U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Conversion of the Radiometric Age Data Bank (RADB) to the National Geochronological Data Base (NGDB)

by

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Open-File Report 93-336

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Introduction

The U.S. Geological Survey has maintained a database of geochronologic information since 1976. In 1991, this database was transferred from a mainframe computer to a microcomputer in order to facilitate wider dissemination of the geochronologic information. It is anticipated that this database will be part of a complete geologic information system in the future.

Background

The Radiometric Age Data Bank (RADB) was established in 1976 to catalog the increasing number of age determinations being made on rock units in the United States. It was designed with flexibility of data retrieval as a priority and contained sufficiently comprehensive supporting information to evaluate an age determination critically. The information in the database is gleaned primarily from published reports; interpretations of ages stored in the database are generally those of the original investigators except where later work has clearly revised the earlier interpretation. The database system used to manage the RADB is GIPSY (General Information Processing System); an Amdahl computer hosted the database.

Goal

The RADB required specialized knowledge in order to access its information. In fact, it was primarily operated by one person (R.F. Marvin) who provided reports of search requests by sending a printout to the requester after running a query of the RADB. The first step in providing wider access to the database is described in this report. The database was transferred to a Macintosh microcomputer running Double Helix relational database software. This system is much more flexible than the older system, both from the designers and end-user viewpoints. Data entry is more direct, creation of reports is interactive and the system is fast enough to provide immediate feedback for simple searches. This new database is known as the National Geochronological Data Base (NGDB).

The primary purpose of this report is to document the changes made to the database during the transfer of information from the RADB to the NGDB and to show the methods used so that any errors inadvertently caused by the transfer may be traced. In order to discuss the conversion process, the structure of the RADB must be understood. Each record in the RADB may contain information for hundreds of fields; the stored information includes geographic coordinates, geologic description, reference, and up to five sets of fields for each age system: potassium-argon (K-Ar), rubidium-strontium (Rb-Sr), uranium-thorium-lead (U-Th-Pb), fission-track, and lead-alpha. The output from the RADB is specified by means of "dictionary" files, which determine which fields are printed and the format of the printed output. Each field is labeled by a short alpha-numeric name (e.g. B20); these field labels are coded according to the type of information in the field and it is this coding that indicates the structure of the database (Zartman and others, 1976).

Tables 1-7 show the original RADB fields grouped by their function as indicated by the first letter of the field ID. Although all data in GIPSY is textual by

definition, some fields logically contain numeric data as indicated. These seven groups of fields form the basis of the relational structure of the NGDB. Note that the field B20 (record number) is repeated in the other geochronologic relations in order to provide a key for cross-reference. The five geochronologic systems could have multiple analyses for a given record number as indicated by an "x" in the field IDs; these multiple entries are consolidated in the relational structure of the NGDB.

Table 1. Location and Geology Fields

GIPSY Field ID	Name	Type
A20	Country code	Text
A40	State code	Number
A60	County	Text
A72	Quad scale den	Number
A74	Quad name/#	Text
A80	Latitude	Text
A85	Longitude	Text
A90	Location comment	Text
A100	Location precision code	Number
A110	Sample source code	Number
A130	Rock name	Text
A140	Description	Text
A150	Geologic unit code	Text
A160	Lexicon age list	Text
A170	Petrographic code	Text
B20	Record #	Number
B40	Ref year	Number
B60	Ref #	Number
B70	Lab code list	Text
B90	Compiler	Text
B100	Date compiled	Text

Table 2. Potassium-Argon

GIPSY Field ID*	Name	Type
B20	Record #	Number
C2x	Decay const code	Number
CAx	Lab sample #	Text
CBx5	Mineral code	Text
CCx	Sample comments	Text
CEx	K2O %	Number
CGx	Ar40-rad moles	Number
CHx	Ar rad %	Number
CLx	Age	Number
CMx	Age error	Number
CPx	Analysis type code	Number
CPx5	Analytical comments	Text
CRx	Sample suite #	Number
CTx01-CTx33	Age comment list	Text
CTx31	Reference list	Text
CTx40	Other comments	Text
x	Analysis #	Number

* $1 \leq x \leq 5$

Table 3. Rubidium-Strontium

GIPSY Field ID*	Name	Type
B20	Record #	Number
D2x	Decay const code	Number
DAx	Lab sample #	Text
DBx5	Mineral code	Text
DCx	Sample comments	Text
DEx	Rb ppm	Number
DFx	Sr ppm	Number
DGx	Sr87-rad ppm	Number
DHx	Sr87 rad %	Number
DIx	87Rb/86Sr	Number
DJx	87Sr/86Sr	Number
DLx	Age	Number
DMx	Age error	Number
DNx	IR 87Sr/86Sr	Number
DPx	Analysis type code	Number
DPx5	Analytical comments	Text
DRx	Sample suite #	Number
DTx01-DTx33	Age comment list	Text
DTx31	Reference list	Text
DTx40	Other comments	Text
N1/T1	Normal?	Flag
x	Analysis #	Number

* $1 \leq x \leq 5$

Table 4. Uranium-Thorium-Lead

GIPSY Field ID*	Name	Type
B20	Record #	Number
E2x	Decay const code	Number
EAx	Lab sample #	Text
EBx5	Mineral code	Text
ECx	Sample comments	Text
EEx	U ppm	Number
EFx	Th ppm	Number
EGx	Pb ppm	Number
EHx5	Pb204 %	Number
EHx6	Pb206 %	Number
EHx7	Pb207 %	Number
EHx8	Pb208 %	Number
ELx0	206-238 Age	Number
ELx1	207-235 Age	Number
ELx2	207-206 Age	Number
ELx3	208-232 Age	Number
ELx5	Conc upper x Age	Number
ELx6	Conc lower x Age	Number
EMx0	206-238 Age error	Number
EMx1	207-235 Age error	Number
EMx2	207-206 Age error	Number
EMx3	208-232 Age error	Number
EMx5	Conc upper x Age error	Number
EMx6	Conc lower x Age error	Number
ENx	IR Pb list	Text
EPx5	Analytical comments	Text
ERx	Sample suite #	Number
ETx01-ETx33	Age comment list	Text
ETx31	Reference list	Text
ETx40	Other comments	Text
x	Analysis #	Number

* $1 \leq x \leq 5$

Table 5. Lead-Alpha

GIPSY Field ID*	Name	Type
B20	Record #	Number
GAx	Lab sample #	Text
GBx5	Mineral code	Text
GCx	Sample comments	Text
GEx	Alpha/mg-hr	Number
GFx	Pb ppm	Number
GLx	Age	Number
GMx	Age error	Number
GPx5	Analytical comments	Text
GTx01-GTx33	Age comment list	Text
GTx31	Reference list	Text
GTx40	Other comments	Text
x	Analysis #	Number

* $1 \leq x \leq 5$

Table 6. Fission-Track

GIPSY Field ID*	Name	Type
B20	Record #	Number
HAx	Lab sample #	Text
HBx5	Mineral code	Text
HCx	Sample comments	Text
HEx	rho-s	Number
HFx	Fossil tracks	Number
HGx	rho-i	Number
HHx	Induced tracks	Number
HJx	rho-s/rho-i	Number
HLx	Age	Number
HMx	Age error	Number
HNx	Neutron flux density	Number
HPx	U ppm	Number
HPx5	Analytical comments	Text
HQx	lambda-F	Number
HTx01-HTx33	Age comment list	Text
HTx31	Reference list	Text
HTx40	Other comments	Text
x	Analysis #	Number

* $1 \leq x \leq 5$

Table 7. References

GIPSY Field ID	Name	Type
B40-B60	Ref yr & number	Text
RA1	Reference	Text

Conversion

The approach used for downloading the RADB data into text files was as follows. Six separate dictionaries were defined in order to get six separate ASCII files containing related information. The dictionaries are listed in Appendices 1-6. The general format of a GIPSY dictionary (Office of Information Systems Programs, 1975) is listed in Table 8.

Table 8. General format of a GIPSY dictionary

Columns	Entry
1-7	Label (field ID)
9-10	Level control (default of "01" used)
11-12	Spacing (default of "00" used)
13	Search option (default of upper case OK)
14	Print option (set to "1" for single line printing)
15	Print control (blank for single-spacing)
16-20	Internal format number (numeric field ID)
22-80	Item description (information to be printed)

An example of the resulting output is shown in Table 9. Following a 20-line header, each field containing data will be listed at the beginning of a line followed by a "\" and then the actual field contents. The line length is 122 characters including a carriage return; field contents can extend to multiple lines.

Table 9. Example of ASCII file output from RADB

```
1  G I P S Y  -  UNIVERSITY OF OKLAHOMA   2:29 P.M. TUESDAY   SEPTEMBER   3,1991
0FORM
0 RADB
0SELECT
0 A. B20
        RECORD NUMBER.....
0 LOGIC A
     SEARCH
 14:29:17.1 SEARCH BEGINNING
 14:29:43.0 SEARCH COMPLETED
0 SEARCHED   16448
0 SELECTED   16448      SUBSET    1
0 VARIABLES  SATISFIED
0     A      16448
0FORM
0 DICT1
0PRINT NOPAGE
1                                                                          PAGE 0001

+
0                                                                        RECORD 00001

 B20   \  0008332
 B40   \  76
 B60   \  00037
 B70   \  SM
 B90   \  ROY, R.W.
 B100  \  80 08
 A20   \  US
 A40   \  41
 A60   \  KLAMATH
```

```
 A72   \  250000
 A74   \  CRESCENT
 A80   \  43-20-06 N
 A85   \  121-22-48 W
 A90   \  BALD MOUNTAIN AREA
 A100  \  3
 A110  \  1
 A130  \  RHYOLITE
 A170  \  A121
 A160  \  121
 A140  \  RHYOLITE DOME
 RA1   \  MCKEE, E.H., MACLEOD, N.S., AND WALKER, G.W., 1976, POTASSIUM-ARGON
   AGES OF LATE CENOZOIC SILICIC VOLCANIC ROCKS, SOUTHEAST OREGON:
   ISOCHRON/WEST, NO. 15, P. 37-41.
0                                                                    RECORD 00002

 B20   \  OOO8332
 B40   \  76
 B60   \  00037
 B70   \  SM
 B90   \  ROY, R.W.
 B100  \  80 08
 A20   \  US
 A40   \  41
 A60   \  KLAMATH
 A72   \  250000
 A74   \  CRESCENT
 A80   \  43-20-06 N
 A85   \  121-22-48 W
 A90   \  BALD MOUNTAIN AREA
 A100  \  3
 A110  \  1
 A130  \  RHYOLITE
 A170  \  A121
 A160  \  121
 A140  \  RHYOLITE DOME
 RA1   \  MCKEE, E.H., MACLEOD, N.S., AND WALKER, G.W., 1976, POTASSIUM-ARGON
   AGES OF LATE CENOZOIC SILICIC VOLCANIC ROCKS, SOUTHEAST OREGON:
   ISOCHRON/WEST, NO. 15, P. 37-41.
0                                                                    RECORD 00003

 B20   \  OOO8332
1                                                                        PAGE 0002

 B40   \  76
 B60   \  00037
 B70   \  SM
 B90   \  ROY, R.W.
 B100  \  80 08
 A20   \  US
 A40   \  41
 A60   \  KLAMATH
 A72   \  250000
 A74   \  CRESCENT
 A80   \  43-20-06 N
 A85   \  121-22-48 W
 A90   \  BALD MOUNTAIN AREA
 A100  \  3
 A110  \  1
 A130  \  RHYOLITE
 A170  \  A121
 A160  \  121
```

```
A140  \  RHYOLITE DOME
RA1   \  MCKEE, E.H., MACLEOD, N.S., AND WALKER, G.W., 1976, POTASSIUM-ARGON
  AGES OF LATE CENOZOIC SILICIC VOLCANIC ROCKS, SOUTHEAST OREGON:
  ISOCHRON/WEST, NO. 15, P. 37-41.
```

Six files generated by the GIPSY database contain the complete RADB as described in Table 10.

Table 10. Files created by GIPSY containing RADB data

Name	Size (MB)	Date transferred
Dict1.Data	51.6	9/24/91
Dict2.Data	26.2	9/25/91
Dict3.Data	19.0	10/4/91
Dict4.Data	9.6	10/4/91
Dict5.Data	7.0	10/4/91
Dict6.Data	8.3	10/4/91

The output from GIPSY is incompatible with any commonly used format for direct reading by a microcomputer database program. Also, some fields do not have a simple correspondence from the RADB to the NGDB. Therefore, a conversion program was written which allows individual handling of special fields. Input files (field lists) control the handling and error checking of the GIPSY files. The field lists are reproduced in Appendices 7-13; each line in the list contains 12 characters interpreted as in Table 11.

