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A COMPUTER SYSTEM FOR THE STORAGE AND RETRIEVAL OF GRAVITY DATA KINGDOM OF SAUDI ARABIA

by

Richard H. Godson and Gordon E. Andreasen

U. S. Geological Survey
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ILLUSTRATIONS

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ABSTRACT

A computer system has been developed for the systematic storage and retrieval of gravity data. All pertinent facts relating to gravity station measurements and computed Bouguer values may be retrieved either by project name or by geographical coordinates. Features of the system include visual display in the form of printer listings of gravity data and printer plots of station locations. The retrieved data format interfaces with the format of GEOPAC, a system of computer programs designed for the analysis of geophysical data.

INTRODUCTION

For the past several years high speed digital computers have provided a convenient and rapid means to systematically store large volumes of information and to retrieve selected items by various criteria. In this particular application a system of storing gravity measurements has been devised enabling the interested investigator to recall all or any part of the stored data. The initiation of such a system in Saudi Arabia is needed because the rate of data collection is increasing and the problems of inventory and accessibility will increase. Creation of a central gravity data bank permits systematic storage while making the information readily available to interested parties.

Each gravity value consists of a number of related measurements usually referred to as "gravity facts". These include time of measurement, geographical coordinates and elevation of the gravity station, and the computed Bouguer anomaly. Entry to the storage bank is by punched cards which are then stored on a magnetic device. The computer lists the data stored and provides a plot of station locations.

Stored data can be retrieved by either project name or by geographical coordinates. The computer provides a visual display in the form of a list of the retrieved data and a plot of station locations. An important feature of the retrieval is the simultaneous creation of a magnetic tape (or disk) file containing the data in a form acceptable for entry into GEOPAC, a system of computer programs designed for the analysis of geophysical data (Godson, 1973).

The system was developed as part of the work agreement between the U. S. Geological Survey and the Ministry of Petroleum and Mineral Resources, Kingdom of Saudi Arabia. It was tested, is operational, and is on file at the IBM 370/145 computer at the Computer Center, College of Petroleum and Minerals, Dhahran.

DESCRIPTION

Gravity station data are stored as a file on a magnetic device. Data for each station or stations are assigned a project name and any number of projects can be stored in the same file. Each project, however, must be assigned a different name, so that each is uniquely identified within the file. Data input consists of a parameter card to initiate execution, an identification card containing the project name, and a set of gravity station cards, altogether called a "data set"

A description of the information contained on the input cards and their associated formats is explained below in Data Input. If more than one project is to be stored on a particular tape or disk file, a new identification card and associated gravity station cards must be included. This procedure is repeated until all projects have been stored (see figure 1 for generalized chart of data flow).

The gravity data is stored on a magnetic device in an unformatted form using Fortran reference number 12 (FT12F001). The first record contains the project name and the number of stations in the project. The following records contain station gravity data, one record for each of the stations (Appendix 1: Gravity storage format).

As the station data are placed on a storage device, it is printed (fig. 2) and stored in the computer. At the same time the maximum and minimum latitude and longitude is calculated for each data set.

After storage of a data set is complete, the geodetic position of each station is computed, using a Lambert conformal conic map projection, and converted to X,Y coordinates. The Y-axis is the median longitude of the data set as determined from the minimum and maximum longitude values and the X-axis is the equator.

When all the station locations have been converted, a position plot is produced on the printer (fig. 3). This plot serves as a visual check for erroneous locations in the input data. It also provides a convenient means for determining optimum dimensions for the orthogonal grid transformation.

At the conclusion of the printer plot, the data is output on a temporary disk file in case additional processing may be required. The data format is compatible with the requirements for input to the

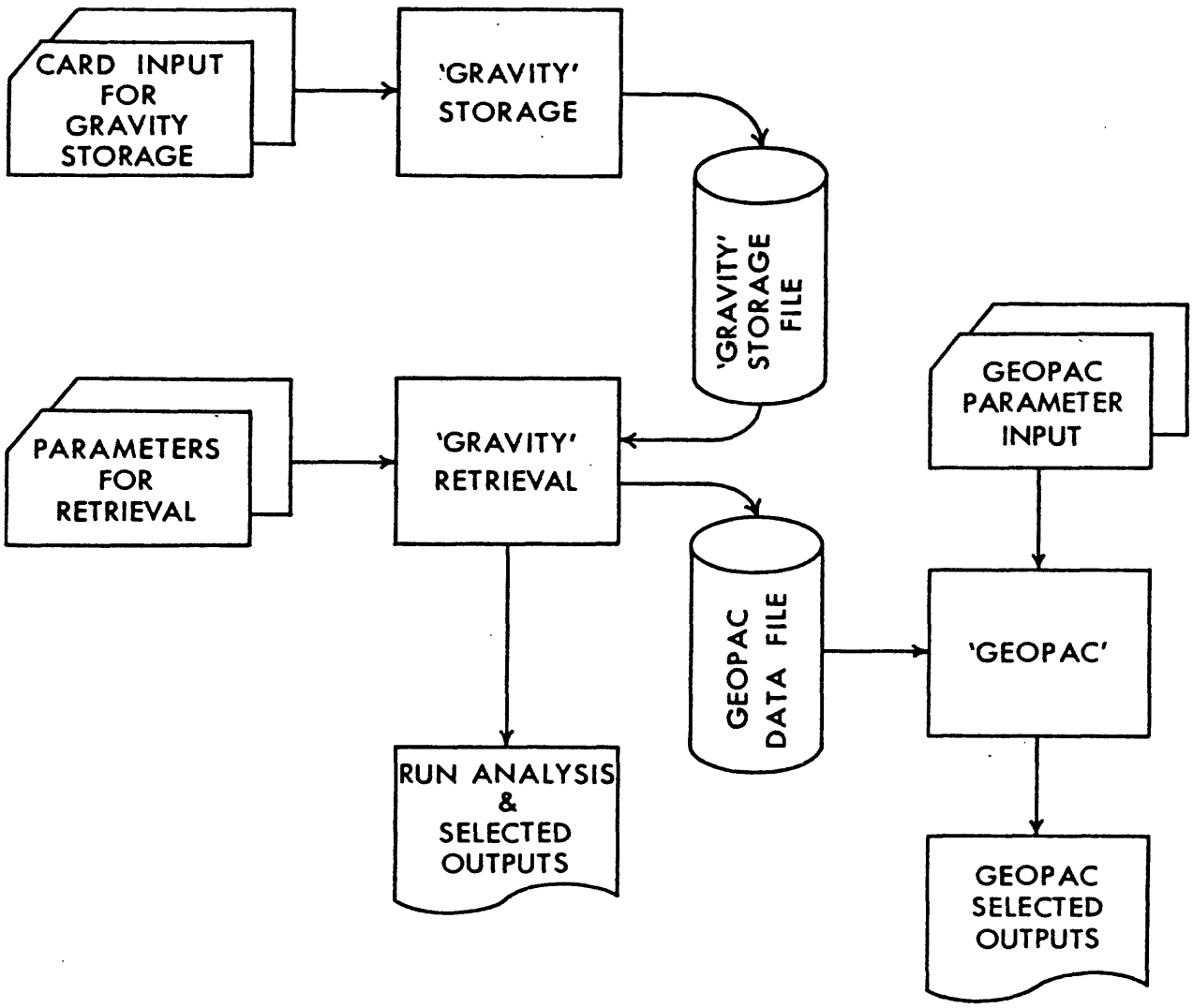

Figure 1.- Generalized flow chart of the gravity storage and retrieval system.

