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GSMGRASS: A program to convert a GSMAP data base into ASCII files that can be imported directly into the Geographic Resources Analysis Support System (GRASS).

By

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Open-File Report
90-539A Documentation (Paper Copy)
90-539B (Executable Program Disk)

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INTRODUCTION

GSMAP is a microcomputer program that can be used in the compilation and drafting of geologic maps and illustrations. GSMAP is a vector based program that runs under MS-DOS (or PC-DOS). Geographic Resources Analysis Support System (GRASS) is a geographic information system developed by the U. S. Army Construction Engineering Laboratory (USACERL). GRASS is a raster based system that runs on the UNIX operating system on a number of different hardware configurations. This openfile report provides a computer program and instructions to convert data stored in a GSMAP data base to ASCII files that can be directly imported into the GRASS system.

SYSTEM REQUIREMENTS

GSMGRASS was written and tested using the Microsoft QuickBASIC Compiler Release 4.00b. The program described in this document should execute correctly on IBM PC/XT/AT microcomputers, and requires the following: at least 512 RAM, a hard disk, and a 8087 math co-processor. The program was tested on a Compaq Portable III with 640K of RAM memory and DOS 3.31. The minimum software required to use the program is MS-DOS (or PC-DOS) 2.0 or higher and the OpenFile release diskette.

RELEASE DISK

The release disk contains the following files:

GSMGRASS.EXE   Executable code for GSMGRASS

INSTALLATION

The file GSMGRASS.EXE should be copied from the release disk into any directory that is within the current PATH search list. The release disk should be stored as a backup.

BACKGROUND

GSMAP (Selner and Taylor, 1989) utilizes an IBM PC (or compatible) microcomputer, a digitizer and a plotter. As a practical "graphics program" designed for the earth sciences it enables digital compilation of graphical elements. GSMAP operates on either geodetic (latitude,longitude) coordinates or on Cartesian (X,Y) coordinates. Map projections supported by GSMAP include Universal Transverse Mercator, Polyconic, Lambert Conformal Conic, Albers Equal Area and Equidistant Conic. Data can be digitized from maps that use any of these projections, then plotted using the same or another projection. The programs are oriented to the production of hard copy using a plotter. Each different kind of data such as lines, symbols, areas or text is assigned a different code within seven different series. Each series of 99 different codes can represent different attributes. The program is available from the Books and Open-Files Section, USGS, P.O. Box 25046, Denver, CO 80225 (303)-236-7476.

GRASS is a geographic information system that is raster based. It was developed at USACERL to provide a series of tools that would enable a user to perform analysis of combinations of various types of line, area and point data. The GRASS system can import data form various sources including data from Digital Element Models (DEM) developed by the USGS and the Defense Mapping Agency; LANDSAT or SPOT satellite images; and Digital Line Graph (DLG) data sets. It also contains a subsystem to digitize new information called "DIGIT". This subsystem (DIGIT) provides the mechanism to import ASCII files and to topologically structure point, line and area data. GRASS runs under the UNIX operating system on various hardware platforms such as the SUN, HP9000, MASSCOMP workstations. Special versions of GRASS are also available for higher capacity models of personal computers such as the IBM PC and the APPLE Macintosh. Each type of data can be attributed and is normally stored as a series of maps. Individual maps (such as those containing data on elevations, soil types, vegetation,etc.) are called "map layers". In a GRASS analysis, you see the interrelationships between or among map layers. To obtain information regardig GRASS contact the GRASS Information Center USACERL, P.O. Box 4005, Champaign IL 6084-4005 or contact Kathy Norman, (217)-373-7220.

PROGRAM DESCRIPTION

GSMGRASS is a conversion routine that permits the user to retrieve information stored in a GSMAP data base and to write the information regarding its location(s) and attributes to ASCII files that can be transmitted to a GRASS workstation for use in performing geographic analysis. GSMAP data is stored as a series of lines, points, and areas in the form of graphical elements. The data is not topologically structured; however, it contains all of the information necessary for GRASS to be able to form map layers that are topologically structured.