Table 11. Field list record interpretation

Column	Entry
1-6	GIPSY field label (e.g. B20)
7	Used or not (t for true, f for false)
8	Numeric or not (t or f)
9	1:1 correspondence from RADB to NGDB (t/f)
10	Analysis number (1 to 5)
11-12	Field number for new database

The program used to convert the GIPSY print files to text files suitable for reading into a database is written in THINK Pascal. The main program listing provides an outline of the tasks involved (Table 12).

Table 12. Pascal listing of program GIPSY2TEXT

```
program GIPSY2TEXT;

{Program to convert GIPSY file dumps to tab-delimited text files for reading into}
{a database program. Field listing files with information on each field that}
{appears in the dump file must be in the same folder as this program. Standard file}
{dialogs are used to open the GIPSY file and a file for the new data. Accumulated}
{errors in numeric fields are displayed and the program can be halted by clicking}
{the mouse.}

    uses
        GIPSYGlobals, FileOpener, Init, GIPSYPrep, GIPSYStuff, GIPSYSpecials;

begin
    ShowScreen;
    GetProcessNumber;
    SetVars;
    GetFieldArray;
    ShowFieldArray;
    if not GetInputFile(true) then
        halt;
    if not SetOutputFile(false) then
        begin
            close(inFile);
            halt;
        end;
    GetFileLength;
    StripHeader;
    NewGIPSYRecord;
    MainLoop;
    close(inFile);
    close(outFile);
end.
```

The "uses" clause specifies other "units" used to compile the complete "GIPSY2TEXT" program. These units are listed in Appendices 14-19. The first procedure called is "ShowScreen", which determines window positions for a drawing and a text window and displays these windows to the user. Next, "GetProcessNumber" asks the user to identify which field list is to be processed during this run. "SetVars" simply sets certain variables which only depend on the choice of field list being processed. "GetFieldArray" reads the field list and stores the information into an array of records in memory. "ShowFieldArray" displays the list

as read from memory, displays the total number of fields and waits for the user to acknowledge before proceeding. The next seven lines invoke dialogs allowing the user to specify the source file (from GIPSY) and the file to store the tab-delimited text generated by "GIPSY2TEXT". "GetFileLength" determines the total number of records in the GIPSY file in order to inform the user of the progress as the conversion proceeds. "StripHeader" skips the first 20 lines of the file which contain extraneous information. "NewGIPSYRecord" initializes certain data structures that change when each record is processed. The conversion itself is accomplished by the "MainLoop" procedure which reads and processes the data and checks for user interaction. This procedure consists of one "while" loop which continues program execution until the end of the input file is reached. Once the file has been processed (or the user presses the mouse button), the last two lines close the files before the program quits.

Error checking during the conversion is extensive. The program aborts if it finds fields which do not match the given field list. The program skips lines that it considers invalid; these lines would be those containing page numbers or other extraneous information. In general, all lines of the GIPSY file are processed and, except for fields which need special processing, the field content is simply written back out to a tab-delimited text file at the appropriate place. Fields which contain numeric data are checked character by character for non-numeric data which might cause data loss upon input into the new database. In this process, "l" characters are converted to ones and "O" or "o" characters are converted to zeros. Other characters which could not be part of a valid number are deleted from the field and a tally of these errors is kept. Loading the tab-delimited text file into Double Helix usually resulted in some data loss due to numeric fields which, in spite of the precautions taken, still contained non-numeric information. Double Helix skips fields which contain data which are invalid based on the type of field. In this case, these fields would be those designated to hold numeric data. The dominant reason for skipped fields is the unfortunate occurrence of fields which contained two or more numbers separated by a comma and space. These evidently result from two or more analyses (e.g. K_2O) that the RADB compiler input into a single field rather than averaging the results as the original investigator probably intended. Fields containing such information have thus been lost from the NGDB; the information itself is still available by going back to the original reference. Table 13 shows a summary of the errors and skipped fields resulting from the conversion.

Table 13. Errors reported and fields with invalid data (skipped)

Process Number	Topic	Conversion Errors	Skipped Fields
1	Location & Geology	71	10
2	Potassium-Argon	2363	949
3	Rubidium-Strontium	204	8
4	Uranium-Thorium-Lead	54	3
5	Lead-Alpha	36	3
6	Fission-Track	33	2
7	References	0	0

Example output from "GIPSY2TEXT" is shown in Table 14; this tab-delimited ouput can be processed by most microcomputer database systems. Complete source code listings for the units used in the program "GIPSY2TEXT" are given in Appendices 14-19. The source code is extensively commented and no further explanation is provided. A companion program, "DupRefs", used to delete sequential duplicates from the converted references file is documented in Appendices 20-22.

Table 14. Example of ASCII file output from GIPSY2TEXT*

```
0008332 Δ 76 Δ 00037 Δ SM Δ ROY, R.W. Δ 80 08 Δ US Δ 41 Δ KLAMATH Δ 250000 Δ
      CRESCENT Δ 43-20-06 N Δ 121-22-48 W Δ BALD MOUNTAIN AREA Δ 3 Δ 1 Δ
      RHYOLITE Δ A121 Δ  Δ 121 Δ RHYOLITE DOME
0008332 Δ 76 Δ 00037 Δ SM Δ ROY, R.W. Δ 80 08 Δ US Δ 41 Δ KLAMATH Δ 250000 Δ
      CRESCENT Δ 43-20-06 N Δ 121-22-48 W Δ BALD MOUNTAIN AREA Δ 3 Δ 1 Δ
      RHYOLITE Δ A121 Δ  Δ 121 Δ RHYOLITE DOME
0008332 Δ 76 Δ 00037 Δ SM Δ ROY, R.W. Δ 80 08 Δ US Δ 41 Δ KLAMATH Δ 250000 Δ
      CRESCENT Δ 43-20-06 N Δ 121-22-48 W Δ BALD MOUNTAIN AREA Δ 3 Δ 1 Δ
      RHYOLITE Δ A121 Δ  Δ 121 Δ RHYOLITE DOME
```

* Input file from Table 9 using Field List 1 (Appendix 7). Δ = tab.

References

Office of Information Systems Programs, 1975, GIPSY Documentation Series, Univ. of Oklahoma, Norman, Oklahoma: Volume II - User's Guide, 146 p.

Zartman, R.E., Cole, J.C., and Marvin, R.F., 1976, User's Guide to the Radiometric Age Data Bank (RADB): U.S. Geological Survey Open-File Report 76-674, 77 p.

Appendix 1. RADB Dictionary for Location, Geology, and Reference

```
B20             1  1010 B20    \
B40             1  1030 B40    \
B60             1  1050 B60    \
B70             1  1060 B70    \
B90             1  1075 B90    \
B100            1  1080 B100   \
A20             1  1105 A20    \
A40             1  1690 A40    \
A60             1  1760 A60    \
A72             1  1772 A72    \
A74             1  1774 A74    \
A80             1  1780 A80    \
A85             1  1785 A85    \
A90             1  1790 A90    \
A100            1  1800 A100   \
A110            1  1810 A110   \
A130            1  1830 A130   \
A170            1  1870 A170   \
A150            1  1850 A150   \
A160            1  1860 A160   \
A140            1  1840 A140   \
RA1             1 10100 RA1    \
```

Appendix 2. RADB Dictionary for Potassium-Argon

```
B20          1  1010 B20    \
C10          1  4000 C10    \
C20          1  4020 C20    \
C21          1  4021 C21    \
C22          1  4022 C22    \
C23          1  4023 C23    \
C24          1  4024 C24    \
C26          1  4026 C26    \
C27          1  4027 C27    \
C28          1  4028 C28    \
C29          1  4029 C29    \
C25          1  4025 C25    \
CA1          1  4102 CA1    \
CB15         1  4105 CB15   \
CB10         1  4104 CB10   \
CC1          1  4106 CC1    \
CE1          1  4110 CE1    \
CG1          1  4119 CG1    \
CH1          1  4122 CH1    \
CL1          1  4128 CL1    \
CM1          1  4130 CM1    \
CP1          1  4140 CP1    \
CP15         1  4145 CP15   \
CR1          1  4150 CR1    \
CT1          1  4160 CT1    \
CT101        1  4161 CT101  \
CT102        1  4162 CT102  \
CT103        1  4163 CT103  \
CT104        1  4164 CT104  \
CT105        1  4165 CT105  \
CT106        1  4166 CT106  \
CT107        1  4167 CT107  \
CT108        1  4168 CT108  \
CT109        1  4169 CT109  \
CT110        1  4170 CT110  \
CT111        1  4171 CT111  \
CT112        1  4172 CT112  \
CT113        1  4173 CT113  \
CT114        1  4174 CT114  \
CT115        1  4175 CT115  \
CT120        1  4180 CT120  \
CT121        1  4181 CT121  \
CT122        1  4182 CT122  \
CT124        1  4184 CT124  \
CT125        1  4185 CT125  \
CT128        1  4188 CT128  \
CT133        1  4186 CT133  \
CT140        1  4189 CT140  \
CT131        1  4191 CT131  \
```

```
CA2          1  4202 CA2   \
CB25         1  4205 CB25  \
CB20         1  4204 CB20  \
CC2          1  4206 CC2   \
CE2          1  4210 CE2   \
CG2          1  4219 CG2   \
CH2          1  4222 CH2   \
CL2          1  4228 CL2   \
CM2          1  4230 CM2   \
CP2          1  4240 CP2   \
CP25         1  4245 CP25  \
CR2          1  4250 CR2   \
CT2          1  4260 CT2   \
CT201        1  4261 CT201 \
CT202        1  4262 CT202 \
CT203        1  4263 CT203 \
CT204        1  4264 CT204 \
CT205        1  4265 CT205 \
CT206        1  4266 CT206 \
CT207        1  4267 CT207 \
CT208        1  4268 CT208 \
CT209        1  4269 CT209 \
CT210        1  4270 CT210 \
CT211        1  4271 CT211 \
CT212        1  4272 CT212 \
CT213        1  4273 CT213 \
CT214        1  4274 CT214 \
CT215        1  4275 CT215 \
CT220        1  4280 CT220 \
CT221        1  4281 CT221 \
CT222        1  4282 CT222 \
CT224        1  4284 CT224 \
CT225        1  4285 CT225 \
CT228        1  4288 CT228 \
CT233        1  4286 CT233 \
CT240        1  4289 CT240 \
CT231        1  4291 CT231 \
CA3          1  4302 CA3   \
CB35         1  4305 CB35  \
CB30         1  4304 CB30  \
CC3          1  4306 CC3   \
CE3          1  4310 CE3   \
CG3          1  4319 CG3   \
CH3          1  4322 CH3   \
CL3          1  4328 CL3   \
CM3          1  4330 CM3   \
CP3          1  4340 CP3   \
CP35         1  4345 CP35  \
CR3          1  4350 CR3   \
CT3          1  4360 CT3   \
CT301        1  4361 CT301 \
```

```
CT302        1  4362 CT302 \
CT303        1  4363 CT303 \
CT304        1  4364 CT304 \
CT305        1  4365 CT305 \
CT306        1  4366 CT306 \
CT307        1  4367 CT307 \
CT308        1  4368 CT308 \
CT309        1  4369 CT309 \
CT310        1  4370 CT310 \
CT311        1  4371 CT311 \
CT312        1  4372 CT312 \
CT313        1  4373 CT313 \
CT314        1  4374 CT314 \
CT315        1  4375 CT315 \
CT320        1  4380 CT320 \
CT321        1  4381 CT321 \
CT322        1  4382 CT322 \
CT324        1  4384 CT324 \
CT325        1  4385 CT325 \
CT328        1  4388 CT328 \
CT333        1  4386 CT333 \
CT340        1  4389 CT340 \
CT331        1  4391 CT331 \
CA4          1  4402 CA4   \
CB45         1  4405 CB45  \
CB40         1  4404 CB40  \
CC4          1  4406 CC4   \
CE4          1  4410 CE4   \
CG4          1  4419 CG4   \
CH4          1  4422 CH4   \
CL4          1  4428 CL4   \
CM4          1  4430 CM4   \
CP4          1  4440 CP4   \
CP45         1  4445 CP45  \
CR4          1  4450 CR4   \
CT4          1  4460 CT4   \
CT401        1  4461 CT401 \
CT402        1  4462 CT402 \
CT403        1  4463 CT403 \
CT404        1  4464 CT404 \
CT405        1  4465 CT405 \
CT406        1  4466 CT406 \
CT407        1  4467 CT407 \
CT408        1  4468 CT408 \
CT409        1  4469 CT409 \
CT410        1  4470 CT410 \
CT411        1  4471 CT411 \
CT412        1  4472 CT412 \
CT413        1  4473 CT413 \
CT414        1  4474 CT414 \
CT415        1  4475 CT415 \
```

```
CT420        1  4480 CT420 \
CT421        1  4481 CT421 \
CT422        1  4482 CT422 \
CT424        1  4484 CT424 \
CT425        1  4485 CT425 \
CT428        1  4488 CT428 \
CT433        1  4486 CT433 \
CT440        1  4489 CT440 \
CT431        1  4491 CT431 \
CA5          1  4502 CA5   \
CB55         1  4505 CB55  \
CB50         1  4504 CB50  \
CC5          1  4506 CC5   \
CE5          1  4510 CE5   \
CG5          1  4519 CG5   \
CH5          1  4522 CH5   \
CL5          1  4528 CL5   \
CM5          1  4530 CM5   \
CP5          1  4540 CP5   \
CP55         1  4545 CP55  \
CR5          1  4550 CR5   \
CT5          1  4560 CT5   \
CT501        1  4561 CT501 \
CT502        1  4562 CT502 \
CT503        1  4563 CT503 \
CT504        1  4564 CT504 \
CT505        1  4565 CT505 \
CT506        1  4566 CT506 \
CT507        1  4567 CT507 \
CT508        1  4568 CT508 \
CT509        1  4569 CT509 \
CT510        1  4570 CT510 \
CT511        1  4571 CT511 \
CT512        1  4572 CT512 \
CT513        1  4573 CT513 \
CT514        1  4574 CT514 \
CT515        1  4575 CT515 \
CT520        1  4580 CT520 \
CT521        1  4581 CT521 \
CT522        1  4582 CT522 \
CT524        1  4584 CT524 \
CT525        1  4585 CT525 \
CT528        1  4588 CT528 \
CT533        1  4586 CT533 \
CT540        1  4589 CT540 \
CT531        1  4591 CT531 \
```