STORAGE HAS BEEN REQUESTED FOR DATA SET PHOSPHATE TWO

NUMBER OF RECORDS = 94

STATION	D	M	Y	T	LATD	LATM	LONGD	LONGM	ELEV	A	MN	TC	GRV	COG	SBA	CBA
HS28	26	7	68	535	29	46.15	38	10.53	754.70		G62	0.0	978755.57	979199.67	-71.66	0.0
14	26	7	68	337	29	32.97	38	7.70	703.70		G62	0.0	978755.57	979100.19	-64.25	0.0
HS 112812	26	7	68	4 2	29	32.59	38	10.63	799.50		G62	0.0	978755.57	979074.10	-70.89	0.0
15X	26	7	68	420	29	34.87	38	14.71	778.40		G62	0.0	978755.57	979083.37	-66.72	0.0
16	26	7	68	440	29	37.35	38	14.98	742.10		G62	0.0	978755.57	979093.77	-68.66	0.0
17	26	7	68	5 5	29	44.90	38	14.37	656.20		G62	0.0	978755.57	979121.15	-67.94	0.0
HS 1827X	26	7	68	611	29	39.99	38	6.55	864.60		G62	0.0	978755.57	979070.74	-71.01	0.0
12	26	7	68	637	29	43.98	38	7.48	770.70		G62	0.0	978755.57	979095.71	-69.66	0.0
13	25	7	68	439	29	37.88	38	7.83	798.00		G62	0.0	978755.57	979084.27	-67.85	0.0
14X	25	7	68	547	29	30.78	38	13.16	718.00		G62	0.0	978755.57	979091.59	-67.11	0.0
15	25	7	68	611	29	30.46	38	15.60	712.80		G62	0.0	978755.57	979091.12	-68.19	0.0
21	25	7	68	634	29	24.66	38	14.92	749.00		G62	0.0	978755.57	979076.52	-68.22	0.0
22	25	7	68	654	29	23.56	38	22.48	737.70		G62	0.0	978755.57	979069.42	-76.13	0.0
23	25	7	68	726	29	28.48	38	21.96	819.00		G62	0.0	978755.57	979058.49	-77.39	0.0
24	25	7	68	825	29	30.71	38	22.16	787.70		G62	0.0	978755.57	979068.09	-76.82	0.0
25	25	7	68	937	29	37.00	38	23.25	735.90		G62	0.0	978755.57	979090.42	-72.78	0.0
18	27	7	68	410	29	50.82	38	15.70	643.50		G62	0.0	978755.57	979131.38	-67.87	0.0
19	27	7	68	435	29	52.50	38	7.03	710.20		G62	0.0	978755.57	979120.05	-68.25	0.0
20	27	7	68	5 0	30	0.27	38	7.12	628.20		G62	0.0	978755.57	979151.17	-63.35	0.0
5X	27	7	68	620	29	42.64	37	59.60	898.60		G62	0.0	978755.57	979066.70	-71.80	0.0
5	27	7	68	646	29	37.98	37	59.74	721.40		G62	0.0	978755.57	979104.25	-63.07	0.0
4X	27	7	68	723	29	38.16	37	54.81	783.70		G62	0.0	978755.57	979086.37	-69.92	0.0
4	27	7	68	750	29	38.28	37	52.40	754.40		G62	0.0	978755.57	979093.20	-68.01	0.0
3X	27	7	68	817	29	38.77	37	48.14	823.50		G62	0.0	978755.57	979072.12	-76.14	0.0
3	27	7	68	9 4	29	37.99	37	45.99	813.80		G62	0.0	978755.57	979071.62	-77.54	0.0
TU116	28	7	68	357	29	43.93	37	46.09	1046.20		G62	0.0	978755.57	979030.27	-80.45	0.0
TU116X	28	7	68	434	29	44.12	37	47.82	980.50		G62	0.0	978755.57	979055.74	-75.03	0.0
2	28	7	68	5 2	29	52.70	37	46.31	929.30		G62	0.0	978755.57	979071.01	-74.46	0.0
TU117	28	7	68	529	29	59.50	37	48.39	845.50		G62	0.0	978755.57	979098.24	-72.55	0.0
11X	28	7	68	546	30	1.77	37	46.68	835.50		G62	0.0	978755.57	979101.83	-73.87	0.0
11	28	7	68	6 9	30	8.38	37	45.04	744.30		G62	0.0	978755.57	979131.03	-71.21	0.0
10	28	7	68	629	30	6.00	37	51.71	688.40		G62	0.0	978755.57	979139.45	-70.69	0.0
6	29	7	68	354	29	44.65	37	59.50	839.40		G62	0.0	978755.57	979083.08	-69.64	0.0
6X	29	7	68	421	29	48.44	37	59.31	874.30		G62	0.0	978755.57	979076.60	-71.58	0.0
7	29	7	68	443	29	52.29	37	59.69	779.10		G62	0.0	978755.57	979104.52	-69.96	0.0
8	29	7	68	5 5	30	0.26	37	59.58	700.10		G62	0.0	978755.57	979132.95	-67.41	0.0
9	29	7	68	524	30	7.40	37	59.94	628.30		G62	0.0	978755.57	979158.22	-65.57	0.0
9X	29	7	68	543	30	3.94	37	56.39	678.20		G62	0.0	978755.57	979140.17	-69.29	0.0
10	29	7	68	6 8	30	6.00	37	51.71	688.40		G62	0.0	978755.57	979139.42	-70.72	0.0
PP 762A	29	1	69	839	29	52.65	37	55.68	839.30		G62	0.0	978755.57	979085.90	-77.21	0.0
PP 763A	29	1	69	9 0	29	54.95	37	55.93	785.60		G62	0.0	978755.57	979106.10	-70.55	0.0
PP 767A	29	1	69	1129	30	1.95	37	56.28	704.60		G62	0.0	978755.57	979132.92	-68.76	0.0
PP 765	29	1	69	1154	29	58.70	37	55.63	734.60		G62	0.0	978755.57	979108.14	-83.47	0.0
PP 247A	30	1	69	820	29	46.13	38	4.10	852.40		G62	0.0	978755.57	979080.71	-71.39	0.0
PP 797A	30	1	69	1015	29	48.25	38	4.59	781.30		G62	0.0	978755.57	979099.53	-69.29	0.0
PP 798A	30	1	69	1030	29	50.63	38	4.40	754.80		G62	0.0	978755.57	979107.62	-69.49	0.0
PP 229A	28	1	69	746	29	44.18	37	55.25	960.40		G62	0.0	978755.57	979054.95	-73.38	0.0
PP 230A	28	1	69	810	29	42.09	37	55.17	957.10		G62	0.0	978755.57	979051.81	-74.67	0.0
PP 228A	28	1	69	855	29	46.07	37	54.83	934.10		G62	0.0	978755.57	979062.87	-73.08	0.0
PP 760A	28	1	69	1035	29	48.43	37	55.05	869.30		G62	0.0	978755.57	979080.44	-71.31	0.0
PP 761A	28	1	69	1046	29	50.65	37	54.93	861.70		G62	0.0	978755.57	979086.62	-69.50	0.0

Figure 2.- Printer listing of stored gravity data.

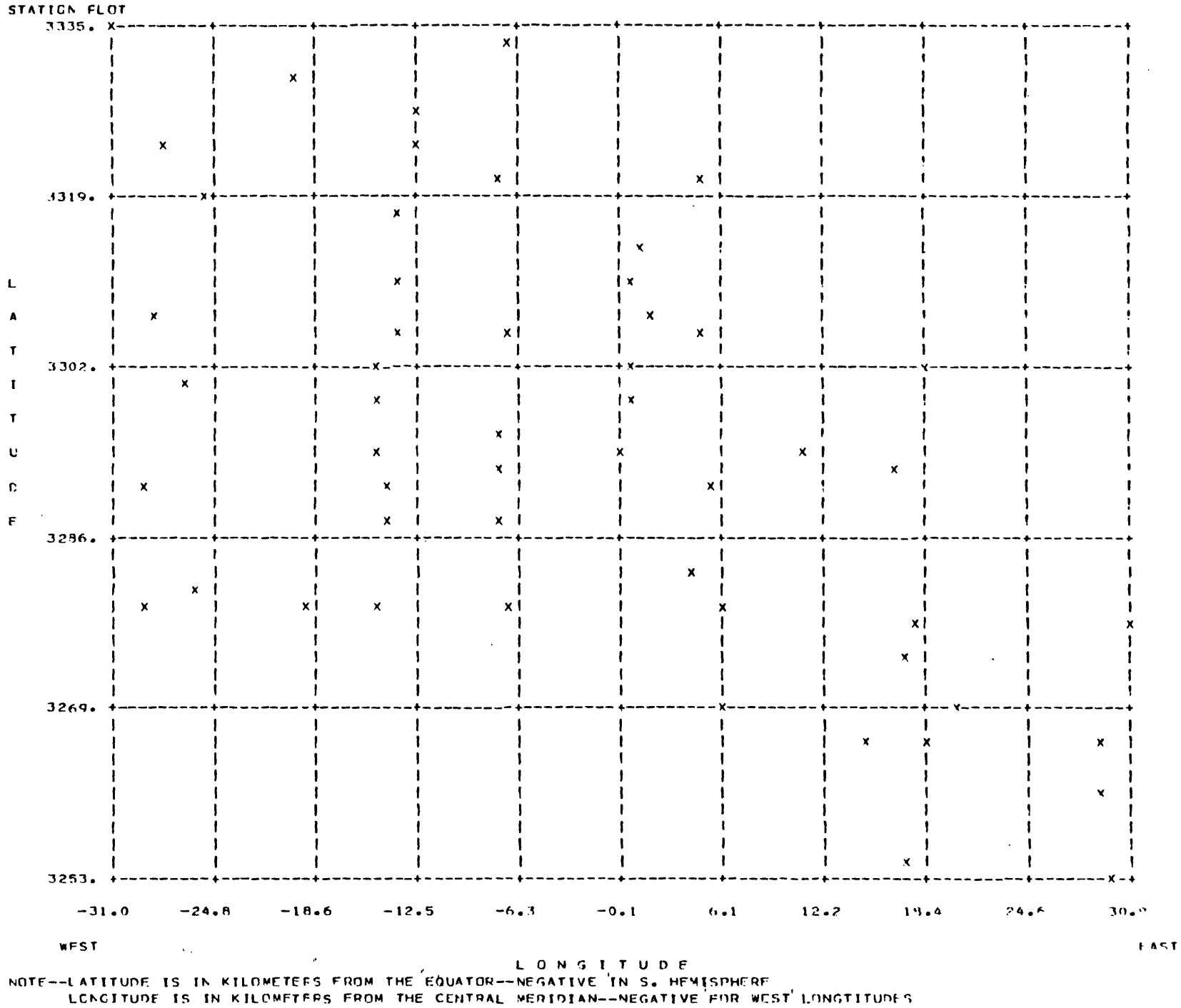

Figure 3.- Printer plot of gravity station locations.

subroutine GRID3D in GEOPAC, which grids randomly-spaced data for processing by other subroutines (Appendix 2).

Any number of data sets (projects) can be stored at one time. The data are placed on tape or disk in the order they enter the computer.