Location data regarding elements stored in a GSMAP data base can be either geodetic coordinates (latitude,longitude) or cartesian coordinates (X,Y). GRASS uses cartesian coordinates, usually Universal Transverse Mercator X,Y. GSMGRASS provides a series of projection routines to convert geodetic coordinates to cartesian coordinates. These projections are the Universal Transverse Mercator, Transverse Mercator, Oblique Mercator, Mercator, Lambert Conformal Conic, Albers Equal Area, and Equidistant Conic. The parameters for a projection are specified in an ASCII file called a projection file. The contents of each line in a projection file for the various types of projection are described in the Appendix of this document.

The GSMGRASS program requires a GSMAP data base as input. This data base should contain only data that will be used to create one map layer once it is imported into the GRASS environment. The user should utilize the GSMAP utility program (GSMUTIL) to separate into different GSMAP data bases the information for the GRASS map layers that are to apply to the geographic analysis to be performed using GRASS.

Each execution of the GSMGRASS program will produce three ASCII output files from one input GSMAP data base. These files will have the GSMAP data base name with a suffix appended to represent the type of data contained. The three files are used as follows:

digit file - contains locational data for lines and area boundaries.
attribute file - contains attributes for the lines and area boundaries.
site file - contains the location and attributes for a site.

For example, if the GSMAP data base name is TEST, then the follwing files would be created:

TEST.DIG contains the location data for lines and polygons.
TEST.ATT contains the attributes of the lines and polygons.
TEST.SIT contains the location and attributes for site data.

The following text covers the seven types of GSMAP data types and explains how GSMGRASS converts the data into the three ASCII files that will be created during each program execution.

Codes 1-99 Lines and Decorated Lines
Each entry will produce a series of lines in the digit file flagged with a code (A) indicating an area boundary. A single record in the attribute file will be written indicating the attribute (GSMAP code and subcode) and flagged with a code (L) indicating a line.

Codes 100-199 Tabular Data Codes
Each entry will produce one line in the site file containing the location and attributes (GSMAP code and subcode).

Codes 200-299 Individually Rotatable Symbols
Each entry will produce one line in the site file containing the location and attributes (GSMAP code and subcode).

Codes 300-399 User-Defined Symbols
Each entry will produce one line in the site file containing the location and attributes (GSMAP code and subcode).

Codes 400-499 Polygons
Each entry will produce a series of lines in the digit file flagged with a code (A) indicating an area boundary. A single record in the attribute file will be written indicating the attribute (GSMAP code and subcode) and flagged with a code (A) indicating an area.

Codes 500-599 Text
Each entry will produce one or more (leaders lines in the attribute file flagged with a code (A) indicating an area.

Codes 600-699 Splined Lines

Each entry will produce a series of lines in the digit file flagged with a code (A) indicating an area boundary. A single record in the attribute file will be written indicating the attribute (GSMAP code and subcode) and flagged with a code (L) indicating a line.

Codes 700-799 Special Text
Each entry will produce one record in the attribute file flagged with a code (A) indicating an area.

PROGRAM OPERATION

The program is executed from the DOS prompt by typing GSMGRASS followed by a carriage return. In the following text user responses are underlined to differentiate the questions and an example answer. The GSMAP data base name (TEST) used is an example and should be replaced with the name assigned when the GSMAP data base was created.

C>GSMGRASS

A brief disclaimer screen will appear for a second and then the screen will clear and the program will request the GSMAP data base name.

ENTER GSMAP DATA BASE NAME: TEST

The program will open the data base and check to see the type of coordinates that are stored. If the coordinates are geodetic, the progarm will request the name of the projection file.

ENTER PROJECTION FILENAME: TEST.PRJ

The program will then attempt to create the three output files, i.e. TEST.DIG, TEST.ATT and TEST.SIT. If the program detects the existence of a file with the same name, the user is asked if he wishes to proceed or not since the program would write over the existing data. If he indicates no (N), then the program returns to the DOS system.