Appendix 3. RADB Dictionary for Rubidium-Strontium

```
B20             1  1010 B20    \
D10             1  5000 D10    \
D20             1  5020 D20    \
D21             1  5021 D21    \
D22             1  5022 D22    \
D25             1  5025 D25    \
DA1             1  5102 DA1    \
DB15            1  5105 DB15   \
DB10            1  5104 DB10   \
DC1             1  5106 DC1    \
DE1             1  5110 DE1    \
DF1             1  5112 DF1    \
N1              1  5114 N1     \
T1              1  5116 T1     \
DG1             1  5118 DG1    \
DH1             1  5122 DH1    \
DI1             1  5123 DI1    \
DJ1             1  5124 DJ1    \
DL1             1  5128 DL1    \
DM1             1  5130 DM1    \
DN1             1  5134 DN1    \
DP1             1  5140 DP1    \
DP15            1  5145 DP15   \
DR1             1  5150 DR1    \
DT1             1  5160 DT1    \
DT101           1  5161 DT101  \
DT102           1  5162 DT102  \
DT103           1  5163 DT103  \
DT104           1  5164 DT104  \
DT105           1  5165 DT105  \
DT106           1  5166 DT106  \
DT107           1  5167 DT107  \
DT108           1  5168 DT108  \
DT109           1  5169 DT109  \
DT110           1  5170 DT110  \
DT111           1  5171 DT111  \
DT112           1  5172 DT112  \
DT113           1  5173 DT113  \
DT114           1  5174 DT114  \
DT115           1  5175 DT115  \
DT120           1  5180 DT120  \
DT121           1  5181 DT121  \
DT122           1  5182 DT122  \
DT124           1  5184 DT124  \
DT128           1  5188 DT128  \
DT133           1  5185 DT133  \
DT140           1  5189 DT140  \
DT131           1  5191 DT131  \
DA2             1  5202 DA2    \
```

```
DB25          1  5205 DB25  \
DB20          1  5204 DB20  \
DC2           1  5206 DC2   \
DE2           1  5210 DE2   \
DF2           1  5212 DF2   \
N2            1  5214 N2    \
T2            1  5216 T2    \
DG2           1  5218 DG2   \
DH2           1  5222 DH2   \
DI2           1  5223 DI2   \
DJ2           1  5224 DJ2   \
DL2           1  5228 DL2   \
DM2           1  5230 DM2   \
DN2           1  5234 DN2   \
DP2           1  5240 DP2   \
DP25          1  5245 DP25  \
DR2           1  5250 DR2   \
DT2           1  5260 DT2   \
DT201         1  5261 DT201 \
DT202         1  5262 DT202 \
DT203         1  5263 DT203 \
DT204         1  5264 DT204 \
DT205         1  5265 DT205 \
DT206         1  5266 DT206 \
DT207         1  5267 DT207 \
DT208         1  5268 DT208 \
DT209         1  5269 DT209 \
DT210         1  5270 DT210 \
DT211         1  5271 DT211 \
DT212         1  5272 DT212 \
DT213         1  5273 DT213 \
DT214         1  5274 DT214 \
DT215         1  5275 DT215 \
DT220         1  5280 DT220 \
DT221         1  5281 DT221 \
DT222         1  5282 DT222 \
DT224         1  5284 DT224 \
DT228         1  5288 DT228 \
DT233         1  5285 DT233 \
DT240         1  5289 DT240 \
DT231         1  5291 DT231 \
DA3           1  5302 DA3   \
DB35          1  5305 DB35  \
DB30          1  5304 DB30  \
DC3           1  5306 DC3   \
DE3           1  5310 DE3   \
DF3           1  5312 DF3   \
N3            1  5314 N3    \
T3            1  5316 T3    \
DG3           1  5318 DG3   \
DH3           1  5322 DH3   \
```

```
DI3          1  5323 DI3   \
DJ3          1  5324 DJ3   \
DL3          1  5328 DL3   \
DM3          1  5330 DM3   \
DN3          1  5334 DN3   \
DP3          1  5340 DP3   \
DP35         1  5345 DP35  \
DR3          1  5350 DR3   \
DT3          1  5360 DT3   \
DT301        1  5361 DT301 \
DT302        1  5362 DT302 \
DT303        1  5363 DT303 \
DT304        1  5364 DT304 \
DT305        1  5365 DT305 \
DT306        1  5366 DT306 \
DT307        1  5367 DT307 \
DT308        1  5368 DT308 \
DT309        1  5369 DT309 \
DT310        1  5370 DT310 \
DT311        1  5371 DT311 \
DT312        1  5372 DT312 \
DT313        1  5373 DT313 \
DT314        1  5374 DT314 \
DT315        1  5375 DT315 \
DT320        1  5380 DT320 \
DT321        1  5381 DT321 \
DT322        1  5382 DT322 \
DT324        1  5384 DT324 \
DT328        1  5388 DT328 \
DT333        1  5385 DT333 \
DT340        1  5389 DT340 \
DT331        1  5391 DT331 \
DA4          1  5402 DA4   \
DB45         1  5405 DB45  \
DB40         1  5404 DB40  \
DC4          1  5406 DC4   \
DE4          1  5410 DE4   \
DF4          1  5412 DF4   \
N4           1  5414 N4    \
T4           1  5416 T4    \
DG4          1  5418 DG4   \
DH4          1  5422 DH4   \
DI4          1  5423 DI4   \
DJ4          1  5424 DJ4   \
DL4          1  5428 DL4   \
DM4          1  5430 DM4   \
DN4          1  5434 DN4   \
DP4          1  5440 DP4   \
DP45         1  5445 DP45  \
DR4          1  5450 DR4   \
DT4          1  5460 DT4   \
```

```
DT401        1  5461 DT401 \
DT402        1  5462 DT402 \
DT403        1  5463 DT403 \
DT404        1  5464 DT404 \
DT405        1  5465 DT405 \
DT406        1  5466 DT406 \
DT407        1  5467 DT407 \
DT408        1  5468 DT408 \
DT409        1  5469 DT409 \
DT410        1  5470 DT410 \
DT411        1  5471 DT411 \
DT412        1  5472 DT412 \
DT413        1  5473 DT413 \
DT414        1  5474 DT414 \
DT415        1  5475 DT415 \
DT420        1  5480 DT420 \
DT421        1  5481 DT421 \
DT422        1  5482 DT422 \
DT424        1  5484 DT424 \
DT428        1  5488 DT428 \
DT433        1  5485 DT433 \
DT440        1  5489 DT440 \
DT431        1  5491 DT431 \
DA5          1  5502 DA5   \
DB55         1  5505 DB55  \
DB50         1  5504 DB50  \
DC5          1  5506 DC5   \
DE5          1  5510 DE5   \
DF5          1  5512 DF5   \
N5           1  5514 N5    \
T5           1  5516 T5    \
DG5          1  5518 DG5   \
DH5          1  5522 DH5   \
DI5          1  5523 DI5   \
DJ5          1  5524 DJ5   \
DL5          1  5528 DL5   \
DM5          1  5530 DM5   \
DN5          1  5534 DN5   \
DP5          1  5540 DP5   \
DP55         1  5545 DP55  \
DR5          1  5550 DR5   \
DT5          1  5560 DT5   \
DT501        1  5561 DT501 \
DT502        1  5562 DT502 \
DT503        1  5563 DT503 \
DT504        1  5564 DT504 \
DT505        1  5565 DT505 \
DT506        1  5566 DT506 \
DT507        1  5567 DT507 \
DT508        1  5568 DT508 \
DT509        1  5569 DT509 \
DT510        1  5570 DT510 \
```

```
DT511        1  5571 DT511 \
DT512        1  5572 DT512 \
DT513        1  5573 DT513 \
DT514        1  5574 DT514 \
DT515        1  5575 DT515 \
DT520        1  5580 DT520 \
DT521        1  5581 DT521 \
DT522        1  5582 DT522 \
DT524        1  5584 DT524 \
DT528        1  5588 DT528 \
DT533        1  5585 DT533 \
DT540        1  5589 DT540 \
DT531        1  5591 DT531 \
```

```
B20          1  1010 B20   \
E10          1  6000 E10   \
E20          1  6020 E20   \
E21          1  6021 E21   \
E22          1  6022 E22   \
E23          1  6023 E23   \
E24          1  6024 E24   \
E25          1  6025 E25   \
EA1          1  6102 EA1   \
EB15         1  6105 EB15  \
EB10         1  6104 EB10  \
EC1          1  6106 EC1   \
EE1          1  6110 EE1   \
EF1          1  6112 EF1   \
EG1          1  6114 EG1   \
EH15         1  6121 EH15  \
EH16         1  6122 EH16  \
EH17         1  6123 EH17  \
EH18         1  6124 EH18  \
EL10         1  6127 EL10  \
EM10         1  6128 EM10  \
EL11         1  6131 EL11  \
EM11         1  6132 EM11  \
EL12         1  6135 EL12  \
EM12         1  6136 EM12  \
EL13         1  6138 EL13  \
EM13         1  6139 EM13  \
EL15         1  6143 EL15  \
EM15         1  6144 EM15  \
EN1          1  6146 EN1   \
EP15         1  6148 EP15  \
ER1          1  6150 ER1   \
ET1          1  6160 ET1   \
ET101        1  6161 ET101 \
ET102        1  6162 ET102 \
ET103        1  6163 ET103 \
ET104        1  6164 ET104 \
ET105        1  6165 ET105 \
ET106        1  6166 ET106 \
ET107        1  6167 ET107 \
ET108        1  6168 ET108 \
ET109        1  6169 ET109 \
ET110        1  6170 ET110 \
ET111        1  6171 ET111 \
ET112        1  6172 ET112 \
ET113        1  6173 ET113 \
ET114        1  6174 ET114 \
ET115        1  6175 ET115 \
ET120        1  6180 ET120 \
```

```
ET121        1  6181 ET121 \
ET124        1  6184 ET124 \
ET128        1  6186 ET128 \
ET140        1  6188 ET140 \
ET131        1  6191 ET131 \
EA2          1  6202 EA2   \
EB25         1  6205 EB25  \
EB20         1  6204 EB20  \
EC2          1  6206 EC2   \
EE2          1  6210 EE2   \
EF2          1  6212 EF2   \
EG2          1  6214 EG2   \
EH25         1  6221 EH25  \
EH26         1  6222 EH26  \
EH27         1  6223 EH27  \
EH28         1  6224 EH28  \
EL20         1  6227 EL20  \
EM20         1  6228 EM20  \
EL21         1  6231 EL21  \
EM21         1  6232 EM21  \
EL22         1  6235 EL22  \
EM22         1  6236 EM22  \
EL23         1  6238 EL23  \
EM23         1  6239 EM23  \
EL25         1  6243 EL25  \
EM25         1  6244 EM25  \
EN2          1  6246 EN2   \
EP25         1  6248 EP25  \
ER2          1  6250 ER2   \
ET2          1  6260 ET2   \
ET201        1  6261 ET201 \
ET202        1  6262 ET202 \
ET203        1  6263 ET203 \
ET204        1  6264 ET204 \
ET205        1  6265 ET205 \
ET206        1  6266 ET206 \
ET207        1  6267 ET207 \
ET208        1  6268 ET208 \
ET209        1  6269 ET209 \
ET210        1  6270 ET210 \
ET211        1  6271 ET211 \
ET212        1  6272 ET212 \
ET213        1  6273 ET213 \
ET214        1  6274 ET214 \
ET215        1  6275 ET215 \
ET220        1  6280 ET220 \
ET221        1  6281 ET221 \
ET224        1  6284 ET224 \
ET228        1  6286 ET228 \
ET240        1  6288 ET240 \
ET231        1  6291 ET231 \
```

```
EA3          1  6302 EA3   \
EB35         1  6305 EB35  \
EB30         1  6304 EB30  \
EC3          1  6306 EC3   \
EE3          1  6310 EE3   \
EF3          1  6312 EF3   \
EG3          1  6314 EG3   \
EH35         1  6321 EH35  \
EH36         1  6322 EH36  \
EH37         1  6323 EH37  \
EH38         1  6324 EH38  \
EL30         1  6327 EL30  \
EM30         1  6328 EM30  \
EL31         1  6331 EL31  \
EM31         1  6332 EM31  \
EL32         1  6335 EL32  \
EM32         1  6336 EM32  \
EL33         1  6338 EL33  \
EM33         1  6339 EM33  \
EL35         1  6343 EL35  \
EM35         1  6344 EM35  \
EN3          1  6346 EN3   \
EP35         1  6348 EP35  \
ER3          1  6350 ER3   \
ET3          1  6360 ET3   \
ET301        1  6361 ET301 \
ET302        1  6362 ET302 \
ET303        1  6363 ET303 \
ET304        1  6364 ET304 \
ET305        1  6365 ET305 \
ET306        1  6366 ET306 \
ET307        1  6367 ET307 \
ET308        1  6368 ET308 \
ET309        1  6369 ET309 \
ET310        1  6370 ET310 \
ET311        1  6371 ET311 \
ET312        1  6372 ET312 \
ET313        1  6373 ET313 \
ET314        1  6374 ET314 \
ET315        1  6375 ET315 \
ET320        1  6380 ET320 \
ET321        1  6381 ET321 \
ET324        1  6384 ET324 \
ET328        1  6386 ET328 \
ET340        1  6388 ET340 \
ET331        1  6391 ET331 \
EA4          1  6402 EA4   \
EB45         1  6405 EB45  \
EB40         1  6404 EB40  \
EC4          1  6406 EC4   \
EE4          1  6410 EE4   \
```

```
EF4          1  6412 EF4   \
EG4          1  6414 EG4   \
EH45         1  6421 EH45  \
EH46         1  6422 EH46  \
EH47         1  6423 EH47  \
EH48         1  6424 EH48  \
EL40         1  6427 EL40  \
EM40         1  6428 EM40  \
EL41         1  6431 EL41  \
EM41         1  6432 EM41  \
EL42         1  6435 EL42  \
EM42         1  6436 EM42  \
EL43         1  6438 EL43  \
EM43         1  6439 EM43  \
EL45         1  6443 EL45  \
EM45         1  6444 EM45  \
EN4          1  6446 EN4   \
EP45         1  6448 EP45  \
ER4          1  6450 ER4   \
ET4          1  6460 ET4   \
ET401        1  6461 ET401 \
ET402        1  6462 ET402 \
ET403        1  6463 ET403 \
ET404        1  6464 ET404 \
ET405        1  6465 ET405 \
ET406        1  6466 ET406 \
ET407        1  6467 ET407 \
ET408        1  6468 ET408 \
ET409        1  6469 ET409 \
ET410        1  6470 ET410 \
ET411        1  6471 ET411 \
ET412        1  6472 ET412 \
ET413        1  6473 ET413 \
ET414        1  6474 ET414 \
ET415        1  6475 ET415 \
ET420        1  6480 ET420 \
ET421        1  6481 ET421 \
ET424        1  6484 ET424 \
ET428        1  6486 ET428 \
ET440        1  6488 ET440 \
ET431        1  6491 ET431 \
EA5          1  6502 EA5   \
EB55         1  6505 EB55  \
EB50         1  6504 EB50  \
EC5          1  6506 EC5   \
EE5          1  6510 EE5   \
EF5          1  6512 EF5   \
EG5          1  6514 EG5   \
EH55         1  6521 EH55  \
EH56         1  6522 EH56  \
EH57         1  6523 EH57  \
EH58         1  6524 EH58  \
```

```
EL50        1  6527 EL50  \
EM50        1  6528 EM50  \
EL51        1  6531 EL51  \
EM51        1  6532 EM51  \
EL52        1  6535 EL52  \
EM52        1  6536 EM52  \
EL53        1  6538 EL53  \
EM53        1  6539 EM53  \
EL55        1  6543 EL55  \
EM55        1  6544 EM55  \
EN5         1  6546 EN5   \
EP55        1  6548 EP55  \
ER5         1  6550 ER5   \
ET5         1  6560 ET5   \
ET501       1  6561 ET501 \
ET502       1  6562 ET502 \
ET503       1  6563 ET503 \
ET504       1  6564 ET504 \
ET505       1  6565 ET505 \
ET506       1  6566 ET506 \
ET507       1  6567 ET507 \
ET508       1  6568 ET508 \
ET509       1  6569 ET509 \
ET510       1  6570 ET510 \
ET511       1  6571 ET511 \
ET512       1  6572 ET512 \
ET513       1  6573 ET513 \
ET514       1  6574 ET514 \
ET515       1  6575 ET515 \
ET520       1  6580 ET520 \
ET521       1  6581 ET521 \
ET524       1  6584 ET524 \
ET528       1  6586 ET528 \
ET540       1  6588 ET540 \
ET531       1  6591 ET531 \
```