Gravity data can be retrieved from a storage file in one of two ways: by project name (data set ID) or by geographical coordinates. If retrieval by project name is required, a card with the identification name on it is input into the computer and the storage file is scanned until a match is made between the identification on the card and a project identification stored on the file. When a match occurs the station data is listed on the printer (fig. 4), the geographical coordinates are converted, a plot of station locations is printed (fig. 5), and the data stored temporarily on disk in GEOPAC format, using the identification name as the "output I.D.".

Often it is desirable to retrieve all the station data that exist in an area bounded by specified latitudes and longitudes. In this mode of retrieval a card is input specifying maximum and minimum latitudes and longitudes. The storage file is then scanned and those stations having latitudes and longitudes on or within the boundaries specified are retrieved. The same procedure described in the previous paragraph then follows. An example of the printer listing and station plot obtained from this mode of retrieval is shown in figures 6 and 7.

Since retrieval in this manner may transcend several data sets, the ID of the data output on temporary disk file is necessarily different than when retrieval is by identification name. The disk output ID used in this case are the letters 'RETR'. This ID is

RETRIEVAL HAS BEEN REQUESTED FOR DATA SET PHOSPHATE TWO

NUMBER OF RECORDS = 54

STATION	D	M	Y	T	LATD	LATM	LONGD	LONGM	ELEV	A	NN	TC	GRV	COG	SBA	CBA
MS26	26	7	68	535	29	46.15	38	10.83	756.70		G62	0.0	978755.57	979099.47	-71.66	0.0
14	26	7	68	337	29	32.97	38	7.70	703.20		G62	0.0	978755.57	979100.13	-64.25	0.0
MS 112812	26	7	68	4 2	29	32.59	38	16.63	799.50		G62	0.0	978755.57	979074.10	-70.69	0.0
15X	26	7	68	420	29	34.87	38	14.71	778.40		G62	0.0	978755.57	979083.77	-68.72	0.0
16	26	7	68	440	29	37.35	38	14.98	767.10		G62	0.0	978755.57	979097.77	-68.66	0.0
17	26	7	68	5 5	29	44.90	38	14.37	656.20		G62	0.0	978755.57	979121.15	-67.94	0.0
MS 1827X	26	7	68	611	29	39.99	38	6.55	864.60		G62	0.0	978755.57	979070.74	-71.01	0.0
12	26	7	68	637	29	43.98	38	7.48	770.70		G62	0.0	978755.57	979095.71	-69.66	0.0
13	25	7	68	439	29	37.88	38	7.83	798.00		G62	0.0	978755.57	979084.27	-67.95	0.0
14X	25	7	68	547	29	30.78	38	13.16	718.00		G62	0.0	978755.57	979091.59	-67.11	0.0
15	25	7	68	611	29	30.46	38	15.60	712.80		G62	0.0	978755.57	979091.12	-68.19	0.0
21	25	7	68	634	29	24.66	38	14.92	749.00		G62	0.0	978755.57	979078.52	-68.22	0.0
22	25	7	68	654	29	23.56	38	22.48	737.70		G62	0.0	978755.57	979069.42	-76.13	0.0
23	25	7	68	726	29	28.48	38	21.96	819.00		G62	0.0	978755.57	979058.49	-77.39	0.0
24	25	7	68	825	29	30.71	38	22.16	787.70		G62	0.0	978755.57	979068.09	-76.82	0.0
25	25	7	68	937	29	37.00	38	23.25	735.90		G62	0.0	978755.57	979090.42	-72.78	0.0
18	27	7	68	410	29	50.82	38	15.70	643.50		G62	0.0	978755.57	979131.38	-67.87	0.0
19	27	7	68	435	29	52.50	38	7.03	710.20		G62	0.0	978755.57	979120.05	-68.25	0.0
20	27	7	68	5 0	30	0.27	38	7.12	628.20		G62	0.0	978755.57	979151.17	-63.35	0.0
5X	27	7	68	620	29	42.64	37	59.60	898.60		G62	0.0	978755.57	979066.70	-71.80	0.0
5	27	7	68	646	29	37.98	37	59.74	721.40		G62	0.0	978755.57	979104.25	-63.07	0.0
4X	27	7	68	723	29	38.16	37	54.81	783.70		G62	0.0	978755.57	979086.37	-68.92	0.0
4	27	7	68	750	29	38.28	37	52.40	754.40		G62	0.0	978755.57	979093.20	-68.01	0.0
3X	27	7	68	817	29	38.77	37	48.14	823.50		G62	0.0	978755.57	979072.12	-76.14	0.0
3	27	7	68	9 4	29	37.99	37	45.99	813.80		G62	0.0	978755.57	979071.62	-77.54	0.0
TU116	28	7	68	357	29	43.93	37	46.09	1048.20		G62	0.0	978755.57	979070.27	-80.45	0.0
TU116X	28	7	68	434	29	49.12	37	47.82	980.50		G62	0.0	978755.57	979058.74	-75.03	0.0
2	28	7	68	5 2	29	52.70	37	46.31	929.30		G62	0.0	978755.57	979071.01	-74.46	0.0
TU117	28	7	68	529	29	59.50	37	48.39	845.50		G62	0.0	978755.57	979098.24	-72.55	0.0
11X	28	7	68	546	30	1.77	37	46.68	835.50		G62	0.0	978755.57	979101.61	-73.87	0.0
11	28	7	68	6 9	30	8.38	37	45.04	744.30		G62	0.0	978755.57	979131.03	-71.21	0.0
10	28	7	68	629	30	6.00	37	51.71	688.40		G62	0.0	978755.57	979139.45	-70.69	0.0
6	29	7	68	354	29	44.65	37	59.50	839.40		G62	0.0	978755.57	979083.09	-69.64	0.0
6X	29	7	68	421	29	46.44	37	59.31	874.30		G62	0.0	978755.57	979076.60	-71.58	0.0
7	29	7	68	443	29	52.29	37	59.69	779.10		G62	0.0	978755.57	979104.52	-69.98	0.0
8	29	7	68	5 5	30	0.26	37	59.58	700.10		G62	0.0	978755.57	979132.95	-67.41	0.0
9	29	7	68	524	30	7.40	37	59.94	628.30		G62	0.0	978755.57	979158.22	-65.57	0.0
9X	29	7	68	543	30	3.94	37	56.39	678.20		G62	0.0	978755.57	979140.17	-69.29	0.0
10	29	7	68	6 8	30	6.00	37	51.71	688.40		G62	0.0	978755.57	979139.47	-70.72	0.0
PP 762A	29	1	69	839	29	52.65	37	55.68	839.30		G62	0.0	978755.57	979085.90	-77.21	0.0
PP 763A	29	1	69	9 0	29	54.95	37	55.83	785.60		G62	0.0	978755.57	979106.10	-70.55	0.0
PP 767A	29	1	69	1129	30	1.95	37	56.28	704.60		G62	0.0	978755.57	979132.92	-68.76	0.0
PP 765	29	1	69	1154	29	58.70	37	55.63	734.60		G62	0.0	978755.57	979108.14	-83.42	0.0
PP 747A	30	1	69	820	29	48.13	38	4.10	852.40		G62	0.0	978755.57	979080.71	-71.38	0.0
PP 797A	30	1	69	1015	29	48.25	38	4.59	781.30		G62	0.0	978755.57	979099.53	-69.29	0.0
PP 798A	30	1	69	1030	29	50.63	38	4.40	754.80		G62	0.0	978755.57	979107.62	-69.49	0.0
PP 229A	28	1	69	746	29	44.18	37	55.25	980.40		G62	0.0	978755.57	979094.95	-73.78	0.0
PP 230A	28	1	69	810	29	42.09	37	55.17	957.10		G62	0.0	978755.57	979051.61	-74.67	0.0
PP 228A	28	1	69	855	29	46.07	37	54.93	934.10		G62	0.0	978755.57	979062.87	-73.68	0.0
PP 760A	28	1	69	1035	29	48.43	37	55.05	909.30		G62	0.0	978755.57	979080.44	-71.31	0.0
PP 761A	28	1	69	1046	29	50.65	37	54.93	861.70		G62	0.0	978755.57	979086.62	-69.50	0.0

Figure 4.- Printer listing of gravity data retrieved by project name.

