbonate_Fe_bearing_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 47 = dolomite.25+calcite.25+mont_Na.5_fit.gz, found 4018 pixels with this material (1.11% of valid image pixels).
File 48 = calcite.8+montmorillonite_Na.2_fit.gz, found 16543 pixels with this material (4.56% of valid image pixels).
File 49 = calcite.8+montmorillonite_Ca.2_fit.gz, found 21098 pixels with this material (5.81% of valid image pixels).
File 50 = calcite.7+muscovite.3_fit.gz, found 27736 pixels with this material (7.64% of valid image pixels).
File 51 = dolomite.5+montmorillonite_Na.5_fit.gz, found 41 pixels with this material (0.01% of valid image pixels).
File 52 = kaolin.2+calcite.8_fit.gz, found 532 pixels with this material (0.15% of valid image pixels).
File 53 = chalcedony_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 54 = hydrated_silica_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 55 = tremolite_or_talc_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).
File 56 = serpentine_or_dolomite+calcite_fit.gz, found 65 pixels with this material (0.02% of valid image pixels).
File 57 = serpentine1_fit.gz, found 102 pixels with this material (0.03% of valid image pixels).
File 58 = serpentine2_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].

File 59 = serpentine3_fit.gz, found 39 pixels with this material (0.01% of valid image pixels).
 File 60 = serpentine4_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).

In comparison to verbose level 2 of the MICA image cube mode, verbose level 3 contains additional reporting on the class names, values, and colors assigned in the summary maps.

Default class values and colors:

class_name	value	red	grn	blu
Not_Classified	0	0	0	0
vegetation_green	1	255	0	0
vegetation.dry+green	2	0	255	0
snow_melting	3	0	0	255
snow_slush	4	255	255	0
water	5	0	255	255
water_sediment_high	6	255	0	255
water_sediment_low	7	255	180	0
dry_veg_grass	8	255	140	255
dry_veg_grass_2_3um	9	0	200	75
dry_veg_nongrass	10	150	100	30
dry_veg_nongrass_2_3um	11	180	110	210
muscovite_lowAl	12	216	0	0
muscovite_medAl	13	0	216	0
muscovite_medhighAl	14	0	0	216
muscovite_Fe-rich	15	216	216	0
illite	16	0	216	216
illite_gds4	17	216	0	216
kaolinite_wx1	18	216	153	0
kaolinite_pxl	19	216	119	216
kaolin+clay_mica_or_halloysite	20	0	170	63
kaol_possible_alunite_or_dickite	21	127	85	25
buddingtonite	22	153	93	178
buddingtonite+montmorillonite	23	178	0	0
alunite_K_250c	24	0	178	0
alunite_Na_450c	25	0	0	178
pyrophyllite	26	178	178	0
jarosite_Na	27	0	178	178
jarosite_K	28	178	0	178
montmorillonite_Na	29	178	126	0
montmorillonite_Ca	30	178	98	178
gypsum	31	0	140	52
chlorite_lowFe	32	105	70	21
epidote	33	126	77	147
pyrophyllite.5+alunite.5	34	140	0	0
alunite.5+kaolinite.5	35	0	140	0
alunite.25+kaolinite.75	36	0	0	140
kaolin.5+muscovite_medAl	37	140	140	0
kaolin.5+muscovite_medhighAl	38	0	140	140
kaolin+muscovite_mix_intimate	39	140	0	140
kaolin.5+smectite.5	40	140	99	0
jarosite+muscovite_mix_intimate	41	140	77	140
chlorite+muscovite	42	0	110	41
calcite_abundant	43	82	55	16
calcite	44	99	60	115
dolomite	45	114	0	0

carbonate_Fe_bearing	46	0	114	0
dolomite.25+calcite.25+mont_Na.5	47	0	0	114
calcite.8+montmorillonite_Na.2	48	114	114	0
calcite.8+montmorillonite_Ca.2	49	0	114	114
calcite.7+muscovite.3	50	114	0	114
dolomite.5+montmorillonite_Na.5	51	114	81	0
kaolin.2+calcite.8	52	114	63	114
chalcedony	53	0	90	33
hydrated_silica	54	67	45	13
tremolite_or_talc	55	81	49	94
serpentine_or_dolomite+calcite	56	89	0	0
serpentine1	57	0	89	0
serpentine2	58	0	0	89
serpentine3	59	89	89	0
serpentine4	60	0	89	89

Created output file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_defaultindex
Normal termination of make_envi_classification_image.pro ... Elapsed Time = 0.84 seconds

Creating an ENVI Classification Image for ALL materials using default DN values and colors, including the non-data pixels.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_defaultindex_withnondataclass

Starting make_envi_classification_image.pro at Mon Apr 25 13:08:44 2011

Processing the mask for non-data pixels...

Found 0 pixels of non-data (0.00% of all image pixels).

Number of data pixels = 363044.

Processing the input images...

File 1 =	vegetation_green_fit.gz, found	14258 pixels with this material (3.93% of valid image pixels).
File 2 =	vegetation_dry+green_fit.gz, found	5230 pixels with this material (1.44% of valid image pixels).
File 3 =	snow_melting_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 4 =	snow_slush_fit.gz, found	2 pixels with this material (0.00% of valid image pixels).
File 5 =	water_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 6 =	water_sediment_high_fit.gz, found	26 pixels with this material (0.01% of valid image pixels).
File 7 =	water_sediment_low_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 8 =	dry_veg_grass_fit.gz, found	20360 pixels with this material (5.61% of valid image pixels).
File 9 =	dry_veg_grass_2_3um_fit.gz, found	19714 pixels with this material (5.43% of valid image pixels).
File 10 =	dry_veg_nongrass_fit.gz, found	274 pixels with this material (0.08% of valid image pixels).
File 11 =	dry_veg_nongrass_2_3um_fit.gz, found	9914 pixels with this material (2.73% of valid image pixels).
File 12 =	muscovite_lowAl_fit.gz, found	1917 pixels with this material (0.53% of valid image pixels).
File 13 =	muscovite_medAl_fit.gz, found	2068 pixels with this material (0.57% of valid image pixels).
File 14 =	muscovite_medhighAl_fit.gz, found	8903 pixels with this material (2.45% of valid image pixels).
File 15 =	muscovite_Fe-rich_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 16 =	illite_fit.gz, found	358 pixels with this material (0.10% of valid image pixels).
File 17 =	illite_gds4_fit.gz, found	67 pixels with this material (0.02% of valid image pixels).
File 18 =	kaolinite_wxl_fit.gz, found	17 pixels with this material (0.00% of valid image pixels).
File 19 =	kaolinite_pxl_fit.gz, found	45 pixels with this material (0.01% of valid image pixels).
File 20 =	kaolin+clay_mica_or_halloysite_fit.gz, found	553 pixels with this material (0.15% of valid image pixels).
File 21 =	kaol_possible_alunite_or_dickite_fit.gz, found	3 pixels with this material (0.00% of valid image pixels).
File 22 =	buddingtonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 23 =	buddingtonite+montmorillonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 24 =	alunite_K_250c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 25 =	alunite_Na_450c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 26 =	pyrophyllite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 27 =	jarosite_Na_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 28 =	jarosite_K_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 29 =	montmorillonite_Na_fit.gz, found	3730 pixels with this material (1.03% of valid image pixels).
File 30 =	montmorillonite_Ca_fit.gz, found	877 pixels with this material (0.24% of valid image pixels).
File 31 =	gypsum_fit.gz, found	34 pixels with this material (0.01% of valid image pixels).
File 32 =	chlorite_lowFe_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	

File 33 = epidote_fit.gz, found 64 pixels with this material (0.02% of valid image pixels).
File 34 = pyrophyllite.5+alunite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 35 = alunite.5+kaolinite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 36 = alunite.25+kaolinite.75_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 37 = kaolin.5+muscovite_medAl_fit.gz, found 1319 pixels with this material (0.36% of valid image pixels).
File 38 = kaolin.5+muscovite_medhighAl_fit.gz, found 2621 pixels with this material (0.72% of valid image pixels).
File 39 = kaolin+muscovite_mix_intimate_fit.gz, found 5184 pixels with this material (1.43% of valid image pixels).
File 40 = kaolin.5+smectite.5_fit.gz, found 481 pixels with this material (0.13% of valid image pixels).
File 41 = jarosite+muscovite_mix_intimate_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 42 = chlorite+muscovite_fit.gz, found 3 pixels with this material (0.00% of valid image pixels).
File 43 = calcite_abundant_fit.gz, found 37019 pixels with this material (10.20% of valid image pixels).
File 44 = calcite_fit.gz, found 144044 pixels with this material (39.68% of valid image pixels).
File 45 = dolomite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 46 = carbonate_Fe_bearing_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 47 = dolomite.25+calcite.25+mont_Na.5_fit.gz, found 4018 pixels with this material (1.11% of valid image pixels).
File 48 = calcite.8+montmorillonite_Na.2_fit.gz, found 16543 pixels with this material (4.56% of valid image pixels).
File 49 = calcite.8+montmorillonite_Ca.2_fit.gz, found 21098 pixels with this material (5.81% of valid image pixels).
File 50 = calcite.7+muscovite.3_fit.gz, found 27736 pixels with this material (7.64% of valid image pixels).
File 51 = dolomite.5+montmorillonite_Na.5_fit.gz, found 41 pixels with this material (0.01% of valid image pixels).
File 52 = kaolin.2+calcite.8_fit.gz, found 532 pixels with this material (0.15% of valid image pixels).
File 53 = chalcedony_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 54 = hydrated_silica_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 55 = tremolite_or_talc_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).
File 56 = serpentine_or_dolomite+calcite_fit.gz, found 65 pixels with this material (0.02% of valid image pixels).
File 57 = serpentine1_fit.gz, found 102 pixels with this material (0.03% of valid image pixels).
File 58 = serpentine2_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 59 = serpentine3_fit.gz, found 39 pixels with this material (0.01% of valid image pixels).
File 60 = serpentine4_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).

Default class values and colors:

class_name	value	red	grn	blu
Not_Classified	0	0	0	0
vegetation_green	1	255	0	0
vegetation.dry+green	2	0	255	0
snow_melting	3	0	0	255
snow_slush	4	255	255	0
water	5	0	255	255
water_sediment_high	6	255	0	255
water_sediment_low	7	255	180	0
dry_veg_grass	8	255	140	255
dry_veg_grass_2_3um	9	0	200	75
dry_veg_nongrass	10	150	100	30
dry_veg_nongrass_2_3um	11	180	110	210
muscovite_lowAl	12	216	0	0
muscovite_medAl	13	0	216	0
muscovite_medhighAl	14	0	0	216
muscovite_Fe-rich	15	216	216	0
illite	16	0	216	216
illite_gds4	17	216	0	216
kaolinite_wxl	18	216	153	0
kaolinite_pxl	19	216	119	216
kaolin+clay_mica_or_halloysite	20	0	170	63
kaol_possible_alunite_or_dickite	21	127	85	25
buddingtonite	22	153	93	178
buddingtonite+montmorillonite	23	178	0	0
alunite_K_250c	24	0	178	0
alunite_Na_450c	25	0	0	178
pyrophyllite	26	178	178	0
jarosite_Na	27	0	178	178
jarosite_K	28	178	0	178

montmorillonite_Na	29	178	126	0
montmorillonite_Ca	30	178	98	178
gypsum	31	0	140	52
chlorite_lowFe	32	105	70	21
epidote	33	126	77	147
pyrophyllite.5+alunite.5	34	140	0	0
alunite.5+kaolinite.5	35	0	140	0
alunite.25+kaolinite.75	36	0	0	140
kaolin.5+muscovite_medAl	37	140	140	0
kaolin.5+muscovite_medhighAl	38	0	140	140
kaolin+muscovite_mix_intimate	39	140	0	140
kaolin.5+smectite.5	40	140	99	0
jarosite+muscovite_mix_intimate	41	140	77	140
chlorite+muscovite	42	0	110	41
calcite_abundant	43	82	55	16
calcite	44	99	60	115
dolomite	45	114	0	0
carbonate_Fe_bearing	46	0	114	0
dolomite.25+calcite.25+mont_Na.5	47	0	0	114
calcite.8+montmorillonite_Na.2	48	114	114	0
calcite.8+montmorillonite_Ca.2	49	0	114	114
calcite.7+muscovite.3	50	114	0	114
dolomite.5+montmorillonite_Na.5	51	114	81	0
kaolin.2+calcite.8	52	114	63	114
chalcedony	53	0	90	33
hydrated_silica	54	67	45	13
tremolite_or_talc	55	81	49	94
serpentine_or_dolomite+calcite	56	89	0	0
serpentine1	57	0	89	0
serpentine2	58	0	0	89
serpentine3	59	89	89	0
serpentine4	60	0	89	89
Non-data pixels	61	60	60	60

Created output file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_defaultindex_withnondataclass
Normal termination of make_envi_classification_image.pro ... Elapsed Time = 0.88 seconds

Creating an ENVI Classification Image for Materials with DN values and colors ranked by top-pixel counts.

Number of files = 39

Materials =

```

calcite
calcite_abundant
calcite.7+muscovite.3
calcite.8+montmorillonite_Ca.2
dry_veg_grass
dry_veg_grass_2_3um
calcite.8+montmorillonite_Na.2
vegetation_green
dry_veg_nongrass_2_3um
muscovite_medhighAl
vegetation.dry+green
kaolin+muscovite_mix_intimate
dolomite.25+calcite.25+mont_Na.5
montmorillonite_Na
kaolin.5+muscovite_medhighAl
muscovite_medAl
muscovite_lowAl
kaolin.5+muscovite_medAl
montmorillonite_Ca

```

kaolin+clay_mica_or_halloysite
kaolin.2+calcite.8
kaolin.5+smectite.5
illite
dry_veg_nongrass
serpentine1
illite_gds4
serpentine_or_dolomite+calcite
epidote
kaolinite_pxl
dolomite.5+montmorillonite_Na.5
serpentine3
gypsum
water_sediment_high
kaolinite_wxl
kaol_possible_alunite_or_dickite
chlorite+muscovite
snow_slush
serpentine4
tremolite_or_talc

Output Classification file =

C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_mappedmaterials_rankedbypixelcount

Starting make_envi_classification_image.pro at Mon Apr 25 13:08:45 2011

Processing the input images...