Appendix 5. RADB Dictionary for Lead-Alpha

```
B20          1  1010 B20    \
G10          1  8000 G10    \
GA1          1  8102 GA1    \
GB15         1  8105 GB15   \
GB10         1  8104 GB10   \
GC1          1  8106 GC1    \
GE1          1  8110 GE1    \
GF1          1  8112 GF1    \
GL1          1  8128 GL1    \
GM1          1  8130 GM1    \
GP15         1  8145 GP15   \
GT1          1  8160 GT1    \
GT101        1  8161 GT101  \
GT102        1  8162 GT102  \
GT103        1  8163 GT103  \
GT104        1  8164 GT104  \
GT105        1  8165 GT105  \
GT106        1  8166 GT106  \
GT107        1  8167 GT107  \
GT108        1  8168 GT108  \
GT109        1  8169 GT109  \
GT110        1  8170 GT110  \
GT111        1  8171 GT111  \
GT112        1  8172 GT112  \
GT113        1  8173 GT113  \
GT114        1  8174 GT114  \
GT115        1  8175 GT115  \
GT120        1  8180 GT120  \
GT121        1  8181 GT121  \
GT124        1  8184 GT124  \
GT140        1  8188 GT140  \
GT131        1  8191 GT131  \
GA2          1  8202 GA2    \
GB25         1  8205 GB25   \
GB20         1  8204 GB20   \
GC2          1  8206 GC2    \
GE2          1  8210 GE2    \
GF2          1  8212 GF2    \
GL2          1  8228 GL2    \
GM2          1  8230 GM2    \
GP25         1  8245 GP25   \
GT2          1  8260 GT2    \
GT201        1  8261 GT201  \
GT202        1  8262 GT202  \
GT203        1  8263 GT203  \
GT204        1  8264 GT204  \
GT205        1  8265 GT205  \
GT206        1  8266 GT206  \
GT207        1  8267 GT207  \
```

```
GT208        1  8268 GT208 \
GT209        1  8269 GT209 \
GT210        1  8270 GT210 \
GT211        1  8271 GT211 \
GT212        1  8272 GT212 \
GT213        1  8273 GT213 \
GT214        1  8274 GT214 \
GT215        1  8275 GT215 \
GT220        1  8280 GT220 \
GT221        1  8281 GT221 \
GT224        1  8284 GT224 \
GT240        1  8288 GT240 \
GT231        1  8291 GT231 \
GA3          1  8302 GA3   \
GB35         1  8305 GB35  \
GB30         1  8304 GB30  \
GC3          1  8306 GC3   \
GE3          1  8310 GE3   \
GF3          1  8312 GF3   \
GL3          1  8328 GL3   \
GM3          1  8330 GM3   \
GP35         1  8345 GP35  \
GT3          1  8360 GT3   \
GT301        1  8361 GT301 \
GT302        1  8362 GT302 \
GT303        1  8363 GT303 \
GT304        1  8364 GT304 \
GT305        1  8365 GT305 \
GT306        1  8366 GT306 \
GT307        1  8367 GT307 \
GT308        1  8368 GT308 \
GT309        1  8369 GT309 \
GT310        1  8370 GT310 \
GT311        1  8371 GT311 \
GT312        1  8372 GT312 \
GT313        1  8373 GT313 \
GT314        1  8374 GT314 \
GT315        1  8375 GT315 \
GT320        1  8380 GT320 \
GT321        1  8381 GT321 \
GT324        1  8384 GT324 \
GT340        1  8388 GT340 \
GT331        1  8391 GT331 \
```

```
B20          1  1010 B20    \
H10          1  9000 H10    \
HA1          1  9102 HA1    \
HB15         1  9105 HB15   \
HB10         1  9104 HB10   \
HC1          1  9106 HC1    \
HE1          1  9110 HE1    \
HF1          1  9112 HF1    \
HG1          1  9114 HG1    \
HH1          1  9116 HH1    \
HJ1          1  9118 HJ1    \
HL1          1  9128 HL1    \
HM1          1  9130 HM1    \
HN1          1  9132 HN1    \
HP1          1  9134 HP1    \
HQ1          1  9136 HQ1    \
HP15         1  9145 HP15   \
HT1          1  9160 HT1    \
HT101        1  9161 HT101  \
HT102        1  9162 HT102  \
HT103        1  9163 HT103  \
HT104        1  9164 HT104  \
HT105        1  9165 HT105  \
HT106        1  9166 HT106  \
HT107        1  9167 HT107  \
HT108        1  9168 HT108  \
HT109        1  9169 HT109  \
HT110        1  9170 HT110  \
HT111        1  9171 HT111  \
HT112        1  9172 HT112  \
HT113        1  9173 HT113  \
HT114        1  9174 HT114  \
HT115        1  9175 HT115  \
HT120        1  9180 HT120  \
HT121        1  9181 HT121  \
HT122        1  9182 HT122  \
HT124        1  9184 HT124  \
HT140        1  9188 HT140  \
HT131        1  9191 HT131  \
HA2          1  9202 HA2    \
HB25         1  9205 HB25   \
HB20         1  9204 HB20   \
HC2          1  9206 HC2    \
HE2          1  9210 HE2    \
HF2          1  9212 HF2    \
HG2          1  9214 HG2    \
HH2          1  9216 HH2    \
HJ2          1  9218 HJ2    \
HL2          1  9228 HL2    \
```

```
HM2          1  9230 HM2   \
HN2          1  9232 HN2   \
HP2          1  9234 HP2   \
HQ2          1  9236 HQ2   \
HP25         1  9245 HP25  \
HT2          1  9260 HT2   \
HT201        1  9261 HT201 \
HT202        1  9262 HT202 \
HT203        1  9263 HT203 \
HT204        1  9264 HT204 \
HT205        1  9265 HT205 \
HT206        1  9266 HT206 \
HT207        1  9267 HT207 \
HT208        1  9268 HT208 \
HT209        1  9269 HT209 \
HT210        1  9270 HT210 \
HT211        1  9271 HT211 \
HT212        1  9272 HT212 \
HT213        1  9273 HT213 \
HT214        1  9274 HT214 \
HT215        1  9275 HT215 \
HT220        1  9280 HT220 \
HT221        1  9281 HT221 \
HT222        1  9282 HT222 \
HT224        1  9284 HT224 \
HT240        1  9288 HT240 \
HT231        1  9291 HT231 \
HA3          1  9302 HA3   \
HB35         1  9305 HB35  \
HB30         1  9304 HB30  \
HC3          1  9306 HC3   \
HE3          1  9310 HE3   \
HF3          1  9312 HF3   \
HG3          1  9314 HG3   \
HH3          1  9316 HH3   \
HJ3          1  9318 HJ3   \
HL3          1  9328 HL3   \
HM3          1  9330 HM3   \
HN3          1  9332 HN3   \
HP3          1  9334 HP3   \
HQ3          1  9336 HQ3   \
HP35         1  9345 HP35  \
HT3          1  9360 HT3   \
HT301        1  9361 HT301 \
HT302        1  9362 HT302 \
HT303        1  9363 HT303 \
HT304        1  9364 HT304 \
HT305        1  9365 HT305 \
HT306        1  9366 HT306 \
HT307        1  9367 HT307 \
HT308        1  9368 HT308 \
```