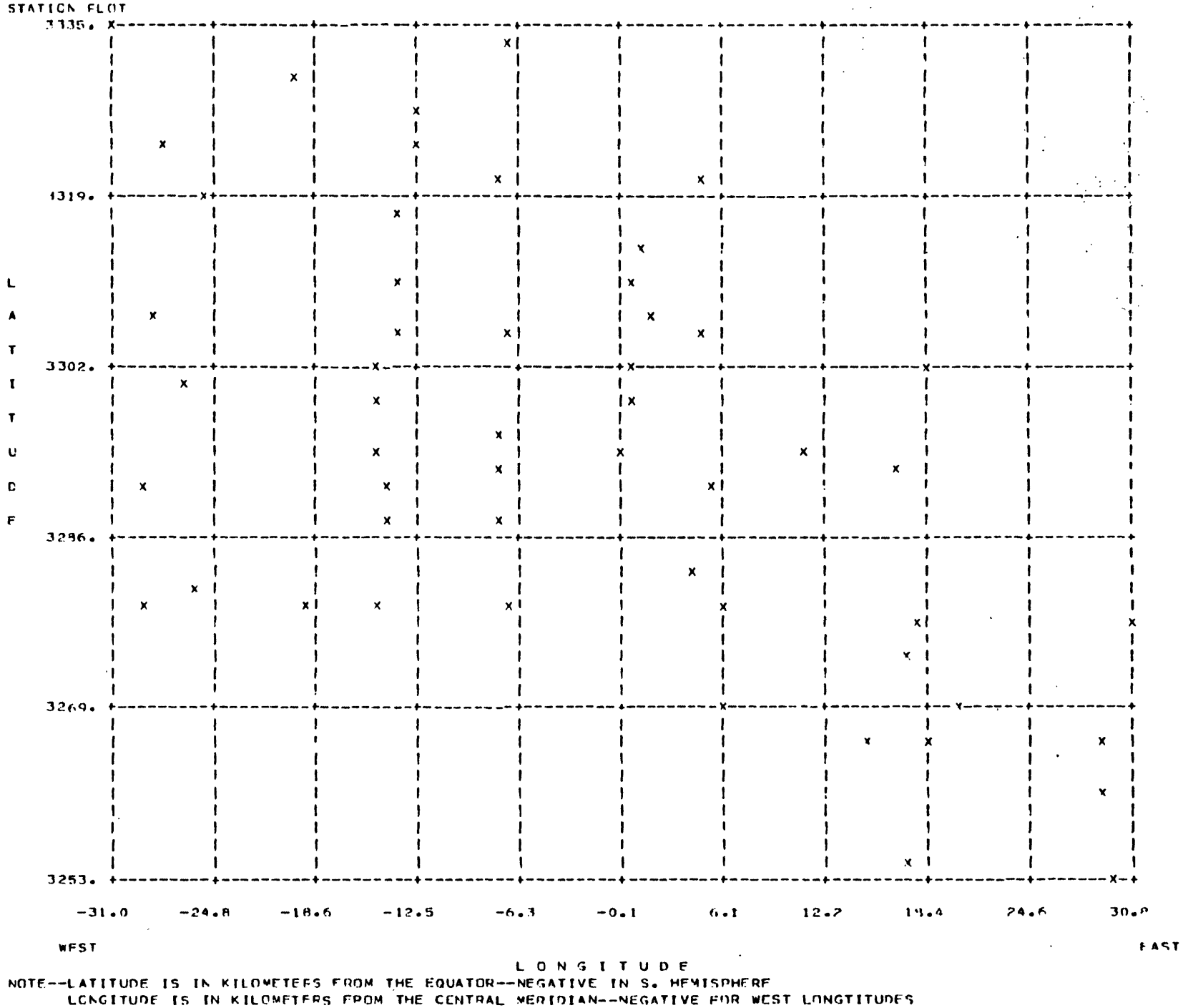

Figure 5. - Printer plot of gravity station locations retrieved by project name.

SUBROUTINE GRFT30

RETRIEVAL REQUESTED FOR THE FOLLOWING RANGE

LATITUDE FROM 29 25.00 TO 30 5.00

LONGTITUDE FROM 37 50.00 TO 38 10.00

STATION	D	M	Y	T	LATD	LATM	LONGD	LONGM	ELEV	A	MN	TC	GRV	COG	SBA	CBA
14	26	7	68	337	29	32.97	38	7.70	703.20		G62	0.0	978755.57	979100.19	-64.25	0.0
NS 182TX	26	7	68	611	29	39.99	38	6.85	864.60		G62	0.0	978755.57	979070.74	-71.01	0.0
12	26	7	68	637	29	43.98	38	7.46	779.70		G62	0.0	978755.57	979095.71	-69.66	0.0
13	25	7	68	439	29	37.88	38	7.83	799.60		G62	0.0	978755.57	979084.27	-67.85	0.0
19	27	7	68	435	29	52.50	38	7.03	710.20		G62	0.0	978755.57	979120.05	-68.25	0.0
20	27	7	68	5 0	30	0.27	38	7.12	629.20		G62	0.0	978755.57	979151.17	-63.35	0.0
5X	27	7	68	620	29	42.64	37	59.60	898.60		G62	0.0	978755.57	979088.70	-71.80	0.0
5	27	7	68	646	29	37.98	37	59.74	721.40		G62	0.0	978755.57	979104.25	-63.07	0.0
4X	27	7	68	723	29	38.16	37	54.81	783.70		G62	0.0	978755.57	979086.37	-68.92	0.0
4	27	7	68	750	29	36.28	37	52.40	754.40		G62	0.0	978755.57	979093.20	-68.81	0.0
6	29	7	68	354	29	44.65	37	59.50	839.40		G62	0.0	978755.57	979083.08	-69.64	0.0
6X	29	7	68	421	29	46.44	37	59.11	874.30		G62	0.0	978755.57	979070.60	-71.58	0.0
7	29	7	68	443	29	52.29	37	59.69	779.10		G62	0.0	978755.57	979104.52	-69.96	0.0
8	29	7	68	5 5	30	0.26	37	59.58	700.10		G62	0.0	978755.57	979132.95	-67.41	0.0
9X	29	7	68	543	30	3.94	37	58.39	678.20		G62	0.0	978755.57	979140.17	-69.29	0.0
PP 762A	29	1	69	839	29	52.65	37	55.68	839.30		G62	0.0	978755.57	979085.90	-77.21	0.0
PP 763A	29	1	69	9 0	29	54.95	37	55.83	785.60		G62	0.0	978755.57	979106.10	-70.55	0.0
PP 767A	29	1	69	1129	30	1.95	37	56.28	704.60		G62	0.0	978755.57	979132.92	-68.78	0.0
PP 768	29	1	69	1154	29	58.70	37	55.63	734.60		G62	0.0	978755.57	979108.14	-83.42	0.0
PP 247A	30	1	69	820	29	46.13	38	4.10	852.40		G62	0.0	978755.57	979080.71	-71.38	0.0
PP 797A	30	1	69	1015	29	48.25	38	4.59	781.30		G62	0.0	978755.57	979099.53	-69.29	0.0
PP 798A	30	1	69	1030	29	50.63	38	4.40	754.80		G62	0.0	978755.57	979107.62	-69.49	0.0
PP 229A	28	1	69	746	29	44.18	37	55.25	960.40		G62	0.0	978755.57	979054.95	-73.38	0.0
PP 230A	28	1	69	810	29	42.09	37	55.17	957.10		G62	0.0	978755.57	979051.61	-74.67	0.0
PP 228A	28	1	69	855	29	46.07	37	54.83	934.10		G62	0.0	978755.57	979062.87	-73.08	0.0
PP 760A	28	1	69	1035	29	48.43	37	55.05	869.30		G62	0.0	978755.57	979080.44	-71.31	0.0
PP 761A	28	1	69	1046	29	50.65	37	54.83	861.70		G62	0.0	978755.57	979086.62	-69.50	0.0
PP 799A	31	1	69	1055	29	52.90	38	5.10	684.30		G62	0.0	978755.57	979127.56	-66.36	0.0
PP 800A	31	1	69	11 7	29	54.90	38	4.42	697.40		G62	0.0	978755.57	979125.29	-66.64	0.0
PP 801A	31	1	69	1120	29	57.02	38	4.87	654.60		G62	0.0	978755.57	979140.74	-63.58	0.0

Figure 6.- Printer listing of data retrieved by geographical coordinates.

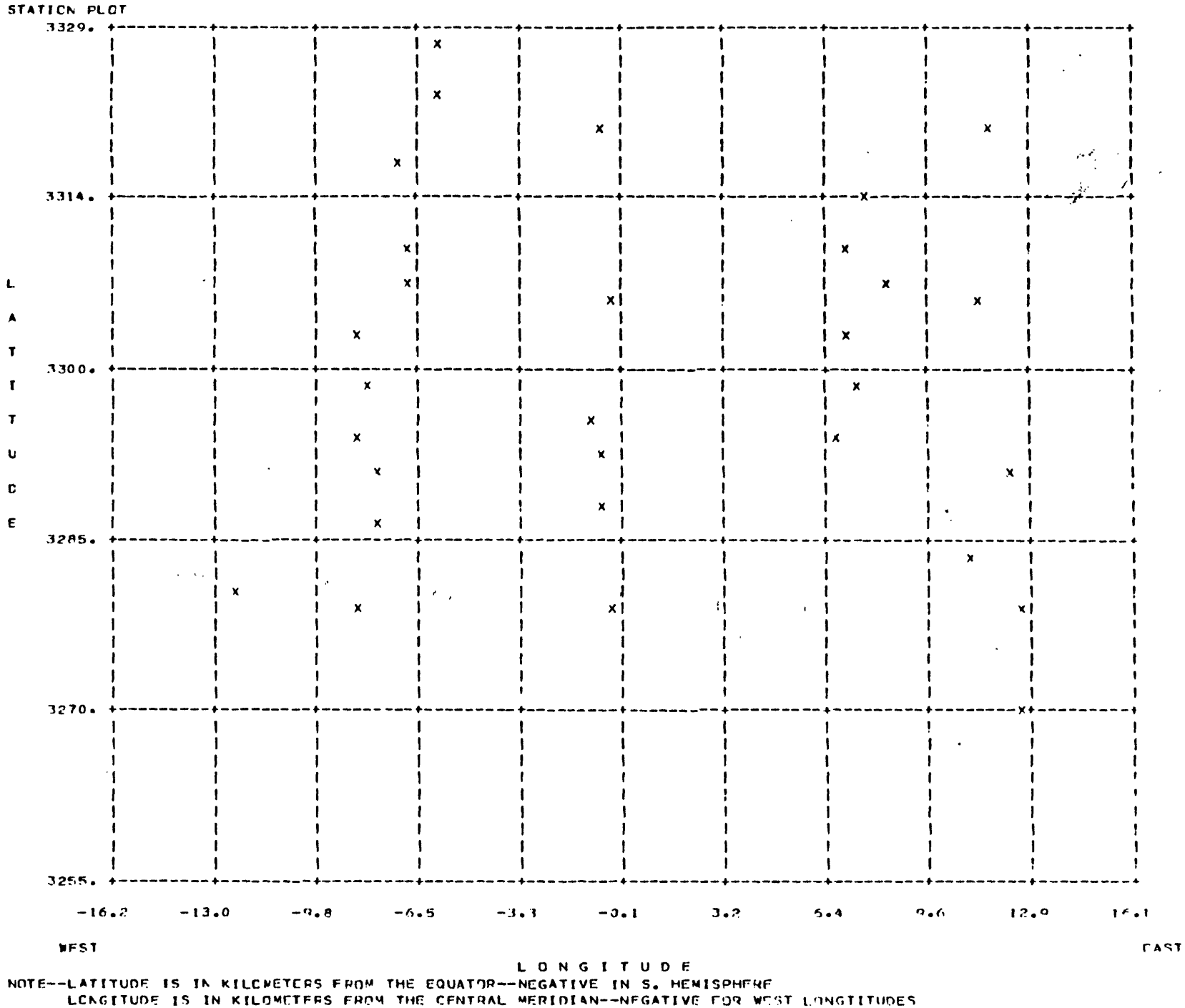

Figure 7.- Printer plot of gravity station locations retrieved by geographical coordinates.

required if additional processing by GEOPAC is required.

