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SPVIEW

Spectral Plot Program for Accessing the USGS Digital Spectral Library Database

with MS - DOS Personal Computers

VERSION 1.00

by

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93 - 593 A Documentation (Paper Copy)

93 - 593 B 3 MS-DOS 3.5 inch diskettes containing Executable Programs, Source Code, Digital Mineral Spectral Library, and Digital Documentation

This report is preliminary and has not been reviewed for conformity with the U.S. Geological Survey editorial standards. Use of trade names in this report is for descriptive purposes only and does not imply endorsement by the USGS. Although these programs have been extensively tested, the USGS makes no guarantee of correct results.

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## Introduction

This open-file describes an MS-DOS computer program that accesses USGS Spectrum Processing Routines (SPECPR) format data files (Clark, 1993) such as the USGS Digital Spectral Library: Version 1: 0.2 to 3.0 $\mu$ m (Clark et al., 1993). The distribution diskettes include this document, software and source code, and the USGS Digital Spectral Library. Ancillary programs that read, write, and display mineral spectra and descriptive text are included. The USGS library of 498 mineral spectra has been previously released as a 1,326 page Open-File Report (93-592) by R. Clark, G. Swayze, A. Gallagher, T. King, and W. Calvin and in digital form with software for Unix computers via the Internet. This library of mineral spectra represents 8 man-years of research and forms the basis for the design, processing, and interpretation of remote sensing data in the visible and near-infrared portions of the electromagnetic spectrum. This document and the accompanying diskettes represent the first distribution of the digital spectral library for MS-DOS Computers.

SPVIEW is an MS-DOS program that allows a copy of the digital spectral library (currently, SPLIB04A) to be read on a PC and permits data extraction using various functions. The user may browse through the table of contents of the mineral spectra and accompanying descriptive text, select a mineral spectrum, and interactively display a scaleable plot of the spectral data. The wavelength (x) and reflectance (y) values can be extracted to an ASCII disk file for direct import into a DOS plotting package (such as RPLOT) or other DOS-based software. Multiple spectra can be interactively displayed so that spectra can be compared.

SPVIEW does not contain any of the capability for processing or mathematically manipulating the spectral data (which is possible with the USGS SPECPR software, Clark, 1993) and is only intended to allow the user to view and extract the basic spectral data in a PC environment. SPECPR software runs in an UNIX environment and is available across the Internet using anonymous FTP. The library file SPLIB04A was created with this software and remains in IEEE (Hewlett Packard, and Sun Microsystems-UNIX computer compatible) binary format. Also available for Unix Machines is SPSEARCH (Gorelick and Clark, 1993) which provides a more extensive search capability of the spectral database, spectral features and ancillary information than does SPVIEW.

SPVIEW is distributed as a 3-diskette ( 3.5-inch, 1.44 MB) Open-File Report. The diskettes contain an installation program, the SPVIEW software, and a compressed copy of the IEEE-format SPECPR digital mineral spectral library, along with software to automatically decompress the spectral library upon installation. The entire package will require approximately 12 MB of disk space. SPVIEW brings the wealth of mineral spectral reflectance data, compiled by the USGS, to the academic, industrial, and international science communities, and allows users with limited computer capabilities access to this important database.

## Files Contained in This Release

### \SPECTRA

README	Disk readme file with abbreviated program descriptions
SPVIEW.EXE	MS-DOS read, plot, and spectral extraction program for use with SPLIB04A
ASCIICAT.EXE	Rearranges and/or concatenates columns of data within ASCII files generated with SPVIEW
SPARITH.EXE	Rescales ASCII spectral files with multiplicative and additive constants.
EXTRACT.BAT	Extracts all spectra within SPLIB04A into ASCII format, 2 column data - (wavelength, reflectance)
CONTENTS.ASC	Listing of all spectra in this database (SPLIB04A)
SPVIEW.ASC	This text-file (ASCII format)
SPFORMAT.ASC	Description of the data format used to create SPLIB04A
SPLIB04A	USGS digital spectral library (IEEE-binary format) (This is HP, Sun Unix-compatible format.)
MODERN.FON	font file used by the SPVIEW plot routine, must remain in \spectra or in current working directory
EXTRACTN.DAT	Data file used by EXTRACT.BAT
EXTRACTE.DAT	Data file used by EXTRACT.BAT
EXTRACT2.DAT	Data file used by EXTRACT.BAT (with Errors)
SPVIEW.DOC	This text-file (Word Perfect 5.1 format)

### \SPECTRA\SOURCE

SPVIEW.FOR	FORTRAN source code for SPVIEW.EXE
SPECPRIO.FOR	SPVIEW subroutine

SPDATA.FOR	SPVIEW subroutine
SPIO.FOR	SPVIEW subroutine
PLOT.FOR	SPVIEW subroutine
FIND.FOR	SPVIEW subroutine
CONVERT.FOR	SPVIEW, ASCIICAT, and SPARITH subroutine
ASCIICAT.FOR	FORTRAN source code for ASCIICAT.EXE
SPARITH.FOR	FORTRAN source code for SPARITH.EXE
FLSP.BAT	MS-FORTRAN V. 5.1 compile batch file (SPVIEW)
FLAS.BAT	MS-FORTRAN V. 5.1 compile batch file (ASCIICAT)
FLARITH.BAT	MS-FORTRAN V. 5.1 compile batch file (SPARITH)
INSTALL.BAT	INSTALL batch file - floppy to hard-disk
MKSPVIEW.BAT	Make SPVIEW batch file - used to create (3) 1.44 MB floppy archive/release of software (requires PK-ZIP software)

## Installation

Installation of the open-file report software using the INSTALL batch program requires 12 megabytes of free hard-disk space. INSTALL automatically creates the subdirectory \SPECTRA, then transfers and decompresses the digital spectral library and associated software. Source code is placed in the subdirectory \SPECTRA\SOURCE.

The INSTALL batch file requires the MS-DOS program RESTORE.EXE which is found in the MS-DOS \DOS directory and will be used by the INSTALL program automatically if \DOS; is located in the PC's PATH statement. Data and programs are self-extracted from the resulting compressed file (using the embedded PKZIP self-extraction software).

Invocation of INSTALL is:

**<floppy-drive> INSTALL <floppy-drive> <hard-drive>**

i.e. **B:INSTALL B: C:**

INSTALL is executed from the **last floppy diskette** (backup diskette 03). Execute the INSTALL batch program from the third diskette, then follow the prompts for inserting the first, second, and then again the third floppy diskette in the PC's drive. Manual installation is possible; see Appendix A.

The install program is stored on the third (last) disk because of the way the MS-DOS BACKUP program stores data across disks. Free space occurs only on the last disk.

Once installed, the software and data may be moved to and run from any subdirectory. EXTRACT must be run from the same directory as SPVIEW, SPLIB04A and the EXTRACT\*.DAT files. All programs accept full path names (except ASCIICAT). For alphanumeric display of axis labels within the plot subroutine of SPVIEW, the file MODERN.FON must be in either the subdirectory \SPECTRA or in the **current working** directory.

## Operation

SPVIEW operates with any SPECPR formatted file. Proper usage requires an understanding of the file structure. SPLIB04A (SPECPR file) is organized as a series of records within the file, which contain either spectral numeric data or spectral description text. These data are used to characterize each mineral sample and its spectrum. Every mineral sample has a text description, reflectance data, associated wavelength, associated wavelength resolution, reflectance error, and feature analysis records. The default spectral file, SPLIB04A contains only one wavelength listing (records 6 and 7) and one wavelength resolution listing (records 8 and 9), that is used by every sample spectrum within this file. Other SPECPR files may contain more than one wavelength and resolution entry. Every mineral sample description within the spectral file SPLIB04A starts with a text listing, then

spectrum and errors, and feature analysis listings. Each listing uses one or more contiguous records.

The three types of data: 1) **text**, 2) **spectral**, and 3) **spectral features**, are used with each library entry. Every sample entry starts with a sample documentation text description. The text is stored in one or more records, with the first record containing the mineral title and the key-word '**DESCRIPT.**' Continuing records have only data and bit flags, and SPVIEW signifies these in its listings by the title '**continuation of text**'. Select the first record for all operations, you should never need to access the continuation records (that would be like reading a sentence at the top of a page that started on the previous page).

The second data type, spectral data, is also stored in one or more records. The first record contains the mineral title and the key-word '**ABS REF.**' Continuing records have the title '**continuation of data**'. Select the first record for all operations. Spectral error (standard deviation of the mean) records follow the spectral data. The first error record contains the title '**errors to previous data**' and is automatically linked with the spectral data.

The feature analysis data type (last data type for each library entry) starts with the title and the key-word '**FEATANL.**' Continuing records have the title '**continuation of data**'. SPVIEW does not currently use the feature analysis data.