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HT309        1  9369 HT309 \
HT310        1  9370 HT310 \
HT311        1  9371 HT311 \
HT312        1  9372 HT312 \
HT313        1  9373 HT313 \
HT314        1  9374 HT314 \
HT315        1  9375 HT315 \
HT320        1  9380 HT320 \
HT321        1  9381 HT321 \
HT322        1  9382 HT322 \
HT324        1  9384 HT324 \
HT340        1  9388 HT340 \
HT331        1  9391 HT331 \
HA4          1  9402 HA4   \
HB45         1  9405 HB45  \
HB40         1  9404 HB40  \
HC4          1  9406 HC4   \
HE4          1  9410 HE4   \
HF4          1  9412 HF4   \
HG4          1  9414 HG4   \
HH4          1  9416 HH4   \
HJ4          1  9418 HJ4   \
HL4          1  9428 HL4   \
HM4          1  9430 HM4   \
HN4          1  9432 HN4   \
HP4          1  9434 HP4   \
HQ4          1  9436 HQ4   \
HP45         1  9445 HP45  \
HT4          1  9460 HT4   \
HT401        1  9461 HT401 \
HT402        1  9462 HT402 \
HT403        1  9463 HT403 \
HT404        1  9464 HT404 \
HT405        1  9465 HT405 \
HT406        1  9466 HT406 \
HT407        1  9467 HT407 \
HT408        1  9468 HT408 \
HT409        1  9469 HT409 \
HT410        1  9470 HT410 \
HT411        1  9471 HT411 \
HT412        1  9472 HT412 \
HT413        1  9473 HT413 \
HT414        1  9474 HT414 \
HT415        1  9475 HT415 \
HT420        1  9480 HT420 \
HT421        1  9481 HT421 \
HT422        1  9482 HT422 \
HT424        1  9484 HT424 \
HT440        1  9488 HT440 \
HT431        1  9491 HT431 \
HA5          1  9502 HA5   \
```

```
HB55          1  9505 HB55  \
HB50          1  9504 HB50  \
HC5           1  9506 HC5   \
HE5           1  9510 HE5   \
HF5           1  9512 HF5   \
HG5           1  9514 HG5   \
HH5           1  9516 HH5   \
HJ5           1  9518 HJ5   \
HL5           1  9528 HL5   \
HM5           1  9530 HM5   \
HN5           1  9532 HN5   \
HP5           1  9534 HP5   \
HQ5           1  9536 HQ5   \
HP55          1  9545 HP55  \
HT5           1  9560 HT5   \
HT501         1  9561 HT501 \
HT502         1  9562 HT502 \
HT503         1  9563 HT503 \
HT504         1  9564 HT504 \
HT505         1  9565 HT505 \
HT506         1  9566 HT506 \
HT507         1  9567 HT507 \
HT508         1  9568 HT508 \
HT509         1  9569 HT509 \
HT510         1  9570 HT510 \
HT511         1  9571 HT511 \
HT512         1  9572 HT512 \
HT513         1  9573 HT513 \
HT514         1  9574 HT514 \
HT515         1  9575 HT515 \
HT520         1  9580 HT520 \
HT521         1  9581 HT521 \
HT522         1  9582 HT522 \
HT524         1  9584 HT524 \
HT540         1  9588 HT540 \
HT531         1  9591 HT531 \
```

Appendix 7. Field list 1 (Location and Geology)

B20	ttt101
B40	ttt102
B60	ttt103
B70	tft104
B90	tft105
B100	tft106
A20	tft107
A40	ttt108
A60	tft109
A72	ttt110
A74	tft111
A80	tft112
A85	tft113
A90	tft114
A100	ttt115
A110	ttt116
A130	tft117
A170	tft118
A150	tft119
A160	tft120
A140	tft121
RA1	fft100

Appendix 8. Field list 2 (Potassium-Argon)

```
B20    ttf101
C10    fft100
C20    tff102
C21    tff102
C22    tff102
C23    tff102
C24    tff102
C26    tff102
C27    tff102
C28    tff102
C29    tff102
C25    tff102
CA1    tft103
CB15   tft105
CB10   fft100
CC1    tft106
CE1    ttt107
CG1    ttt108
CH1    ttt109
CL1    ttt110
CM1    ttt111
CP1    ttt112
CP15   tft113
CR1    ttt114
CT1    fft100
CT101  tff115
CT102  tff115
CT103  tff115
CT104  tff115
CT105  tff115
CT106  tff115
CT107  tff115
CT108  tff115
CT109  tff115
CT110  tff115
CT111  tff115
CT112  tff115
CT113  tff115
CT114  tff115
CT115  tff115
CT120  tff115
CT121  tff115
CT122  tff115
CT124  tff115
CT125  tff115
CT128  tff115
CT133  tff115
CT140  tft116
CT131  tff117
```

```
CA2   tft203
CB25  tft205
CB20  fft200
CC2   tft206
CE2   ttt207
CG2   ttt208
CH2   ttt209
CL2   ttt210
CM2   ttt211
CP2   ttt212
CP25  tft213
CR2   ttt214
CT2   fft200
CT201 tff215
CT202 tff215
CT203 tff215
CT204 tff215
CT205 tff215
CT206 tff215
CT207 tff215
CT208 tff215
CT209 tff215
CT210 tff215
CT211 tff215
CT212 tff215
CT213 tff215
CT214 tff215
CT215 tff215
CT220 tff215
CT221 tff215
CT222 tff215
CT224 tff215
CT225 tff215
CT228 tff215
CT233 tff215
CT240 tft216
CT231 tff217
CA3   tft303
CB35  tft305
CB30  fft300
CC3   tft306
CE3   ttt307
CG3   ttt308
CH3   ttt309
CL3   ttt310
CM3   ttt311
CP3   ttt312
CP35  tft313
CR3   ttt314
CT3   fft300
CT301 tff315
```

```
CT302 tff315
CT303 tff315
CT304 tff315
CT305 tff315
CT306 tff315
CT307 tff315
CT308 tff315
CT309 tff315
CT310 tff315
CT311 tff315
CT312 tff315
CT313 tff315
CT314 tff315
CT315 tff315
CT320 tff315
CT321 tff315
CT322 tff315
CT324 tff315
CT325 tff315
CT328 tff315
CT333 tff315
CT340 tft316
CT331 tff317
CA4   tft403
CB45  tft405
CB40  fft400
CC4   tft406
CE4   ttt407
CG4   ttt408
CH4   ttt409
CL4   ttt410
CM4   ttt411
CP4   ttt412
CP45  tft413
CR4   ttt414
CT4   fft400
CT401 tff415
CT402 tff415
CT403 tff415
CT404 tff415
CT405 tff415
CT406 tff415
CT407 tff415
CT408 tff415
CT409 tff415
CT410 tff415
CT411 tff415
CT412 tff415
CT413 tff415
CT414 tff415
CT415 tff415
```

```
CT420 tff415
CT421 tff415
CT422 tff415
CT424 tff415
CT425 tff415
CT428 tff415
CT433 tff415
CT440 tft416
CT431 tff417
CA5   tft503
CB55  tft505
CB50  fft500
CC5   tft506
CE5   ttt507
CG5   ttt508
CH5   ttt509
CL5   ttt510
CM5   ttt511
CP5   ttt512
CP55  tft513
CR5   ttt514
CT5   fft500
CT501 tff515
CT502 tff515
CT503 tff515
CT504 tff515
CT505 tff515
CT506 tff515
CT507 tff515
CT508 tff515
CT509 tff515
CT510 tff515
CT511 tff515
CT512 tff515
CT513 tff515
CT514 tff515
CT515 tff515
CT520 tff515
CT521 tff515
CT522 tff515
CT524 tff515
CT525 tff515
CT528 tff515
CT533 tff515
CT540 tft516
CT531 tff517
```

Appendix 9. Field list 3 (Rubidium-Strontium)

```
B20    ttf101
D10    fft102
D20    tff102
D21    tff102
D22    tff102
D25    tff102
DA1    tft103
DB15   tft105
DB10   fft100
DC1    tft106
DE1    ttt107
DF1    ttt108
N1     tff109
T1     tff109
DG1    ttt110
DH1    ttt111
DI1    ttt112
DJ1    ttt113
DL1    ttt114
DM1    ttt115
DN1    ttt116
DP1    ttt117
DP15   tft118
DR1    ttt119
DT1    fft100
DT101  tff120
DT102  tff120
DT103  tff120
DT104  tff120
DT105  tff120
DT106  tff120
DT107  tff120
DT108  tff120
DT109  tff120
DT110  tff120
DT111  tff120
DT112  tff120
DT113  tff120
DT114  tff120
DT115  tff120
DT120  tff120
DT121  tff120
DT122  tff120
DT124  tff120
DT128  tff120
DT133  tff120
DT140  tft121
DT131  tff122
DA2    tft203
```

```
DB25  tft205
DB20  fft200
DC2   tft206
DE2   ttt207
DF2   ttt208
N2    tff209
T2    tff209
DG2   ttt210
DH2   ttt211
DI2   ttt212
DJ2   ttt213
DL2   ttt214
DM2   ttt215
DN2   ttt216
DP2   ttt217
DP25  tft218
DR2   ttt219
DT2   fft200
DT201 tff220
DT202 tff220
DT203 tff220
DT204 tff220
DT205 tff220
DT206 tff220
DT207 tff220
DT208 tff220
DT209 tff220
DT210 tff220
DT211 tff220
DT212 tff220
DT213 tff220
DT214 tff220
DT215 tff220
DT220 tff220
DT221 tff220
DT222 tff220
DT224 tff220
DT228 tff220
DT233 tff220
DT240 tft221
DT231 tff222
DA3   tft303
DB35  tft305
DB30  fft300
DC3   tft306
DE3   ttt307
DF3   ttt308
N3    tff309
T3    tff309
DG3   ttt310
DH3   ttt311
```

```
DI3   ttt312
DJ3   ttt313
DL3   ttt314
DM3   ttt315
DN3   ttt316
DP3   ttt317
DP35  tft318
DR3   ttt319
DT3   fft300
DT301 tff320
DT302 tff320
DT303 tff320
DT304 tff320
DT305 tff320
DT306 tff320
DT307 tff320
DT308 tff320
DT309 tff320
DT310 tff320
DT311 tff320
DT312 tff320
DT313 tff320
DT314 tff320
DT315 tff320
DT320 tff320
DT321 tff320
DT322 tff320
DT324 tff320
DT328 tff320
DT333 tff320
DT340 tft321
DT331 tff322
DA4   tft403
DB45  tft405
DB40  fft400
DC4   tft406
DE4   ttt407
DF4   ttt408
N4    tff409
T4    tff409
DG4   ttt410
DH4   ttt411
DI4   ttt412
DJ4   ttt413
DL4   ttt414
DM4   ttt415
DN4   ttt416
DP4   ttt417
DP45  tft418
DR4   ttt419
DT4   fft400
```