File 1 =	calcite_fit.gz, found	144044 pixels with this material (39.68% of valid image pixels).
File 2 =	calcite_abundant_fit.gz, found	37019 pixels with this material (10.20% of valid image pixels).
File 3 =	calcite.7+muscovite.3_fit.gz, found	27736 pixels with this material (7.64% of valid image pixels).
File 4 =	calcite.8+montmorillonite_Ca.2_fit.gz, found	21098 pixels with this material (5.81% of valid image pixels).
File 5 =	dry_veg_grass_fit.gz, found	20360 pixels with this material (5.61% of valid image pixels).
File 6 =	dry_veg_grass_2_3um_fit.gz, found	19714 pixels with this material (5.43% of valid image pixels).
File 7 =	calcite.8+montmorillonite_Na.2_fit.gz, found	16543 pixels with this material (4.56% of valid image pixels).
File 8 =	vegetation_green_fit.gz, found	14258 pixels with this material (3.93% of valid image pixels).
File 9 =	dry_veg_nongrass_2_3um_fit.gz, found	9914 pixels with this material (2.73% of valid image pixels).
File 10 =	muscovite_medhighAl_fit.gz, found	8903 pixels with this material (2.45% of valid image pixels).
File 11 =	vegetation.dry+green_fit.gz, found	5230 pixels with this material (1.44% of valid image pixels).
File 12 =	kaolin+muscovite_mix_intimate_fit.gz, found	5184 pixels with this material (1.43% of valid image pixels).
File 13 =	dolomite.25+calcite.25+mont_Na.5_fit.gz, found	4018 pixels with this material (1.11% of valid image pixels).
File 14 =	montmorillonite_Na_fit.gz, found	3730 pixels with this material (1.03% of valid image pixels).
File 15 =	kaolin.5+muscovite_medhighAl_fit.gz, found	2621 pixels with this material (0.72% of valid image pixels).
File 16 =	muscovite_medAl_fit.gz, found	2068 pixels with this material (0.57% of valid image pixels).
File 17 =	muscovite_lowAl_fit.gz, found	1917 pixels with this material (0.53% of valid image pixels).
File 18 =	kaolin.5+muscovite_medAl_fit.gz, found	1319 pixels with this material (0.36% of valid image pixels).
File 19 =	montmorillonite_Ca_fit.gz, found	877 pixels with this material (0.24% of valid image pixels).
File 20 =	kaolin+clay_mica_or_halloysite_fit.gz, found	553 pixels with this material (0.15% of valid image pixels).
File 21 =	kaolin.2+calcite.8_fit.gz, found	532 pixels with this material (0.15% of valid image pixels).
File 22 =	kaolin.5+smectite.5_fit.gz, found	481 pixels with this material (0.13% of valid image pixels).
File 23 =	illite_fit.gz, found	358 pixels with this material (0.10% of valid image pixels).
File 24 =	dry_veg_nongrass_fit.gz, found	274 pixels with this material (0.08% of valid image pixels).
File 25 =	serpentine1_fit.gz, found	102 pixels with this material (0.03% of valid image pixels).
File 26 =	illite_gds4_fit.gz, found	67 pixels with this material (0.02% of valid image pixels).
File 27 =	serpentine_or_dolomite+calcite_fit.gz, found	65 pixels with this material (0.02% of valid image pixels).
File 28 =	epidote_fit.gz, found	64 pixels with this material (0.02% of valid image pixels).
File 29 =	kaolinite_pxl_fit.gz, found	45 pixels with this material (0.01% of valid image pixels).
File 30 =	dolomite.5+montmorillonite_Na.5_fit.gz, found	41 pixels with this material (0.01% of valid image pixels).
File 31 =	serpentine3_fit.gz, found	39 pixels with this material (0.01% of valid image pixels).
File 32 =	gypsum_fit.gz, found	34 pixels with this material (0.01% of valid image pixels).
File 33 =	water_sediment_high_fit.gz, found	26 pixels with this material (0.01% of valid image pixels).
File 34 =	kaolinite_wxl_fit.gz, found	17 pixels with this material (0.00% of valid image pixels).
File 35 =	kaol_possible_alunite_or_dickite_fit.gz, found	3 pixels with this material (0.00% of valid image pixels).

File 36 = chlorite+muscovite_fit.gz, found 3 pixels with this material (0.00% of valid image pixels).
 File 37 = snow_slush_fit.gz, found 2 pixels with this material (0.00% of valid image pixels).
 File 38 = serpentine4_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).
 File 39 = tremolite_or_talc_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).

Default class values and colors:

class_name	value	red	grn	blu
Not_Classified	0	0	0	0
calcite	1	255	0	0
calcite_abundant	2	0	255	0
calcite.7+muscovite.3	3	0	0	255
calcite.8+montmorillonite_Ca.2	4	255	255	0
dry_veg_grass	5	0	255	255
dry_veg_grass_2_3um	6	255	0	255
calcite.8+montmorillonite_Na.2	7	255	180	0
vegetation_green	8	255	140	255
dry_veg_nongrass_2_3um	9	0	200	75
muscovite_medhighA1	10	150	100	30
vegetation.dry+green	11	180	110	210
kaolin+muscovite_mix_intimate	12	216	0	0
dolomite.25+calcite.25+mont_Na.5	13	0	216	0
montmorillonite_Na	14	0	0	216
kaolin.5+muscovite_medhighA1	15	216	216	0
muscovite_medA1	16	0	216	216
muscovite_lowA1	17	216	0	216
kaolin.5+muscovite_medA1	18	216	153	0
montmorillonite_Ca	19	216	119	216
kaolin+clay_mica_or_halloysite	20	0	170	63
kaolin.2+calcite.8	21	127	85	25
kaolin.5+smectite.5	22	153	93	178
illite	23	178	0	0
dry_veg_nongrass	24	0	178	0
serpentine1	25	0	0	178
illite_gds4	26	178	178	0
serpentine_or_dolomite+calcite	27	0	178	178
epidote	28	178	0	178
kaolinite_px1	29	178	126	0
dolomite.5+montmorillonite_Na.5	30	178	98	178
serpentine3	31	0	140	52
gypsum	32	105	70	21
water_sediment_high	33	126	77	147
kaolinite_wx1	34	140	0	0
kaol_possible_alunite_or_dickite	35	0	140	0
chlorite+muscovite	36	0	0	140
snow_slush	37	140	140	0
serpentine4	38	0	140	140
tremolite_or_talc	39	140	0	140

Created output file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_mappedmaterials_rankedbypixelcount
 Normal termination of make_envi_classification_image.pro ... Elapsed Time = 0.94 seconds

Creating an ENVI Classification Image for Materials with DN values and colors ranked by top-pixel counts, including the non-data pixels.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_mappedmaterials_rankedbypixelcount_withnondataclass
 Starting make_envi_classification_image.pro at Mon Apr 25 13:08:46 2011

Processing the mask for non-data pixels...

Found 0 pixels of non-data (0.00% of all image pixels).

Number of data pixels = 363044.

Processing the input images...

File 1 = calcite_fit.gz, found 144044 pixels with this material (39.68% of valid image pixels).
 File 2 = calcite_abundant_fit.gz, found 37019 pixels with this material (10.20% of valid image pixels).

File 3 =	calcite.7+muscovite.3_fit.gz,	found	27736 pixels with this material (7.64% of valid image pixels).
File 4 =	calcite.8+montmorillonite_Ca.2_fit.gz,	found	21098 pixels with this material (5.81% of valid image pixels).
File 5 =	dry_veg_grass_fit.gz,	found	20360 pixels with this material (5.61% of valid image pixels).
File 6 =	dry_veg_grass_2_3um_fit.gz,	found	19714 pixels with this material (5.43% of valid image pixels).
File 7 =	calcite.8+montmorillonite_Na.2_fit.gz,	found	16543 pixels with this material (4.56% of valid image pixels).
File 8 =	vegetation_green_fit.gz,	found	14258 pixels with this material (3.93% of valid image pixels).
File 9 =	dry_veg_nongrass_2_3um_fit.gz,	found	9914 pixels with this material (2.73% of valid image pixels).
File 10 =	muscovite_medhighAl_fit.gz,	found	8903 pixels with this material (2.45% of valid image pixels).
File 11 =	vegetation.dry+green_fit.gz,	found	5230 pixels with this material (1.44% of valid image pixels).
File 12 =	kaolin+muscovite_mix_intimate_fit.gz,	found	5184 pixels with this material (1.43% of valid image pixels).
File 13 =	dolomite.25+calcite.25+mont_Na.5_fit.gz,	found	4018 pixels with this material (1.11% of valid image pixels).
File 14 =	montmorillonite_Na_fit.gz,	found	3730 pixels with this material (1.03% of valid image pixels).
File 15 =	kaolin.5+muscovite_medhighAl_fit.gz,	found	2621 pixels with this material (0.72% of valid image pixels).
File 16 =	muscovite_medAl_fit.gz,	found	2068 pixels with this material (0.57% of valid image pixels).
File 17 =	muscovite_lowAl_fit.gz,	found	1917 pixels with this material (0.53% of valid image pixels).
File 18 =	kaolin.5+muscovite_medAl_fit.gz,	found	1319 pixels with this material (0.36% of valid image pixels).
File 19 =	montmorillonite_Ca_fit.gz,	found	877 pixels with this material (0.24% of valid image pixels).
File 20 =	kaolin+clay_mica_or_halloysite_fit.gz,	found	553 pixels with this material (0.15% of valid image pixels).
File 21 =	kaolin.2+calcite.8_fit.gz,	found	532 pixels with this material (0.15% of valid image pixels).
File 22 =	kaolin.5+smectite.5_fit.gz,	found	481 pixels with this material (0.13% of valid image pixels).
File 23 =	illite_fit.gz,	found	358 pixels with this material (0.10% of valid image pixels).
File 24 =	dry_veg_nongrass_fit.gz,	found	274 pixels with this material (0.08% of valid image pixels).
File 25 =	serpentine1_fit.gz,	found	102 pixels with this material (0.03% of valid image pixels).
File 26 =	illite_gds4_fit.gz,	found	67 pixels with this material (0.02% of valid image pixels).
File 27 =	serpentine_or_dolomite+calcite_fit.gz,	found	65 pixels with this material (0.02% of valid image pixels).
File 28 =	epidote_fit.gz,	found	64 pixels with this material (0.02% of valid image pixels).
File 29 =	kaolinite_pxl_fit.gz,	found	45 pixels with this material (0.01% of valid image pixels).
File 30 =	dolomite.5+montmorillonite_Na.5_fit.gz,	found	41 pixels with this material (0.01% of valid image pixels).
File 31 =	serpentine3_fit.gz,	found	39 pixels with this material (0.01% of valid image pixels).
File 32 =	gypsum_fit.gz,	found	34 pixels with this material (0.01% of valid image pixels).
File 33 =	water_sediment_high_fit.gz,	found	26 pixels with this material (0.01% of valid image pixels).
File 34 =	kaolinite_wxl_fit.gz,	found	17 pixels with this material (0.00% of valid image pixels).
File 35 =	kaol_possible_alunite_or_dickite_fit.gz,	found	3 pixels with this material (0.00% of valid image pixels).
File 36 =	chlorite+muscovite_fit.gz,	found	3 pixels with this material (0.00% of valid image pixels).
File 37 =	snow_slush_fit.gz,	found	2 pixels with this material (0.00% of valid image pixels).
File 38 =	serpentine4_fit.gz,	found	1 pixels with this material (0.00% of valid image pixels).
File 39 =	tremolite_or_talc_fit.gz,	found	1 pixels with this material (0.00% of valid image pixels).

Default class values and colors:

class_name	value	red	grn	blu
Not_Classified	0	0	0	0
calcite	1	255	0	0
calcite_abundant	2	0	255	0
calcite.7+muscovite.3	3	0	0	255
calcite.8+montmorillonite_Ca.2	4	255	255	0
dry_veg_grass	5	0	255	255
dry_veg_grass_2_3um	6	255	0	255
calcite.8+montmorillonite_Na.2	7	255	180	0
vegetation_green	8	255	140	255
dry_veg_nongrass_2_3um	9	0	200	75
muscovite_medhighAl	10	150	100	30
vegetation.dry+green	11	180	110	210
kaolin+muscovite_mix_intimate	12	216	0	0
dolomite.25+calcite.25+mont_Na.5	13	0	216	0
montmorillonite_Na	14	0	0	216
kaolin.5+muscovite_medhighAl	15	216	216	0
muscovite_medAl	16	0	216	216
muscovite_lowAl	17	216	0	216
kaolin.5+muscovite_medAl	18	216	153	0
montmorillonite_Ca	19	216	119	216

kaolin+clay_mica_or_halloysite	20	0	170	63
kaolin.2+calcite.8	21	127	85	25
kaolin.5+smectite.5	22	153	93	178
illite	23	178	0	0
dry_veg_nongrass	24	0	178	0
serpentine1	25	0	0	178
illite_gds4	26	178	178	0
serpentine_or_dolomite+calcite	27	0	178	178
epidote	28	178	0	178
kaolinite_pxl	29	178	126	0
dolomite.5+montmorillonite_Na.5	30	178	98	178
serpentine3	31	0	140	52
gypsum	32	105	70	21
water_sediment_high	33	126	77	147
kaolinite_wxl	34	140	0	0
kaol_possible_alunite_or_dickite	35	0	140	0
chlorite+muscovite	36	0	0	140
snow_slush	37	140	140	0
serpentine4	38	0	140	140
tremolite_or_talc	39	140	0	140
Non-data pixels	40	60	60	60

Created output file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_mappedmaterials_rankedbypixelcount_withnondataclass
Normal termination of make_envi_classification_image.pro ... Elapsed Time = 0.88 seconds

Creating an ENVI Classification Image for ALL materials using user-indexed DN values and colors.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_userindex

Classification parameters:

