UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

E2MCOD: a program to determine and list Digital Line Graph (DLG)
line attributes from a CD-ROM titled
1:2,000,000-Scale Digital Line Graph (DLG)

and

E2MGSM: a program to retrieve DLG line data from a CD-ROM titled
1:2,000,000-Scale Digital Line Graph
and convert those data to a GSMAP database.

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TABLE OF CONTENTS

INTRODUCTION

The United States Geological Survey (USGS) has released a Compact Disc-Read Only Memory (CD-ROM) (US Geological Survey, 1990). This disc contains National Atlas data at a scale of 1:2,000,000 as Digital Line Graph (DLG) files. The data contain line and area records consisting of eight thematic layers in three formats. Those thematic layers are 1) the continental divide, 2) rivers and streams, 3) water bodies, 4) roads and trails, 5) railroads, 6) political boundaries, 7) administrative boundaries, and 8) airports, and the Alaska pipeline. A more complete description of the DLG thematic layers follows under the heading **DIGITAL LINE GRAPH FILES**. The programs provided in this publication deal with only the line records in the Standard DLG format.

The program E2MCOD determines and lists the line-type major-minor line attributes from the 1:2,000,000 National Atlas CD-ROM. The program E2MGSM retrieves and converts user-selected line-type DLG data into a GSMAP database (Selner and Taylor, 1991).

GSMAP is a practical "graphics program" designed for the earth sciences to enable digital compilation of maps and drawings. GSMAP uses an IBM-PC compatible microcomputer, a digitizer and a plotter. GSMAP can operate on either geodetic (latitude, longitude) coordinates or on Cartesian (X,Y) coordinates.

CONVERSION CONSIDERATIONS

DLG files contain both a major and a minor attribute for each line. The program E2MGSM translates DLG major attributes to GSMAP parameter 1, and DLG minor attributes to GSMAP parameter 2. You supply GSMAP line codes via a major-minor code file. We discuss major-minor code files briefly in the next paragraph and in detail under its own heading later in this paper. We have included major-minor example code files you can use as is or change as desired.

DLG files contain more line code attributes (about 225) than GSMAP can deal with (99). To handle DLG line codes in GSMAP format, we have combined similar DLG line code attributes into one GSMAP code. For example, we have combined the 14 DLG line code attributes for perennial water bodies into one GSMAP code. Major-minor code files control the attribute combining. You can change the example major-minor code files on the distribution disk as desired. However, we advise caution you if alter the example code files. Be careful that you don't give different types of lines in an output GSMAP data base the same GSMAP line code. The example code files use 40 GSMAP line codes, leaving the remaining 59 codes for the user to define as desired.

1

DIGITAL LINE GRAPH FILES

The USGS originally made the 1:2,000,000-scale Digital Line Graph (DLG) data available to the public as a series of magnetic tapes. You can purchase the magnetic tape DLG files separately or as a set covering a thematic layer or as a set covering a geographic region. However, as most microcomputer users do not have access to 9-track tape drives, the data are not easily available to such individuals. The USGS sells the magnetic tape medium DLG data to the public for the cost of reproduction. Because of the processing involved to select and process a desired DLG portion, the cost is high. For example, the entire 1:2,000,000-scale DLG data set in one of the distribution formats costs $531. The cost for all the available 1:2,000,000-scale DLG data on magnetic tape is $1,413.

The 1-2,000,000-scale DLG data are now also available on a CD-ROM you can be purchase from the USGS for $32.00. The CD-ROM includes all three distribution formats. CD-ROM drives, including controller card and system software, cost as little as $400 for an internal drive, and $500 for an external drive, as of this writing.

The 1,200,000-scale DLG data are subdivided into 21 geographic regions, covering the conterminous 48 states, Alaska, and Hawaii. The DLG data are stored in a map coordinate system that is unique for each region. The E2MGSM program uses a transformation of the x,y coordinates of the Albers Equal Area Projection relative to the center of the map area. The program converts map coordinates to Albers Equal Area map coordinates. Finally E2MGSM converts the Albers coordinates to latitude-longitude coordinates.

The DLG CD-ROM contains copies of the original data in three formats: a standard format (indicated by the file extension LGS), an optional format and a graphic format. The standard format minimizes storage requirements. The optional format is for data interchange. The graphic format is compatible with the GS-CAM (Geological Survey - Cartographic Automatic Mapping) software. Domaratz and others (1983) have listed a complete description of the record structure for each of the three DLG formats and a description of the major-minor DLG codes. This publication is available from USGS Earth Science Information Centers (ESIC's). ESIC's also sell the CD-ROM titled 1:2,000,000-Scale Digital Line Graph (DLG) Data. You can reach the EISC main office by telephone at 1-800-USA-MAPS. The DLG CD-ROM contains the entire text of Circular 895-D.