The program will then proceed to process the input GSMAP Data Base. After processing all entries, the program will close the input data base, the output files and return to prompt for a GSMAP Data Base Name. If another data base is to be processed, the flow is repeated; if not, a carriage return will cause the program to exit to the DOS system.

REFERENCES

Selner, Gary I. and Taylor, Richard B., 1989, GSDRAW and GSMAP System Version 6.0: Graphic Programs and Utility Programs for the IBM PC and Compatible Microcomputers to assist Compilation and Publication of Geologic Maps and Illustrations: U.S. Geological Survey Open-File Report 89-373A, 53 p., Program Disks 89-373B, 5 disks.

Snyder,J.P., 1987, map Projections, a working Manual: U.S. Geological Survey Professional paper 1395, 393 p.

APPENDIX

Map projections and USGS practice are described by Snyder, 1982, in U.S.Geological Survey Bulletin 1532 and Professional Paper 1395. Information on the map projection is given in marginal notes on USGS maps, but the data on the parallels and meridian used to prepare the map is not provided. The summary below should help, but please read the original by Snyder. This bulletin and the Professional Paper answer questions you should have. Unless otherwise stated on the map margin or in the Snyder reports, use the Clarke 1866 Ellipsoid.

Small Scale Maps

Maps labeled Albers Equal-Area projection

When used for maps of the 48 conterminous states, the standard parallels are 29,30,0,N degrees and 45,30,0,N . The central meridian is 96,0,0,W.

For maps of Alaska, the standard parallels are 55,0,0,N degrees and 65,0,0,N degrees. The central meridian is 154,0,0,W.

For maps of Hawaii, the standard parallels are 8,0,0,N and 18,0,0,N. The central meridian is 157,0,0,W.

Maps labeled Lambert Conformal Conic

The Lambert conformal conic is used by the USGS for a map of the US showing all 50 states in true relative position. This map has been issued at scales of 1:6,000,000 and at 1:10,000,000. For this map the standard parallels are 37,0,0,N and 65,0,0 N. The central meridian is the line of longitude at the center of the sheet.

Maps labeled Transverse Mercator

In 1979 a spherical form of the Transverse Mercator was chosen for a base map of North America at a scale of 1:5,000,000 for tectonic and other geologic maps. The scale factor along the central meridian of 100,0,0,W longitude is reduced to 0.926, see projection parameter file Example 8 below.

State Scale Maps (1:500,000)

For the 500,000 scale base maps of the 48 contiguous states, the Lambert projection was used. The standard meridian is the line of longitude central to the map.

1 x 2 Degree Maps (1:250,000)

Maps labeled Transverse Mercator

Army Map Service (AMS) 1 degree by 2 degree sheets use the Transverse Mercator projection. The principal meridian is the line of longitude central to the map.

Maps labeled Universal Transverse Mercator (UTM)

The UTM projection will be used by the USGS for 1 x 2 degree sheets as it updates the AMS series. The proper central meridian can be determined either by using tables listing the central meridian for the UTM Zone or by locating the nearest line of longitude of whole number of degrees that is divisible by 3 but not by 2.

30' x 60' Maps (1:100,000)

For all new 30 minute by 60 minute quadrangles, the UTM projection is used. The proper central meridian can be determined either by using tables listing the central meridian for the UTM Zone or by locating the nearest line of longitude of whole number of degrees that is divisible by 3 but not by 2.

15' Quadrangles (1:62,500)

Maps labeled Polyconic

Many 15 minute quadrangle maps have been drawn using the Polyconic projection. The central meridian is the line of longitude central to the map.

7 1/2' Quadrangles (1:24,000)

Maps labeled Polyconic

Many 7 1/2 minute quadrangle maps have been drawn using the Polyconic projection. The central meridian is generally the line of longitude central to the map. Use of this line as the central meridian won't cause problems.