1	calcite_abundant	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\calcite_abundant_fit.	1	20	75	0
2	calcite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\calcite_fit.gz	1	40	105	10
3	calcite.7+muscovite.3	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\calcite.7+muscovite.3	1	113	160	90
4	calcite.8+montmorillonite_Ca.2	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\calcite.8+montmorillo	1	188	185	115
5	calcite.8+montmorillonite_Na.2	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\calcite.8+montmorillo	1	188	185	115
6	carbonate_Fe_bearing	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\carbonate_Fe_bearing_	0	220	185	255
7	dolomite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dolomite_fit.gz	0	205	25	255
8	dolomite.5+montmorillonite_Na.	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dolomite.5+montmorill	1	165	20	200
9	dolomite.25+calcite.25+mont_Na	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dolomite.25+calcite.2	1	165	20	200
10	epidote	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\epidote_fit.gz	1	225	25	0
11	chlorite_lowFe	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\chlorite_lowFe_fit.gz	0	225	25	0
12	chlorite+muscovite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\chlorite+muscovite_fi	1	225	25	0
13	muscovite_lowAl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\muscovite_lowAl_fit.g	1	250	150	0
14	muscovite_medAl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\muscovite_medAl_fit.g	1	250	150	0
15	muscovite_medhighAl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\muscovite_medhighAl_f	1	250	150	0
16	muscovite_Fe-rich	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\muscovite_Fe-rich_fit	0	250	150	0
17	illite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\illite_fit.gz	1	230	120	0
18	illite_gds4	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\illite_gds4_fit.gz	1	230	120	0
19	kaolinite_wxl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolinite_wxl_fit.gz	1	25	85	245
20	kaolinite_pxl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolinite_pxl_fit.gz	1	25	85	245
21	kaolin+clay_mica_or_halloysite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolin+clay_mica_or_h	1	40	145	255
22	kaolin.5+muscovite_medAl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolin.5+muscovite_me	1	40	145	255
23	kaolin+muscovite_mix_intimate	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolin+muscovite_mix_	1	40	145	255
24	kaolin.5+muscovite_medhighAl	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolin.5+muscovite_me	1	40	145	255
25	kaolin.5+smectite.5	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolin.5+smectite.5_f	1	40	145	255
26	kaolin.2+calcite.8	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaolin.2+calcite.8_fi	1	40	145	255
27	montmorillonite_Na	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\montmorillonite_Na_fi	1	130	210	255
28	montmorillonite_Ca	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\montmorillonite_Ca_fi	1	130	210	255
29	alunite_Na_450c	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\alunite_Na_450c_fit.g	0	250	160	185
30	alunite_K_250c	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\alunite_K_250c_fit.gz	0	250	160	185
31	alunite.5+kaolinite.5	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\alunite.5+kaolinite.5	0	255	195	195

32	alunite.25+kaolinite.75	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\alunite.25+kaolinite.	0	255	195	195
33	pyrophyllite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\pyrophyllite_fit.gz	0	145	25	55
34	pyrophyllite.5+alunite.5	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\pyrophyllite.5+alunite	0	145	25	55
35	jarosite_Na	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\jarosite_Na_fit.gz	0	218	112	214
36	jarosite_K	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\jarosite_K_fit.gz	0	218	112	214
37	jarosite+muscovite_mix_intimat	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\jarosite+muscovite_mi	0	218	112	214
38	kaol_possible_alunite_or_dicki	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\kaol_possible_alunite	1	30	30	185
39	buddingtonite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\buddingtonite_fit.gz	0	255	210	0
40	buddingtonite+montmorillonite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\buddingtonite+montmor	0	255	210	0
41	serpentine1	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\serpentine1_fit.gz	1	160	215	50
42	serpentine2	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\serpentine2_fit.gz	0	160	215	50
43	serpentine3	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\serpentine3_fit.gz	1	160	215	50
44	serpentine4	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\serpentine4_fit.gz	1	160	215	50
45	serpentine_or_dolomite+calcite	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\serpentine_or_dolomit	1	176	131	255
46	tremolite_or_talc	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\tremolite_or_talc_fit	1	100	40	180
47	hydrated_silica	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\hydrated_silica_fit.g	0	255	255	75
48	chalcedony	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\chalcedony_fit.gz	0	255	255	75
49	gypsum	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\gypsum_fit.gz	1	240	0	255
50	vegetation_green	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\vegetation_green_fit.	1	225	205	170
51	vegetation.dry+green	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\vegetation.dry+green_	1	225	205	170
52	dry_veg_grass	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dry_veg_grass_fit.gz	1	147	115	48
53	dry_veg_grass_2_3um	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dry_veg_grass_2_3um_f	1	147	115	48
54	dry_veg_nongrass	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dry_veg_nongrass_fit.	1	147	115	48
55	dry_veg_nongrass_2_3um	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\dry_veg_nongrass_2_3u	1	147	115	48
56	snow_melting	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\snow_melting_fit.gz	0	80	0	115
57	snow_slush	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\snow_slush_fit.gz	1	80	0	115
58	water	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\water_fit.gz	0	180	180	180
59	water_sediment_low	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\water_sediment_low_fi	0	180	180	180
60	water_sediment_high	C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\water_sediment_high_f	1	180	180	180

Starting make_envi_classification_image.pro at Mon Apr 25 13:08:47 2011

Processing the input images...

File 1 =	calcite_abundant_fit.gz,	found	37019 pixels with this material (10.20% of valid image pixels).
File 2 =	calcite_fit.gz,	found	144044 pixels with this material (39.68% of valid image pixels).
File 3 =	calcite.7+muscovite.3_fit.gz,	found	27736 pixels with this material (7.64% of valid image pixels).
File 4 =	calcite.8+montmorillonite_Ca.2_fit.gz,	found	21098 pixels with this material (5.81% of valid image pixels).
File 5 =	calcite.8+montmorillonite_Na.2_fit.gz,	found	16543 pixels with this material (4.56% of valid image pixels).
File 6 =	carbonate_Fe_bearing_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 7 =	dolomite_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 8 =	dolomite.5+montmorillonite_Na.5_fit.gz,	found	41 pixels with this material (0.01% of valid image pixels).
File 9 =	dolomite.25+calcite.25+mont_Na.5_fit.gz,	found	4018 pixels with this material (1.11% of valid image pixels).
File 10 =	epidote_fit.gz,	found	64 pixels with this material (0.02% of valid image pixels).
File 11 =	chlorite_lowFe_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 12 =	chlorite+muscovite_fit.gz,	found	3 pixels with this material (0.00% of valid image pixels).
File 13 =	muscovite_lowAl_fit.gz,	found	1917 pixels with this material (0.53% of valid image pixels).
File 14 =	muscovite_medAl_fit.gz,	found	2068 pixels with this material (0.57% of valid image pixels).
File 15 =	muscovite_medhighAl_fit.gz,	found	8903 pixels with this material (2.45% of valid image pixels).
File 16 =	muscovite_Fe-rich_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 17 =	illite_fit.gz,	found	358 pixels with this material (0.10% of valid image pixels).
File 18 =	illite_gds4_fit.gz,	found	67 pixels with this material (0.02% of valid image pixels).
File 19 =	kaolinite_wxl_fit.gz,	found	17 pixels with this material (0.00% of valid image pixels).
File 20 =	kaolinite_pxl_fit.gz,	found	45 pixels with this material (0.01% of valid image pixels).
File 21 =	kaolin+clay_mica_or_halloysite_fit.gz,	found	553 pixels with this material (0.15% of valid image pixels).
File 22 =	kaolin.5+muscovite_medAl_fit.gz,	found	1319 pixels with this material (0.36% of valid image pixels).
File 23 =	kaolin+muscovite_mix_intimate_fit.gz,	found	5184 pixels with this material (1.43% of valid image pixels).
File 24 =	kaolin.5+muscovite_medhighAl_fit.gz,	found	2621 pixels with this material (0.72% of valid image pixels).
File 25 =	kaolin.5+smectite.5_fit.gz,	found	481 pixels with this material (0.13% of valid image pixels).
File 26 =	kaolin.2+calcite.8_fit.gz,	found	532 pixels with this material (0.15% of valid image pixels).
File 27 =	montmorillonite_Na_fit.gz,	found	3730 pixels with this material (1.03% of valid image pixels).
File 28 =	montmorillonite_Ca_fit.gz,	found	877 pixels with this material (0.24% of valid image pixels).

File 29 = alunite_Na_450c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 30 = alunite_K_250c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 31 = alunite.5+kaolinite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 32 = alunite.25+kaolinite.75_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 33 = pyrophyllite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 34 = pyrophyllite.5+alunite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 35 = jarosite_Na_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 36 = jarosite_K_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 37 = jarosite+muscovite_mix_intimate_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 38 = kaol_possible_alunite_or_dickite_fit.gz, found 3 pixels with this material (0.00% of valid image pixels).
File 39 = buddingtonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 40 = buddingtonite+montmorillonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 41 = serpentine1_fit.gz, found 102 pixels with this material (0.03% of valid image pixels).
File 42 = serpentine2_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 43 = serpentine3_fit.gz, found 39 pixels with this material (0.01% of valid image pixels).
File 44 = serpentine4_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).
File 45 = serpentine_or_dolomite+calcite_fit.gz, found 65 pixels with this material (0.02% of valid image pixels).
File 46 = tremolite_or_talc_fit.gz, found 1 pixels with this material (0.00% of valid image pixels).
File 47 = hydrated_silica_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 48 = chalcedony_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 49 = gypsum_fit.gz, found 34 pixels with this material (0.01% of valid image pixels).
File 50 = vegetation_green_fit.gz, found 14258 pixels with this material (3.93% of valid image pixels).
File 51 = vegetation_dry+green_fit.gz, found 5230 pixels with this material (1.44% of valid image pixels).
File 52 = dry_veg_grass_fit.gz, found 20360 pixels with this material (5.61% of valid image pixels).
File 53 = dry_veg_grass_2_3um_fit.gz, found 19714 pixels with this material (5.43% of valid image pixels).
File 54 = dry_veg_nongrass_fit.gz, found 274 pixels with this material (0.08% of valid image pixels).
File 55 = dry_veg_nongrass_2_3um_fit.gz, found 9914 pixels with this material (2.73% of valid image pixels).
File 56 = snow_melting_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 57 = snow_slush_fit.gz, found 2 pixels with this material (0.00% of valid image pixels).
File 58 = water_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 59 = water_sediment_low_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 60 = water_sediment_high_fit.gz, found 26 pixels with this material (0.01% of valid image pixels).

User specified class values and colors:

Not_Classified	0	0	0	0
calcite_abundant	1	20	75	0
calcite	2	40	105	10
calcite.7+muscovite.3	3	113	160	90
calcite.8+montmorillonite_Ca.2	4	188	185	115
calcite.8+montmorillonite_Na.2	5	188	185	115
carbonate_Fe_bearing	6	220	185	255
dolomite	7	205	25	255
dolomite.5+montmorillonite_Na.5	8	165	20	200
dolomite.25+calcite.25+mont_Na.5	9	165	20	200
epidote	10	225	25	0
chlorite_lowFe	11	225	25	0
chlorite+muscovite	12	225	25	0
muscovite_lowAl	13	250	150	0
muscovite_medAl	14	250	150	0
muscovite_medhighAl	15	250	150	0
muscovite_Fe-rich	16	250	150	0
illite	17	230	120	0
illite_gds4	18	230	120	0
kaolinite_wxl	19	25	85	245
kaolinite_pxl	20	25	85	245
kaolin+clay_mica_or_halloysite	21	40	145	255
kaolin.5+muscovite_medAl	22	40	145	255
kaolin+muscovite_mix_intimate	23	40	145	255
kaolin.5+muscovite_medhighAl	24	40	145	255
kaolin.5+smectite.5	25	40	145	255

kaolin.2+calcite.8	26	40	145	255
montmorillonite_Na	27	130	210	255
montmorillonite_Ca	28	130	210	255
alunite_Na_450c	29	250	160	185
alunite_K_250c	30	250	160	185
alunite.5+kaolinite.5	31	255	195	195
alunite.25+kaolinite.75	32	255	195	195
pyrophyllite	33	145	25	55
pyrophyllite.5+alunite.5	34	145	25	55
jarosite_Na	35	218	112	214
jarosite_K	36	218	112	214
jarosite+muscovite_mix_intimate	37	218	112	214
kaol_possible_alunite_or_dickite	38	30	30	185
buddingtonite	39	255	210	0
buddingtonite+montmorillonite	40	255	210	0
serpentine1	41	160	215	50
serpentine2	42	160	215	50
serpentine3	43	160	215	50
serpentine4	44	160	215	50
serpentine_or_dolomite+calcite	45	176	131	255
tremolite_or_talc	46	100	40	180
hydrated_silica	47	255	255	75
chalcedony	48	255	255	75
gypsum	49	240	0	255
vegetation_green	50	225	205	170
vegetation.dry+green	51	225	205	170
dry_veg_grass	52	147	115	48
dry_veg_grass_2_3um	53	147	115	48
dry_veg_nongrass	54	147	115	48
dry_veg_nongrass_2_3um	55	147	115	48
snow_melting	56	80	0	115
snow_slush	57	80	0	115
water	58	180	180	180
water_sediment_low	59	180	180	180
water_sediment_high	60	180	180	180

Created output file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_userindex
Normal termination of make_envi_classification_image.pro ... Elapsed Time = 0.81 seconds

Creating an ENVI Classification Image for ALL materials using user-indexed DN values and colors, including the non-data pixels.

Output classification file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_userindex_withnondataclass

Starting make_envi_classification_image.pro at Mon Apr 25 13:08:48 2011

Processing the mask for non-data pixels...

Found 0 pixels of non-data (0.00% of all image pixels).

Number of data pixels = 363044.

Processing the input images...