In addition to creation of a temporary disk file, an option is provided to punch the station data on cards in the storage input format.

PROGRAM EXECUTION

The program that stores and retrieves the data is a subroutine in GEOPAC called GRET3D, and resides on a disk at the Computer Center.

The control cards necessary to execute GEOPAC are shown in the appendix under GEOPAC cataloged procedure and execution control cards. One card following the //GO.SYSIN DD * card is necessary to invoke the GRET3D subroutine. This card must have the characters GRET3D punched in columns 1-6 and optionally an output file number for temporary disk in columns 14 and 15. If these columns are left blank, the output file number defaults to 15. Following the above card are the parameter and input cards described in the following sections of this report.

If storage and retrieval is required in the same job, then two separate executions of the subroutine GRET3D are necessary; one for storage and one for retrieval. The subroutine is executed by the card having the characters GRET3D in columns 1-6 as explained in the above paragraph. As many as these separate calls to the subroutine can be performed in one job as is required.

Additional processing such as model or trend studies after storage or retrieval can be accomplished in one run and the reader is referred to GEOPAC for an explanation of those routines.

DATA INPUT

Data input is by data sets from cards only. One parameter card that instructs the program to store data, one ID card and two cards for each station of a project data set are required. An unlimited number of project data sets can be processed at one time by supplying the appropriate identification and station cards.

Parameter card

Columns	Format	Name	Description
50	I1	ISTR	Any non-zero number must be punched in this column.
75-80	A6	SNAME	The characters GRET3D must be punched in these columns.

Identification card

Columns	Format	Name	Description
1-20	5A4	JD	Date set identification.
27-30	I40	N	The number of stations in the data set, N $\leq$1000.

Station card 1

Columns	Format	Name	Description
1-16	4A4	IST	Station identification.
17-18	I2	IDA	Day.
19-20	I2	IM	Month.
21-24	I4	IY	Year.
25-26	I2	IT	Time in hours, GMT.
27-28	I2	ITM	Time in minutes.
29-31	I3	LATD	Degrees of latitude.
32-36	F5.2	LATM	Minutes of latitude.
37-40	I4	LONGD	Degrees of longitude.
41-45	F5.2	LONGM	Minutes of longitude.
46-54	F9.2	ELEV	Elevation in meters.
55	A1	ELEVA	Elevation accuracy code. Not used at the present time.
56-59	A4	MN	The number of the gravity meter used.
60-80	F9.2	GBV	The gravity base value in milligals used for this data set (e.g. Jiddah airport value). It would be the same value on all station cards of a data set.

Columns	Format	Name	Description
77-80	A4	JST	The first four characters of the station identification (columns 1-4).

Station card 2

Columns	Format	Name	Description
1-8	F8.2	SBA	Simple Bouguer anomaly in milligals calculated with a density of 2.67.
9-17	F9.0	COG	Observed gravity in milligals.
18-25	F8.3	TC	Terrane correction in milligals.
26-33	F8.2	CBA	Complete Bouguer anomaly in milligals calculated with a density of 2.67.
77-80	A4	KST	The first four characters of the station ID. It must match the characters punched in the same columns of station card 1.

RETRIEVAL PROCEDURE

One parameter card is necessary to retrieve data from a storage file. The format of the card depends on whether retrieval is by data set identification or by latitude and longitude limits. The format for retrieval by data set identification is as follows:

Columns	Format	Name	Description
1-20	5A4	ID	Data set identification.
40	I1	OP	If punched card output is desired, punch a '1' in this column
75-80	A6	SNAME	The characters GRET3D must be punched in these columns.

The format for retrieval by latitude and longitude is as follows:

Columns	Format	Name	Description
1-2	I2	NLATD	Degrees of north latitude.
3-7	F5.0	NLATM	Minutes of north latitude.
8-9	I2	SLATD	Degrees of south latitude.
10-14	F5.0	SLATM	Minutes of south latitude
21-23	I3	WLONGD	Degrees of west longitude.
24-28	F5.0	WLONGM	Minutes of west longitude.
29-31	I3	ELONGD	Degrees of east longitude.
32-36	F5.0	ELONGM	Minutes of east longitude.
40	I1	OP	If punched card output is desired, punch a '1' in this column.
75-80	A6	SNAME	The characters GRET3D must be punched in these columns.

REFERENCES

Godson, Richard H., 1973, GEOPAC: U. S. Geol. Survey open file rept. (IR) SA-162, 146 p.

APPENDIX 1. - Gravity storage format

The records are written in unformatted binary form. The number of records per data set is equal to the number of stations plus one.

Record One

Type	Length	Description
Alphanumeric	20 bytes	Data set identification.
Integer	4 bytes	Number of stations in the data set.

Remaining Records

Type	Length	Description
Alphanumeric	16 bytes	Station identification.
Integer	4 bytes	Day of the meter reading.
Integer	4 bytes	Month of the meter reading.
Integer	4 bytes	Year of the meter reading.
Integer	4 bytes	Time in hours of the meter reading.
Integer	4 bytes	Time in minutes of the meter reading.
Integer	4 bytes	Degree of station latitude.
Real	4 bytes	Minutes of station latitude.
Integer	4 bytes	Degrees of station longitude.
Real	4 bytes	Minutes of station longitude.
Real	8 bytes	Station elevation.
Alphanumeric	4 bytes	Elevation accuracy code.
Alphanumeric	4 bytes	Meter number.
Real	8 bytes	Gravity of the base station.
Real	4 bytes	Simple Bouguer anomaly computed with a density of 2.67.
Real	8 bytes	Computed gravity value of the station.
Real	4 bytes	Terrane correction.
Real	4 bytes	Complete Bouguer anomaly computed with a density of 2.67.

The following example shows how a data set would be read:

```
READ(IDISK,END=999) (JD(I),I=1,5),N
DO  10  I=1,N
READ(IDISK) (IST(J),J=1,4),IDA,IM,IY,IT,ITM,
*LATD,LATM,LONGD,LONGM,ELEV,ELEVA,MN,GBV,SBA,COG,TC,CBA
CONTINUE
```

APPENDIX 2.- Data format on temporary disk file - GEOPAC format

The records are written in unformatted binary form. The number of records per data set is equal to the number of stations plus two. The format is compatible with input requirements of subroutine GRID3D in GEOPAC.

Record One

Type	Length	Description
Alphanumeric	20 bytes	Data set identification.

Record Two

Type	Length	Description
Integer	4 bytes	The number of stations in the data set.
Real	4 bytes	The maximum X coordinate.
Real	4 bytes	The minimum X coordinate.
Real	4 bytes	The maximum Y coordinate.
Real	4 bytes	The minimum Y coordinate.

Remaining Records

Type	Length	Description
Real	4 bytes	X coordinate of the station.
Real	4 bytes	Y coordinate of the station.
Real	4 bytes	Simple Bouguer anomaly value computed with a density of 2.67.
Real	4 bytes	Complete Bouguer anomaly value computed with a density of 2.67.
Real	4 bytes	A dummy value of 0.0.

APPENDIX 3. - GEOPAC cataloged procedure and execution control cards.

```
//USG303Y JOB S60,' USGS  ANDREASEN ',MSGLEVEL=(1,1),CLASS=N
//GEOSYS PROC TAPE=SCRTCH
//GO EXEC PGM=GEOPAC
//STEPLIB DD DSN=USG.LOADLIB,DISP=SHR
//GO.FT05F001 DD DDNAME=SYSIN
//GO.FT06F001 DD SYSOUT=A
//GO.FT07F001 DD SYSOUT=B,DCB=BLKSIZE=80
//GO.FT09F001 DD DSN=PLOT,LABEL=(,NL),UNIT=(TAPE9,,DEFER),
//             DISP=(NEW,KEEP),DCB=(BLKSIZE=8000),VOL=SER=&TAPE
//GO.FT10F001 DD DSN=&&PROFILE,UNIT=SYSDA,SPACE=(TRK,(2,2)),
// DCB=(RECFM=VBS,BLKSIZE=2000)
//GO.FT11F001 DD DSN=&&WORK1,UNIT=SYSDA,SPACE=(CYL,(2,2)),
// DCB=(RECFM=VBS,BLKSIZE=2000)
//GO.FT12F001 DD DSN=&&GREV,UNIT=SYSDA,SPACE=(TRK,(2,2)),
// DCB=(RECFM=VBS,BLKSIZE=2000)
//GO.FT14F001 DD DSN=&&GRID,UNIT=SYSDA,SPACE=(TRK,(2,2)),
// DCB=(RECFM=VBS,BLKSIZE=2000)
//GO.FT15F001 DD DSN=&&WORK2,UNIT=SYSDA,SPACE=(CYL,(2,2)),
// DCB=(RECFM=VBS,BLKSIZE=2000)
//GO.FT16F001 DD DSN=&&CONTRD,UNIT=SYSDA,SPACE=(TRK,(2,2)),
// DCB=(RECFM=VBS,BLKSIZE=2000)
// PEND
// EXEC GEOSYS,TIME=3
//GO.SYSIN DD *
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing.