SPVIEW initially displays the table of contents of the selected spectral file. The user scrolls sequentially through the file, listing the record number, title, and data type for each record, starting with record one. Select any record of interest using the forward and backward scroll keys, jump to the record, or find the record, then read or extract the mineral text description, or plot, read, or extract the spectral data.

Within the table of contents, four fields are displayed: the record number, title, length of data, and related records. Key words in the title field indicate the starting text and data records for particular minerals. They are **DESCRIPT** (starting record of text), **ABS REF** (starting record of a spectrum), **errors to previous data** (starting record of the standard deviation of the mean for the previous spectrum), and **FEATANL** (starting record of the feature analysis data).

The expanded (default) table of contents mode displays all text, numeric, data continuation records, and empty records. To read or extract mineral text descriptions, select the first text record (non-continuation record) containing the key-word '**DESCRIPT**' for a particular mineral sample, by typing its record number, then use the <r> read record function. Follow the prompts. To plot, read, or extract numeric spectral data, select the first numeric data record (non-continuation record) containing the key-word '**ABS REF**' by typing its record number, then use the <r> read record function and follow the prompts. The function <r> always accesses the current record highlighted by the asterisk.

A more concise display is possible by collapsing the table of contents using the <c> collapse function. This mode displays only the spectrum record numbers and titles by excluding display of text, feature analysis, and continuation records. Read or extract the mineral text descriptions by selecting the mineral record, then use the <t> read text function. Plot, read, or extract numeric spectral data by selecting the mineral record, then use the <r> read record function. In the collapsed table of contents mode, only the first record of the mineral spectrum is presented in the table of contents. The text record for this



mineral is cross linked to the spectral record, so use the spectral record for both spectral and text operations.

## **Public Domain**

All USGS data and programs within this open-file are in the public domain. The data and programs in this open-file may be freely copied and distributed in compressed or uncompressed form. When uncompressed, the software may be copied with the MS-DOS COPY command. The compressed disks may be copied with the MS-DOS DISKCOPY command.

The compression software - PKZIP and PKSFY are licensed for this application from:

PKWARE, Inc.  
9025 N. Deerwood Dr.  
Brown Deer, WI 53223-2437  
(copyright 1993, all rights reserved by PKWARE, Inc.)

## **Requirements**

SPVIEW requires an MS-DOS compatible computer with color VGA graphics, a 1.44MB 3.5 inch floppy drive, MS-DOS 5.0 or greater, 12 megabytes of hard-disk space, and at least 415 kilobytes of conventional memory (415K bytes free RAM). The MS-DOS commands MEM and CHKDSK will display your current memory usage.

## Program Users Guide

### SPVIEW

SPVIEW reads, displays, and extracts spectra from USGS SPECPR (Clark, 1993) spectral data files created on UNIX systems. SPVIEW runs on any MS-DOS PC compatible computer equipped with VGA graphics. It translates on the fly, SPECPR files in native IEEE-binary format, to PC compatible ASCII. All output is in MS-DOS ASCII (PC) format.

SPVIEW requires the supplied font file MODERN.FON, which should remain in the same directory as SPVIEW.

Operation of SPVIEW is controlled through a system of menus. The first menu (main screen) is used for text or data selection. The main screen displays the record number and title for each record in the database (SPLIB04A). Users position the cursor "\*" next to the text or data record of interest by scrolling forward or backward through the file, jumping to a known record number, or finding a record by matching search information. Data may then be extracted for viewing or plotting using the read record (spectrum) or read text menus. Spectra may also be imported for plotting using the import ASCII spectrum menu.

**syntax: press key: <f> means to press the 'f' key, then Enter (Return)**

**enter: {new record number} means to type an integer number, then Enter**

#### main screen (expanded table of contents)

- press key:
- <Enter> forward - advance the screen to the next 20 records
  - <b> backward - backup the screen to the previous 20 records
  - <r> read (spectrum or text) - read data or text record for various presentations, current record to read is highlighted with an asterisk (see Read Record below). Data may then be written into an ASCII file.
  - <i> import ASCII spectrum - read in a spectrum from an ASCII file, in wavelength (column 1) - reflectance format (column 2), with or without first line title (when no 1st line title is present, the filename is used), into the plot subroutine.
  - <c> collapse table of contents - displays only spectrum titles with record numbers.
  - <q> quit program - terminates program (or use <Ctrl> <C>)
  - <f> find spectrum - find first occurrence of an entered character string within a spectral title (data record) or within a field of the text record. Character strings are sensitive to case and spaces. Find starts the search at the record following the cursor "\*", moves downward through the SPECPR file (e.g. SPLIB04A), and will wrap to the beginning of the file when no match occurs. Find also can be used to generate a spectral contents ASCII text-file of a SPECPR file (see Find below).

**<n>** find next occurrence of the 'find' character string.  
or enter: **{new record number}** - positions record pointer on the record of interest, which then may be read by the **<r>** function.  
Also used to jump throughout the database. The current record is highlighted by a '\*' before the record number.

### main screen (collapsed table of contents)

same commands as expanded table of contents except:

**<r>** read record - read data spectrum record  
**<t>** read text - read text record of spectrum

### read record

Read Record **<r>** presents the text and spectral data in readable form, listable data values, or as graphic spectral plots. This information may be directed to the screen console (CON), written to a printer (PRN), or written to a disk file. To select a spectrum, type the **<record number> <Enter>**, then type **<r> <enter>** to enter read record function with the spectral data.

**text info (<r> read record-expanded mode, or <t> read text-collapse mode):**

press: **<Enter>** to read - page through the sample-description text,  
press **<Enter>** to display next page

or type: **'PRN'** to print - writes sample-description text to printer  
**{filename}** to disk - writes sample-description text to a disk file; use any filename, will not over-write existing files  
**'EXIT'** to return - aborts function, returns to main screen

**data spectrum (<r> read record)-all modes:**

press: **<Enter>** for screen plot - display a graphic spectral plot on screen, see spectral plots below

**<v>** verbose; toggles ASCII resolution and errors - sets output to display wavelengths and reflectance; or wavelengths, resolution, reflectance, and errors in the ASCII listings to screen, printer, or file.

or type: **'CON'** ASCII screen dump - writes spectral values to the screen console. Channel, wavelength, and reflectance values displayed. File may be scrolled forward and backwards a screen at a time using **<q>** to quit, **<b>** backup, and **<return>** to continue.

**'PRN'** print - writes spectrum values to printer

**{filename}** disk - writes spectral values to a disk file; use any filename, will not over-write existing files (null values: -1.23E34)

**'EXIT'** return - aborts function, returns to main screen

## **find spectrum**

Find Spectrum <f> is used to search the spectral database and locate spectral data or sample description text which match values set by the user. Find starts the search at the record following the cursor "\*", moves downward through the SPECPR file (e.g. SPLIB04A), and terminates the search at the first match, positioning the cursor next to that record listing. If no match occurs, find will wrap the search to the beginning of the file and continue, when prompted.

Find may be used to search for character strings within the spectral data title or within the sample-descriptive text records and is case sensitive. 18 text fields within the text record may be searched. Text search fields below are numbered identically to the search fields found within SPSEARCH (see bibliography).

---

### **search spectral data record title:**

<0> Spectral Title (DATA) search (40 character spectrum data title)

### **or search descriptive text record text-fields:**

<1> TITLE: (40 character spectrum text title)  
<2> DOCUMENTATION\_FORMAT: ('MINERAL', 'ELEMENT', or 'PLANT')  
<3> SAMPLE\_ID: (spectrum ID number without grain size)  
<4> MINERAL\_TYPE: (Carbonate, Oxide, Phosphate, Sulfide, etc.)  
<5> MINERAL: (mineral or mineral group name)  
<6> FORMULA: (mineral formula, no subscript, superscript)  
<7> FORMULA\_NROFF: (mineral formula, UNIX NROFF format)  
<8> COLLECTION\_LOCALITY: (sample collection site)  
<9> ORIGINAL\_DONOR:  
<10> CURRENT\_SAMPLE\_LOCATION:  
<11> ULTIMATE\_SAMPLE\_LOCATION:  
<12> SAMPLE\_DESCRIPTION: (general text)  
<14> XRD\_ANALYSIS: (general text)  
<16> COMPOSITIONAL\_ANALYSIS\_TYPE: ('XRF', 'EM(WDS)', 'ICP', 'WChem')  
<17> COMPOSITION\_TRACE: (Trace elements, element nomenclature)  
<18> COMPOSITION\_DISCUSSION: (general text)  
<20> MICROSCOPIC\_EXAMINATION: (general text)  
<22> LIB\_SPECTRA: (record # of spectrum for this mineral)

or

<q> quit find (search)  
<\*> generate CONTENTS.ASC file

---

Within find, enter the number of the field to be searched (see field numbers above), then enter the character string to match. The search data type (TEXT record or DATA record), the keyword (field name), and the search word will be displayed. Pressing <q> <Enter> will terminate find and return the program to the main menu. The <\*> option of find generates a spectral contents ASCII text-file of SPLIB04A (same as the CONTENTS.ASC file as shipped).