File 1 =	calcite_abundant_fit.gz,	found	37019 pixels with this material (10.20% of valid image pixels).
File 2 =	calcite_fit.gz,	found	144044 pixels with this material (39.68% of valid image pixels).
File 3 =	calcite.7+muscovite.3_fit.gz,	found	27736 pixels with this material (7.64% of valid image pixels).
File 4 =	calcite.8+montmorillonite_Ca.2_fit.gz,	found	21098 pixels with this material (5.81% of valid image pixels).
File 5 =	calcite.8+montmorillonite_Na.2_fit.gz,	found	16543 pixels with this material (4.56% of valid image pixels).
File 6 =	carbonate_Fe_bearing_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 7 =	dolomite_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 8 =	dolomite.5+montmorillonite_Na.5_fit.gz,	found	41 pixels with this material (0.01% of valid image pixels).
File 9 =	dolomite.25+calcite.25+mont_Na.5_fit.gz,	found	4018 pixels with this material (1.11% of valid image pixels).
File 10 =	epidote_fit.gz,	found	64 pixels with this material (0.02% of valid image pixels).
File 11 =	chlorite_lowFe_fit.gz	is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].	
File 12 =	chlorite+muscovite_fit.gz,	found	3 pixels with this material (0.00% of valid image pixels).
File 13 =	muscovite_lowAl_fit.gz,	found	1917 pixels with this material (0.53% of valid image pixels).

```

File 14 = muscovite_medAl_fit.gz, found 2068 pixels with this material ( 0.57% of valid image pixels).
File 15 = muscovite_medhighAl_fit.gz, found 8903 pixels with this material ( 2.45% of valid image pixels).
File 16 = muscovite_Fe-rich_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 17 = illite_fit.gz, found 358 pixels with this material ( 0.10% of valid image pixels).
File 18 = illite_gds4_fit.gz, found 67 pixels with this material ( 0.02% of valid image pixels).
File 19 = kaolinite_wxl_fit.gz, found 17 pixels with this material ( 0.00% of valid image pixels).
File 20 = kaolinite_pxl_fit.gz, found 45 pixels with this material ( 0.01% of valid image pixels).
File 21 = kaolin+clay_mica_or_halloysite_fit.gz, found 553 pixels with this material ( 0.15% of valid image pixels).
File 22 = kaolin.5+muscovite_medAl_fit.gz, found 1319 pixels with this material ( 0.36% of valid image pixels).
File 23 = kaolin+muscovite_mix_intimate_fit.gz, found 5184 pixels with this material ( 1.43% of valid image pixels).
File 24 = kaolin.5+muscovite_medhighAl_fit.gz, found 2621 pixels with this material ( 0.72% of valid image pixels).
File 25 = kaolin.5+smectite.5_fit.gz, found 481 pixels with this material ( 0.13% of valid image pixels).
File 26 = kaolin.2+calcite.8_fit.gz, found 532 pixels with this material ( 0.15% of valid image pixels).
File 27 = montmorillonite_Na_fit.gz, found 3730 pixels with this material ( 1.03% of valid image pixels).
File 28 = montmorillonite_Ca_fit.gz, found 877 pixels with this material ( 0.24% of valid image pixels).
File 29 = alunite_Na_450c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 30 = alunite_K_250c_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 31 = alunite.5+kaolinite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 32 = alunite.25+kaolinite.75_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 33 = pyrophyllite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 34 = pyrophyllite.5+alunite.5_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 35 = jarosite_Na_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 36 = jarosite_K_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 37 = jarosite+muscovite_mix_intimate_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 38 = kaol_possible_alunite_or_dickite_fit.gz, found 3 pixels with this material ( 0.00% of valid image pixels).
File 39 = buddingtonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 40 = buddingtonite+montmorillonite_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 41 = serpentine1_fit.gz, found 102 pixels with this material ( 0.03% of valid image pixels).
File 42 = serpentine2_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 43 = serpentine3_fit.gz, found 39 pixels with this material ( 0.01% of valid image pixels).
File 44 = serpentine4_fit.gz, found 1 pixels with this material ( 0.00% of valid image pixels).
File 45 = serpentine_or_dolomite+calcite_fit.gz, found 65 pixels with this material ( 0.02% of valid image pixels).
File 46 = tremolite_or_talc_fit.gz, found 1 pixels with this material ( 0.00% of valid image pixels).
File 47 = hydrated_silica_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 48 = chalcedony_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 49 = gypsum_fit.gz, found 34 pixels with this material ( 0.01% of valid image pixels).
File 50 = vegetation_green_fit.gz, found 14258 pixels with this material ( 3.93% of valid image pixels).
File 51 = vegetation.dry+green_fit.gz, found 5230 pixels with this material ( 1.44% of valid image pixels).
File 52 = dry_veg_grass_fit.gz, found 20360 pixels with this material ( 5.61% of valid image pixels).
File 53 = dry_veg_grass_2_3um_fit.gz, found 19714 pixels with this material ( 5.43% of valid image pixels).
File 54 = dry_veg_nongrass_fit.gz, found 274 pixels with this material ( 0.08% of valid image pixels).
File 55 = dry_veg_nongrass_2_3um_fit.gz, found 9914 pixels with this material ( 2.73% of valid image pixels).
File 56 = snow_melting_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 57 = snow_slush_fit.gz, found 2 pixels with this material ( 0.00% of valid image pixels).
File 58 = water_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 59 = water_sediment_low_fit.gz is specified as not existing (zero pixels mapped) based on the command line keyword [FILES_EXIST].
File 60 = water_sediment_high_fit.gz, found 26 pixels with this material ( 0.01% of valid image pixels).

```

User specified class values and colors:

```

Not_Classified 0 0 0 0
calcite_abundant 1 20 75 0
calcite 2 40 105 10
calcite.7+muscovite.3 3 113 160 90
calcite.8+montmorillonite_Ca.2 4 188 185 115
calcite.8+montmorillonite_Na.2 5 188 185 115
carbonate_Fe_bearing 6 220 185 255
dolomite 7 205 25 255
dolomite.5+montmorillonite_Na.5 8 165 20 200
dolomite.25+calcite.25+mont_Na.5 9 165 20 200
epidote 10 225 25 0

```

chlorite_lowFe	11	225	25	0
chlorite+muscovite	12	225	25	0
muscovite_lowAl	13	250	150	0
muscovite_medAl	14	250	150	0
muscovite_medhighAl	15	250	150	0
muscovite_Fe-rich	16	250	150	0
illite	17	230	120	0
illite_gds4	18	230	120	0
kaolinite_wxl	19	25	85	245
kaolinite_pxl	20	25	85	245
kaolin+clay_mica_or_halloysite	21	40	145	255
kaolin.5+muscovite_medAl	22	40	145	255
kaolin+muscovite_mix_intimate	23	40	145	255
kaolin.5+muscovite_medhighAl	24	40	145	255
kaolin.5+smectite.5	25	40	145	255
kaolin.2+calcite.8	26	40	145	255
montmorillonite_Na	27	130	210	255
montmorillonite_Ca	28	130	210	255
alunite_Na_450c	29	250	160	185
alunite_K_250c	30	250	160	185
alunite.5+kaolinite.5	31	255	195	195
alunite.25+kaolinite.75	32	255	195	195
pyrophyllite	33	145	25	55
pyrophyllite.5+alunite.5	34	145	25	55
jarosite_Na	35	218	112	214
jarosite_K	36	218	112	214
jarosite+muscovite_mix_intimate	37	218	112	214
kaol_possible_alunite_or_dickite	38	30	30	185
buddingtonite	39	255	210	0
buddingtonite+montmorillonite	40	255	210	0
serpentine1	41	160	215	50
serpentine2	42	160	215	50
serpentine3	43	160	215	50
serpentine4	44	160	215	50
serpentine_or_dolomite+calcite	45	176	131	255
tremolite_or_talc	46	100	40	180
hydrated_silica	47	255	255	75
chalcedony	48	255	255	75
gypsum	49	240	0	255
vegetation_green	50	225	205	170
vegetation.dry+green	51	225	205	170
dry_veg_grass	52	147	115	48
dry_veg_grass_2_3um	53	147	115	48
dry_veg_nongrass	54	147	115	48
dry_veg_nongrass_2_3um	55	147	115	48
snow_melting	56	80	0	115
snow_slush	57	80	0	115
water	58	180	180	180
water_sediment_low	59	180	180	180
water_sediment_high	60	180	180	180
Non-data pixels	61	60	60	60

Created output file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\mica_class_allmaterials_userindex_withnondataclass
Normal termination of make_envi_classification_image.pro ... Elapsed Time = 0.91 seconds

Ending mica_imagecube_array_specpr.pro at Mon Apr 25 13:08:48 2011
Elapsed time = 0 hours 4 minutes 7 seconds.

Output report for verbose level 4. “Function 4.1 – Run MICA for Image Cubes”

During the processing, additional reporting on the match to the central pixel of every 10th line of the image is made at verbose level four. This includes the weighted fit values of every reference spectrum and the corresponding weighted depth. Also shown are the weighted fit values before any feature or continuum constraints are applied. The top 5 fits, ranked in descending order of fit value are also shown.

Starting mica_imagecube_array_specpr.pro at Mon Apr 25 13:13:35 2011

Operating System Type = Windows (NOT performing byteorder operations)

Command Line Options

FILE_DN_COLORS = 0
DELETED_CHANNELS = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124

Image Cube = C:\usgsprism\mica_hymap\cube\testcube_hymap124ch

Number of Bands = 124
Number of Lines = 814
Number of Samples = 446

Processing Parameters:

TETRACORDER PROCESSING OPTIONS ARE TURNED OFF! FIT VALUES ARE IN TERMS OF r^2 THE COEFFICIENT OF DETERMINATION

OPTION TO CHECK THE SIGN OF THE DEPTHS IS TURNED ON!

Setting wavelengths based on WAVELENGTH_SPECPR_RECORD keyword in the command file structure.

Wavelength SPECPR file = C:\usgsprism\mica_hymap\splib06b_cvhymap07_124ch
Wavelength SPECPR record = 6

Deleted Channels found = 30, 31, 32, 44, 45, 46, 47, 48, 60, 61, 62, 63, 64, 90, 91, 92, 93, 94, 95, 96, 124
Number of Good Channels = 103

Searching for command file keyword value for FILE_DN_COLORS...

FILE_DN_COLORS = C:\usgsprism\mica_hymap\mica_colors_group2_hymap2007.txt

class_name	class_value	red	grn	blu
calcite_abundant	1	20	75	0
calcite	2	40	105	10
calcite.7+muscovite.3	3	113	160	90
calcite.8+montmorillonite_Ca.2	4	188	185	115
calcite.8+montmorillonite_Na.2	5	188	185	115
carbonate_Fe_bearing	6	220	185	255
dolomite	7	205	25	255
dolomite.5+montmorillonite_Na.5	8	165	20	200
dolomite.25+calcite.25+mont_Na.5	9	165	20	200
epidote	10	225	25	0
chlorite_lowFe	11	225	25	0
chlorite+muscovite	12	225	25	0
muscovite_lowAl	13	250	150	0
muscovite_medAl	14	250	150	0
muscovite_medhighAl	15	250	150	0
muscovite_Fe-rich	16	250	150	0
illite	17	230	120	0
illite_gds4	18	230	120	0
kaolinite_wxl	19	25	85	245

```
          kaolinite_px1          20   25   85  245
kaolin+clay_mica_or_halloysite  21   40  145  255
```

Same reporting on colors as verbose level 2

```
          water_sediment_low      59  180  180  180
          water_sediment_high     60  180  180  180
Number of color entries found in the file =      60
```

```
Scale factor for reference spectra (command file value) =      1.0000000
Scale factor for observed spectra (command file value) =     20000.000
```

```
Value indicating a non-data pixel in an image cube (from command file) = -1.0000
```

REFERENCE ENTRIES:

Same reporting on reference material spectral features as verbose level 3 of the spectral records mode of MICA.

DIAGNOSTIC FEATURE ENTRIES:

Same reporting on diagnostic features as verbose level 3 of the spectral records mode of MICA.

COMMAND FILE NOT FEATURE REFERENCE ENTRIES:

Same reporting on NOT features as verbose level 3 of the spectral records mode of MICA.

```
Analyzing the first reference spectrum against the command file to test its integrity.
...passed the integrity check.
```

```
Searching for the default non-data mask file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
and associated ENVI header file = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.hdr
Opened and read a non-data mask file at the default location = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\image_nodata_pixels.gz
with dimensions that match the input image cube.
Found 0 non-data pixels, which is 0.% of all pixels.
```

----- STARTING ANALYSIS -----

Image cube analyzed:C:\usgsprism\mica_hymap\cube\testcube_hymap124ch
 Number of Bands = 124
 Number of Lines = 814
 Number of Samples = 446
 Command file used:C:\usgsprism\mica_hymap\mica_cmds_group2_hymap2007.mcf
 Total number of reference spectra = 60
 Total number of reference features = 111
 Total number of reference NOT spectra = 12
 Total number of invocations of NOT features = 62
 Beginning line by line analysis of the image cube at Mon Apr 25 13:13:42 2011

In comparison to verbose level 2 of the MICA image cube mode, verbose level 3 contains additional reporting on the final weighted fits to each reference spectrum for every 10th line of the image being analyzed.