```
      SUBROUTINE GRET3D
C
C     SUBROUTINE RETRIEVES A DATA SET FROM GRAVITY TAPE BY ID OR
C     RETRIEVES STATION DATA WITHIN SPECIFIED LATITUDES AND LONGTITUDES
C     THE SUBROUTINE CAN ALSO STORE REDUCED GRAVITY DATA
C
      INTEGER PROJ(5),SPROJ(3),GRS(3),MON,DAY,YEAR,PROJCH(3),          00000040
     1        OBSERV(3),METER(2),REFNOH,ELUNIT,STAID(2),TIME,          00000050
     2        ELACC,LATD,LONGD,RDIN,PRCUT,MASTER,SCRAP  ,LINE(130),    00000060
     3        NLATD,SLATD,WLONGD,ELONGD,TITLE(90),OPT(2)               00000070
      REAL     CG,TC1,TC2,     LATM,LONGM,SP,CB,W,LATS,LONGS,
     1        NLATM,WLONGM,SLATM, WLONGM,NLATS,SLATS,WLONGS,           00000100
     2        ELONGS,BUFF(5),IL                                        00000110
      REAL*8 ELEV,COG,GRV
      REAL * 8 SNAME,BLANK/' '/,PNAME/'GRET3D'/
      INTEGER OP,CMD
      LOGICAL*1  IVERT                                                 00000080
      LOGICAL * 1 GRAPH(6000)
      DIMENSION XX(1000),YY(1000),Z1(1000),Z2(1000),Z3(1000),NN(5)
      DIMENSION JD(5),IST(4),Z(3),ID(5),JRETR(5)
      DATA NN/1,0,0,0,1/
      DATA JRETR/'RETR',' ',' ',' ',' '/
C
C     FORMATS
C
  700 FORMAT('0','END OF FILE ENCOUNTERED')
  900 FORMAT(20X,I3,F5.0,I3,F5.0)
  910 FORMAT(I2,F5.0,I2,F5.0,6X,I3,F5.0,I3,F5.0,3X,I1)
  920 FORMAT(5A4)
  930 FORMAT(5A4,19X,I1,9X,I1)
 1000 FORMAT(1H1)                                                      00000290
 1010 FORMAT('0','RETRIEVAL REQUESTED FOR THE FOLLOWING RANGE'//,
     1 1X,'LATITUDE FROM',I3,F6.2,' TO',I3,F6.2,//,1X,'LONGTITUDE FROM',
     2 I3,F7.2,' TO',I3,F7.2,/)
 1020 FORMAT(' ',60X,I3,F7.2/' ',54X,20A1)                             00000340
 1030 FORMAT(' ',53X,A1,19X,A1)                                        00000370
 1040 FORMAT(' ',42X,I3,F7.2,1X,A1,19X,A1,1X,I3,F7.2)                  00000400
 1050 FORMAT(' ',54X,20A1/' ',60X,I3,F7.2)                             00000450
 1060 FORMAT(5A4,I1C)
 1070 FORMAT(/' ',130A1)
 2001 FORMAT(4A4,2I2,I4,2I2,I3,F5.2,I4,F5.2,F9.3,A1,A4,F9.2,8X,A4,
     1 /,F8.2,F5.2,F8.3,F8.2,43X,A4)
 2002 FORMAT('0',4A4,3X,I2,1X,I2,1X,I2,3X,I2,I2,  3X,I2,1X,F5.2,4X,I2,
     1 2X,F5.2,2X,F7.2,1X,A1,2X,A4,2X,F8.3,3X,F9.2,3X,F9.2,2X,F8.2,
     2 2X,F8.2)
 2003 FORMAT(' ',5X,'STATION',8X,'D',2X,'M',2X,'Y',5X,'T',3X,'LATD',1X,
     1 'LATM',2X,'LONGD',1X,'LONGM',4X,'ELEV',2X,'A',3X,'MN',7X,'TC',
     2 8X,'GRV',9X,'COG',9X,'SEA',7X,'CBA')
 2004 FORMAT('0','RETRIEVAL HAS BEEN REQUESTED FOR DATA SET',3X,5A4,///,
     4 1X,'NUMBER OF RECORDS =',I4,//)
 2005 FORMAT('0','DATA SET NAMED ',5A4,' NOT FOUND')
 2006 FORMAT('1','STATION PLOT')
 2007 FORMAT(1HC,5X,'WEST',100X,'  EAST',/50X,' L O N G I T U D E',/,
     1' NOTE--LATITUDE IS IN KILOMETERS FROM THE EQUATOR--NEGATIVE IN S.00003540
     2 HEMISPHERE',//,7X,'LONGTITUDE IS IN KILOMETERS FROM THE CENTRAL MER00003550
     3IDIAN--NEGATIVE FOR WEST LONGTITUDES',////)
 2008 FORMAT(/////,1X,'1000 STATIONS HAVE BEEN RETRIEVED - SEARCH',
     1 ' IS ENDED')
 2009 FORMAT('0',  'STORAGE HAS BEEN REQUESTED FOR DATA SET',3X,5A4,///,
     4 1X,'NUMBER OF RECORDS =',I4,//)
     1 - 80')
```

APPENDIX 4.- Subroutine GRET3D and PRPLOT listing - Continued.

```
 2100 FORMAT(/////,1X,'ID CN STATION CARDS DO NOT AGREE')
 9100 FORMAT(74X,A6)
 9200 FORMAT('0','FIRST CARD OF DATA SET DOES NOT HAVE GRET3D IN COLS 75
 9300 FORMAT('1',44X,'S U B R O U T I N E  G R E T 3 D',/)
C
      ICARD=5
      IPRINT=6
      IPUNCH=7
      ITAPE=12
      DO 3 I=1,1000
      Z3(I)=0.0
    3 CONTINUE
C
C     OP = 1 PUNCH CARDS
C
      WRITE(IPRINT,9300)
    5 READ(ICARD,9100,END=998) SNAME
      IF(SNAME.EQ.BLANK) GO TO 999
      IF(SNAME.NE.PNAME) GO TO 9998
      IRETR=0
      READ(99,900) WLONGD,WLONGM,ELONGD,ELONGM
      IF(WLONGD.EQ.0..AND.WLONGM.EQ.0..AND.ELONGD.EQ.0..AND.ELONGM.EQ.
     1 0.) GO TO 2000
C
C     RETRIEVAL BY LATITUDE AND LONGTITUDE
C
   10 READ (99,910)   NLATD,NLATM,SLATD,SLATM,WLONGD,WLONGM,
     1 ELONGD,ELONGM,CP
      K=0
      IRETR=1
      NLATS = SECOND(NLATD,NLATM)                                    00000240
      SLATS = SECOND(SLATD,SLATM)                                    00000250
      WLONGS = SECOND(WLONGD,WLONGM)                                 00000260
      ELONGS = SECOND(ELONGD,ELONGM)                                 00000270
      XMX=ELONGS
      XMN=WLONGS
      YMX=NLATS
      YMN=SLATS
      WRITE(IPRINT,1010) SLATD,SLATM,NLATD,NLATM,WLONGD,WLONGM,
     1 ELONGD,ELONGM
      WRITE(IPRINT,2003)
   90 READ(ITAPE,END=950) (JD(I),I=1,5),N
      DO 200 I=1,N
      READ(ITAPE) (IST(J),J=1,4),IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,LONGM,
     1 ELEV,ELEVA,MN,GBV,SBA,COG,TC,CBA
      LATS=SECOND(LATD,LATM)
      LONGS=SECOND(LONGD,LONGM)
C     TEST                                                           00000600
      IF (LATS .LT.SLATS) GO TO 100                                  00000610
      IF (LATS .GT.NLATS) GO TO 100                                  00000620
      IF(LONGS.LT.WLONGS) GO TO 100
      IF(LONGS.GT.ELONGS) GO TO 100
      IF(OP.EQ.1) WRITE(IPUNCH,2001)
     1 (IST(J),J=1,4),IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,LONGM,ELEV,
     2 ELEVA,MN,GBV,IST(1),SBA,COG,TC,CBA,IST(1)
      WRITE(IPRINT,2002) IST,IDA,IM,IY,IT,ITM,LATD,LATM,
     1 LONGD,LONGM,ELEV,ELEVA,MN,TC,GBV,COG,SBA,CBA
      K=K+1
      IF(K.GT.1000) GO TO 997
      XX(K)=LONGS
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing - Continued.

```
      YY(K)=LATS
      Z1(K)=SBA
      Z2(K)=CBA
  100 CONTINUE
  200 CONTINUE
      GO TO 90
C
C     RETRIEVAL BY ID
C
 2000 READ(99,930) (ID(I),I=1,5),OP,ISTR
      IF(ISTR.NE.0) GO TO 2080
 2010 READ(ITAPE,END=998) JD,N
      DO 2015 K=1,5
      IF(ID(K).EQ.JD(K)) GO TO 2014
      GO TO 2017
 2014 CONTINUE
 2015 CONTINUE
      GO TO 2030
 2017 DO 2020 I=1,N
      READ(ITAPE) (IST(J),J=1,4),IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,LONGM,
     1 ELEV,ELEVA,MN,GBV,SBA,COG,TC,CBA
 2020 CONTINUE
      GO TO 2010
 2030 WRITE(IPRINT,2004) JD,N
      WRITE(IPRINT,2003)
      XMX=-1.0E49
      XMN=1.0E49
      YMX=-1.0E49
      YMN=1.0E49
      DO 2040 I=1,N
      READ(ITAPE) (IST(J),J=1,4),IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,LONGM,
     1 ELEV,ELEVA,MN,GBV,SBA,COG,TC,CBA
      WRITE(IPRINT,2002) IST,IDA,IM,IY,IT,ITM,LATD,LATM,
     1 LONGD,LONGM,ELEV,ELEVA,MN,TC,GBV,COG,SBA,CBA
      IF(CP.EQ.1) WRITE(IPUNCH,2001)
     1 (IST(J),J=1,4),IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,LONGM,ELEV,
     2 ELEVA,MN,GBV,IST(1),SBA,COG,TC,CBA,IST(1)
      IF(I.GT.1000) GO TO 997
      LATS=SECOND(LATD,LATM)
      LONGS=SECOND(LONGD,LONGM)
      IF(LATS.GT.YMX) YMX=LATS
      IF(LATS.LT.YMN) YMN=LATS
      IF(LONGS.GT.XMX) XMX=LONGS
      IF(LONGS.LT.XMN) XMN=LONGS
      XX(I)=LONGS
      YY(I)=LATS
      Z1(I)=SBA
      Z2(I)=CBA
 2040 CONTINUE
      K=N
  950 REWIND ITAPE
      IF(K.EQ.0) GO TO 994
C
C     COMPUTE POLYCONIC PROJECTION
C
 2050 CMSEC=(XMX+XMN)/2.0
      IL=CMSEC-XMX
      CALL POLP(0.,YMX,IL,XP,YP)
      XMX=.0014*(-XP)
      YMX=.0014*YP
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing - Continued.