The table below lists and describes the eight thematic DLG data types. The numbers enclosed within parentheses are the GSMAP line codes from the major-minor code files distributed on the accompanying disk.

Category	Type of Information
Hypsography	Continental divide (70)
Rivers and streams	Perennial and intermittent streams and rivers, and canals (51-57)
Water bodies	US coastline, including the Great lakes; perennial, intermittent, and dry lakes; swamps; small islands; and glaciers (60-65)
Roads and trails	Interstate, US, and primary State highways; State secondary and light duty roads; unimproved roads; and auto ferry routes (1-5)
Railroads	Mainline and branchline railroads (20-22)
Political boundaries	International boundaries; states; counties; and in Alaska, boroughs (10-13)
Administrative boundaries	Federally administered forests, parks, recreation areas, wildlife refuges, wilderness areas, and military and Indian reservations (40-49)
Cultural features	Airports, and the Alaska pipeline (30-32)

SYSTEM REQUIREMENTS

You need an IBM-PC compatible microcomputer running PC-DOS or MS-DOS 2.0 or later with at least 512KB installed RAM to use the E2MCOD and E2MGSM programs. We strongly recommend that you install hard disk drive.

To use the DLG CD-ROM, you need a CD-ROM drive, and CD-ROM system software. If you want to view the DLG data on the monitor using the display software on the DLG CD-ROM, the minimum display requirements are an EGA monitor and adapter card. However, if you don't need to display the DLG data, the minimum display requirements are then simply a monochrome (MDA) monitor and adapter.

CONTENTS OF THE RELEASE DISK

File	Explanation
E2MCOD.EXE	Program to determine and list line-type DLG codes
E2MGSM.EXE	DLG to GSMAP conversion program
AB.CTL	Example control file for selecting administrative boundaries
CF.CTL	Example control file for selecting cultural features
HP.CTL	Example control file for selecting the continental divide (hypsography)
PB.CTL	Example control file for selecting political boundaries
RD.CTL	Example control file for selecting roads
RR.CTL	Example control file for selecting railroads
ST.CTL	Example control file for selecting streams and rivers
WB.CTL	Example control file for selecting water bodies
AB.COD	Example of specifying administrative boundary
CF.COD	Example of specifying cultural feature codes
HP.COD	Example of specifying hypsography codes codes
PB.COD	Example of specifying political boundary codes
RD.COD	Example of specifying road codes
RR.COD	Example of specifying railroad codes
ST.COD	Example of specifying stream and river codes
WB.COD	Example of specifying water body codes
COLORADO.BND	Example of specifying a geographic boundary to select features within the state of Colorado
S13_PB.LGS	Southern California political boundary DLG file for tutorial
13PB.ASC	ASCII output file from E2MCOD for tutorial
13PB.COD	Major-minor code file for S13_PB.LGS for tutorial
13PB.CTL	Control file for S13_PB.LGS for tutorial
13PB.PRJ	GSMAP projection file for tutorial
13PB.PLT	GSMAP plot file for tutorial

INSTALLATION

Copy the programs E2MCOD.EXE and E2MGSM.EXE to a directory on your hard disk that you have added to the default path list. You also may wish to copy the example control, major-minor code, and tutorial files into the same directory. Copy the desired DLG files from the DLG CD-ROM to the hard disk using the DOS copy command, or read and convert directly from the CD-ROM to GSMAP format.

4

E2MCOD PROGRAM DESCRIPTION

The E2MCOD program examines the contents of a standard format DLG file contained in the STD subdirectory of the DLG CD-ROM, and writes an ASCII file containing the unique DLG attribute codes in that file. You can identify standard format DLG files by the file extension LGS.

E2MCOD PROGRAM OPERATION

Start the program by typing E2MCOD and then press the ENTER key. Press the ENTER key after responding to each prompt from the program.

After displaying an introductory screen, the program will display the following prompt:

ENTER NAME OF DLG INPUT FILE(Q TO EXIT):

Type the name of the DLG file you want to process.