Generally, most searches will use the 'MINERAL:' field for locating mineral or mineral group spectra within the text record and the 'Spectral Title' field for locating minerals within the spectral data record.

### **spectral plots**

Spectra are plotted graphically on the screen, initially in black and white, required for graphic screen dumps to a printer using the MS-DOS GRAPHICS.COM program. GRAPHICS.COM must be loaded before running SPVIEW (i.e. **GRAPHICS LASERJETII**). The initial plot displays a reflectance (Y-axis) range from 0.0 to 1.0 and a wavelength (X-axis) range covering the data minimum and maximum. Y-axis reflectance may use any real positive number, negative numbers are set to zero (-1.23E34 DELETED-POINT values are skipped).

Graphic rescaling, spectral buffer operations, and plot termination routines are present. They may be accessed directly (no prompt - start typing) or prompted for (screen prompt) by pressing <Enter>.

---

#### **screen prompt:**

**rescale:**       wavelengths MIN & MAX and refl. MIN and MAX  
                  <a> auto-scale - scale plot to maximum size

**buffers:**       <s>0-4 save - saves the current spectrum to a new buffer  
                  <r>a|0-4 read - display spectrum in a buffer  
                  <z>0-4 zero - zero out a buffer (erase spectrum)

**termination:** <Enter> to quit - press Enter key twice, once to display the  
                  prompt, then to terminate plot routine and return to the  
                  main screen.

---

For the <s> <number>, <r> <number>, and <z> <number> options, '0'-'4' refers to choosing a number between 0 and 4. For the <r> <number> option, 'a' refers to choosing all buffers, and | refers to choosing one or the other argument, either the 'a' argument or the 0-4 argument.

## plot commands:

enter: {**wavelength minimum, wavelength maximum, reflectance minimum, and reflectance maximum**} - rescales the plot. To rescale, enter wavelength minimum and maximum and reflectance minimum and maximum, separated by commas or spaces. A comma may be used to retain the current value for any particular argument, and trailing arguments need not be entered, retaining their current values automatically.

or press key: **<a>** - autoscales the plot to its maximum range in wavelength and reflectance

**<s> <number>** - saves the current (highlighted by '\*') spectrum to a new buffer. Numbers range from 0 to 4.

**<r> <number>** - reads the spectrum from the chosen buffer and plots it to the screen. Numbers range from 0 to 4, or all buffers from 1 to 4 may be plotted simultaneously with 'a'.

**<z> <number>** - zeros out the buffer. The spectrum stored within the buffer is erased. Numbers range from 0 to 4.

**<Enter>** - terminates the plot routine and returns the program to the main menu (main screen).

example - to plot wavelengths .945 - 2.31 $\mu$ m, and absolute reflectance .1 - .659

rescale: wavelengths MIN & MAX and refl. MIN and MAX

**enter: .945 2.31 .1 .659**

if only the reflectance range needed changed, we could have entered: **.,.1 .659**

if only the wavelength range needed changed, we could have entered: **.945 2.31**

Rescaling may also be done automatically to maximize the plot using the **<a>** command, which auto-scales the plot to fit the maximum plot boundaries.

There are five spectral buffers, numbered 0 through 4, with 0 being used by the current spectrum plot. Buffer 0 is over-written every time the plot routine is re-entered from the main menu. Buffers 1 through 4 retain their spectra until purposely over-written.

Any of the five buffers may have a new spectrum written to it using the **<s> <number>** save function. The save function copies the spectrum in the current buffer (highlighted by the '\*') to the new buffer. When re-entering the plot routine from the main menu, buffer 0 is set as the current buffer. The plot **<r> <number>** buffer function (not the main menu read function) sets the current buffer to the read buffer.

Plots are colored black & white (buffer 0), green (buffer 1), blue (buffer 2), red (buffer 3), and yellow (buffer 4).

**examples (random organization of commands to show usage only):**

the plot routine is started and displays the spectrum stored in buffer 0

<s> <1> <Enter>      stores the current spectrum into buffer 1. <s> means  
press the 's' key, <1> means press the '1' key, and  
<Enter> means press the Enter key, one after the other  
<Enter> <Enter>      return to the main menu for another spectrum  
[the Enter key is pressed twice]

the plot routine is restarted and displays another spectrum in buffer 0 (overwriting the  
previous spectrum)

<s> <2> <Enter>      stores the new current spectrum into buffer 2  
<r> <a> <Enter>      displays buffers 1 - 4, buffer 0 is still the current buffer,  
so no '\*' is show by any spectrum  
<r> <2> <Enter>      displays buffer 2 and makes it current  
<s> <4> <Enter>      saves current spectrum (what's in buffer 2) to buffer 4  
<r> <a> <Enter>      displays buffers 1 - 4, buffer 3 is still empty, buffer 2  
has a '\*' next to its title  
<z> <4> <Enter>      zeros out (erases) buffer 4  
<r> <1> <Enter>      displays buffer 1 and makes it current  
<s> <0> <Enter>      saves current spectrum (buffer 1) to buffer 0  
<r> <0> <Enter>      displays buffer 0 and makes it current  
<Print Screen>      dumps the black and white buffer 0 spectrum to the  
printer (assuming GRAPHICS was run before starting  
SPVIEW)  
<Enter> <Enter>      return to the main menu

Remember, buffer 0 is always over-written when bringing in a new spectrum.

## ASCIICAT

ASCIICAT concatenates columns of ASCII data from multiple source-files into an ASCII output-file. Columns of ASCII data may also be re-arranged or deleted. Single source-files may also be used. This program rearranges spectral formats for use in various plot packages. A maximum of five columns of data may be concatenated per output-file. First line titles will be skipped if present; spectral titles are not written into the output file.

Start the program, then enter the INPUT filename. The input file ASCII column number to copy must be entered, matched with the output file column number. This is repeated until a new input file is required and accessed using the <n> new input file function or until all required columns have been entered and the <q> quit entry function is selected. Enter the OUTPUT filename, and all the data columns from the input file or files are copied in the correct order into the output file. Filename lengths are 12 characters maximum (for this program only).

example - reverse column 1 and 2, then add column 3 from a different file:

```
INPUT filename:          spec1
enter: input column, output column: 1 2
enter: input column, output column: 2 1
enter: input column, output column: <n>
INPUT filename:          spec2
enter: input column, output column: 3 3
enter: input column, output column: <q>
enter: OUTPUT filename:  spec1.rev
```

As can be seen, the output column order may be entered in any sequence, or even changed several times; just make sure that all output columns are filled between column 1 and the ending column, or the program will ask for a fix.

## SPARITH

SPARITH re-scales ASCII spectral files with multiplicative and additive constants. File format of the spectrum is as a two column (wavelengths and reflectance) ASCII real number text-file with or without a first line title. The first column of data in the input file (wavelengths) is copied unmodified to the output file while the second column of data (reflectance) has the arithmetic constants applied, then written to the output file. Spectral titles are transferred to the new file when present. This program is useful for re-scaling data for plotting and comparison with other spectra. Data may be generated for graphic overlays and offsets. SPARITH prompts for the input filename, the real number multiplicative and additive constants, and the output filename.

## EXTRACT

EXTRACT is a batch file which extracts all text and spectra from the SPLIB04A file and writes them out in ASCII format as separate files. Each ASCII spectral file contains a title, wavelength and reflectance data. EXTRACT runs from the \SPECTRA directory and places all extracted spectra in the directory \SPECTRA\EXTRACT. To run, start EXTRACT by typing: "EXTRACT". No further input is required.



Spectral files will include resolution and errors data (along with the wavelength and reflectance data) by using the 'errors' argument within the batch file EXTRACT. Wavelength, wavelength resolution, reflectance data, and error bars (of the reflectance data) will be included in all ASCII spectrum files during extraction from SPLIB04A. Start EXTRACT with the 'errors' argument by typing: "EXTRACT ERRORS". No further input is required.

EXTRACT generates 996 spectral and text-files (one file each for spectrum and text description). 17.9 megabytes is used when generating ASCII spectral files with wavelength and reflectance data and 26.1 megabytes is used with files containing wavelength, resolution, reflectance, and error data. All text-files contain the MS-DOS filename extension .txt while all spectral files (data) contain the filename extension .spc.

These ASCII files may be combined using the MS-DOS COPY command into one or more files.

To generate a single 1.12 MB ASCII file (TEXT.ASC) containing all spectra text descriptions with page breaks, type:

**COPY \*.TXT TEXT.ASC**

To generate a single 8.3 MB ASCII file (SPECTRA.ASC) containing all spectral data with mineral titles, type:

**COPY \*.SPC SPECTRA.ASC**

Likewise, the data may be gathered into more than one text-file by changing the wildcard options of the copy command. It is important when gathering files together with wildcards not to use the same MS-DOS extension for the output file as used by the input files.