Maps labeled Lambert or Transverse Mercator

Beginning in the late 1950's the USGS began using projections that were based on the parameters that serve as the basis of the State Plane Coordinate system. Depending on the state, the projection will be either Lambert Conformal Conic, Transverse Mercator or Oblique Mercator (panhandle of Alaska only). USGS Bulletin 1532 (Snyder, 1982) presents an excellent description of the basis of the SPCS and the projection that is used for each State. This Bulletin also describes in Table 8 the projection parameters that are used for each zone of each State. Table 8 lists a scale reduction for Transverse Mercator such as 1:2500. The projection file requires a scale factor. The formula to compute scale factor from scale reduction is scale factor = 1.0 - (1/scale reduction) i.e. a 1:2500 scale reduction results in a scale factor of 0.9996 or scale factor=1.0 -(1.0/2500)=0.9996. A useful approximation for digitizing and plotting is to use the Polyconic Projection. The maximum difference in the 700-800 mm diagonals of 7 1/2 or 15 minute quadrangles between Transverse

Mercator, Lambert, and Polyconic projections is about 0.05 mm. This is a much smaller figure than that expected due to size changes due to changes in humidity for a paper copy. It is only twice the accuracy attributed to a good digitizer.

Projections supported:

Cylindrical:
Mercator, Transverse Mercator, Universal Transverse Mercator, Oblique Mercator

Conic:
Polyconic, Lambert Conformal Conic, Albers Equal Area, Equidistant Conic

Examples of Projection Files

Latitude,Longitude values are entered in Degrees, Minutes, Seconds and followed by the appropriate letter designating compass direction: for example, W longitude, N latitude in the conterminous U.S. Equatorial and polar radii are specified in kilometers.

Universal Transverse Mercator

File	Description of Contents
1	"1" designates Universal Transverse Mercator
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
105,0,0,W	Longitude, Principal Meridian of UTM Zone
0.9996	Scale factor

Albers Equal Area

File	Description of contents
2	"2" designates Albers Equal Area
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
45,30,0,N	Latitude, first standard parallel
29,30,0,N	Latitude, second standard parallel
100,0,0,W	Longitude, meridian central to map

Lambert Conformal Conic

File	Description of contents
3	"3" designates Lambert Conformal Conic
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
33,0,0,N	Latitude, first standard parallel
45,0,0,N	Latitude, second standard parallel
105,0,0,W	Longitude, meridian central to map

Mercator

File	Description of contents
4	"4" designates Mercator
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
105,0,0,W	Longitude, Meridian Central to map

Polyconic

File	Description of contents
5	"5" designates Polyconic
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
105,0,0,W	Longitude, meridian central to map

Transverse Mercator

File	Description of contents
6	"6" designates Transverse Mercator
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
105,0,0,W	Longitude, meridian central to map
0.9996	Scale factor

Parameters of special DNAG map for spherical Earth

File	Description of contents
6	"6" designates Transverse Mercator
6371.204	Radius of Earth in km
6371.204	Radius of Earth in Km
100,0,0,W	Longitude, meridian central to map
0.926	Scale factor unique to this map

Oblique Mercator Projection
The sample oblique mercator projection file provides parameters used in generating the Appalachian Map

File	Contents
7	"7" designates Oblique Mercator
6378.2064	Equatorial radius, in km, Clarke 1866
6356.5838	Polar radius in km, Clarke 1866
1.0	Scale factor along central axis
42,0,0,N	Latitude, center point of projection
73,0,0,W	Longitude, center point of projection
51,30,0,N	Latitude, S end of line defining axis
56,0,0,W	Longitude, S end of line defining axis
33,30,0,N	Latitude, N end of line defining axis
84,30,0,W	Longitude, N end of line defining axis

Equidistant Conic

File	Description of contents
8	"8" designates Equidistant Conic
6378.38584	Radius of Earth in km
6356.910	Radius of Earth in Km
9,0,0,N	Latitude, first standard parallel
4,0,0,N	Latitude, second standard parallel
66,0,0,W	Longitude, meridian central to map

Values in this example are for Venezuela maps labeled "Proyeccion Conico Secante Compensada." This projection is also used for certain maps in Alaska labeled "Modified Mercator", see Snyder, 1982.