After you enter the DLG file name, the program displays the next prompt:

ENTER NAME OF ASCII OUTPUT FILE FOR ATTRIBUTE CODES:

Enter the ASCII file name as requested. After entering the ASCII file name, the program processes the data, creates the requested ASCII file, displays information about that file, and finally displays the first prompt again.

Examine the contents of the ASCII file(s) to determine the unique attribute codes in the DLG LGS file(s). A typical ASCII output file looks like this:

```
   290,    6030
   290,    6065
   290,    6082
```

Use the pertinent table(s) in Appendix A, USGS Circular 895-D, or the tables published on the DLG CD-ROM from USGS Circular 895-D, to interpret the ASCII output files. In the example above, the DLG code 290, 6030 indicates a national monument with a length at the longest dimension of more than 20 km (12 mi). The DLG code 290, 6065 indicates a national wildlife refuge with a length at the longest dimension of more than 20 km (12 mi). The DLG code 290, 6082 indicates a federal military reservation with an area of more than 405 hectares (1,000 acres).

E2MGSM PROGRAM DESCRIPTION

Use E2MGSM to select portions of the data from one or more
standard format DLG files contained on the DLG CD-ROM and
generate a GSMAP data base with the lines attributed by GSMAP
codes. You must stipulate the instructions for the E2MGSM
program in a control file. The program can operate in a
pseudo-batch method where you stipulate the selection criteria
and the DLG files to be processed, and then leave the process to
operate unattended until the retrieval processes are completed.
Such batch processing is advantageous because of the numerous
attribute codes in the original DLG files, the large volume of
data and the slow speed of CD-ROM drives.

The control file contains the information below:

1. Whether the DLG data to be processed are within the
conterminous United States, Alaska or Hawaii. You need this
information for setting up the parameters required to convert
the DLG map coordinates to geodetic coordinates.

2. The name of the output GSMAP data base, its title and the
geographic corners for the data base.

3. Whether to select by major-minor codes and if so, the name of
as ASCII file that contains records specifying the major-minor
codes and the GSMAP codes you want to assign to the DLG data.

4. Whether to trim the data to a geographic boundary and if so,
the format of and the name of an ASCII file that contains the
points making a geographic polygon for trimming. The geographic
boundary must delineate a closed area. The first and last points
must be the same.

5. A series of DOS filenames for the DLG data you want to
process.

The program displays the contents of the control file parameters
and the contents of the attribute file and the boundary file on
the screen as the program reads them in. If E2MGSM is run as a
batch process, you can go on to other tasks while the batch
process is running. Otherwise, the program requests you to press
the ENTER key to continue processing. After the parameters are
set, the program displays at the bottom of the screen the name of
the DLG file being processed and a counter showing the number of
lines written to the GSMAP output data base.

E2MGSM PROGRAM OPERATION

Start the program by typing E2MGSM and then press the ENTER key. Press the ENTER key after responding to each prompt from the program.

After displaying an introductory screen, the program will then display the following prompt:

ENTER THE NAME OF THE CONTROL FILE:

Type the filename for the control file and then depress the ENTER key.

An alternative method of starting the program running is to type the name of the program followed by one or more spaces and the DOS filename of the control file:

E2MGSM ADMIN.CTL

Using the alternative method allows batch processing of DLG to GSMAP conversions. Use a text editor or a word processing program that can export ASCII files to create a batch file such as this one:

```
echo off
E2MGSM ADMIN.CTL
E2MGSM POLIT.CTL
E2MGSM WATER.CTL
```

and then run it.

E2MGSM CONTROL FILE DESCRIPTION

Make the control file with any editor or word processing program capable of creating an ASCII file. The contents of the file are:

Record 1. Specify a numeric code that indicates the geographic area that contains the data from the following list:

1 = Conterminous 48 states
2 = Alaska
3 = Hawaii

To process data from the state of Colorado, this record would contain a 1 (one) as the only character on the first line.

Example: 1

Record 2. The GSMAP data base name. The name must be one to eight characters long and cannot contain special characters or blanks. Do not add a file extension to the name.

Example: ADMIN

<u>Record 3</u>. The GSMAP map title. The name can be from one to 16 characters long and can contain no special characters.

Example: ADMIN BOUNDARIES

<u>Record 4</u>. The geographic northwest corner for the GSMAP data base. Latitude degrees, minutes, seconds, N or S, longitude degrees, minutes, seconds, W or E.

Example: 39,0,0,N,108,0,0,W

<u>Record 5</u>. Same as 3 except for the southwest corner.