## References

- Clark, R. N., 1993, SPECTrum Processing Routines Users Manual Version 3 (program SPECPR), USGS Open-File Report 93-595, 202p.
- Clark, R. N., Swayze, G. A., Gallagher, A. J., King, T. V. V., and Calvin, W. M., 1993, The U. S. Geological Survey, digital spectral library: version 1: 0.2 to 3.0 micrometers, USGS Open-File Report 93-592, 1326p.
- Gorelick, N. and Clark, R. N., 1993, Spsearch users manual, USGS Open-File Report 93-594, 23p.

## **Appendix A - Software Installation**

All files are archived in compressed form using PKZIP 2.04g (c) 1993 and MS-DOS ver. 5.0 BACKUP. The compressed files are self extracting; only the program RESTORE (MS-DOS ver. 5.0 or greater) is required to install these programs.

### **AUTOMATIC INSTALLATION**

For automatic program extraction, invoke the install program:

**<from-drive> INSTALL <from-drive> <to-drive>**  
i.e. **B:INSTALL B: C:**

### **MANUAL INSTALLATION**

Manual installation is not required when using the AUTOMATIC INSTALL program.

Steps used in manual extraction are:

(with PKZIP 2.04g (c) 1993 and MS-DOS ver. 5.0 or greater RESTORE)

- 1) C:
- 2) RESTORE B: \SPECTRA\SPVIEWZ.EXE
- 3) CD \SPECTRA
- 4) SPVIEWZ.EXE
- 5) DEL SPVIEWZ.EXE
- 6) MD SOURCE
- 7) COPY \*.FOR SOURCE /V
- 8) COPY \*.BAT SOURCE /V
- 9) DEL \*.FOR (answer Y at prompt)
- 10) DEL \*.BAT (answer Y at prompt)
- 11) COPY SOURCE\EXTRACT.BAT C: /V
- 12) DEL SOURCE\EXTRACT.BAT

## Appendix B - SPECPR Availability

SPLIB04A is the digital form of the version 1 USGS Digital Spectral Library which has been published in paper copy as USGS Open-file Report 93-592 (Clark et al., 1993) and is available via anonymous ftp on the Internet. This Spectral Library describes various highly characterized mineral spectra. It is in IEEE-binary format and may be processed using the spectral processing software - SPECPR (Clark, 1993). SPECPR software runs on most UNIX systems, including Hewlett Packard (HP), and SUN workstations, and is available, along with future updates to the digital spectral data, via anonymous FTP on the internet:

```
ftp speclab.cr.usgs.gov
```

```
login as anonymous
```

```
password is your userid@machine
```

```
cd pub/spectral.library      (SPLIB04A digital library as found in this  
                             present open-file)
```

```
or: cd pub/specpr           (SPECPR software)  
or: cd pub/spsearch        (SPSEARCH software)  
or: cd pub/spview          (SPVIEW software)
```

```
get README
```

Follow instructions in the README file for obtaining the data.

for hardcopies (see Reference Section) contact:

USGS Dept. of the Interior  
Books and Open-File Reports Section  
U.S. Geological Survey  
Box 25425, Denver Federal Center  
Denver, CO 80225 (303) 236-7476

for information, contact:

Roger N. Clark  
U. S. Geological Survey  
MS 964  
Box 25046  
Denver Federal Center  
Denver, CO 80225

rclark@speclab.cr.usgs.gov (303) 236-1332

**Appendix C - Included Spectra: USGS mineral spectral library file SPLIB04A (IEEE-binary format)**

**TITLE DESCRIPTION SPECTRAL CLASSIFICATION CODE**

- W1 - wavelength range 1
- R1 - resolution range 1
- B - Beckman spectrometer
- a, b, c, d, ? - quality of spectrum
  - a - pure
  - b - spectrally pure, might contain mineral impurities
  - c - spectrally pure except for some weak features
  - d - significant spectral contamination
  - ? - insufficient analysis of purity
- ABS REF - ABSOLUTE REFLECTANCE (calibrated reflectance data)

deleted points are assigned a value of  $-1.23 \times 10^{34}$  (-1.23E+34)

**MINERAL TABLE OF CONTENTS**

Record Number	Spectrum Description Title			
-----	-----			
16	Acmite NMNH133746	W1R1Ba	ABS	REF
28	Actinolite HS116.3B	W1R1Bb	ABS	REF
40	Actinolite HS22.3B	W1R1Bb	ABS	REF
51	Actinolite HS315.4B	W1R1Bb	ABS	REF
62	Actinolite NMNH80714	W1R1Bb	ABS	REF
73	Actinolite NMNHR16485	W1R1Ba	ABS	REF
84	Adularia GDS57 Orthoclase	W1R1Ba	ABS	REF
95	Albite GDS30 74-250um fr	W1R1Ba	ABS	REF
106	Albite HS324.3B	W1R1Bc	ABS	REF
117	Albite HS66.3B	W1R1Bc	ABS	REF
128	Allanite HS293.3B	W1R1Bb	ABS	REF
140	Almandine HS114.3B	W1R1B?	ABS	REF
151	Almandine WS475	W1R1B?	ABS	REF
162	Almandine WS476	W1R1Bb	ABS	REF
172	Almandine WS477	W1R1Bb	ABS	REF
183	Almandine WS478	W1R1B?	ABS	REF
193	Almandine WS479	W1R1Bb	ABS	REF
204	Alunite GDS84 Na03	W1R1Ba	ABS	REF
215	Alunite GDS83 Na63	W1R1Ba	ABS	REF
226	Alunite GDS82 Na82	W1R1Ba	ABS	REF
239	Alunite AL706 Na__	W1R1Bb	ABS	REF
251	Alunite HS295.3B	W1R1Ba	ABS	REF
261	Alunite SUSTDA-20	W1R1Ba	ABS	REF
271	Ammonioalunite NMNH145596	W1R1Bd	ABS	REF
281	Ammonium Chloride GDS77	W1R1Ba	ABS	REF
291	Ammonio-jarosite SCR-NHJ	W1R1B?	ABS	REF
301	Ammonio-Illite/Smec GDS87	W1R1B?	ABS	REF
311	Ammonio-Smectite GDS86	W1R1B?	ABS	REF
322	Amphibole NMNH78662	W1R1B?	ABS	REF

Record Number	Spectrum Description	Title			
333	Analcime	GDS1	W1R1Ba	ABS	REF
345	Andalusite	NMNR17898	W1R1Bc	ABS	REF
356	Andesine	HS142.3B	W1R1Bc	ABS	REF
367	Andradite	GDS12	W1R1Bc	ABS	REF
378	Andradite	HS111.3B	W1R1B?	ABS	REF
390	Andradite	NMNH113829	W1R1Ba	ABS	REF
401	Andradite	WS487	W1R1Bc	ABS	REF
412	Andradite	WS488	W1R1Bc	ABS	REF
423	Anhydrite	GDS42 <250um	W1R1Ba	ABS	REF
435	Annite	WS660	W1R1Ba	ABS	REF
446	Annite	WS661	W1R1Ba	ABS	REF
457	Anorthite	GDS28 Synth.<74	W1R1Ba	ABS	REF
467	Anorthite	HS201.3B	W1R1Ba	ABS	REF
479	Anorthite	HS349.3B	W1R1Bc	ABS	REF
490	Anthophyllite	HS286.3B	W1R1Bb	ABS	REF
502	Antigorite	NMNH96917 >250	W1R1Bb	ABS	REF
514	Antigorite	NMNH96917 165u	W1R1Bb	ABS	REF
526	Antigorite	NMNH96917 120u	W1R1Bb	ABS	REF
538	Antigorite	NMNH96917 70um	W1R1Bb	ABS	REF
550	Antigorite	NMNH96917 32um	W1R1Bb	ABS	REF
562	Antigorite	NMNH96917 <30u	W1R1Bb	ABS	REF
573	Antigorite	NMNH17958	W1R1Bb	ABS	REF
583	Arsenopyrite	HS262.3B	W1R1Bc	ABS	REF
594	Augite	NMNH120049	W1R1Bb	ABS	REF
604	Augite	WS588	W1R1Ba	ABS	REF
614	Augite	WS592	W1R1Bb	ABS	REF
625	Axinite	HS342.3B	W1R1Bb	ABS	REF
635	Azurite	WS316	W1R1B?	ABS	REF
646	Barite	HS79.3B	W1R1Bb	ABS	REF
656	Bassanite	GDS145 (syn)	W1R1Ba	ABS	REF
666	Beryl	GDS9 <150um gs	W1R1Bb	ABS	REF
678	Beryl	HS180.3B	W1R1Ba	ABS	REF
690	Biotite	HS28.3B	W1R1Bb	ABS	REF
700	Bloedite	GDS147	W1R1Ba	ABS	REF
711	Bronzite	HS9.3B	W1R1Bc	ABS	REF
720	Brookite	HS443.2B	W1R1B?	ABS	REF
732	Brucite	HS247.3B	W1R1Bc	ABS	REF
744	Buddingtonite	GDS85 D-206	W1R1Bb	ABS	REF
754	Buddingtonite	NHB2301	W1R1Bb	ABS	REF
765	Butlerite	GDS25	W1R1Ba	ABS	REF
776	Bytownite	HS106.3B	W1R1Bc	ABS	REF
787	Calcite	WS272	W1R1Ba	ABS	REF
799	Calcite	HS48.3B	W1R1Ba	ABS	REF
809	Calcite	CO2004	W1R1Bb	ABS	REF
820	Carbon Black	GDS68 sm.ap.	W1R1Ba	ABS	REF
830	Carnallite	NMNH98011	W1R1Ba	ABS	REF
840	Carnallite	HS430.3B	W1R1Ba	ABS	REF
852	Cassiterite	HS279.3B	W1R1Bc	ABS	REF
862	Celestite	HS251.3B	W1R1Ba	ABS	REF
873	Celsian	HS200.3B	W1R1Bd	ABS	REF
884	Chabazite	HS193.3B	W1R1Bb	ABS	REF
894	Chalcedony	CU91-6A	W1R1Bb	ABS	REF
905	Chalcopyrite	HS431.3B	W1R1Bb	ABS	REF
915	Chalcopyrite	S26-36	W1R1Bb	ABS	REF
924	Chert	ANP90-6D (White)	W1R1B?	ABS	REF
938	Chlorapatite	WS423	W1R1Ba	ABS	REF
949	Chlorite	HS179.3B	W1R1Ba	ABS	REF
961	Chlorite	SMR-13.a 104-150	W1R1Ba	ABS	REF
973	Chlorite	SMR-13.b 60-104u	W1R1Ba	ABS	REF