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Output Name	Fit Value	(Fit before) (constraints)	Depth Value
0	vegetation_green	0.0000	(0.4455)	-0.0492
1	vegetation.dry+green	0.0000	(0.3744)	-0.0269
2	snow_melting	0.0000	(0.0852)	0.0015
3	snow_slush	0.0000	(0.1156)	-0.0047
4	water	0.0000	(0.7277)	-0.3616
5	water_sediment_high	0.0000	(0.6878)	-0.0136
6	water_sediment_low	0.0000	(0.6898)	-0.0136
7	dry_veg_gFass	0.0000	(0.3420)	0.0189
8	dry_veg_grass_2_3um	0.6485	(0.6485)	0.0356
9	dry_veg_nongrass	0.0000	(0.3343)	0.0195
10	dry_veg_nongrass_2_3um	0.6626	(0.6626)	0.0398
11	muscovite_lowAl	0.0000	(0.4077)	-0.0090
12	muscovite_medAl	0.0000	(0.3441)	-0.0023
13	muscovite_medhighAl	0.0000	(0.2946)	-0.0029
14	muscovite_Fe-rich	0.0000	(0.4287)	-0.0175
15	illite	0.0000	(0.6184)	-0.0095
16	illite_gds4	0.0000	(0.6935)	-0.0087
17	kaolinite_wxl	0.0000	(0.4171)	-0.0118
18	kaolinite_pxl	0.0000	(0.4829)	-0.0174
19	kaolin+clay_mica_or_halloysite	0.0000	(0.4741)	-0.0184
20	kaol_possible_alunite_or_dickite	0.0000	(0.3473)	-0.0108
21	buddingtonite	0.0000	(0.2610)	-0.0214
22	buddingtonite+montmorillonite	0.0000	(0.3523)	-0.0212
23	alunite_K_250c	0.0000	(0.5391)	-0.0125
24	alunite_Na_450c	0.0000	(0.6336)	-0.0144
25	pyrophyllite	0.0000	(0.5462)	-0.0084
26	jarosite_Na	0.0000	(0.3757)	-0.0350
27	jarosite_K	0.0000	(0.3994)	-0.0357
28	montmorillonite_Na	0.0000	(0.4021)	-0.0123
29	montmorillonite_Ca	0.0000	(0.4829)	-0.0116
30	gypsum	0.0000	(0.4808)	-0.0129
31	chlorite_lowFe	0.0000	(0.4414)	-0.0776
32	epidote	0.0000	(0.4404)	0.0334
33	pyrophyllite.5+alunite.5	0.0000	(0.4749)	-0.0125
34	alunite.5+kaolinite.5	0.0000	(0.4373)	-0.0106
35	alunite.25+kaolinite.75	0.0000	(0.4253)	-0.0107
36	kaolin.5+muscovite_medAl	0.0000	(0.3788)	-0.0137
37	kaolin.5+muscovite_medhighAl	0.0000	(0.3008)	-0.0124
38	kaolin+muscovite_mix_intimate	0.0000	(0.4076)	-0.0144
39	kaolin.5+smectite.5	0.0000	(0.3526)	-0.0129
40	jarosite+muscovite_mix_intimate	0.0000	(0.6737)	-0.0358
41	chlorite+muscovite	0.0000	(0.2378)	-0.0092
42	calcite_abundant	0.0000	(0.8521)	0.0468
43	calcite	0.8521	(0.8521)	0.0468
44	dolomite	0.0000	(0.4394)	0.0329
45	carbonate_Fe_bearing	0.0000	(0.8867)	-0.0137
46	dolomite.25+calcite.25+mont_Na.5	0.0000	(0.5586)	0.0183

47	calcite.8+montmorillonite_Na.2	0.0000	(0.5914)	0.0153
48	calcite.8+montmorillonite_Ca.2	0.0000	(0.6414)	0.0152
49	calcite.7+muscovite.3	0.0000	(0.4650)	0.0228
50	dolomite.5+montmorillonite_Na.5	0.0000	(0.4819)	0.0155
51	kaolin.2+calcite.8	0.0000	(0.5505)	0.0188
52	chalcedony	0.0000	(0.1302)	-0.0174
53	hydrated_silica	0.0000	(0.1097)	-0.0164
54	tremolite_or_talc	0.0000	(0.3274)	0.0139
55	serpentine_or_dolomite+calcite	0.6203	(0.6203)	0.0432
56	serpentine1	0.6828	(0.6828)	0.0468
57	serpentine2	0.0000	(0.6203)	0.0432
58	serpentine3	0.0000	(0.6828)	0.0468
59	serpentine4	0.0000	(0.6203)	0.0432

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
44	calcite	0.8521	0.0468
57	serpentine1	0.6828	0.0468
11	dry_veg_nongrass_2_3um	0.6626	0.0398
9	dry_veg_grass_2_3um	0.6485	0.0356
56	serpentine_or_dolomite+calcite	0.6203	0.0432

In comparison to verbose level 2 of the MICA image cube mode, verbose level 3 contains additional reporting on the top 5 weighted fits to reference spectra for every 10th line of the image being analyzed.

Input spectrum (line=10,sample=223) was best matched by calcite with a fit of 0.8521 and a depth of 0.0468 and a fit*depth of 0.0399

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Output Name	Fit Value	(Fit before) (constraints)	Depth Value
0	vegetation_green	0.0000	(0.4617)	-0.0509
1	vegetation.dry+green	0.0000	(0.3900)	-0.0298
2	snow_melting	0.0000	(0.1171)	0.0026
3	snow_slush	0.0000	(0.0533)	-0.0013
4	water	0.0000	(0.7446)	-0.3590
5	water_sediment_high	0.0000	(0.6740)	-0.0073
6	water_sediment_low	0.0000	(0.6810)	-0.0073
7	dry_veg_grass	0.0000	(0.3446)	0.0185
8	dry_veg_grass_2_3um	0.5870	(0.5870)	0.0330
9	dry_veg_nongrass	0.0000	(0.2747)	0.0177
10	dry_veg_nongrass_2_3um	0.0000	(0.5410)	0.0342
11	muscovite_lowAl	0.0000	(0.3303)	-0.0077
12	muscovite_medAl	0.0000	(0.2824)	-0.0013
13	muscovite_medhighAl	0.0000	(0.2711)	-0.0013
14	muscovite_Fe-rich	0.0000	(0.3666)	-0.0163
15	illite	0.0000	(0.5740)	-0.0078
16	illite_gds4	0.0000	(0.6407)	-0.0068
17	kaolinite_wxl	0.0000	(0.4096)	-0.0098
18	kaolinite_pxl	0.0000	(0.4697)	-0.0151
19	kaolin+clay_mica_or_halloysite	0.0000	(0.4511)	-0.0159
20	kaol_possible_alunite_or_dickite	0.0000	(0.4222)	-0.0102

21	buddingtonite	0.0000	(0.1919)	-0.0182
22	buddingtonite+montmorillonite	0.0000	(0.2673)	-0.0183
23	alunite_K_250c	0.0000	(0.5797)	-0.0110
24	alunite_Na_450c	0.0000	(0.6675)	-0.0126
25	pyrophyllite	0.0000	(0.7462)	-0.0116
26	jarosite_Na	0.0000	(0.4781)	-0.0397
27	jarosite_K	0.0000	(0.4915)	-0.0398
28	montmorillonite_Na	0.0000	(0.3389)	-0.0099
29	montmorillonite_Ca	0.0000	(0.2959)	-0.0086
30	gypsum	0.0000	(0.5375)	-0.0110
31	chlorite_lowFe	0.0000	(0.4352)	-0.0760
32	epidote	0.0000	(0.5157)	0.0313
33	pyrophyllite.5+alunite.5	0.0000	(0.5459)	-0.0112
34	alunite.5+kaolinite.5	0.0000	(0.4442)	-0.0089
35	alunite.25+kaolinite.75	0.0000	(0.4268)	-0.0089
36	kaolin.5+muscovite_medAl	0.0000	(0.3454)	-0.0120
37	kaolin.5+muscovite_medhighAl	0.0000	(0.2672)	-0.0107
38	kaolin+muscovite_mix_intimate	0.0000	(0.3504)	-0.0122
39	kaolin.5+smectite.5	0.0000	(0.3471)	-0.0117
40	jarosite+muscovite_mix_intimate	0.0000	(0.6511)	-0.0346
41	chlorite+muscovite	0.0000	(0.2088)	-0.0076
42	calcite_abundant	0.0000	(0.8174)	0.0441
43	calcite	0.8174	(0.8174)	0.0441
44	dolomite	0.0000	(0.4022)	0.0304
45	carbonate_Fe_bearing	0.0000	(0.8504)	-0.0069
46	dolomite.25+calcite.25+mont_Na.5	0.0000	(0.5450)	0.0197
47	calcite.8+montmorillonite_Na.2	0.0000	(0.5645)	0.0172
48	calcite.8+montmorillonite_Ca.2	0.0000	(0.5667)	0.0180
49	calcite.7+muscovite.3	0.0000	(0.4605)	0.0233
50	dolomite.5+montmorillonite_Na.5	0.0000	(0.4100)	0.0178
51	kaolin.2+calcite.8	0.0000	(0.5244)	0.0178
52	chalcedony	0.0000	(0.1682)	-0.0199
53	hydrated_silica	0.0000	(0.1452)	-0.0189
54	tremolite_or_talc	0.0000	(0.1576)	0.0101
55	serpentine_or_dolomite+calcite	0.5888	(0.5888)	0.0405
56	serpentine1	0.7138	(0.7138)	0.0461
57	serpentine2	0.0000	(0.5888)	0.0405
58	serpentine3	0.0000	(0.7138)	0.0461
59	serpentine4	0.0000	(0.5888)	0.0405

TOP 5 FITS:

Reference Spectrum	Output Name	Fit Value	Depth Value
44	calcite	0.8174	0.0441
57	serpentine1	0.7138	0.0461
56	serpentine_or_dolomite+calcite	0.5888	0.0405
9	dry_veg_grass_2_3um	0.5870	0.0330

Remaining fits are zero.

Input spectrum (line=20,sample=223) was best matched by calcite with a fit of 0.8174 and a depth of 0.0441 and a fit*depth of 0.0360

FINAL WEIGHTED FITS ADJUSTED BY CONSTRAINTS:

Reference Spectrum	Output Name	Fit Value (Fit before)	Depth Value (constraints)
44	calcite	0.8174	0.0441
57	serpentine1	0.7138	0.0461
56	serpentine_or_dolomite+calcite	0.5888	0.0405
9	dry_veg_grass_2_3um	0.5870	0.0330

0	vegetation_green	0.0000	(0.4925)	-0.0476
1	vegetation_dry+green	0.0000	(0.3469)	-0.0313
2	snow_melting	0.0000	(0.0507)	0.0015
3	snow_slush	0.0000	(0.0755)	-0.0030
4	water	0.0000	(0.7600)	-0.3285
5	water_sediment_high	0.0000	(0.4513)	-0.0055
6	water_sediment_low	0.0000	(0.4583)	-0.0055
7	dry_veg_grass	0.0000	(0.1686)	0.0035
8	dry_veg_grass_2_3um	0.0000	(0.2282)	0.0134
9	dry_veg_nongrass	0.0000	(0.2466)	0.0016
10	dry_veg_nongrass_2_3um	0.0000	(0.2086)	0.0133
11	muscovite_lowAl	0.0000	(0.1283)	0.0067
12	muscovite_medAl	0.0000	(0.1710)	0.0083
13	muscovite_medhighAl	0.0000	(0.2458)	0.0087
14	muscovite_Fe-rich	0.0000	(0.0136)	-0.0012
15	illite	0.0000	(0.1954)	0.0058
16	illite_gds4	0.0000	(0.2198)	0.0061
17	kaolinite_wxl	0.0000	(0.0922)	-0.0056
18	kaolinite_pxl	0.0000	(0.1252)	-0.0072
19	kaolin+clay_mica_or_halloysite	0.0000	(0.0499)	-0.0048
20	kaol_possible_alunite_or_dickite	0.0000	(0.1035)	-0.0059
21	buddingtonite	0.0000	(0.3309)	-0.0169
22	buddingtonite+montmorillonite	0.0000	(0.2744)	-0.0131
23	alunite_K_250c	0.0000	(0.4627)	-0.0097
24	alunite_Na_450c	0.0000	(0.2945)	-0.0093
25	pyrophyllite	0.0000	(0.6596)	-0.0178
26	jarosite_Na	0.0000	(0.5358)	-0.0308
27	jarosite_K	0.0000	(0.5030)	-0.0295
28	montmorillonite_Na	0.0000	(0.0833)	0.0045
29	montmorillonite_Ca	0.0000	(0.2631)	0.0075
30	gypsum	0.0000	(0.4080)	-0.0054
31	chlorite_lowFe	0.0000	(0.3181)	-0.0817
32	epidote	0.0000	(0.2887)	0.0133
33	pyrophyllite.5+alunite.5	0.0000	(0.4729)	-0.0105
34	alunite.5+kaolinite.5	0.0000	(0.2452)	-0.0053
35	alunite.25+kaolinite.75	0.0000	(0.2179)	-0.0050
36	kaolin.5+muscovite_medAl	0.0000	(0.0000)	0.0001
37	kaolin.5+muscovite_medhighAl	0.0000	(0.0022)	0.0008
38	kaolin+muscovite_mix_intimate	0.0000	(0.0211)	0.0025
39	kaolin.5+smectite.5	0.0000	(0.0041)	-0.0011
40	jarosite+muscovite_mix_intimate	0.0000	(0.4020)	-0.0238
41	chlorite+muscovite	0.0000	(0.0942)	-0.0002
42	calcite_abundant	0.0000	(0.5232)	0.0236
43	calcite	0.0000	(0.5232)	0.0236
44	dolomite	0.0000	(0.1026)	0.0092
45	carbonate_Fe_bearing	0.0000	(0.6770)	-0.0138
46	dolomite.25+calcite.25+mont_Na.5	0.0000	(0.5461)	0.0171
47	calcite.8+montmorillonite_Na.2	0.0000	(0.5154)	0.0182
48	calcite.8+montmorillonite_Ca.2	0.6639	(0.6639)	0.0179
49	calcite.7+muscovite.3	0.0000	(0.5215)	0.0182
50	dolomite.5+montmorillonite_Na.5	0.0000	(0.5569)	0.0147
51	kaolin.2+calcite.8	0.0000	(0.4052)	0.0124
52	chalcedony	0.0000	(0.1806)	-0.0127
53	hydrated_silica	0.0000	(0.1737)	-0.0128
54	tremolite_or_talc	0.0000	(0.0054)	-0.0014

```

55          serpentine_or_dolomite+calcite    0.0000    (0.2440)    0.0175
56          serpentine1                      0.0000    (0.4113)    0.0235
57          serpentine2                      0.0000    (0.2440)    0.0175
58          serpentine3                      0.0000    (0.4113)    0.0235

```

Reporting on the match to the central pixel of every 10th line is omitted for brevity.

```

59          serpentine4    0.0000    (0.7064)    0.0966
TOP 5 FITS:
Reference
Spectrum      Output Name      Fit Value      Depth
              Value
-----
44          calcite    0.9459    0.1032
11          dry_veg_nongrass_2_3um    0.7337    0.0879
9          dry_veg_grass_2_3um    0.7325    0.0798
57          serpentine1    0.7141    0.1003
56          serpentine_or_dolomite+calcite    0.7064    0.0966
Input spectrum (line=810,sample=223) was best matched by calcite with a fit of 0.9459 and a depth of 0.1032 and a fit*depth of 0.0976

```

Finished line by line analysis at Mon Apr 25 13:18:08 2011
Elapsed time = 0 hours 4 minutes 26 seconds.