Example: 38,0,0,N,108,0,0,W

<u>Record 6</u>. Same as 3 except for the southeast corner.

Example: 38,0,0,N,106,0,0,W

<u>Record 7</u>. Same as 3 except for the northeast corner.

Example: 39,0,0,N,106,0,0,W

<u>Record 8</u>. Y indicates you want to use a geographic boundary trim file; N indicates you don't want to use geographic boundary trim file. If record 8 is a N, then omit records 9 and 10.

Example: Y

<u>Record 9</u>.   If record 8 contains a Y, then record 9 must be the name of an ASCII file that contains the coordinates of a polygonal geographic boundary file.

Example: COLORADO.BND

An example of a boundary file is given later in this paper.

<u>Record 10</u>. If Record 8 contains a Y, then Record 10 indicates if the geographic coordinates of the boundary file are in decimal degrees (DD) or degrees,minutes,seconds,code (DMS).

Example: DMS

<u>Record 11</u>. Specify if you want to select data by major-minor DLG pairs by entering Y or N.

Example: Y

<u>Record 12</u>. If Record 11 contains a Y, then Record 12 is the name of an ASCII file that provides major-minor pairs and the GSMAP code you want to assign to that pair. We explain major-minor

code files later in this paper. If Record 11 contains a N, then Record 12 must be the GSMAP code to assign to all the line work.

Example: ADMIN.COD

Record 13, 14, ... These records contain the full pathname of the DLG files that you want to process, one file per line.

Examples: G:\STD\SECT10\S10_AB.LGS
           G:\STD\SECT10\S10_WB.LGS

The above two lines assume that the drive designation for the CD-ROM drive is G:. STD refers to a subdirectory on the DLG CD-ROM that contains standard format DLG files. SECT10 refers to a subdirectory that encompasses DLG files for Colorado, Kansas, and Nebraska. The two LGS files are administrative boundary and water body standard format DLG files.

The entire control file given above is:

```
1
ADMIN
ADMIN BOUNDARIES
41,4,59.99,N,109,9,59.99,W
36,54,59.99,N,109,9,59.99,W
36,54,59.99,N,102,0,0,W
41,4,59.99,N,102,0,0,W
Y
COLORADO.BND
DMS
Y
ADMIN.COD
G:\STD\SECT10\S10_AB.LGS
G:\STD\SECT10\S11_AB.LGS
```

MAJOR-MINOR CODE FILE

This file consists of a series of records that contain a DLG major code, a DLG minor code, a GSMAP code and an optional comment enclosed within double quotation marks. The appendix tables of USGS Circular 895-D lists DLG major-minor codes. The text of this circular is also published on the 1:2,000,000 DLG CD-ROM. The example code files included on the release disk contain the standard format defined codes covered in the circular. You can copy these files and change them as needed with a text editor or a word processing program that can write ASCII files. You need major-minor code files for selecting the desired line features; such code files are limited to a maximum of 250 records.

Example: 290,3001,1,"River/stream (double line, shoreline)"
          290,3002,2,"River/stream (double line, centerline)"

In the example above, 290 is the DLG major code, 3001 and 3002 are the DLG minor codes, and 1 and 2 are the GSMAP attribute codes. The DLG major code will become parameter 1 in the GSMAP database, and the DLG minor code will become parameter 2 in the GSMAP database. Put a comma after the DLG major code, after the DLG minor code, and after the GSMAP attribute code.

BOUNDARY FILE

A boundary file consists of records containing the geographic coordinates for a series of points that form a closed polygon. Boundary files are use to select a geographically bound area from a larger DLG file. The format is either in decimal degrees or degrees, minutes, seconds, depending on what you stipulated on Record 11 of the control file. If you used the decimal degree format, note that west longitudes are negative, and south latitudes are negative. To close the polygon, the first and last point must be the same. The maximum number of points in the polygon is 250.

Example for DD format: 39.0,-108.0
                        38.0,-108.0
                        38.0,-106.0
                        39.0,-106.0
                        39.0,-108.0

Example for DMS format: 39,0,0,N,108,0,0,W
                         38,0,0,N,108,0,0,W
                         38,0,0,N,106,0,0,W
                         39,0,0,N,106,0,0,W
                         39,0,0,N,108,0,0,W

TUTORIAL

Included on the distribution disk is the file S13_PB.LGS, the Southern California political boundary DLG file from the 1:2,000,000 DLG CD-ROM. Use the program E2MCOD to determine the unique major-minor line attributes in that file. Shown below is a sample run of that program. The ASCII output file name contains information needed to build a control file for the program E2MGSM. After you enter E2MCOD, the program displays an introductory screen. Then, after a few seconds, the program requests information form the user. The prompts from the program are shown in upper case; the responses from the user are shown in lower case.