```
DT401 tff420
DT402 tff420
DT403 tff420
DT404 tff420
DT405 tff420
DT406 tff420
DT407 tff420
DT408 tff420
DT409 tff420
DT410 tff420
DT411 tff420
DT412 tff420
DT413 tff420
DT414 tff420
DT415 tff420
DT420 tff420
DT421 tff420
DT422 tff420
DT424 tff420
DT428 tff420
DT433 tff420
DT440 tft421
DT431 tff422
DA5   tft503
DB55  tft505
DB50  fft500
DC5   tft506
DE5   ttt507
DF5   ttt508
N5    tff509
T5    tff509
DG5   ttt510
DH5   ttt511
DI5   ttt512
DJ5   ttt513
DL5   ttt514
DM5   ttt515
DN5   ttt516
DP5   ttt517
DP55  tft518
DR5   ttt519
DT5   fft500
DT501 tff520
DT502 tff520
DT503 tff520
DT504 tff520
DT505 tff520
DT506 tff520
DT507 tff520
DT508 tff520
DT509 tff520
DT510 tff520
```

```
DT511 tff520
DT512 tff520
DT513 tff520
DT514 tff520
DT515 tff520
DT520 tff520
DT521 tff520
DT522 tff520
DT524 tff520
DT528 tff520
DT533 tff520
DT540 tft521
DT531 tff522
```

Appendix 10. Field list 4 (Uranium-Thorium-Lead)

```
B20   ttf101
E10   fft100
E20   tff102
E21   tff102
E22   tff102
E23   tff102
E24   tff102
E25   tff102
EA1   tft103
EB15  tft105
EB10  fft100
EC1   tft106
EE1   ttt107
EF1   ttt108
EG1   ttt109
EH15  ttt110
EH16  ttt111
EH17  ttt112
EH18  ttt113
EL10  ttt114
EM10  ttt115
EL11  ttt116
EM11  ttt117
EL12  ttt118
EM12  ttt119
EL13  ttt120
EM13  ttt121
EL15  ttt122
EM15  ttt123
EN1   tft124
EP15  tft125
ER1   ttt126
ET1   fft100
ET101 tff127
ET102 tff127
ET103 tff127
ET104 tff127
ET105 tff127
ET106 tff127
ET107 tff127
ET108 tff127
ET109 tff127
ET110 tff127
ET111 tff127
ET112 tff127
ET113 tff127
ET114 tff127
ET115 tff127
ET120 tff127
```

```
ET121 tff127
ET124 tff127
ET128 tff127
ET140 tft128
ET131 tff129
EA2   tft203
EB25  tft205
EB20  fft200
EC2   tft206
EE2   ttt207
EF2   ttt208
EG2   ttt209
EH25  ttt210
EH26  ttt211
EH27  ttt212
EH28  ttt213
EL20  ttt214
EM20  ttt215
EL21  ttt216
EM21  ttt217
EL22  ttt218
EM22  ttt219
EL23  ttt220
EM23  ttt221
EL25  ttt222
EM25  ttt223
EN2   tft224
EP25  tft225
ER2   ttt226
ET2   fft200
ET201 tff227
ET202 tff227
ET203 tff227
ET204 tff227
ET205 tff227
ET206 tff227
ET207 tff227
ET208 tff227
ET209 tff227
ET210 tff227
ET211 tff227
ET212 tff227
ET213 tff227
ET214 tff227
ET215 tff227
ET220 tff227
ET221 tff227
ET224 tff227
ET228 tff227
ET240 tft228
ET231 tff229
```

```
EA3   tft303
EB35  tft305
EB30  fft300
EC3   tft306
EE3   ttt307
EF3   ttt308
EG3   ttt309
EH35  ttt310
EH36  ttt311
EH37  ttt312
EH38  ttt313
EL30  ttt314
EM30  ttt315
EL31  ttt316
EM31  ttt317
EL32  ttt318
EM32  ttt319
EL33  ttt320
EM33  ttt321
EL35  ttt322
EM35  ttt323
EN3   tft324
EP35  tft325
ER3   ttt326
ET3   fft300
ET301 tff327
ET302 tff327
ET303 tff327
ET304 tff327
ET305 tff327
ET306 tff327
ET307 tff327
ET308 tff327
ET309 tff327
ET310 tff327
ET311 tff327
ET312 tff327
ET313 tff327
ET314 tff327
ET315 tff327
ET320 tff327
ET321 tff327
ET324 tff327
ET328 tff327
ET340 tft328
ET331 tff329
EA4   tft403
EB45  tft405
EB40  fft400
EC4   tft406
EE4   ttt407
```

```
EF4   ttt408
EG4   ttt409
EH45  ttt410
EH46  ttt411
EH47  ttt412
EH48  ttt413
EL40  ttt414
EM40  ttt415
EL41  ttt416
EM41  ttt417
EL42  ttt418
EM42  ttt419
EL43  ttt420
EM43  ttt421
EL45  ttt422
EM45  ttt423
EN4   tft424
EP45  tft425
ER4   ttt426
ET4   fft400
ET401 tff427
ET402 tff427
ET403 tff427
ET404 tff427
ET405 tff427
ET406 tff427
ET407 tff427
ET408 tff427
ET409 tff427
ET410 tff427
ET411 tff427
ET412 tff427
ET413 tff427
ET414 tff427
ET415 tff427
ET420 tff427
ET421 tff427
ET424 tff427
ET428 tff427
ET440 tft428
ET431 tff429
EA5   tft503
EB55  tft505
EB50  fft500
EC5   tft506
EE5   ttt507
EF5   ttt508
EG5   ttt509
EH55  ttt510
EH56  ttt511
EH57  ttt512
EH58  ttt513
```

```
EL50  ttt514
EM50  ttt515
EL51  ttt516
EM51  ttt517
EL52  ttt518
EM52  ttt519
EL53  ttt520
EM53  ttt521
EL55  ttt522
EM55  ttt523
EN5   tft524
EP55  tft525
ER5   ttt526
ET5   fft500
ET501 tff527
ET502 tff527
ET503 tff527
ET504 tff527
ET505 tff527
ET506 tff527
ET507 tff527
ET508 tff527
ET509 tff527
ET510 tff527
ET511 tff527
ET512 tff527
ET513 tff527
ET514 tff527
ET515 tff527
ET520 tff527
ET521 tff527
ET524 tff527
ET528 tff527
ET540 tft528
ET531 tff529
```

Appendix 11. Field list 5 (Lead-Alpha)

```
B20    ttf101
G10    fft100
GA1    tft102
GB15   tft103
GB10   fft100
GC1    tft105
GE1    ttt106
GF1    ttt107
GL1    ttt108
GM1    ttt109
GP15   tft110
GT1    fft100
GT101  tff111
GT102  tff111
GT103  tff111
GT104  tff111
GT105  tff111
GT106  tff111
GT107  tff111
GT108  tff111
GT109  tff111
GT110  tff111
GT111  tff111
GT112  tff111
GT113  tff111
GT114  tff111
GT115  tff111
GT120  tff111
GT121  tff111
GT124  tff111
GT140  tft112
GT131  tff113
GA2    tft202
GB25   tft203
GB20   fft200
GC2    tft205
GE2    ttt206
GF2    ttt207
GL2    ttt208
GM2    ttt209
GP25   tft210
GT2    fft200
GT201  tff211
GT202  tff211
GT203  tff211
GT204  tff211
GT205  tff211
GT206  tff211
GT207  tff211
```

```
GT208 tff211
GT209 tff211
GT210 tff211
GT211 tff211
GT212 tff211
GT213 tff211
GT214 tff211
GT215 tff211
GT220 tff211
GT221 tff211
GT224 tff211
GT240 tft212
GT231 tff213
GA3   tft302
GB35  tft303
GB30  fft300
GC3   tft305
GE3   ttt306
GF3   ttt307
GL3   ttt308
GM3   ttt309
GP35  tft310
GT3   fft300
GT301 tff311
GT302 tff311
GT303 tff311
GT304 tff311
GT305 tff311
GT306 tff311
GT307 tff311
GT308 tff311
GT309 tff311
GT310 tff311
GT311 tff311
GT312 tff311
GT313 tff311
GT314 tff311
GT315 tff311
GT320 tff311
GT321 tff311
GT324 tff311
GT340 tft312
GT331 tff313
```

Appendix 12. Field list 6 (Fission-Track)

```
B20   ttf101
H10   fft100
HA1   tft102
HB15  tft103
HB10  fft100
HC1   tft105
HE1   ttt106
HF1   ttt107
HG1   ttt108
HH1   ttt109
HJ1   ttt110
HL1   ttt111
HM1   ttt112
HN1   ttt113
HP1   ttt114
HQ1   ttt115
HP15  tft116
HT1   fft100
HT101 tff117
HT102 tff117
HT103 tff117
HT104 tff117
HT105 tff117
HT106 tff117
HT107 tff117
HT108 tff117
HT109 tff117
HT110 tff117
HT111 tff117
HT112 tff117
HT113 tff117
HT114 tff117
HT115 tff117
HT120 tff117
HT121 tff117
HT122 tff117
HT124 tff117
HT140 tft118
HT131 tff119
HA2   tft202
HB25  tft203
HB20  fft200
HC2   tft205
HE2   ttt206
HF2   ttt207
HG2   ttt208
HH2   ttt209
HJ2   ttt210
HL2   ttt211
```

```
HM2   ttt212
HN2   ttt213
HP2   ttt214
HQ2   ttt215
HP25  tft216
HT2   fft200
HT201 tff217
HT202 tff217
HT203 tff217
HT204 tff217
HT205 tff217
HT206 tff217
HT207 tff217
HT208 tff217
HT209 tff217
HT210 tff217
HT211 tff217
HT212 tff217
HT213 tff217
HT214 tff217
HT215 tff217
HT220 tff217
HT221 tff217
HT222 tff217
HT224 tff217
HT240 tft218
HT231 tff219
HA3   tft302
HB35  tft303
HB30  fft300
HC3   tft305
HE3   ttt306
HF3   ttt307
HG3   ttt308
HH3   ttt309
HJ3   ttt310
HL3   ttt311
HM3   ttt312
HN3   ttt313
HP3   ttt314
HQ3   ttt315
HP35  tft316
HT3   fft300
HT301 tff317
HT302 tff317
HT303 tff317
HT304 tff317
HT305 tff317
HT306 tff317
HT307 tff317
HT308 tff317
```

```
HT309 tff317
HT310 tff317
HT311 tff317
HT312 tff317
HT313 tff317
HT314 tff317
HT315 tff317
HT320 tff317
HT321 tff317
HT322 tff317
HT324 tff317
HT340 tft318
HT331 tff319
HA4   tft402
HB45  tft403
HB40  fft400
HC4   tft405
HE4   ttt406
HF4   ttt407
HG4   ttt408
HH4   ttt409
HJ4   ttt410
HL4   ttt411
HM4   ttt412
HN4   ttt413
HP4   ttt414
HQ4   ttt415
HP45  tft416
HT4   fft400
HT401 tff417
HT402 tff417
HT403 tff417
HT404 tff417
HT405 tff417
HT406 tff417
HT407 tff417
HT408 tff417
HT409 tff417
HT410 tff417
HT411 tff417
HT412 tff417
HT413 tff417
HT414 tff417
HT415 tff417
HT420 tff417
HT421 tff417
HT422 tff417
HT424 tff417
HT440 tft418
HT431 tff419
HA5   tft502
```

```
HB55  tft503
HB50  fft500
HC5   tft505
HE5   ttt506
HF5   ttt507
HG5   ttt508
HH5   ttt509
HJ5   ttt510
HL5   ttt511
HM5   ttt512
HN5   ttt513
HP5   ttt514
HQ5   ttt515
HP55  tft516
HT5   fft500
HT501 tff517
HT502 tff517
HT503 tff517
HT504 tff517
HT505 tff517
HT506 tff517
HT507 tff517
HT508 tff517
HT509 tff517
HT510 tff517
HT511 tff517
HT512 tff517
HT513 tff517
HT514 tff517
HT515 tff517
HT520 tff517
HT521 tff517
HT522 tff517
HT524 tff517
HT540 tft518
HT531 tff519
```

Appendix 13. Field list 7 (Reference)