```
      IL=CMSEC-XMN
      CALL POLP(0.,YMN,IL,XP,YP)
      XMN=.001*(-XP)
      YMN=.001*YP
      N=K
      DO 2060 I=1,N
      IL=CMSEC-XX(I)
      CALL POLP(0.,YY(I),IL,XP,YP)
      XX(I)=.001*(-XP)
      YY(I)=.001*YP
 2060 CONTINUE
C
C     PRINTER PLOT OF STATIONS
C
      CALL PLOT1(NN,5,10,10,10)
      WRITE(IPRINT,2006)
      CALL PLOT2(GRAPH,XMX,XMN,YMX,YMN)
      CALL PLOT3('X',XX,YY,N)
      CALL PLOT4(30,'                L A T I T U D E')
      WRITE(IPRINT,2007)
C
C     WRITE ON DISK FOR INPUT TO GRIDDING SUBROUTINE
C
      IF(IRETR.NE.1) GO TO 2065
      DO 2063 I=1,5
      JD(I)=JRETR(I)
 2063 CONTINUE
 2065 WRITE(JDISK) JD
      WRITE(JDISK) N,XMX,XMN,YMX,YMN
      DO 2070 I=1,N
      WRITE(JDISK) XX(I),YY(I),Z1(I),Z2(I),Z3(I)
 2070 CONTINUE
      GO TO 5
C
C     STORAGE OF REDUCED DATA FROM CARDS
C
 2080 READ(ICARD,1060,END=998) JD,N
      WRITE(IPRINT,2009) JD,N
      WRITE(ITAPE) JD,N
      XMX=-1.0E49
      XMN=1.0E49
      YMX=-1.0E49
      YMN=1.0E49
      WRITE(IPRINT,2003)
      DO 2090 I=1,N
      READ(ICARD,2001,END=998) IST,IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,
     1 LONGM,ELEV,ELEVA,MN,GBV,JST,SBA,COG,TC,CBA,KST
      IF(JST.NE.KST) GO TO 995
      LATS=SECOND(LATD,LATM)
      LONGS=SECOND(LONGD,LONGM)
      WRITE(ITAPE) IST,IDA,IM,IY,IT,ITM,LATD,LATM,LONGD,
     1 LONGM,ELEV,ELEVA,MN,GBV,SBA,COG,TC,CBA
      WRITE(IPRINT,2002) IST,IDA,IM,IY,IT,ITM,LATD,LATM,
     1 LONGD,LONGM,ELEV,ELEVA,MN,TC,GBV,COG,SBA,CBA
      IF(LATS.GT.YMX) YMX=LATS
      IF(LATS.LT.YMN) YMN=LATS
      IF(LONGS.GT.XMX) XMX=LONGS
      IF(LONGS.LT.XMN) XMN=LONGS
      XX(I)=LONGS
      YY(I)=LATS
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing - Continued.

```
      Z1(I)=SBA
      Z2(I)=CBA
 2090 CONTINUE
      K=N
      GO TO 2050
  994 WRITE(IPRINT,2200)
 2200 FORMAT('0','NUMBER OF RETRIEVED STATIONS IS ZERO')
      GO TO 9999
  995 WRITE(IPRINT,2100)
      GO TO 9999
  997 WRITE(IPRINT,2008)
      GO TO 950
  999 REWIND JDISK
      REWIND ITAPE
      RETURN
 9998 WRITE(IPRINT,9200)
      GO TO 9999
  998 WRITE(IPRINT,700)
      REWIND JDISK
      REWIND ITAPE
      RETURN 2
  996 WRITE(IPRINT,2005) ID
 9999 REWIND JDISK
      REWIND ITAPE
      RETURN 1
      END                                                          00001220
C
C
C
      FUNCTION SECOND(IDEG,FMIN)                                   00001230
C     CONVERTS ANGLE IN INTEGER DEGREES,FLOATING MINUTES TO        00001240
C     FLOATING SECONDS.                                            00001250
      DEG = IDEG                                                   00001260
      SECOND = SIGN(1.,DEG)*(3600.*ABS(DEG)+ 60.*FMIN)             00001270
      RETURN                                                       00001280
      END                                                          00001290
C
C
C
      SUBROUTINE PCLP (P1,P2,IL,X,Y)                                C   1
C     POLYCONIC PROJECTION OF POINT LAT=P2, DIFF LONG=IL FROM ARBITRARY  C   2
C     CENTRAL MERIDIAN. LAT OF ARBITRARY ORIGIN IS P1. X=DIST FROM CM   C   3
C     ALONG LAT P2. Y=DIST FROM P1 TO P2. X,Y IN METERS.            C   4
C     P1,P2,AND IL IN SECONDS.                                      C   5
      REAL IL,LA,IP,IPR                                             C   6
      DATA ARCONE,ESQ,LA,A0,A2,A4,A6,A8/4.8481368E-6,6.7686580E-3,637820  C   7
     16.4,6367399.7,32433.888,34.4187,.0454,6.0E-5/                 C   8
      IP=P2-P1                                                      C   9
      SINP2=SIN(P2*ARCONE)                                          C  10
      COSP2=COS(P2*ARCONE)                                          C  11
      THETA=IL*SINP2                                                C  12
      A=SQRT(1.0-(ESQ*(2.*SINP2)))/(LA*ARCONE)                      C  13
      IF (SINP2) 1,2,1                                              C  14
    1 COT=COSP2/SINP2                                               C  15
      GO TO 3                                                       C  16
    2 COT=1.0E73                                                    C  17
    3 X=(COT*SIN(THETA*ARCONE))/(A*ARCONE)                          C  18
      IPR=IP*ARCONE                                                 C  19
      PR=((P2+P1)/2.)*ARCONE                                        C  20
      Y=A0*IPR-(A2*COS(2.*PR)*SIN(IPR))+(A4*COS(4.*PR)*SIN(2.*IPR))-(A6*  C  21
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing - Continued.