----- END ANALYSIS -----

Writing the results to ENVI files:

Output directory = C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\

Writing the composite all materials images to ENVI files for fit, depth and fit*depth (fd):

Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_fits.gz
Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_depths.gz
Created C:\usgsprism\mica_hymap\cube\testcube_output\group2\images\all_materials_fds.gz

Writing the individual material images to ENVI files (with gzip compression) for fit, depth and fit*depth (fd):

Output files for material = vegetation_green with 14258 pixels selected as the best match were successfully written.

This block of reporting on the creation of summary maps is the same as verbose level 3, not repeated here.

Ending mica_imagecube_array_specpr.pro at Mon Apr 25 13:18:20 2011

Elapsed time = 0 hours 4 minutes 45 seconds.

Appendix C. DESCRIPT pages of example spectra



Clark and others 2007 USGS Data Series 231 Spectral Library splib06a Sample Description

TITLE: Rangeland L02-022 S20% G09% DESCRIPT

DOCUMENTATION_FORMAT: PLANT

SAMPLE_ID: L02-022

PLANT_TYPE: Mixed rangeland shrubs, grasses, and forbs

PLANT:

LATIN_NAME:

COLLECTION_LOCALITY: Left Hand Creek, in the Grass Creek Management area of the Bureau of Land Management, is located in central Wyoming, approximately 20 miles northwest of Thermopolis, Wyoming

COLLECTION_LATITUDE: 43 deg. 57.329 min. N

COLLECTION_LONGITUDE: 108 deg. 49.751 min. W

DATUM: NAD83

ORIGINAL_DONOR: Raymond F. Kokaly, USGS

SAMPLE_DESCRIPTION:

This spectrum is the average reflectance for an area of rangeland covered by mixed shrubs, grasses and forbs as detailed in this description of site number L02-022.

Collection Date

The reflectance data were collected on 5-Jul-2002.

Site Vegetation Description

The total vegetation cover on this site was 49%. The following table shows the percent cover by cover class:

Cover Category, Sub-Category	Cover (%)
Vegetation, Total Cover	49

Vegetation, Tree	13
Vegetation, Shrub	20
Vegetation, Grass	9
Vegetation, Forb	6
Non-vegetation, Total Cover	51
Non-vegetation, Litter	26
Non-vegetation, Bare	21
Non-vegetation, Other	4

The following table shows the cover by tree species in the site (for trees with greater than 2% cover):

Shrub Species	Cover (%)
<i>Pinus flexilis</i>	13

The following table shows the cover by shrub species in the site (for shrubs with greater than 2% cover):

Shrub Species	Cover (%)	Avg. Height (cm)
<i>Artemisia tridentata</i>	19	40

The following table shows the cover by grass species in the site (for grasses with greater than 2% cover):

Grass Species	Cover (%)
<i>Festuca idahoensis</i>	7

The following table shows the cover by forb species in the site (for forbs with greater than 2% cover):

Forb Species	Cover (%)
<i>Artemisia frigida</i>	4

Field Observations

No comments.

Site Orientation

The average elevation over the area of the site is 1962 meters (6437 feet). The average slope of the site is 25 percent, with a East aspect of 71 degrees.

Site Burn History

The area of this plot has not recently burned (since 1996).

Site Location, Dimensions, and Vegetation Sampling

The center coordinates of this rangeland plot are 43 deg. 57.329 min. N, 108 deg. 49.751 min. W (datum is NAD83).

The diameter of this circular vegetation plot was 15.2 meters. Within this plot, four subplots of 0.5 meter diameter were established 5 meters from the center at the four cardinal directions (north, east, south and west). Within these subplots, grass and forb species were identified and associated percent cover of each were visually estimated. Litter cover and the percent area of bare ground were also visually estimated. For each shrub in the larger plot, the species was identified, the lateral dimensions were measured, and the height was measured. The cover of trees, shrubs, grasses, forbs, litter and bare ground were calculated from the full plot and subplot measurements. Field identifications of *Tetradymia canescens* (winterfat) were inconsistent between the 2003 and 2004 field seasons. Shrubs identified as gray rabbitbrush (*Chrysothamnus nauseosus*) and winterfat (*Krascheninnikovia lanata*) in 2003 were later found to be spineless horsebrush (*Tetradymia canescens*). Therefore, all three shrub species were lumped as spineless horsebrush in cover calculations.

Spectral Measurement Procedures

This spectrum is the average of 98 measurements made throughout site L02-022. These spectra were collected using an ASD Full Range Field Pro spectrometer in reflectance mode, relative to a Spectralon reference panel. While walking through the site, the fiber optic cable was pointed at nadir (straight down) at approximately shoulder height. The instrument was programmed to record 6 second averages of reflectance while moving through the site (thus, each recorded spectrum was an average of 60 individual measurements). These recorded spectra were examined for artifacts due to low signal:noise, detector offsets and atmospheric contamination. Those spectra with large artifacts were not included in further processing. An average of the remaining 98 spectra was computed. This average spectrum was converted to absolute reflectance by multiplying by the reflectance spectrum of the Spectralon reference panel. The following channels were deleted (set to a value of $-1.23e+34$) from the spectrum because of remaining artifacts: 1-6, 410-413, 576-592, 761-801, 1006-1051, 1441-1591, 2111-2151 (corresponding to the wavelength ranges of 0.350-0.355, 0.759-0.762, 0.925-0.941, 1.110-1.150, 1.355-1.400, 1.790-1.940, and 2.460-2.510 micrometers).

Left Hand Creek General Description

The Left Hand Creek Study area is in central Wyoming, located 20 miles northwest of Thermopolis, Wyoming in the "Grass Creek Management Area," managed by the Worland Field Office of the Bureau of Land Management. The approximate center of the study area is 43.9608 degrees North latitude and 108.8828 degrees West longitude. The general area consists of lowland creeks (approximate average elevation of 1900 m) covered by mountain big sagebrush (*Artemisia tridentata*), grasses and forbs, interspersed with higher ridges (approximate average elevation of 2100 m) covered by mountain big sagebrush, grasses and forbs with some sparsely forested areas containing Limber pine (*Pinus flexilis*), and Rocky Mountain Juniper (*Juniperus scopulorum*) with Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) on steeper north-facing slopes.

Project Background

This site was measured as part of a cooperative U.S. Geological Survey and Bureau of Land Management project funded by the Joint Fire Science Program.



IMAGE_OF_SAMPLE:

END_SAMPLE_DESCRIPTION.

COMPOSITIONAL_ANALYSIS_TYPE: None # XRF, EM(WDS), ICP(Trace), WChem

COMPOSITION KEYWORD	Composition ASCII	Amount	Weight Percent, %
COMPOSITION:	Water:		%(of fresh weight)
COMPOSITION:	Total_Chlorophyll:		%(of fresh weight)

COMPOSITION:	Chlorophyll_A:		%(of fresh weight)
COMPOSITION:	Chlorophyll_B:		%(of fresh weight)
COMPOSITION:	Nitrogen:		%(of dry weight)
COMPOSITION:	Lignin:		%(of dry weight)
COMPOSITION:	Cellulose:		%(of dry weight)

COMPOSITION_DISCUSSION:

END_COMPOSITION_DISCUSSION.

TRACE_ELEMENT_ANALYSIS:

TRACE_ELEMENT_DISCUSSION:

END_TRACE_ELEMENT_DISCUSSION.

SPECTROSCOPIC_DISCUSSION:

END_SPECTROSCOPIC_DISCUSSION.

SPECTRAL_PURITY: 1a2_3_4_ # 1= 0.2-3, 2= 1.5-6, 3= 6-25, 4= 20-150 microns

LIB_SPECTRA_HED:	where	Wave Range	Av_Rs_Pwr	Comment
LIB_SPECTRA:	splib06a r 33152			g.s.=



**Clark and others 2007 USGS Data Series 231
Spectral Library splib06a Sample Description**

TITLE: Rangeland L02-042 S01% G57% DESCRIPT

DOCUMENTATION_FORMAT: PLANT

SAMPLE_ID: L02-042

PLANT_TYPE: Mixed rangeland shrubs, grasses, and forbs

PLANT:

LATIN_NAME:

COLLECTION_LOCALITY: Left Hand Creek, in the Grass Creek Management area of the Bureau of Land Management, is located in central Wyoming, approximately 20 miles northwest of Thermopolis, Wyoming

COLLECTION_LATITUDE: 43 deg. 56.741 min. N

COLLECTION_LONGITUDE: 108 deg. 50.420 min. W

DATUM: NAD83

ORIGINAL_DONOR: Raymond F. Kokaly, USGS

SAMPLE_DESCRIPTION:

This spectrum is the average reflectance for an area of rangeland covered by mixed shrubs, grasses and forbs as detailed in this description of site number L02-042.

Collection Date

The reflectance data were collected on 10-Jul-2002.

Site Vegetation Description

The total vegetation cover on this site was 58%. The following table shows the percent cover by cover class:

Cover Category, Sub-Category	Cover (%)
Vegetation, Total Cover	58
Vegetation, Tree	0
Vegetation, Shrub	1

Vegetation, Grass	57
Vegetation, Forb	0
Non-vegetation, Total Cover	42
Non-vegetation, Litter	23
Non-vegetation, Bare	19
Non-vegetation, Other	0

The following table shows the cover by shrub species in the site (for shrubs with greater than 2% cover):

Shrub Species	Cover (%)	Avg. Height (cm)
none		

The following table shows the cover by grass species in the site (for grasses with greater than 2% cover):

Grass Species	Cover (%)
<i>Pascopyrum smithii</i>	57

The following table shows the cover by forb species in the site (for forbs with greater than 2% cover):

Forb Species	Cover (%)
none	

Field Observations

The exposed soil is very dry. There are burned sagebrush stumps and the stump of a burned pine tree in the plot.

Site Orientation

The average elevation over the area of the site is 1977 meters (6486 feet). The average slope of the site is 9 percent, with a Southeast aspect of 129 degrees.

Site Burn History

The area of this plot has recently burned (since 1996).

Site Location, Dimensions, and Vegetation Sampling

The center coordinates of this rangeland plot are 43 deg. 56.741 min. N, 108 deg. 50.420 min. W (datum is NAD83). The diameter of this circular vegetation plot was 15.2 meters. Within this plot, four subplots of 0.5 meter diameter were established 5 meters from the center at the four cardinal directions (north, east, south and west). Within these subplots, grass and forb species

were identified and associated percent cover of each were visually estimated. Litter cover and the percent area of bare ground were also visually estimated. For each shrub in the larger plot, the species was identified, the lateral dimensions were measured, and the height was measured. The cover of trees, shrubs, grasses, forbs, litter and bare ground were calculated from the full plot and subplot measurements. Field identifications of *Tetradymia canescens* (winterfat) were inconsistent between the 2003 and 2004 field seasons. Shrubs identified as gray rabbitbrush (*Chrysothamnus nauseosus*) and winterfat (*Krascheninnikovia lanata*) in 2003 were later found to be spineless horsebrush (*Tetradymia canescens*). Therefore, all three shrub species were lumped as spineless horsebrush in cover calculations.

Spectral Measurement Procedures

This spectrum is the average of 100 measurements made throughout site L02-042. These spectra were collected using an ASD Full Range Field Pro spectrometer in reflectance mode, relative to a Spectralon reference panel. While walking through the site, the fiber optic cable was pointed at nadir (straight down) at approximately shoulder height. The instrument was programmed to record 6 second averages of reflectance while moving through the site (thus, each recorded spectrum was an average of 60 individual measurements). These recorded spectra were examined for artifacts due to low signal:noise, detector offsets and atmospheric contamination. Those spectra with large artifacts were not included in further processing. An average of the remaining 100 spectra was computed. This average spectrum was converted to absolute reflectance by multiplying by the reflectance spectrum of the Spectralon reference panel. The following channels were deleted (set to a value of $-1.23e+34$) from the spectrum because of remaining artifacts: 1-6, 410-413, 576-592, 761-801, 1006-1051, 1441-1591, 2111-2151 (corresponding to the wavelength ranges of 0.350-0.355, 0.759-0.762, 0.925-0.941, 1.110-1.150, 1.355-1.400, 1.790-1.940, and 2.460-2.510 micrometers).

Left Hand Creek General Description

The Left Hand Creek Study area is in central Wyoming, located 20 miles northwest of Thermopolis, Wyoming in the "Grass Creek Management Area," managed by the Worland Field Office of the Bureau of Land Management. The approximate center of the study area is 43.9608 degrees North latitude and 108.8828 degrees West longitude. The general area consists of lowland creeks (approximate average elevation of 1900 m) covered by mountain big sagebrush (*Artemisia tridentata*), grasses and forbs, interspersed with higher ridges (approximate average elevation of 2100 m) covered by mountain big sagebrush, grasses and forbs with some sparsely forested areas containing Limber pine (*Pinus flexilis*), and Rocky Mountain Juniper (*Juniperus scopulorum*) with Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) on steeper north-facing slopes.

Project Background

This site was measured as part of a cooperative U.S. Geological Survey and Bureau of Land Management project funded by the Joint Fire Science Program.



IMAGE_OF_SAMPLE:

END_SAMPLE_DESCRIPTION.

COMPOSITIONAL_ANALYSIS_TYPE: None # XRF, EM(WDS), ICP(Trace), WChem

COMPOSITION KEYWORD	Composition ASCII	Amount	Weight Percent, %
COMPOSITION:	Water:		%(of fresh weight)
COMPOSITION:	Total_Chlorophyll:		%(of fresh weight)
COMPOSITION:	Chlorophyll_A:		%(of fresh weight)
COMPOSITION:	Chlorophyll_B:		%(of fresh weight)
COMPOSITION:	Nitrogen:		%(of dry weight)
COMPOSITION:	Lignin:		%(of dry weight)
COMPOSITION:	Cellulose:		%(of dry weight)

COMPOSITION_DISCUSSION:

END_COMPOSITION_DISCUSSION.