Record Number	Spectrum Description Title				
985	Chlorite SMR-13.c 45-60um	W1R1Ba	ABS	REF	
997	Chlorite SMR-13.d 30-45um	W1R1Ba	ABS	REF	
1009	Chlorite SMR-13.e <30um	W1R1Ba	ABS	REF	
1020	Chromite HS281.3B	W1R1Ba	ABS	REF	
1031	Chrysocolla HS297.3B	W1R1Bb	ABS	REF	
1042	Chrysotile HS323.1B	W1R1Ba	ABS	REF	
1053	Cinnabar HS133.3B	W1R1Bc	ABS	REF	
1064	Clinochlore NMNH83369	W1R1Ba	ABS	REF	
1076	Clinochlore_Fe GDS157	W1R1Ba	ABS	REF	
1088	Clinochlore GDS158 Flagst	W1R1Ba	ABS	REF	
1099	Clinochlore GDS159	W1R1Ba	ABS	REF	
1110	Clinochlore_Fe SC-CCa-1.a	W1R1Ba	ABS	REF	
1121	Clinochlore_Fe SC-CCa-1.b	W1R1Ba	ABS	REF	
1132	Clinochlore_Fe SC-CCa-1.c	W1R1Ba	ABS	REF	
1143	Clinoptilolite GDS2	W1R1Bb	ABS	REF	
1153	Clinoptilolite GDS152	W1R1Ba	ABS	REF	
1164	Clinozoisite HS299.2B	W1R1Bd	ABS	REF	
1175	Clintonite NMNH126553	W1R1Bb	ABS	REF	
1186	Cobaltite HS264.3B	W1R1Bb	ABS	REF	
1195	Colemanite GDS143	W1R1Ba	ABS	REF	
1206	Cookeite CAR-1.a 104-150u	W1R1Bb	ABS	REF	
1217	Cookeite CAR-1.b 60-104um	W1R1Bb	ABS	REF	
1228	Cookeite CAR-1.c <30um	W1R1Bb	ABS	REF	
1239	Copiapite GDS21	W1R1Ba	ABS	REF	
1249	Coquimbite GDS22	W1R1B?	ABS	REF	
1260	Cordierite HS346.3B	W1R1Bd	ABS	REF	
1271	Corrensite CorWa-1	W1R1Bb	ABS	REF	
1282	Corundum HS283.3B	W1R1Ba	ABS	REF	
1292	Covellite HS477.2B	W1R1Bb	ABS	REF	
1301	Cronstedtite M3542	W1R1Bb	ABS	REF	
1313	Cumingtonite HS294.3B	W1R1B?	ABS	REF	
1323	Cuprite HS127.3B	W1R1Bb	ABS	REF	
1333	Datolite HS442.3B	W1R1Bb	ABS	REF	
1344	Datolite SU51399	W1R1Bb	ABS	REF	
1355	Desert_Varnish GDS141	W1R1Ba	ABS	REF	
1365	Desert_Varnish GDS78A Rhy	W1R1Ba	ABS	REF	
1374	Desert_Varnish ANP90-14	W1R1Ba	ABS	REF	
1388	Diaspore HS416.3B	W1R1Ba	ABS	REF	
1398	Dickite NMNH106242	W1R1Ba	ABS	REF	
1408	Dickite NMNH46967	W1R1Ba	ABS	REF	
1418	Diopside HS317.3B (Cr)	W1R1Bc	ABS	REF	
1429	Diopside HS15.3B	W1R1Bc	ABS	REF	
1440	Diopside NMNHR18685 ~160	W1R1Bb	ABS	REF	
1451	Dipyre BM1959,505.HLsp	W1R1Bb	ABS	REF	
1462	Dolomite HS102.3B	W1R1Bb	ABS	REF	
1472	Dolomite COD2005	W1R1Bb	ABS	REF	
1483	Dumortierite HS190.3B	W1R1Bc	ABS	REF	
1495	Elbaite NMNH94217-1.a 659	W1R1Ba	ABS	REF	
1507	Elbaite NMNH94217-1.b 196	W1R1Ba	ABS	REF	
1519	Elbaite NMNH94217-1.c <74	W1R1Ba	ABS	REF	
1529	Endellite GDS16	W1R1Bb	ABS	REF	
1541	Enstatite NMNH128288	W1R1Bc	ABS	REF	
1552	Epidote GDS26.a 75-200um	W1R1Bb	ABS	REF	
1564	Epidote GDS26.b <75um	W1R1Bb	ABS	REF	
1575	Epidote HS328.3B	W1R1Bb	ABS	REF	
1585	Epsomite GDS149	W1R1Bc	ABS	REF	
1596	Erionite+Offretite GDS72	W1R1Bb	ABS	REF	
1606	Erionite+Merlinoit GDS144	W1R1Bb	ABS	REF	
1615	Eugsterite GDS140 Syn	W1R1Bb	ABS	REF	