```
B20    fft100
B40    ttf101
B60    ttf101
B70    fft100
B90    fft100
B100   fft100
A20    fft100
A40    fft100
A60    fft100
A72    fft100
A74    fft100
A80    fft100
A85    fft100
A90    fft100
A100   fft100
A110   fft100
A130   fft100
A170   fft100
A150   fft100
A160   fft100
A140   fft100
RA1    tft102
```

Appendix 14. Pascal source code for unit GIPSYGlobals

```
unit GIPSYGlobals;
    {global variables and types for GIPSY conversion programs}

interface

    const
        Tab = chr(9);                       {horizontal tab character}
        BackSlash = chr(92);                {backSlash \ character}
        FileNameBegin = 'Field List';       {first part of file name}
        NullStr = '';                       {null string}
        Space = chr(32);                    {space character}
        Indent = '   ';                     {3-space indentation}
        BSPos = 8;                          {position of backSlash character}
        HeadLines = 20;                     {number of header lines to be skipped}
        LineLength = 122;                   {length of line including <CR>}
        NumSet = ['0'..'9', '.', '+', '-', 'E', ','];  {chars allowed in numbers}

    type
        gStr = string[LineLength];          {string with length of GIPSY dump line}
        fStr = string[6];                   {string for field labels}
        fieldRec = record
                used: boolean;
                number: boolean;
                one2one: boolean;
                GIPSYLabel: fStr;
                analNum: integer;
                helixNum: integer;
            end;
        fieldRecArray = array[1..250] of fieldRec;
        lineRec = record
                line: packed array[1..LineLength] of char;
            end;

    var
        outFile: text;                      {output text file (tab-delimited) for reading by Helix}
        inList: text;                       {input file for list of GIPSY field labels}
        inFile: file of lineRec;            {input file made by GIPSY}
        recordNum: integer;                 {current Helix record number}
        GFieldNum: integer;                 {GIPSY field number}
        fieldNum: integer;                  {current Helix field number}
        analNum: integer;                   {current Helix analysis number}
        totalFields: integer;               {total number of GIPSY fields}
        numFields: integer;                 {number of Helix fields}
        fieldLabel: fStr;                   {GIPSY field label read from inFile e.g. B20___}
        proNum: 1..7;                       {process number}
        firstLetter: char;                  {first letter of process}
        listFileName: string[31];           {name of file containing field list}
        dictArray: fieldRecArray;           {array of GIPSY info records}
        gDumpStr: gStr;                     {line from GIPSY dump file}
```

```
        fieldText: gStr;                {field text read from GIPSY dump file}
        fieldCont: gStr;                {field content after processing}
        newAnalNum: boolean;            {true if analysis number changed}
        analNumDone: boolean;           {true if analysis number written to field}
        lastGRecordNum: gStr;           {last GIPSY record number}
        lastDecayCode: gStr;            {last decay constant code}
        hasDecay: boolean;              {true if decay constants in this process}
        wrapLine: boolean;              {true if line read is wrapped from previous line}
        disp: boolean;                  {true if user wants display}
        theRect: rect;                  {output window rectangle}
        numError: integer;              {number of errors in number fields}
        fileLength: longint;            {length of file in lines}
        numLines: longint;              {number of lines read}

implementation

end.
```

Appendix 15. Pascal source code for unit FileOpener

```
unit FileOpener;
  {unit to provide functions to open text files for reading or writing}

interface

    uses
        GIPSYGLobals;

    const
        vert = 120;                    {coordinates for upper left corner of file dialogs}
        horiz = 80;

    function GetInputFile (random: boolean): boolean;
  {function to allow user to select a text file for input}
    {associating the users file with the file variable inFile}
    {function returns false if file selection unsuccessful}
    {random should be set to true for random access}
    {requires global variable inFile}

    function SetOutputFile (random: boolean): boolean;
  {function to allow user to select a text file for output,}
    {associating the users file with the file variable outFile;}
    {function returns false if file selection unsuccessful}
    {random should be set to true for random access}
    {requires global variable outFile}

implementation

    var
        upLeft: point;                 {upper left corner of file dialogs}
        rep: SFReply;                  {record for info returned by OS}
        types: SFTypeList;             {file types accepted (text only)}

    function GetInputFile;
    begin
        GetInputFile := false;                      {set result to false until completed}
        SetPt(upLeft, horiz, vert);                 {point for upper left corner of dialog}
        types[0] := 'TEXT';                         {only allow selection of text files}
        SFGetFile(upLeft, '', nil, 1, types, nil, rep);  {file selection dialog}
        if not (rep.good) then
            exit(GetInputFile);                     {user selected cancel}
        if setVol(nil, rep.vRefNum) <> NoErr then
            exit(GetInputFile);                     {IO Error}
        if random then
            Open(inFile, rep.fName)
        else
            Reset(inFile, rep.fName);               {open the file}
        GetInputFile := true;  {successful completion}
    end; {GetInputFile}
```

```
    function SetOutputFile;
        var
            FileInfo: FInfo;
    begin
        SetOutputFile := false;                    {set result to false until completed}
        setPt(upLeft, horiz, vert);                {point for upper left corner of dialog}
        SFPutFile(upLeft, 'Save as:', '', nil, rep);   {file save d'log}
        if not (rep.good) then
            exit(SetOutputFile);{user selected cancel}
        if setVol(nil, rep.vRefNum) <> NoErr then
            exit(SetOutputFile);{IO Error}
        if random then
            Open(outFile, rep.fName)
        else
            ReWrite(outFile, rep.fName);           {create and open the file}
        if GetFInfo(rep.fName, rep.vRefNum, FileInfo) <> noErr then
            exit(SetOutputFile);
        FileInfo.fdCreator := '????';
        if SetFInfo(rep.fName, rep.vRefNum, FileInfo) <> noErr then
            exit(SetOutputFile);
        SetOutputFile := true;                     {successful completion}
    end; {SetOutputFile}

end. {FileOpener}
```

Appendix 16. Pascal source code for unit Init

```
unit Init;
    {initialization routines}

interface

uses
    GIPSYGlobals;

procedure GetProcessNumber;

procedure SetVars;

procedure ShowScreen;

implementation

procedure GetProcessNumber;
    begin
        page;
        writeln;
        writeln('Location and Geology-1');
        writeln('Potassium-Argon    -2');
        writeln('Rubidium-Strontium -3');
        writeln('Uranium-Thorium-Lead-4');
        writeln('Lead-Alpha         -5');
        writeln('Fission-Track      -6');
        writeln('References         -7');
        writeln;
        write('Which data set do you wish to process? ');
        readln(proNum);
    end;

procedure SetVars;
    begin
        numError := 0;
        numLines := 0;
        case proNum of
            1: begin
                firstLetter := 'L';
                listFileName := concat(FileNameBegin, ' 1');
                hasDecay := false;
            end;
            2: begin
                firstLetter := 'K';
                listFileName := concat(FileNameBegin, ' 2');
                hasDecay := true;
            end;
            3: begin
                firstLetter := 'R';
```

```
                listFileName := concat(FileNameBegin, ' 3');
                hasDecay := true;
            end;
            4: begin
                firstLetter := 'U';
                listFileName := concat(FileNameBegin, ' 4');
                hasDecay := true;
            end;
            5: begin
                firstLetter := 'P';
                listFileName := concat(FileNameBegin, ' 5');
                hasDecay := false;
            end;
            6: begin
                firstLetter := 'F';
                listFileName := concat(FileNameBegin, ' 6');
                hasDecay := false;
            end;
            7: begin
                firstLetter := 'B';
                listFileName := concat(FileNameBegin, ' 7');
                hasDecay := false;
            end;
        end; {case}
    end;

procedure ShowScreen;
    var
        wRect: rect;
    begin
        SetRect(wRect, 50, 50, 200, 200);
        SetRect(theRect, 0, 0, 150, 150);
        SetDrawingRect(wRect);
        ShowDrawing;
        wRect := screenBits.bounds;
        InsetRect(wRect, 30, 30);
        SetTextRect(wRect);
        ShowText;
    end;

end.
```

Appendix 17. Pascal source code for unit GIPSYPrep

```
unit GIPSYPrep;

interface

    uses
        GIPSYGlobals;

    procedure GetFileLength;

    procedure StripHeader;

    procedure GetFieldArray;

    procedure ShowFieldArray;

implementation

    procedure GetFileLength;
    begin
        seek(inFile, MaxLongint);          {go to end of file}
        fileLength := filePos(inFile);     {get record number at end}
        seek(inFile, 0);                   {rewind file to beginning}
    end;

    procedure StripHeader;
        var
            i: integer;
    begin
        seek(inFile, HeadLines);
    end;

    procedure GetFieldArray;
        var
            i: integer;
            lineStr: string[12];                    {string for reading list lines}
            tempStr: fStr;                          {for holding substrings read}
            tempNum: longint;                       {for string to num conversions}
    begin
        reset(inList, listFileName);                {open list file}
        i := 0;                                     {set counter to zero}
        while not eof(inList) do
            begin           {check eof}
                i := i + 1;                         {increment counter}
                readln(inList, lineStr);            {read line of file}
                tempStr := copy(lineStr, 1, 6);     {chars 1-6}
                dictArray[i].GIPSYLabel := tempStr; {= GIPSY label}
                tempStr := copy(lineStr, 7, 1);     {char 7}
                if tempStr = 't' then
                    dictArray[i].used := true       {used=true}
```

```
            else
                dictArray[i].used := false;              {used=false}
            tempStr := copy(lineStr, 8, 1);              {char 8}
            if tempStr = 't' then
                dictArray[i].number := true              {number=true}
            else
                dictArray[i].number := false;            {number=false}
            tempStr := copy(lineStr, 9, 1);              {char 9}
            if tempStr = 't' then
                dictArray[i].one2one := true             {one2one=true}
            else
                dictArray[i].one2one := false;           {one2one=false}
            tempStr := copy(lineStr, 10, 1);             {char 10}
            StringToNum(tempStr, tempNum);
            dictArray[i].analNum := integer(tempNum);    {= analysis number}
            tempStr := copy(lineStr, 11, 2);             {chars 11-12}
            StringToNum(tempStr, tempNum);
            dictArray[i].helixNum := integer(tempNum);   {= Helix field number}
        end; {while}
    close(inList);                                       {close the list file}
    totalFields := i;
end; {GetFieldArray}

procedure ShowFieldArray;
    var
        i: integer;
        ch: char;
begin
    page;                                                {clear text screen}
    for i := 1 to totalFields do
        begin       {loop through number of GIPSY fields}
            write(dictArray[i].GIPSYLabel);              {display label}
            write(dictArray[i].used : 10);               {display used (true or false)}
            if dictArray[i].used then
                begin           {if field is used}
                    write(dictArray[i].one2one : 10); {display one2one (true or false)}
                    if dictArray[i].number then
                        write('  number')
                    else
                        write('    text');               {display number or text}
                    write(dictArray[i].analNum : 4);     {display analysis number}
                    write(dictArray[i].helixNum : 4);    {display Helix field number}
                end; {if}
            writeln;                                     {return}
        end; {for}
    writeln;                                             {skip line}
    writeln('Number of fields = ', totalFields);         {display total number of fields}
    writeln;
    write('Press Return...');                            {wait for user}
    readln;
    page;                                                {clear screen}
```

```
    end; {ShowFieldArray}
end.
```

Appendix 18. Pascal source code for unit GIPSYStuff

```
unit GIPSYStuff;
    {contains generic routines for GIPSY conversions}

interface

    uses
        GIPSYGlobals, GIPSYSpecials;

    procedure NewGIPSYRecord;

    procedure MainLoop;

implementation

    procedure WriteTab;
    begin
        write(outFile, Tab);
        fieldNum := fieldNum + 1;                    {now in next Helix field}
    end; {WriteTab}

    procedure WriteContent (theStr: gStr);
        var
            i: integer;
    begin
        write(outFile, theStr);                      {valid chars of field content written here}
    end; {WriteContent}

    procedure ShowProgress;
        var
            percentDone: integer;
    begin
        numLines := filePos(inFile);                 {get current line number}
        percentDone := integer(trunc((numLines / fileLength) * 100));
        ShowDrawing;
        EraseRect(theRect);
        MoveTo(20, 20);
        WriteDraw(percentDone : 4, ' % done');
        MoveTo(20, 40);
        WriteDraw(numError : 4, ' errors');
    end;

    procedure NewHelixRecord;
    begin
        while numFields > fieldNum do
            WriteTab;                                {write tabs for remaining (empty) fields}
        writeln(outFile);                            {write eoln to end record}
        fieldNum := 1;                               {reset Helix field number}
        analNum := analNum + 1;                      {increment analysis number}
        newAnalNum := true;                          {analysis number changed}
```