TRACE_ELEMENT_ANALYSIS:

TRACE_ELEMENT_DISCUSSION:

END_TRACE_ELEMENT_DISCUSSION.

SPECTROSCOPIC_DISCUSSION:

END_SPECTROSCOPIC_DISCUSSION.

SPECTRAL_PURITY: 1a2_3_4_ # 1= 0.2-3, 2= 1.5-6, 3= 6-25, 4= 20-150 microns

LIB_SPECTRA_HED:	where	Wave Range	Av_Rs_Pwr	Comment
LIB_SPECTRA:	splib06a r 33234			g.s.=



**Clark and others 2007 USGS Data Series 231
Spectral Library splib06a Sample Description**

TITLE: Rangeland L02-043 S01% G07% DESCRIPT

DOCUMENTATION_FORMAT: PLANT

SAMPLE_ID: L02-043

PLANT_TYPE: Mixed rangeland shrubs, grasses, and forbs

PLANT:

LATIN_NAME:

COLLECTION_LOCALITY: Left Hand Creek, in the Grass Creek Management area of the Bureau of Land Management, is located in central Wyoming, approximately 20 miles northwest of Thermopolis, Wyoming

COLLECTION_LATITUDE: 43 deg. 56.706 min. N

COLLECTION_LONGITUDE: 108 deg. 52.564 min. W

DATUM: NAD83

ORIGINAL_DONOR: Raymond F. Kokaly, USGS

SAMPLE_DESCRIPTION:

This spectrum is the average reflectance for an area of rangeland covered by mixed shrubs, grasses and forbs as detailed in this description of site number L02-043.

Collection Date

The reflectance data were collected on 11-Jul-2002.

Site Vegetation Description

The total vegetation cover on this site was 23%. The following table shows the percent cover by cover class:

Cover Category, Sub-Category	Cover (%)
Vegetation, Total Cover	23
Vegetation, Tree	0
Vegetation, Shrub	1
Vegetation, Grass	7

Vegetation, Forb	15
Non-vegetation, Total Cover	77
Non-vegetation, Litter	8
Non-vegetation, Bare	70
Non-vegetation, Other	0

The following table shows the cover by shrub species in the site (for shrubs with greater than 2% cover):

Shrub Species	Cover (%)	Avg. Height (cm)
none		

The following table shows the cover by grass species in the site (for grasses with greater than 2% cover):

Grass Species	Cover (%)
<i>Pseudoroegneria spicata</i>	3
<i>Pascopyrum smithii</i>	3

The following table shows the cover by forb species in the site (for forbs with greater than 2% cover):

Forb Species	Cover (%)
<i>Phlox hoodii</i>	5
<i>Artemisia frigida</i>	3
<i>Antennaria microphylla</i>	3
<i>Iris missouriensis</i>	3

Field Observations

Very sparsely vegetated slope with cobble size rocks and clayish soil exposed. Soil and rocks are a light orange color.

Site Orientation

The average elevation over the area of the site is 2098 meters (6884 feet). The average slope of the site is 26 percent, with a South aspect of 166 degrees.

Site Burn History

The area of this plot has recently burned (since 1996).

Site Location, Dimensions, and Vegetation Sampling

The center coordinates of this rangeland plot are 43 deg. 56.706 min. N, 108 deg. 52.564 min. W (datum is NAD83). The diameter of this circular vegetation plot was 15.2 meters. Within this plot, four subplots of 0.5 meter diameter were established 5 meters from the center at the four cardinal directions (north, east, south and west). Within these subplots, grass and forb species were identified and associated percent cover of each were visually estimated. Litter cover and the percent area of bare ground were also visually estimated. For each shrub in the larger plot, the species was identified, the lateral dimensions were measured, and the height was measured. The cover of trees, shrubs, grasses, forbs, litter and bare ground were calculated from the full plot and subplot measurements. Field

identifications of *Tetradymia canescens* (winterfat) were inconsistent between the 2003 and 2004 field seasons. Shrubs identified as gray rabbitbrush (*Chrysothamnus nauseosus*) and winterfat (*Krascheninnikovia lanata*) in 2003 were later found to be spineless horsebrush (*Tetradymia canescens*). Therefore, all three shrub species were lumped as spineless horsebrush in cover calculations.

Spectral Measurement Procedures

This spectrum is the average of 118 measurements made throughout site L02-043. These spectra were collected using an ASD Full Range Field Pro spectrometer in reflectance mode, relative to a Spectralon reference panel. While walking through the site, the fiber optic cable was pointed at nadir (straight down) at approximately shoulder height. The instrument was programmed to record 6 second averages of reflectance while moving through the site (thus, each recorded spectrum was an average of 60 individual measurements). These recorded spectra were examined for artifacts due to low signal:noise, detector offsets and atmospheric contamination. Those spectra with large artifacts were not included in further processing. An average of the remaining 118 spectra was computed. This average spectrum was converted to absolute reflectance by multiplying by the reflectance spectrum of the Spectralon reference panel. The following channels were deleted (set to a value of -1.23e+34) from the spectrum because of remaining artifacts: 1-6, 410-413, 576-592, 761-801, 1006-1051, 1441-1591, 2111-2151 (corresponding to the wavelength ranges of 0.350-0.355, 0.759-0.762, 0.925-0.941, 1.110-1.150, 1.355-1.400, 1.790-1.940, and 2.460-2.510 micrometers).

Left Hand Creek General Description

The Left Hand Creek Study area is in central Wyoming, located 20 miles northwest of Thermopolis, Wyoming in the "Grass Creek Management Area," managed by the Worland Field Office of the Bureau of Land Management. The approximate center of the study area is 43.9608 degrees North latitude and 108.8828 degrees West longitude. The general area consists of lowland creeks (approximate average elevation of 1900 m) covered by mountain big sagebrush (*Artemisia tridentata*), grasses and forbs, interspersed with higher ridges (approximate average elevation of 2100 m) covered by mountain big sagebrush, grasses and forbs with some sparsely forested areas containing Limber pine (*Pinus flexilis*), and Rocky Mountain Juniper (*Juniperus scopulorum*) with Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) on steeper north-facing slopes.

Project Background

This site was measured as part of a cooperative U.S. Geological Survey and Bureau of Land Management project funded by the Joint Fire Science Program.



IMAGE_OF_SAMPLE:

END_SAMPLE_DESCRIPTION.

COMPOSITIONAL_ANALYSIS_TYPE: None # XRF, EM(WDS), ICP(Trace), WChem

COMPOSITION KEYWORD	Composition ASCII	Amount	Weight Percent, %
COMPOSITION:	Water:		%(of fresh weight)
COMPOSITION:	Total_Chlorophyll:		%(of fresh weight)
COMPOSITION:	Chlorophyll_A:		%(of fresh weight)
COMPOSITION:	Chlorophyll_B:		%(of fresh weight)
COMPOSITION:	Nitrogen:		%(of dry weight)
COMPOSITION:	Lignin:		%(of dry weight)

COMPOSITION:	Cellulose:		% (of dry weight)
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COMPOSITION_DISCUSSION:

END_COMPOSITION_DISCUSSION.

TRACE_ELEMENT_ANALYSIS:

TRACE_ELEMENT_DISCUSSION:

END_TRACE_ELEMENT_DISCUSSION.

SPECTROSCOPIC_DISCUSSION:

END_SPECTROSCOPIC_DISCUSSION.

SPECTRAL_PURITY: 1a2_3_4_ # 1= 0.2-3, 2= 1.5-6, 3= 6-25, 4= 20-150 microns

LIB_SPECTRA_HED:	where	Wave Range	Av_Rs_Pwr	Comment
LIB_SPECTRA:	splib06a r 33258			g.s.=



**Clark and others 2007 USGS Data Series 231
Spectral Library splib06a Sample Description**

TITLE: Rangeland L04-047 S00% G47% DESCRIPT

DOCUMENTATION_FORMAT: PLANT

SAMPLE_ID: L04-047

PLANT_TYPE: Mixed rangeland shrubs, grasses, and forbs

PLANT:

LATIN_NAME:

COLLECTION_LOCALITY: Left Hand Creek, in the Grass Creek Management area of the Bureau of Land Management, is located in central Wyoming, approximately 20 miles northwest of Thermopolis, Wyoming

COLLECTION_LATITUDE: 43 deg. 55.602 min. N

COLLECTION_LONGITUDE: 108 deg. 52.642 min. W

DATUM: NAD83

ORIGINAL_DONOR: Raymond F. Kokaly, USGS

SAMPLE_DESCRIPTION:

This spectrum is the average reflectance for an area of rangeland covered by mixed shrubs, grasses and forbs as detailed in this description of site number L04-047.

Collection Date

The reflectance data were collected on 1-Jul-2004.

Site Vegetation Description

The total vegetation ccover on this site was 84%. The following table shows the percent cover by cover class:

Cover Category, Sub-Category	Cover (%)
Vegetation, Total Cover	84
Vegetation, Tree	0
Vegetation, Shrub	0

Vegetation, Grass	47
Vegetation, Forb	37
Non-vegetation, Total Cover	16
Non-vegetation, Litter	not differentiated
Non-vegetation, Bare	not differentiated
Non-vegetation, Other	not differentiated

The following table shows the cover by shrub species in the site (for shrubs with greater than 2% cover):

Shrub Species	Cover (%)	Avg. Height (cm)
none		

The following table shows the cover by grass species in the site (for grasses with greater than 2% cover):

Grass Species	Cover (%)
<i>Carex sp</i>	25
<i>Juncus balticus</i>	12
<i>Poa pratensis</i>	5
<i>Carex filifolia</i>	3
<i>Hordeum brachyantherum</i>	3

The following table shows the cover by forb species in the site (for forbs with greater than 2% cover):

Forb Species	Cover (%)
<i>Breea canadensis</i>	19
<i>Apocynum cannabinum</i>	8
<i>Thlaspi arvense</i>	5
Unknown forb	3

Field Observations

The plot is sloped. The ground in the site is wet and boggy.

Site Orientation

The average elevation over the area of the site is 2164 meters (7098 feet). The average slope of the site is 31 percent, with a Southwest aspect of 218 degrees.

Site Burn History

The area of this plot has recently burned (since 1996).

Site Location, Dimensions, and Vegetation Sampling

The center coordinates of this rangeland plot are 43 deg. 55.602 min. N, 108 deg. 52.642 min. W (datum is NAD83). The diameter of this circular vegetation plot was 15.2 meters. Within this plot, four subplots of 0.5 meter diameter were established 5 meters from the center at the four cardinal directions (north, east, south and west). Within these subplots, grass and forb species were identified and associated percent cover of each were visually estimated. Litter

cover and the percent area of bare ground were also visually estimated. For each shrub in the larger plot, the species was identified, the lateral dimensions were measured, and the height was measured. The cover of trees, shrubs, grasses, forbs, litter and bare ground were calculated from the full plot and subplot measurements. Field identifications of *Tetradymia canescens* (winterfat) were inconsistent between the 2003 and 2004 field seasons. Shrubs identified as gray rabbitbrush (*Chrysothamnus nauseosus*) and winterfat (*Krascheninnikovia lanata*) in 2003 were later found to be spineless horsebrush (*Tetradymia canescens*). Therefore, all three shrub species were lumped as spineless horsebrush in cover calculations.

Spectral Measurement Procedures

This spectrum is the average of 68 measurements made throughout site L04-047. These spectra were collected using an ASD Full Range Field Pro spectrometer in reflectance mode, relative to a Spectralon reference panel. While walking through the site, the fiber optic cable was pointed at nadir (straight down) at approximately shoulder height. The instrument was programmed to record 6 second averages of reflectance while moving through the site (thus, each recorded spectrum was an average of 60 individual measurements). These recorded spectra were examined for artifacts due to low signal:noise, detector offsets and atmospheric contamination. Those spectra with large artifacts were not included in further processing. An average of the remaining 68 spectra was computed. This average spectrum was converted to absolute reflectance by multiplying by the reflectance spectrum of the Spectralon reference panel. The following channels were deleted (set to a value of -1.23e+34) from the spectrum because of remaining artifacts: 1-6, 410-413, 576-592, 761-801, 1006-1051, 1441-1591, 2111-2151 (corresponding to the wavelength ranges of 0.350-0.355, 0.759-0.762, 0.925-0.941, 1.110-1.150, 1.355-1.400, 1.790-1.940, and 2.460-2.510 micrometers).

Left Hand Creek General Description

The Left Hand Creek Study area is in central Wyoming, located 20 miles northwest of Thermopolis, Wyoming in the "Grass Creek Management Area," managed by the Worland Field Office of the Bureau of Land Management. The approximate center of the study area is 43.9608 degrees North latitude and 108.8828 degrees West longitude. The general area consists of lowland creeks (approximate average elevation of 1900 m) covered by mountain big sagebrush (*Artemisia tridentata*), grasses and forbs, interspersed with higher ridges (approximate average elevation of 2100 m) covered by mountain big sagebrush, grasses and forbs with some sparsely forested areas containing Limber pine (*Pinus flexilis*), and Rocky Mountain Juniper (*Juniperus scopulorum*) with Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) on steeper north-facing slopes.

Project Background

This site was measured as part of a cooperative U.S. Geological Survey and Bureau of Land Management project funded by the Joint Fire Science Program.



IMAGE_OF_SAMPLE:

END_SAMPLE_DESCRIPTION.

COMPOSITIONAL_ANALYSIS_TYPE: None # XRF, EM(WDS), ICP(Trace), WChem

COMPOSITION KEYWORD	Composition ASCII	Amount	Weight Percent, %
COMPOSITION:	Water:		%(of fresh weight)
COMPOSITION:	Total_Chlorophyll:		%(of fresh weight)
COMPOSITION:	Chlorophyll_A:		%(of fresh weight)
COMPOSITION:	Chlorophyll_B:		%(of fresh weight)

COMPOSITION:	Nitrogen:		%(of dry weight)
COMPOSITION:	Lignin:		%(of dry weight)
COMPOSITION:	Cellulose:		%(of dry weight)

COMPOSITION_DISCUSSION:

END_COMPOSITION_DISCUSSION.