ENTER NAME OF DLG INPUT FILE(Q TO EXIT): s13_pb.lgs
ENTER NAME OF ASCII OUTPUT FILE FOR ATTRIBUTE CODES: 13pb.asc
OUTPUT FILE CONTAINS 6 MAJOR,MINOR CODES
ENTER NAME OF DLG INPUT FILE(Q TO EXIT): q

The ASCII output file, 13PB.ASC, looks like this:

```
290,    6001
290,    6005
290,    6009
290,    6011
290,    6012
```

Use the information to build a major-minor code file for the program E2MGSM. Remember that the name of this file will be a record in the E2MGSM control file. If you don't wish to create your own major-minor code file, you can use the one we have included on the distribution disk. We named it 13PB.COD and it looks like this:

```
290,6001,10, "NATIONAL (LAND)"
290,6005,11, "STATE (LAND)"
290,6009,12, "COUNTY, (LAND)"
290,6011,13, "CORPORATE LIMIT (≥1 MILLION POPULATION)"
290,6012,13, "CORPORATE LIMIT (1/2 ≤ 1 MILLION POPULATION)"
```

Next, build a E2MGSM control file. Again, if you don't wish to create your own, we have included for your convenience 13PB.CTL, an example E2MGSM control file, on the distribution disk. It looks like this:

```
1
POLIT
POLITICAL BOUNDS
36,0,0,N,122,0,0,W
32,0,0,N,122,0,0,W
32,0,0,N,114,0,0,W
36,0,0,N,114,0,0,W
N
Y
PB.COD
S13_PB.LGS
```

Next, run the program E2MGSM to convert the DLG file into a GSMAP database. If you use the major-minor code file and the E2MGSM control file included on the distribution disk, the output GSMAP database will have the database name, map title and corner points given in the example E2MGSM control file. To run the program most efficiently, simply type the name of the program followed by at least one space and then the name of the E2MGSM control file on one line and then press the ENTER key. Otherwise, type E2MGSM at the DOS prompt, and follow the prompts from E2MGSM.

Example: E2MGSM 13PB.CTL

The output from the tutorial run of E2MGSM, if you use the E2MGSM control file 13PB.CTL unmodified, is a GSMAP database named

11

POLIT. We have included on the distribution disk 13PB.PRJ, a GSMAP projection file, and 13PB.PLT, a GSMAP plot file. Use GSMAP, 13PB.PLT, and 13PB.PRJ, and if you are familiar with GSMAP, you should be able to generate a plot of the Southern California political boundaries as shown to the right. The plot includes international, state, and county boundaries, and the city limits for Los Angeles and San Diego. You should notice that the Pacific Ocean coastline is not part of the database. The United States coastlines are included in DLG water body files. Therefore, to add the Pacific Ocean coastline to this plot, you need to use the correct water body DLG file, and convert the coastline data to a GSMAP database. Finally, combine the two GSMAP databases to create a more complete map. If you desire, you can add other DLG thematic layers, such as road, rivers and streams, national forests, and wilderness areas. As mentioned earlier, be careful that you don't give different DLG data types the same GSMAP line code.
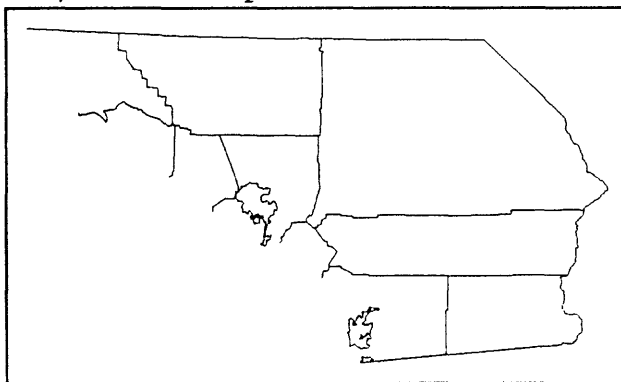
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Selner, Gary I. and Taylor, Richard B., 1991, GSMAP System version 7: Graphic Programs and Utility Programs for the IBM PC and Compatible Microcomputers to assist Compilation and Publication of Geologic Maps and Illustrations: US Geological Survey Open-File Report 91-1, 151 p.

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