Record Number	Spectrum Description Title				
1625	Europium_Oxide GDS33	W1R1Ba	ABS	REF	
1637	Fassaite HS118.3B	W1R1Bc	ABS	REF	
1647	Ferrihydrite GDS75 Sy, F6	W1R1Bb	ABS	REF	
1657	Fluorapatite WS416	W1R1Ba	ABS	REF	
1668	Galena HS37.3	W1R1Bb	ABS	REF	
1679	Galena S102-17	W1R1Bb	ABS	REF	
1689	Galena S102-1B	W1R1Bb	ABS	REF	
1699	Galena S105-2	W1R1Bb	ABS	REF	
1710	Galena S26-39	W1R1Bb	ABS	REF	
1720	Galena S26-40	W1R1Bb	ABS	REF	
1729	Gaylussite NMNH102876-2	W1R1Bb	ABS	REF	
1739	Gibbsite HS423.3B	W1R1Bb	ABS	REF	
1749	Gibbsite WS214	W1R1Bb	ABS	REF	
1760	Glauconite HS313.3B	W1R1Bc	ABS	REF	
1771	Glaucothane HS426.3B	W1R1Bd	ABS	REF	
1781	Goethite WS222	W1R1Ba	ABS	REF	
1792	Goethite HS36.3	W1R1Bb	ABS	REF	
1802	Goethite WS219 (limonite)	W1R1Bc	ABS	REF	
1813	Goethite WS220	W1R1Bc	ABS	REF	
1824	Grossular HS113.3B-HCL	W1R1B?	ABS	REF	
1835	Grossular NMNH155371	W1R1Bc	ABS	REF	
1846	Grossular WS485	W1R1Bc	ABS	REF	
1857	Grossular WS483	W1R1Bb	ABS	REF	
1868	Grossular WS484	W1R1Bc	ABS	REF	
1879	Gypsum HS333.3B	W1R1Ba	ABS	REF	
1889	Gypsum SU2202	W1R1Ba	ABS	REF	
1900	H2O-Ice GDS136 77K	W1R1Ba	ABS	REF	
1910	Halite HS433.3B	W1R1Ba	ABS	REF	
1920	Halloysite NMNH106236	W1R1Ba	ABS	REF	
1930	Halloysite NMNH106237	W1R1Ba	ABS	REF	
1942	Halloysite CM13	W1R1Bb	ABS	REF	
1952	Halloysite KLH503	W1R1Bb	ABS	REF	
1963	Halloysite+Kaolinite CM29	W1R1Ba	ABS	REF	
1974	Hectorite SHCa-1	W1R1Bb	ABS	REF	
1985	Hectorite SHCa-1.Ac-B	W1R1Ba	ABS	REF	
1995	Hedenbergite NMNH119197	W1R1Bb	ABS	REF	
2006	Hedenbergite HS10.3B	W1R1Bc	ABS	REF	
2015	Hematite=2%+98%Qtz GDS76	W1R1Ba	ABS	REF	
2025	Hematite GDS27	W1R1Ba	ABS	REF	
2036	Hematite GDS69.a 150-250u	W1R1Ba	ABS	REF	
2047	Hematite GDS69.b 104-150u	W1R1Ba	ABS	REF	
2058	Hematite GDS69.c 60-104um	W1R1Ba	ABS	REF	
2069	Hematite GDS69.d 30-45um	W1R1Ba	ABS	REF	
2080	Hematite GDS69.e 20-30um	W1R1Ba	ABS	REF	
2091	Hematite GDS69.f 10-20um	W1R1Ba	ABS	REF	
2103	Hematite GDS69.g <10um	W1R1Ba	ABS	REF	
2113	Hematite HS45.3	W1R1B?	ABS	REF	
2122	Hematite WS161	W1R1Bb	ABS	REF	
2132	Hematite FE2602	W1R1Bb	ABS	REF	
2143	Heulandite GDS3	W1R1Ba	ABS	REF	
2153	Heulandite NMNH84534	W1R1Ba	ABS	REF	
2164	Holmquistite HS291.3B	W1R1Bd	ABS	REF	
2174	Hornblende_Mg NMNH117329	W1R1Ba	ABS	REF	
2185	Hornblende_Fe HS115.3B	W1R1Bc	ABS	REF	
2196	Hornblende HS16.3B	W1R1Bc	ABS	REF	
2208	Hornblende HS177.3B	W1R1Bc	ABS	REF	
2218	Howlite GDS155	W1R1Ba	ABS	REF	
2229	Hydrogrossular NMNH120555	W1R1B?	ABS	REF	
2240	Hydroxyl-Apatite WS425	W1R1B?	ABS	REF	



Record Number	Spectrum Description	Title			
2251	Hypersthene NMNHC2368	W1R1Bb	ABS	REF	
2263	Hypersthene PYX02.h >250u	W1R1Bc	ABS	REF	
2274	Hypersthene PYX02.c 180um	W1R1Bc	ABS	REF	
2285	Hypersthene PYX02.b 120um	W1R1Bc	ABS	REF	
2296	Hypersthene PYX02.f 60um	W1R1Bc	ABS	REF	
2308	Hypersthene PYX02.e 34um	W1R1Bc	ABS	REF	
2319	Hypersthene PYX02.d 23um	W1R1Bc	ABS	REF	
2330	Hypersthene PYX02.a 12um	W1R1Bc	ABS	REF	
2341	Hypersthene PYX02.g 7um	W1R1Bc	ABS	REF	
2351	Illite GDS4 (Marblehead)	W1R1Bb	ABS	REF	
2362	Illite IMt-1.a	W1R1Bb	ABS	REF	
2373	Illite IMt-1.b <2um	W1R1Ba	ABS	REF	
2383	Illite IL101 (2M2)	W1R1Bb	ABS	REF	
2393	Illite IL105 (1Md)	W1R1Bd	ABS	REF	
2403	Ilmenite HS231.3B	W1R1Ba	ABS	REF	
2414	Jadeite HS343.3B	W1R1B?	ABS	REF	
2425	Jarosite GDS99 K,Sy 200C	W1R1Ba	ABS	REF	
2436	Jarosite GDS98 K,Sy 90C	W1R1Ba	ABS	REF	
2446	Jarosite GDS100 Na,Sy 90C	W1R1Ba	ABS	REF	
2456	Jarosite GDS101 Na,Sy 200	W1R1Ba	ABS	REF	
2467	Jarosite GDS24 Na	W1R1Ba	ABS	REF	
2477	Jarosite JR2501 K	W1R1Bb	ABS	REF	
2487	Jarosite NMNH95074-1 Na	W1R1Bb	ABS	REF	
2498	Jarosite WS368 Pb	W1R1Bb	ABS	REF	
2508	Jarosite SJ-1 H3O,10-20%	W1R1Ba	ABS	REF	
2518	Kainite NMNH83904	W1R1Ba	ABS	REF	
2529	Kaolinite CM9	W1R1Bb	ABS	REF	
2540	Kaolinite KGa-1 (wxyl)	W1R1Bb	ABS	REF	
2552	Kaolinite KGa-2 (pxyl)	W1R1Bb	ABS	REF	
2563	Kaolinite KL502 (pxyl)	W1R1Bb	ABS	REF	
2574	Kaolinite GDS11 <63um	W1R1Bb	ABS	REF	
2585	Kaolinite CM3	W1R1Ba	ABS	REF	
2597	Kaolinite CM5	W1R1Bb	ABS	REF	
2609	Kaolinite CM7	W1R1Bb	ABS	REF	
2621	Kaolin/Smect KLF506 95%K	W1R1Bb	ABS	REF	
2632	Kaolin/Smect KLF508 85%K	W1R1Bb	ABS	REF	
2643	Kaolin/Smect H89-FR-2 50K	W1R1Bb	ABS	REF	
2654	Kaolin/Smect H89-FR-5 30K	W1R1Bb	ABS	REF	
2665	Kaolin/Smect KLF511 12%K	W1R1Bb	ABS	REF	
2675	Kerogen BK-Cornell	W1R1Ba	ABS	REF	
2685	Labradorite HS105.3B	W1R1B?	ABS	REF	
2696	Labradorite HS17.3B	W1R1B?	ABS	REF	
2706	Laumontite GDS5	W1R1Bb	ABS	REF	
2716	Lazurite HS418.3B	W1R1B?	ABS	REF	
2727	Lepidocrosite GDS80 (Sy)	W1R1B?	ABS	REF	
2737	Lepidolite HS167.3B	W1R1B?	ABS	REF	
2747	Lepidolite NMNH105538	W1R1B?	ABS	REF	
2757	Lepidolite NMNH105543	W1R1B?	ABS	REF	
2767	Lepidolite NMNH88526-1	W1R1Ba	ABS	REF	
2777	Lepidolite NMNH105541	W1R1B?	ABS	REF	
2788	Limonite HS41.3	W1R1B?	ABS	REF	
2798	Lizardite NMNHR4687.a 280	W1R1Ba	ABS	REF	
2809	Lizardite NMNHR4687.b 165	W1R1Ba	ABS	REF	
2820	Lizardite NMNHR4687.c 70	W1R1Ba	ABS	REF	
2831	Lizardite NMNHR4687.d <30	W1R1Ba	ABS	REF	
2842	Maghemite GDS81 Sy (M-3)	W1R1Ba	ABS	REF	
2853	Magnesite+Hydroma HS47.3B	W1R1Ba	ABS	REF	
2864	Magnetite HS195.3B	W1R1Bb	ABS	REF	
2874	Magnetite HS78.3B	W1R1Bb	ABS	REF	