```
    analNumDone := false;                    {analysis number not yet written}
    if (proNum = 1) or (proNum = 7) then
        analNumDone := true;                 {no analysis number for process 1 or 7}
    recordNum := recordNum + 1;              {increment record number}
end;

procedure NewGIPSYRecord;
begin
    NewHelixRecord;                          {new GIPSY record = new Helix record}
    GFieldNum := 0;                          {reset GIPSY field number}
    analNum := 1;                            {reset analysis number}
    newAnalNum := false;                     {analysis number 1 = unchanged}
    ShowProgress;
end;

procedure Update;
    var
        aStr: str255;
        tempStr: gStr;
begin
    if not dictArray[GFieldNum].used then
        exit(Update);
    if dictArray[GFieldNum].number then
        fieldCont := CheckNumber(fieldCont);
    if dictArray[GFieldNum].analNum > analNum then
        NewHelixRecord;
    if newAnalNum then
        begin
            tempStr := lastGRecordNum;       {read chars from last record number}
            WriteContent(tempStr);           {write field to file}
            WriteTab;
            if hasDecay then
                begin
                    tempStr := lastDecayCode;      {read chars from last decay code}
                    WriteContent(tempStr);         {write field to file}
                    WriteTab;
                end; {if}
            newAnalNum := false;
        end; {if}
    if (dictArray[GFieldNum].helixNum > 4) and (not AnalNumDone) then
        begin
            while fieldNum < 4 do
                WriteTab;                          {move to current field}
            NumToString(longint(dictArray[GFieldNum].analNum), aStr);
            tempStr := aStr;
            WriteContent(tempStr);                 {write field to file}
            WriteTab;
            AnalNumDone := true;                   {analyis number written}
        end; {if}
    if not dictArray[GFieldNum].one2one then
        ProcessSpecial;                            {special handling if required}
```

```
    while dictArray[GFieldNum].helixNum > fieldNum do
        WriteTab;                                   {move to current field}
    if wrapLine then
        fieldCont := concat(Space, fieldCont);
    WriteContent(fieldCont);                        {write field contents}
end;

procedure ReadALine;
begin
    get(inFile);                                    {read record from GIPSY dump file}
    if not eof(inFile) then                         {check eof}
        gDumpStr := inFile^.line                    {input string is the line record}
    else
        gDumpStr := NullStr;
    delete(gDumpStr, length(gDumpStr), 1);          {delete final <CR>}
end;

function ReadGIPSYLine: boolean;
begin
    ReadGIPSYLine := true;                              {assume no errors until they occur}
    wrapLine := false;                                  {assume not a wrapped line}
    ReadALine;                                          {read a line}
    if pos(BackSlash, gDumpStr) = BSPos then            {check for \}
        exit(ReadGIPSYLine);                            {OK}
    if pos(Indent, gDumpStr) = 1 then                   {check for spaces and}
        if gDumpStr[4] <> Space then
            begin       {text}
                wrapLine := true;                       {it's a wrap!}
                exit(ReadGIPSYLine);                    {OK}
            end;
    ReadGIPSYLine := false;                             {failed to find good line}
end; {ReadGIPSYLine}

function GetLabel: fStr;
begin
    GetLabel := copy(gDumpStr, (BSPos - 6), 6);
end;

function GetText: gStr;
    var
        numChars: integer;
begin
    if wrapLine then
        GetText := gDumpStr
    else
        begin
            numChars := length(gDumpStr) - BSPos;
            GetText := copy(gDumpStr, (BSPos + 1), numChars);
        end;
end;
```

```
function StripSpace (inStr: gStr): gStr;
begin
    while (length(inStr) > 0) & (inStr[1] = Space) do
        Delete(inStr, 1, 1);
    while (length(inStr) > 0) & (inStr[length(inStr)] = Space) do
        Delete(inStr, length(inStr), 1);
    StripSpace := inStr;
end; {StripSpace}

function Match: boolean;
    var
        found: boolean;
begin
    found := false;
    if wrapLine then
        begin
            found := true;
            Match := found;
            exit(Match);
        end;
    while not found do
        begin
            GFieldNum := GFieldNum + 1;                    {increment GIPSY field number}
            if GFieldNum > totalFields then                {no more fields in this record}
                leave;                                     {leave the while loop}
            if dictArray[GFieldNum].GIPSYLabel = fieldLabel then
                found := true;                             {Found the sucker!}
        end; {while}
    Match := found;                                        {set function to result}
end; {Match}

procedure MainLoop;
    var
        validLine: boolean;
begin
    while not eof(inFile) do
        begin          {check eof}
            repeat
                if eof(inFile) then                        {check eof}
                    leave;
                validLine := ReadGIPSYLine;                {read lines until valid line read}
            until validLine;
            if not wrapLine then                           {if it's not a wrapped line}
                fieldLabel := GetLabel;                    {extract field label}
            fieldText := GetText;                          {extract field text}
            fieldCont := StripSpace(fieldText);            {remove extraneous spaces}
            if not Match then
                begin                                      {match field labels}
                    NewGIPSYRecord;                        {start new record if no match}
                    if not Match then
                        begin                              {if still no match then}
                            close(inFile);
```

```
                        close(outFile);
                        halt;                          {stop on error}
                    end;
                end;
            Update;                                    {handle matched field}
            if Button then
                Leave;                                 {if mouse button pressed then quit}
        end; {while}
    end; {MainLoop}

end.
```

Appendix 19. Pascal source code for unit GIPSYSpecials

```
unit GIPSYSpecials;
    {routines for special case fields}

interface

    uses
        GIPSYGlobals;

    procedure ProcessSpecial;

    function CheckNumber (inStr: gStr): gStr;

implementation

    procedure ProcessSpecial;

        var
            fl45: string[2];                    {field label chars 4-5}

        procedure DoComment;
            var
                tempStr: gStr;
        begin
            tempStr := fl45;                    {label chars 4-5 become comment code}
            if dictArray[GFieldNum].helixNum = fieldNum then
                fieldCont := concat(', ', tempStr)
            else
                fieldCont := tempStr;
        end;

        procedure DoRecordNum;
    {save record number for future use}
        begin
            lastGRecordNum := fieldCont;
        end;

        procedure DoDecay;
    {make and save decay constant code for future use}
            var
                tempStr: fStr;
        begin
            tempStr := copy(fieldLabel, 2, 2);    {label chars 2-3 identify decay constants}
            fieldCont := concat(firstLetter, tempStr);
            lastDecayCode := fieldCont;
        end;

        procedure DoRefYear;
        begin
            fieldCont := concat(fieldCont, '-');    {add - to end of reference year}
```

```
    end;

    procedure DoRefNum;
    begin
        if length(fieldCont) > 0 then
            while fieldCont[1] = '0' do
                delete(fieldCont, 1, 1);
    end;

    procedure DoSr;
    begin
        if fieldLabel[1] = 'N' then
            fieldCont := '1'                    {1 (true) for normal strontium}
        else
            fieldCont := '0';
    end;

    procedure DoRefList;
        var
            dashPos: integer;
    begin
        if length(fieldCont) > 0 then
            begin
                dashPos := pos('-', fieldCont);
                if dashPos > 0 then
                    while (fieldCont[dashPos + 1] = '0') or (fieldCont[dashPos + 1] = 'O') do
                        delete(fieldCont, dashPos + 1, 1);
                dashPos := pos(' ', fieldCont);
                if dashPos > 0 then
                    while (fieldCont[dashPos + 4] = '0') or (fieldCont[dashPos + 4] = 'O') do
                        delete(fieldCont, dashPos + 4, 1);
            end;
    end;

begin
    fl45 := copy(fieldLabel, 4, 2);
    if (fieldLabel[2] = 'T') and (fl45 <> '31') then
        DoComment;
    if fieldLabel = 'B20   ' then
        DoRecordNum;
    if (fieldLabel[2] = '2') and (fieldLabel[1] <> 'B') then
        DoDecay;
    if fieldLabel = 'B40   ' then
        DoRefYear;
    if fieldLabel = 'B60   ' then
        DoRefNum;
    if (fieldLabel[1] = 'T') or (fieldLabel[1] = 'N') then
        DoSr;
    if (fieldLabel[2] = 'T') and (fl45 = '31') then
        DoRefList;
```

```
    end; {ProcessSpecial}

    function CheckNumber (inStr: gStr): gStr;
        var
            strLen: integer;
            i: integer;
    begin
        i := 1;
        while i <= length(inStr) do
            begin               {for each character}
                if not (inStr[i] in NumSet) then                {if not an allowed character}
                    case inStr[i] of
                        'O', 'o':
                            inStr[i] := '0';                    {oh's become zero's}
                        'l':
                            inStr[i] := '1';                    {el's become one's}
                        otherwise
                            begin
                                numError := numError + 1;       {other bad character}
                                delete(inStr, i, 1);            {delete it!}
                            end;
                    end; {case}
                i := i + 1;
            end; {while}
        CheckNumber := inStr;
    end; {CheckNumber}

end.
```

Appendix 20. Pascal source code for program DupRefs

```
program DupRefs;

{Program to remove sequential duplicate references from text file after conversion}
{from GIPSY}

uses
    DupRefsGlobals, FileOpener, FileHandler;

begin
    if not GetInputFile(false) then                    {open input file}
        halt;
    if not SetOutputFile(false) then begin             {open output file}
            close(inFile);
            halt;
        end;
    SetRect(wRect, 50, 50, 250, 100);
    SetRect(theRect, 0, 0, 200, 50);
    SetDrawingRect(wRect);
    ShowDrawing;
    readln(inFile);                                    {strip off first line (empty)}
    lastRefID := '';                                   {initially lastRefID not defined}
    numLines := 0;
    while not eof(inFile) do begin                     {check eof}
            refID := ReadItem(inFile, Tab);            {refID is the string in first field}
            if refID <> lastRefID then begin           {if its not the same as previous}
                    lastRefID := refID;                {set previous to the new one}
                    write(outFile, refID);             {write the refID followed by tab delimiter}
                    write(outFile, Tab);
                    while not eoln(inFile) do begin    {read/write the actual reference}
                            read(inFile, ch);
                            write(outFile, ch);
                        end; {while}
                    writeln(outFile);                  {write <CR>}
                end; {if}
            readln(inFile);                            {skip line/read <CR>}
            numLines := numLines + 1;
            EraseRect(theRect);
            MoveTo(20, 20);
            WriteDraw(numLines : 6, ' lines processed');
            if Button then                             {if mouse clicked then quit}
                leave;
        end; {while}
    close(inFile);                                     {close files}
    close(outFile);
end.
```

Appendix 21. Pascal source code for unit DupRefsGlobals

```
unit DupRefsGlobals;

interface

const
    Tab = chr(9);                {tab character delimiter}

var
    inFile, outFile: text;       {two text files}
    ch: char;                    {character for input/output}
    refID: str255;               {reference year-number}
    lastRefID: str255;           {last reference year-number}
    theRect, wRect: rect;        {window rectangles}
    numLines: longint;           {number of lines processed}

implementation

end.
```

Appendix 22. Pascal source code for unit FileHandler

```
unit FileHandler;
        {unit for generic file routines}

interface

uses
    DupRefsGlobals;

function readItem (var theFile: Text; stopChar: char): str255;

implementation

function readItem (var theFile: Text; stopChar: char): str255;
    {function which returns a string built by reading characters from file}
    {always stops at EOL (<CR>)}
    {global variables: inFile and ch}

    var
        cha: char;                          {character read from file}
        strIndex: integer;                  {position in string}
        dataStr: str255;                    {string to hold cell contents or x,y values}
        inStr: boolean;                     {true if current char within " "}

    begin {readItem}
        strIndex := 0;                      {set starting position to 0}
        dataStr := '';                      {set string to null}
        inStr := false;                     {not within " " yet}
        repeat                              {read until semicolon or <CR> encountered}
            read(theFile, cha);             {read character from file}
            if (cha <> stopChar) then begin {if valid char}
                    strIndex := strIndex + 1;   {increment position}
                    insert(cha, dataStr, strIndex);   {add char to string}
                end;
        until (cha = stopChar) or (eoln(theFile)) or (strIndex = 255);
        readItem := dataStr;
    end; {readItem}

end.
```