TRACE_ELEMENT_ANALYSIS:

TRACE_ELEMENT_DISCUSSION:

END_TRACE_ELEMENT_DISCUSSION.

SPECTROSCOPIC_DISCUSSION:

END_SPECTROSCOPIC_DISCUSSION.

SPECTRAL_PURITY: 1a2_3_4_ # 1= 0.2-3, 2= 1.5-6, 3= 6-25, 4= 20-150 microns

LIB_SPECTRA_HED:	where	Wave Range	Av_Rs_Pwr	Comment
LIB_SPECTRA:	splib06a r 33589			g.s.=

Appendix D. ASD detector corrections and example asd.txt entries

For the correction of detector offsets in ASD spectra, PRISM can utilize an ASD instrument file “asd.txt”, located at “C:\usgsprism\asd.txt” on Windows computers and at “/var/local/usgsprism/asd.txt” on Linux computers. The format of each line in the asd.txt file is:
ASD -Cal #chans endch_det1 beginch_det2 endch_det2 beginch_det3

where,

ASD = the ASD spectrometer number

Cal = the calibration number of the spectrometer

endch_det1 = the last good channel of the first detector

beginch_det2 = the first channel of the second detector

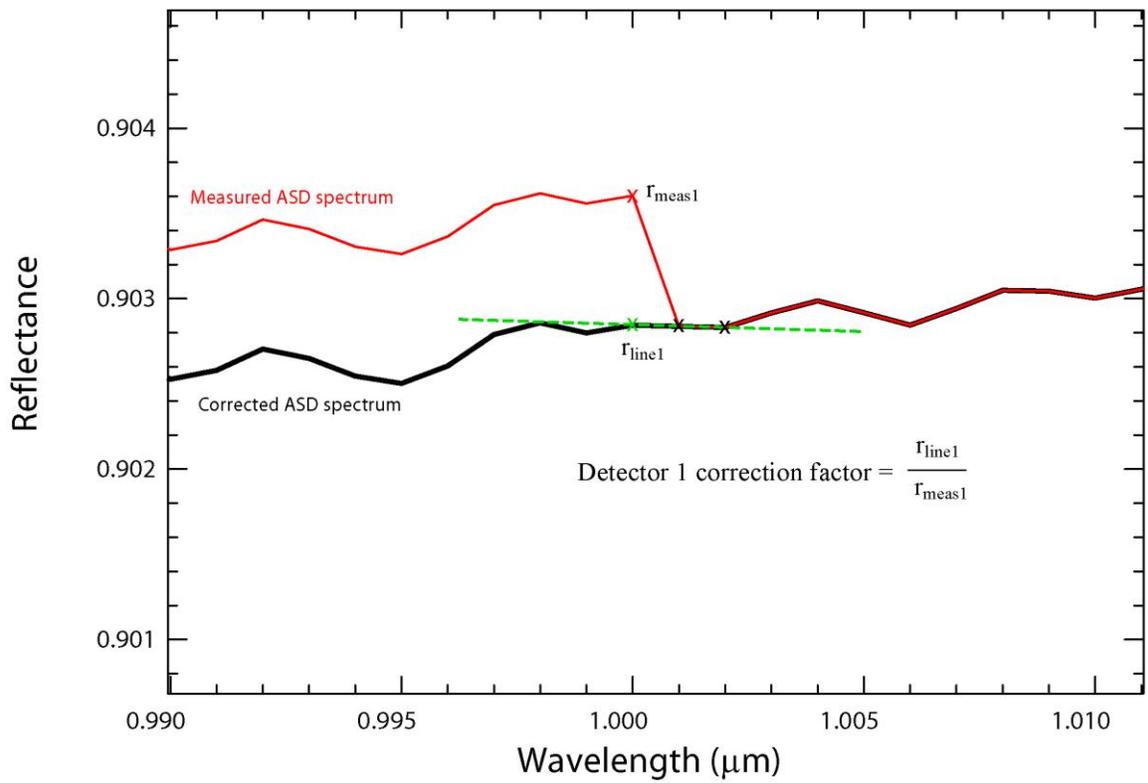
endch_det2 = the last channel of the second detector

beginch_det3 = the first good channel of the third detector

The following are example entries:

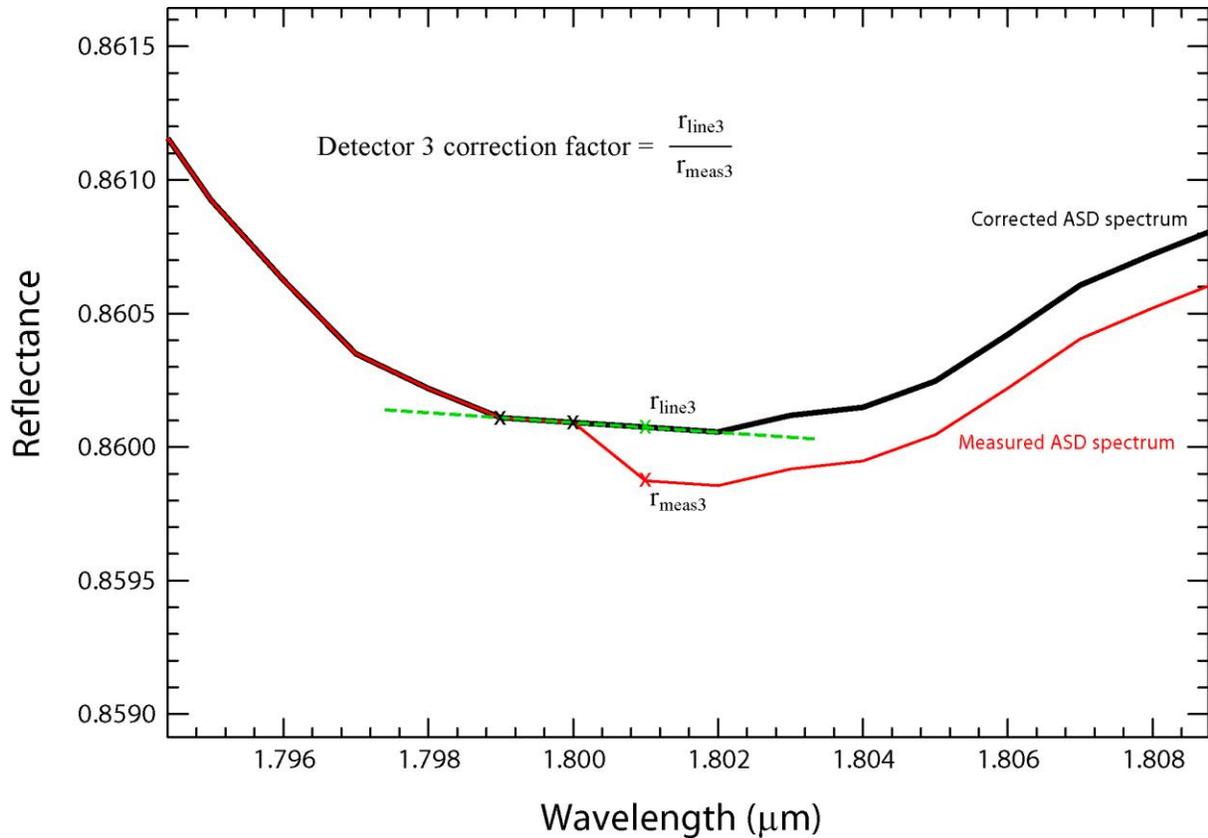
```
653-15 2151 633 634 1451 1452
6015-14 2151 649 650 1446 1447
6251-5 2151 661 662 1421 1422
16139-3 2151 651 652 1481 1482
16208-1 2151 651 652 1481 1482
```

In PRISM, the offset corrections for ASD spectra are two multiplicative scaling factors, the first to adjust detector 1 to match the reflectance level of at the start of detector 2 (fig. D1) and the second to adjust detector 3 to match the reflectance level at the end of detector 2 (fig. D2). To develop the multiplicative factors, a linear extrapolation of the reflectance values in detector 2 are made by, first, fitting a linear function to the two channels at the start of detector 2, for the correction of detector 1. And secondly, determining the equation of a line through the last two channels of detector 2, for correcting detector 3. Next, the closest good channels (*endch_det1* and *beginch_det3*) of the adjacent detectors are used to compute the reflectance values of the lines extended to the wavelength positions of those channels. The multiplicative correction factors are calculated as the ratio of the computed values of the lines extended to the closest good channels divided by the ASD reported values at those channels (figs. D1 and D2).



Record 284 of spd_example1: Mylar calstd GDS513b trans AVG asd653-12 (wavelength record = 8)
 Record 310 of spd_example1: mylar std GDS513b 1way trans average (wavelength record = 8)

Figure D1. Correction factor for the first ASD detector.



Record 284 of spd_example1: Mylar calstd GDS513b trans AVG asd653-12 (wavelength record = 8)
 Record 310 of spd_example1: mylar std GDS513b lway trans average (wavelength record = 8)

Figure D2. Correction factor for the third ASD detector.

Typically, the last good channel of the detector is the same as the last channel of that detector. However, early calibrations of our ASD spectrometers (in the mid- to late-1990s) had several poor channels at the end of the first detector. In such a case, the last “good” channel would be entered in the “asd.txt” file. This might be several channels before the end of the detector. An interpolation would be made to fill in the values between the last good channel of the detector to be corrected and the end channel of detector 2.

Appendix E. Format description and examples of FILE_DN_COLORS

The user can choose to set the FILE_DN_COLORS keyword in the MICA command file (see *appendix A*). The value of the keyword should be set to the name of a text file (including the full directory path to the file) containing the class values and colors that should be assigned to the reference materials. The file is termed the class value and color file. The FILE_DN_COLORS keyword is an optional entry in the MICA command file. If it is not set, the MICA program will skip the creation of a summary image with user-defined class values and colors. If it is set, MICA analysis of image cubes will create the “mica_class_allmaterials_userindex” and “mica_class_allmaterials_userindex_withnondataclass” classification images using the class values and colors listed in the named file.

The format of the FILE_DN_COLORS file is a text file with one line for each material listed in the MICA command file. Each line requires the following four parameters, each separated by one or more spaces:

output_name class_value value_red value_green value_blue

Each *output_name* parameter should be unique and equivalent to one of the output name keywords listed in the MICA command file that has referenced the class value and color file. It needs to match exactly with one of the entries in the command file. Each output name in the MICA command file is required to be in the class value and color file once and only once. The *class_value* parameter can be set to an integer value ranging from one to the number of output names in the MICA command file. Each *output_name* has to be assigned a unique *class_value* number in this range of integers. The pixels that were found to be best matched to the reference spectrum associated with the *output_name* will be set equal to the *class_value* in the “mica_class_allmaterials_userindex” and “mica_class_allmaterials_userindex_withnondataclass” classification images. The *value_red*, *value_green*, and *value_blue* parameters are the loading factors for red, green, and blue to use in creating a color for the class. Their allowable values are between 0 and 255. More than one output name can be assigned the same combination of color values, that is, more than one class in the summary image can be assigned the same color in the “mica_class_allmaterials_userindex” and “mica_class_allmaterials_userindex_withnondataclass” classification images.

The content of the example class value and color file referenced in the sample MICA command file in *appendix A* is shown below.

calcite_abundant	1	20	75	0
calcite	2	40	105	10
calcite.7+muscovite.3	3	113	160	90
calcite.8+montmorillonite_Ca.2	4	188	185	115
calcite.8+montmorillonite_Na.2	5	188	185	115
carbonate_Fe_bearing	6	220	185	255
dolomite	7	205	25	255
dolomite.5+montmorillonite_Na.5	8	165	20	200
dolomite.25+calcite.25+mont_Na.5	9	165	20	200
epidote	10	225	25	0
chlorite_lowFe	11	225	25	0
chlorite+muscovite	12	225	25	0
muscovite_lowAl	13	250	150	0
muscovite_medAl	14	250	150	0

muscovite_medhighAl	15	250	150	0
muscovite_Fe-rich	16	250	150	0
illite	17	230	120	0
illite_gds4	18	230	120	0
kaolinite_wxl	19	25	85	245
kaolinite_pxl	20	25	85	245
kaolin+clay_mica_or_halloysite	21	40	145	255
kaolin.5+muscovite_medAl	22	40	145	255
kaolin+muscovite_mix_intimate	23	40	145	255
kaolin.5+muscovite_medhighAl	24	40	145	255
kaolin.5+smectite.5	25	40	145	255
kaolin.2+calcite.8	26	40	145	255
montmorillonite_Na	27	130	210	255
montmorillonite_Ca	28	130	210	255
alunite_Na_450c	29	250	160	185
alunite_K_250c	30	250	160	185
alunite.5+kaolinite.5	31	255	195	195
alunite.25+kaolinite.75	32	255	195	195
pyrophyllite	33	145	25	55
pyrophyllite.5+alunite.5	34	145	25	55
jarosite_Na	35	218	112	214
jarosite_K	36	218	112	214
jarosite+muscovite_mix_intimate	37	218	112	214
kaol_possible_alunite_or_dickite	38	30	30	185
buddingtonite	39	255	210	0
buddingtonite+montmorillonite	40	255	210	0
serpentine1	41	160	215	50
serpentine2	42	160	215	50
serpentine3	43	160	215	50
serpentine4	44	160	215	50
serpentine_or_dolomite+calcite	45	176	131	255
tremolite_or_talc	46	100	40	180
hydrated_silica	47	255	255	75
chalcedony	48	255	255	75
gypsum	49	240	0	255
vegetation_green	50	225	205	170
vegetation.dry+green	51	225	205	170
dry_veg_grass	52	147	115	48
dry_veg_grass_2_3um	53	147	115	48
dry_veg_nongrass	54	147	115	48
dry_veg_nongrass_2_3um	55	147	115	48
snow_melting	56	80	0	115
snow_slush	57	80	0	115
water	58	180	180	180
water_sediment_low	59	180	180	180
water_sediment_high	60	180	180	180