Record Number	Spectrum Description	Title			
2885	Malachite HS254.3B	W1R1Bb	ABS	REF	
2895	Manganite HS138.3B	W1R1Bb	ABS	REF	
2905	Margarite GDS106	W1R1B?	ABS	REF	
2916	Marialite NMNH126018-2	W1R1Bb	ABS	REF	
2926	Mascagnite GDS65.a (crs)	W1R1Ba	ABS	REF	
2936	Mascagnite GDS65.b (fn)	W1R1Ba	ABS	REF	
2947	Meionite WS700.HLsep	W1R1Bb	ABS	REF	
2958	Meionite WS701	W1R1Bb	ABS	REF	
2969	Mesolite+Hydroxyapop GDS6	W1R1B?	ABS	REF	
2979	Microcline HS82.3B	W1R1Bb	ABS	REF	
2990	Microcline HS103.3B	W1R1Bc	ABS	REF	
3001	Microcline HS107.3B	W1R1Bd	ABS	REF	
3012	Microcline HS108.3B	W1R1Bc	ABS	REF	
3023	Microcline HS151.3B	W1R1Bc	ABS	REF	
3033	Microcline NMNH135231	W1R1Bc	ABS	REF	
3043	Mirabilite GDS150 Na2SO4	W1R1Ba	ABS	REF	
3053	Mizzonite NMNH113775-1	W1R1Bb	ABS	REF	
3064	Mizzonite BM1931,12	W1R1Bb	ABS	REF	
3076	Mizzonite HS350.3B HLSep	W1R1Ba	ABS	REF	
3088	Mizzonite HS351.3BS	W1R1Ba	ABS	REF	
3100	Monazite HS255.3B	W1R1Bc	ABS	REF	
3111	Monticellite HS339.3B	W1R1Bc	ABS	REF	
3122	Montmorillonite SWy-1	W1R1Bb	ABS	REF	
3133	Montmorillonite SAz-1	W1R1Bb	ABS	REF	
3144	Montmorillonite SCa-2.a	W1R1Bb	ABS	REF	
3155	Montmorillonite SCa-2.b	W1R1Ba	ABS	REF	
3166	Montmorillonite CM27	W1R1Bb	ABS	REF	
3177	Montmorillonite CM20	W1R1Bb	ABS	REF	
3189	Montmorillonite CM26	W1R1Bb	ABS	REF	
3202	Montmorillonite STx-1	W1R1Bb	ABS	REF	
3213	Montmorillonite+Illite CM37	W1R1Bc	ABS	REF	
3224	Montmorillonite+Illite CM42	W1R1Bc	ABS	REF	
3235	Mordenite GDS18	W1R1Bb	ABS	REF	
3245	Mordenite+Clinopt. GDS151	W1R1Bb	ABS	REF	
3254	Muscovite GDS107	W1R1Bb	ABS	REF	
3265	Muscovite GDS108	W1R1B?	ABS	REF	
3276	Muscovite GDS111 Guatemal	W1R1Ba	ABS	REF	
3287	Muscovite GDS113 Ruby	W1R1Ba	ABS	REF	
3298	Muscovite GDS114 Marshall	W1R1Ba	ABS	REF	
3309	Muscovite GDS116 Tanzania	W1R1Ba	ABS	REF	
3320	Muscovite GDS117 Isinglas	W1R1Ba	ABS	REF	
3331	Muscovite GDS118 Capitan	W1R1Ba	ABS	REF	
3342	Muscovite GDS119 Mt Alamo	W1R1Ba	ABS	REF	
3353	Muscovite GDS120 Pegma M.	W1R1Ba	ABS	REF	
3364	Muscovite HS146.3B	W1R1Ba	ABS	REF	
3375	Muscovite HS24.3	W1R1Bb	ABS	REF	
3385	Muscovite IL107	W1R1Ba	ABS	REF	
3396	Nacrite GDS88	W1R1Bc	ABS	REF	
3407	Natrolite HS169.3B	W1R1Bb	ABS	REF	
3418	Natrolite+Zeolit HS168.3B	W1R1Bc	ABS	REF	
3428	Natrolite NMNH83380	W1R1B?	ABS	REF	
3439	Neodymium_Oxide GDS34	W1R1Ba	ABS	REF	
3451	Nepheline HS19.3	W1R1Bc	ABS	REF	
3462	Nephrite HS296.3B	W1R1Bc	ABS	REF	
3472	Niter GDS43 (K-Salt peter)	W1R1Ba	ABS	REF	
3483	Nontronite GDS41	W1R1B?	ABS	REF	
3494	Nontronite NG-1.a	W1R1Bb	ABS	REF	
3505	Nontronite NG-1.b <2um fr	W1R1Bb	ABS	REF	
3516	Nontronite SWa-1.a	W1R1Bb	ABS	REF	

Record Number	Spectrum Description Title					
3527	Nontronite SWa-1.b	<2um	W1R1Ba	ABS	REF	
3538	Oligoclase HS110.3B		W1R1Bc	ABS	REF	
3548	Oligoclase HS143.3B		W1R1Bc	ABS	REF	
3559	Olivine NMNH137044.a	160u	W1R1Ba	ABS	REF	
3570	Olivine NMNH137044.b	<74u	W1R1Ba	ABS	REF	
3581	Olivine GDS70.a	GSB 165um	W1R1Bc	ABS	REF	
3592	Olivine GDS70.b	GSB 115um	W1R1Bc	ABS	REF	
3603	Olivine GDS70.c	GSB 70um	W1R1Bc	ABS	REF	
3614	Olivine GDS70.d	GSB <60um	W1R1Bc	ABS	REF	
3625	Olivine HS285.4B		W1R1Bb	ABS	REF	
3636	Olivine HS420.3B		W1R1Bc	ABS	REF	
3647	Olivine KI3005	<60um	W1R1Bb	ABS	REF	
3658	Olivine KI3054	<60um	W1R1Bc	ABS	REF	
3669	Olivine KI3188	<60um	W1R1Bc	ABS	REF	
3680	Olivine KI3189	<60um	W1R1Ba	ABS	REF	
3691	Olivine KI3291	<60um	W1R1Bc	ABS	REF	
3702	Olivine KI3377	<60um	W1R1Bc	ABS	REF	
3713	Olivine KI4143	<60um	W1R1Bc	ABS	REF	
3724	Olivine GDS71.a	TSD 65um	W1R1Bb	ABS	REF	
3735	Olivine GDS71.b	TSD <60um	W1R1Bb	ABS	REF	
3745	Opal WS732		W1R1B?	ABS	REF	
3755	Opal TM8896 (Hyalite)		W1R1Ba	ABS	REF	
3765	Orthoclase NMNH113188		W1R1Ba	ABS	REF	
3775	Orthoclase NMNH142137	Fe	W1R1Bb	ABS	REF	
3786	Orthoclase HS13.3B		W1R1B?	ABS	REF	
3798	Palygorskite CM46		W1R1Bb	ABS	REF	
3808	Palygorskite PFL-1		W1R1Bb	ABS	REF	
3820	Paragonite GDS109		W1R1Ba	ABS	REF	
3831	Pectolite NMNH94865.a		W1R1Ba	ABS	REF	
3841	Pectolite NMNH94865.b		W1R1Ba	ABS	REF	
3851	Perthite HS415.3B		W1R1Bc	ABS	REF	
3862	Phlogopite GDS20	fine fr	W1R1Bb	ABS	REF	
3874	Phlogopite HS23.3B		W1R1Ba	ABS	REF	
3885	Phlogopite WS496		W1R1B?	ABS	REF	
3895	Phlogopite WS675		W1R1B?	ABS	REF	
3906	Pigeonite HS199.3B		W1R1Bb	ABS	REF	
3916	Pinnoite NMNH123943		W1R1Ba	ABS	REF	
3926	Pitch Limonite GDS104	Cu	W1R1B?	ABS	REF	
3935	Polyhalite NMNH92669-4		W1R1Ba	ABS	REF	
3946	Praseodymium Oxide GDS35		W1R1Ba	ABS	REF	
3956	Prochlorite SMR-14.a	115u	W1R1Ba	ABS	REF	
3967	Prochlorite SMR-14.b	32u	W1R1Ba	ABS	REF	
3978	Prochlorite SMR-14.c	<30u	W1R1Ba	ABS	REF	
3989	Psilomelane HS139.3B		W1R1Bb	ABS	REF	
3999	Pyrite HS35.3		W1R1B?	ABS	REF	
4009	Pyrite S142-1		W1R1B?	ABS	REF	
4019	Pyrite S26-8		W1R1B?	ABS	REF	
4029	Pyrite S29-4		W1R1B?	ABS	REF	
4039	Pyrite S30		W1R1B?	ABS	REF	
4049	Pyrope WS474		W1R1B?	ABS	REF	
4060	Pyrophyllite PYS1A	fine g	W1R1Ba	ABS	REF	
4071	Pyrophyllite PYS1A	<850um	W1R1Ba	ABS	REF	
4081	Pyrophyllite SU1421		W1R1Bb	ABS	REF	
4092	Pyroxene HS119.3B		W1R1Bc	ABS	REF	
4103	Pyrrhotite HS269.3B		W1R1B?	ABS	REF	
4113	Quartz HS117.3B	Aventurin	W1R1Bb	ABS	REF	
4124	Quartz GDS31	0-74um fr	W1R1Ba	ABS	REF	
4135	Quartz HS32.4B		W1R1Ba	ABS	REF	
4145	Quartz GDS74	Sand Ottawa	W1R1Bc	ABS	REF	