```
     1CCS(6.*PR)*SIN(3.*IPR))+A8*COS(8.*PR)*SIN(4.*IPR)                    C  22
      RETURN                                                               C  23
      END
C
C
C
      SUBROUTINE PRPLOT                                                    00020300
C   PETE SMIDINGER   SUMMER 1966  MATH & COMP BR  GSFC  NASA              00020400
      IMPLICIT  LOGICAL*1(W), LOGICAL*1(K)                                 00020500
      DIMENSION  NSCALE(5),ABNCS(26),X(1),Y(1)                             00020600
      LOGICAL*1 NOS(10)/'0','1','2','3','4','5','6','7','8','9'/          00020700
      LOGICAL*1  IMAGE(1),CH,LABEL(1)                                      00020800
      LOGICAL*1   VC      ,HC/'-'/,NC/'+'/,BL/' '/                         00020900
     L          , HF/'F'/,HF1/'.'/,HF2/','/                               00021000
      DATA VC/24F/                                                         00021100
      LOGICAL*1  FOR1(19)/'(1XA1,F8. ,1X121A1)'/                           00021200
     L          ,FOR2(15)/'(1XA1, 9X121A1)'/                              00021300
     L          ,FOR3(19)/'(1H0F   .  .   F    . )'/                     00021400
      DATA KPLOT1 /.FALSE./, KPLOT2/.FALSE./                               00021500
      DATA  KABSC,KGRD,KBOTGL /3*.FALSE./                                  00021600
C                                                                          00021700
      ENTRY PLOT1(NSCALE,NHL,NSBH,NVL,NSBV)                                00021800
      KPLOT1=.TRUE.                                                        00021900
      KPLOT2=.FALSE.                                                       00022000
125   NH=IABS(NHL)                                                         00022100
      NSH=IABS(NSBH)                                                       00022200
      NV=IABS(NVL)                                                         00022300
      NSV=IABS(NSBV)                                                       00022400
      NSCL=NSCALE(1)                                                       00022500
      IF(NH*NSH*NV*NSV.NE.0) GO TO 128                                     00022600
      WRITE (6,14)                                                         00022700
14    FORMAT(T5,'SOME PLOT1 ARG. ILLEGALLY 0')                             00022800
      KPLOT=.FALSE.                                                        00022900
      RETURN                                                               00023000
128   KPLOT=.TRUE.                                                         00023100
      IF(NV.LE.25) GO TO 126                                               00023200
      WRITE (6,12)                                                         00023300
      KPLOT=.FALSE.                                                        00023400
12    FORMAT(T5,'NO. OF VERTICAL LINES >25')                               00023500
      RETURN                                                               00023600
126   CONTINUE                                                             00023700
      NVM=NV-1                                                             00023800
      NVP=NV+1                                                             00023900
      NDH=NH*NSH                                                           00024000
      NDHP=NDH+1                                                           00024100
      NDV=NV*NSV                                                           00024200
      NDVP=NDV+1                                                           00024300
      NIMG=(NDHP*NDVP)                                                     00024400
      IF(NDV.LE.120) GO TO 130                                             00024500
      KPLOT=.FALSE.                                                        00024600
      WRITE (6,11)                                                         00024700
11    FORMAT(T5,'WIDTH OF GRAPH >121')                                     00024800
      RETURN                                                               00024900
130   CONTINUE                                                             00025000
      IF(NSCL.EQ.0) GO TO 70                                               00025100
      FSY=10.**NSCALE(2)                                                   00025200
      FSX=10.**NSCALE(4)                                                   00025300
      IY=MIN0(IABS(NSCALE(3)),7)+1                                         00025400
      IX=MIN0(IABS(NSCALE(5)),9)+1                                         00025500
      GO TO 75                                                             00025600
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing - Continued.

```
70    FSY=1.                                                    00025700
      FSX=1.                                                    00025800
      IY=4                                                      00025900
      IX=4                                                      00026000
75    FOR1(10)=NOS(IY)                                          00026100
      NA=MIN0(IX,NSV)-1                                         00026200
      NS=NA-MIN0(NA,120-NDV)                                    00026300
      NB=11-NS+NA                                               00026400
      I1=NB/10                                                  00026500
      I2=NB-I1*10                                               00026600
      FOR3(6)=NOS(I1+1)                                         00026700
      FOR3(7)=NOS(I2+1)                                         00026800
      FOR3(9)=NOS(NA+1)                                         00026900
      IF(NV.GT.0) GO TO 90                                      00027000
      DO 80 J=11,18                                             00027100
80    FOR3(J)=BL                                                00027200
      GO TO 100                                                 00027300
90    I1=NV/10                                                  00027400
      I2=NV-I1*10                                               00027500
      FOR3(11)=NOS(I1+1)                                        00027600
      FOR3(12)=NOS(I2+1)                                        00027700
      FOR3(13)=HF                                               00027800
      I1=NSV/100                                                00027900
      I3=NSV-I1*100                                             00028000
      I2=I3/10                                                  00028100
      I3=I3-I2*10                                               00028200
      FOR3(14)=NOS(I1+1)                                        00028300
      FOR3(15)=NOS(I2+1)                                        00028400
      FOR3(16)=NOS(I3+1)                                        00028500
      FOR3(17)=HF1                                              00028600
      FOR3(18)=FOR3(9)                                          00028700
100   IF(KPLOT1) RETURN                                         00028800
      KPLOT1=.TRUE.                                             00028900
C                                                               00029000
      ENTRY PLOT2(IMAGE,XMAX,XMIN,YMAX,YMIN)                    00029100
      KPLOT2=.TRUE.                                             00029200
      IF(KPLOT1) GO TO 210                                      00029300
      NSCL=0                                                    00029400
      NH=5                                                      00029500
      NSH=10                                                    00029600
      NV=10                                                     00029700
      NSV=10                                                    00029800
      GO TO 128                                                 00029900
210   CONTINUE                                                  00030000
      IF(.NOT.KPLOT)RETURN                                      00030100
      YMX=YMAX                                                  00030200
      DH =     (YMAX-YMIN) / FLOAT(NCH)                         00030300
      DV = ABS(XMAX-XMIN) / FLOAT(NCV)                          00030400
      DO 220 I=1,NVP                                            00030500
220   ABNCS(I)=(XMIN+FLOAT((I-1)*NSV)*DV)*FSX                   00030600
      DO 225 I=1,NIMG                                           00030700
225   IMAGE(I)=BL                                               00030800
      DO 240 I=1,NDHP                                           00030900
      I2=I*NDVP                                                 00031000
      I1=I2-NDV                                                 00031100
      KNHCR=MOD(I-1,NSH).NE.0                                   00031200
      IF(KNHCR) GO TO 230                                       00031300
      DO 229 J=I1,I2                                            00031400
228   IMAGE(J)=HC                                               00031500
230   CONTINUE                                                  00031600
```

APPENDIX 4. - Subroutine GRET3D and PRPLOT listing - Continued.

```
      DO 240 J=I1,I2,NSV                                                00031700
      IF(KNHOR) GO TO 235                                               00031800
      IMAGE(J)=NC                                                       00031900
      GO TO 240                                                         00032000
235   IMAGE(J)=VC                                                       00032100
240   CONTINUE                                                          00032200
      XMIN1=XMIN-DV/2.                                                  00032300
      YMIN1=YMIN-DH/2.                                                  00032400
      RETURN                                                            00032500
C                                                                       00032600
      ENTRY PLOT3(CH,X,Y,N3)                                            00032700
300   IF(KPLOT2) GO TO 312                                              00032800
301   WRITE (6,13)                                                      00032900
13    FORMAT(T5,'PLOT2 MUST BE CALLED')                                 00033000
312   CONTINUE                                                          00033100
      IF(.NOT.KPLOT) RETURN                                             00033200
      IF(N3.GT.0) GO TO 314                                             00033300
      KPLOT=.FALSE.                                                     00033400
      WRITE (6,15)                                                      00033500
15    FORMAT(T5,'PLOT3, ARG2 < 0')                                      00033600
      RETURN                                                            00033700
314   DO 320 I=1,N3                                                     00033800
      DUM1=(X(I)-XMIN1)/DV                                              00033900
      DUM2=(Y(I)-YMIN1)/DH                                              00034000
317   IF(DUM1.LT.0..OR.DUM2.LT.0.) GO TO 320                            00034100
      IF(DUM1.GE.NDVP.OR.DUM2.GE.NDHP) GO TO 320                        00034200
      NX=1+INT(DUM1)                                                    00034300
      NY=1+INT(DUM2)                                                    00034400
315   J=(NDHP-NY)*NDVP+NX                                               00034500
      IMAGE(J)=CH                                                       00034600
320   CONTINUE                                                          00034700
      RETURN                                                            00034800
C                                                                       00034900
      ENTRY PLOT4(NL,LABEL)                                             00035000
      ENTRY FPLOT4(NL,LABEL)                                            00035100
      IF(.NOT.KPLOT) RETURN                                             00035200
      IF(.NOT.KPLOT2) GO TO 301                                         00035300
      DO 420 I=1,NDHP                                                   00035400
      IF(I.EQ.NDHP.AND.KBOTGL) GO TO 420                                00035500
      WL=BL                                                             00035600
      IF(I.LE.NL) WL=LABEL(I)                                           00035700
      I2=I*NDVP                                                         00035800
      I1=I2-NDV                                                         00035900
      IF(MOD(I-1,NSH).EQ.0.AND..NOT.KORD) GO TO 410                     00036000
      WRITE (6,FOR2) WL,(IMAGE(J),J=I1,I2)                              00036100
      GO TO 420                                                         00036200
410   CONTINUE                                                          00036300
      ORDNO=(YMX-FLOAT(I-1)*DH)*FSY                                     00036400
      WRITE (6,FOR1) WL,ORDNO,(IMAGE(J),J=I1,I2)                        00036500
420   CONTINUE                                                          00036600
      IF(KABSC) GO TO 430                                               00036700
      WRITE (6,FOR3) (ABNOS(J),J=1,NVP)                                 00036800
430   RETURN                                                            00036900
C                                                                       00037000
      ENTRY OMIT(LSW)                                                   00037100
      KABSC=MOD(LSW,2).EQ.1                                             00037200
      KORD=MOD(LSW,4).GE.2                                              00037300
      KBOTGL=LSW.GE.4                                                   00037400
      RETURN                                                            00037500
C                                                                       00037600
      ENTRY PLTAPE(ITAPE)                                               00037700
C        NOT YET                                                        00037800
      RETURN                                                            00037900
      END                                                               00038000
```