Record Number	Spectrum Description	Title			
4155	Rectorite	ISR202 (RAR-1)	W1R1B?	ABS	REF
4166	Rectorite	RAR-1	W1R1Bd	ABS	REF
4176	Rhodochrosite	HS338.3B	W1R1Bb	ABS	REF
4187	Rhodochrosite	HS67 <250um	W1R1Bb	ABS	REF
4198	Rhodonite	NMNH6148 >250u	W1R1Ba	ABS	REF
4208	Rhodonite	HS325.3B	W1R1Bc	ABS	REF
4219	Richterite	HS336.3B	W1R1Bc	ABS	REF
4230	Richterite	NMNH150800 HCl	W1R1Bb	ABS	REF
4241	Riebeckite	NMNH122689	W1R1Ba	ABS	REF
4252	Riebeckite	HS326.3B	W1R1Bd	ABS	REF
4262	Rivadavite	NMNH170164	W1R1Ba	ABS	REF
4273	Roscoelite	EN124	W1R1Bb	ABS	REF
4284	Rutile	HS126.3B	W1R1Bc	ABS	REF
4295	Rutile	HS137.3B	W1R1Bd	ABS	REF
4305	Samarium Oxide	GDS36	W1R1Ba	ABS	REF
4317	Sanidine	GDS19	W1R1Ba	ABS	REF
4328	Sanidine	NMNH103200	W1R1Ba	ABS	REF
4339	Saponite	SapCa-1	W1R1Bb	ABS	REF
4350	Saponite	SapCa-1.AcB	W1R1Bb	ABS	REF
4359	Sauconite	GDS135	W1R1B?	ABS	REF
4369	Scolecite	GDS7 acid trtd	W1R1Bb	ABS	REF
4380	Sepiolite	SepNev-1.AcB	W1R1Ba	ABS	REF
4391	Sepiolite	SepNev-1	W1R1Bb	ABS	REF
4402	Sepiolite	SepSp-1	W1R1Bb	ABS	REF
4413	Sepiolite	SepSp-1.AcB	W1R1Bb	ABS	REF
4424	Serpentine	HS318.4B	W1R1Bc	ABS	REF
4435	Serpentine	HS8.3B	W1R1Bc	ABS	REF
4445	Siderite	HS271.3B	W1R1Ba	ABS	REF
4456	Siderophyllite	NMNH104998	W1R1Bb	ABS	REF
4467	Sillimanite	HS186.3B	W1R1Bc	ABS	REF
4478	Smaragdite	HS290.3B	W1R1Bb	ABS	REF
4488	Sodium Bicarbonate	GDS55	W1R1Ba	ABS	REF
4499	Spessartine	NMNH14143	W1R1Ba	ABS	REF
4510	Spessartine	HS112.3B	W1R1Bb	ABS	REF
4520	Spessartine	WS480	W1R1Bb	ABS	REF
4530	Spessartine	WS481	W1R1B?	ABS	REF
4541	Sphalerite	HS136.3B	W1R1B?	ABS	REF
4552	Sphalerite	S102-7	W1R1Bc	ABS	REF
4562	Sphalerite	S102-8	W1R1Bc	ABS	REF
4572	Sphalerite	S26-34	W1R1Bb	ABS	REF
4582	Sphalerite	S26-35	W1R1Bb	ABS	REF
4593	Sphene	HS189.3B	W1R1Bb	ABS	REF
4604	Spodumene	HS210.3B	W1R1Bc	ABS	REF
4615	Staurolite	HS188.3B	W1R1Bb	ABS	REF
4625	Stilbite	GDS8	W1R1B?	ABS	REF
4635	Stilbite	HS482.3B	W1R1B?	ABS	REF
4645	Strontianite	HS272.3B	W1R1Bb	ABS	REF
4655	Sulfur	GDS94 Reagent	W1R1Ba	ABS	REF
4665	Syngenite	GDS139	W1R1Ba	ABS	REF
4675	Talc	GDS23 74-250um fr	W1R1Ba	ABS	REF
4687	Talc	HS21.3B	W1R1Bb	ABS	REF
4698	Talc	WS659	W1R1Bb	ABS	REF
4708	Talc	TL2702	W1R1Ba	ABS	REF
4718	Teepelite+Tron	NMNH102798	W1R1Bc	ABS	REF
4729	Tephroite	HS419.3B	W1R1Bc	ABS	REF
4739	Thenardite	GDS146	W1R1Bc	ABS	REF
4749	Thenardite	HS450.3B	W1R1Ba	ABS	REF
4760	Thuringite	SMR-15.a 115um	W1R1Ba	ABS	REF
4771	Thuringite	SMR-15.b 80um	W1R1Ba	ABS	REF

Record Number	Spectrum Description Title				
4782	Thuringite SMR-15.c 32um	W1R1Ba	ABS	REF	
4793	Thuringite SMR-15.d <30um	W1R1Ba	ABS	REF	
4803	Tincalconite GDS142	W1R1Ba	ABS	REF	
4814	Topaz Wigwam_Area_A_#10	W1R1Bb	ABS	REF	
4826	Topaz Wigwam_Area_2_#12	W1R1Bb	ABS	REF	
4837	Topaz Wigwam_Area_3_#13	W1R1Bb	ABS	REF	
4848	Topaz Wigwam_Area_4_#14	W1R1Bb	ABS	REF	
4859	Topaz Wigwam_Area_5_#15	W1R1Bb	ABS	REF	
4870	Topaz Wigwam_Area_6_#16	W1R1Bb	ABS	REF	
4882	Topaz Harris_Park_#17	W1R1Bb	ABS	REF	
4894	Topaz Crystal_Park_#2	W1R1Bb	ABS	REF	
4906	Topaz Jos_#22	W1R1Bb	ABS	REF	
4918	Topaz Harris_Park_#3	W1R1Bb	ABS	REF	
4930	Topaz Tarryalls_#4	W1R1Bb	ABS	REF	
4942	Topaz Little_3_Mine_#41	W1R1Bb	ABS	REF	
4953	Topaz Cameron_Cone_#42	W1R1Bb	ABS	REF	
4965	Topaz Mt._Antero_#5	W1R1Bb	ABS	REF	
4977	Topaz Glen_Cove_#6	W1R1Bb	ABS	REF	
4989	Topaz Glen_Cove_#8	W1R1Bb	ABS	REF	
5000	Topaz Harris_Park_#9	W1R1Bb	ABS	REF	
5010	Topaz HS184.3B	W1R1Bc	ABS	REF	
5022	Tourmaline HS282.2B	W1R1Bc	ABS	REF	
5033	Tremolite HS18.3	W1R1Bc	ABS	REF	
5044	Tremolite NMNH117611.HCl	W1R1Bc	ABS	REF	
5054	Trona GDS148	W1R1Ba	ABS	REF	
5064	Ulexite HS441.3B	W1R1Ba	ABS	REF	
5074	Ulexite GDS138 Boron, CA	W1R1Ba	ABS	REF	
5085	Uralite HS345.3B	W1R1Bb	ABS	REF	
5096	Uvarovite NMNH106661	W1R1Bb	ABS	REF	
5105	Vermiculite GDS13 Llano	W1R1Ba	ABS	REF	
5116	Vermiculite VTx-1.a <250	W1R1Bc	ABS	REF	
5127	Vermiculite VTx-1.flS	W1R1Bc	ABS	REF	
5137	Vermiculite WS681	W1R1Bc	ABS	REF	
5148	Vesuvianite HS446.3B	W1R1B?	ABS	REF	
5159	Witherite HS273.3B	W1R1Ba	ABS	REF	
5170	Wollastonite HS348.3B	W1R1Bb	ABS	REF	
5182	Zincite+Franklin HS147.3B	W1R1Bb	ABS	REF	
5191	Zircon WS522	W1R1B?	ABS	REF	
5202	Zoisite HS347.3B	W1R1Bb	ABS	REF	
5212	Aspen_Leaf-A DW92-2	W1R1Ba	ABS	REF	
5221	Aspen_Leaf-B DW92-3	W1R1Ba	ABS	REF	
5230	Blackbrush ANP92-9A leavs	W1R1Ba	ABS	REF	
5239	Blue_Spruce DW92-5 needle	W1R1Ba	ABS	REF	
5248	Cheatgrass ANP92-11A mix	W1R1Ba	ABS	REF	
5257	Dry_Long_Grass AV87-2	W1R1Ba	ABS	REF	
5266	Fir_Tree IH91-2 Complete	W1R1Ba	ABS	REF	
5276	Juniper_Bush IH91-4B whol	W1R1Ba	ABS	REF	
5286	Lawn_Grass GDS91 (Green)	W1R1Ba	ABS	REF	
5295	Maple_Leaves DW92-1	W1R1Ba	ABS	REF	
5304	Pinon_Pine ANP92-14A ndl	W1R1Ba	ABS	REF	
5313	Rabbitbrush ANP92-27 whol	W1R1Ba	ABS	REF	
5322	Russian_Olive DW92-4	W1R1Ba	ABS	REF	
5331	Sage_Brush IH91-1B Whole	W1R1Ba	ABS	REF	
5341	Saltbrush ANP92-31A Garrt	W1R1Ba	ABS	REF	
5350	Tumbleweed ANP92-2C Dry	W1R1Ba	ABS	REF	
5359	Walnut_Leaf SUN (Green)	W1R1Ba	ABS	REF	