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DIGITAL GRID OF ISOSTATIC RESIDUAL GRAVITY
OF NORTH AMERICA: A DIGITAL DATABASE

By

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A digital grid of isostatic residual gravity of North America (figure 1) was prepared using an Airy-Heiskanen model of local compensation with the following parameters: density of topographic load, 2.67 g/cm^3 ; density contrast across the bottom of root, 0.35 g/cm^3 ; depth to bottom of root for elevations at sea level, 30 km. The isostatic correction procedure is discussed in detail in Simpson and others (1986). Data gaps in Greenland, parts of western Canada, eastern Russia, and Mexico are caused by absence or unavailability of Bouguer gravity values.

Although global studies of the Earth's gravity field (e.g. Heiskanen and Vening Meinesz, 1958; Bowin, 1985) indicate that, on a worldwide scale, isostatic compensation obtains to a high degree, no single isostatic model or set of isostatic parameters is likely to adequately describe the geometry of compensating masses over an entire continent. However, the depth of the compensating masses will tend to smooth out their gravitational signal at the Earth's surface, and differences between various isostatic models will tend to be smooth and long-wavelength. If one's goal is to enhance the gravitational anomalies produced by geologic bodies in the upper crust, then to first order, the application of some isostatic correction is more important than the exact details of the compensation model used.

It is important to realize that the isostatic residual anomalies appearing on this map, especially those with wavelengths of 1000 km or less, do not necessarily imply the existence of isostatic imbalance. Simpson and others (1986) pointed out that isostatic residual anomalies can exist over density heterogeneities in the middle and upper crust even when such heterogeneities are in perfect isostatic equilibrium. Most of the shorter wavelength anomalies on this map can be attributed to geologic bodies in the middle or upper crust, and most of these bodies, we think, are likely to be nearly in isostatic equilibrium. Longer wavelength anomalies on this map may reflect isostatic imbalance or possibly density heterogeneities deep within the Earth's mantle or core that are effectively decoupled from the shallow isostatic system. The broad isostatic residual gravity low centered over Hudson Bay in Canada probably does reflect isostatic disequilibrium caused by melting of the great Pleistocene ice sheets. Also, the broad gravity highs over the Pacific Ocean south of the Aleutian Islands of Alaska and southwest of the west coast of Central America probably reflect dynamic processes associated with the subduction of oceanic lithospheric plates. For more information on the significance of isostatic residual gravity anomalies and for discussion of some

individual anomalies within the conterminous United States, see Simpson and others (1986, 1988) and Jachens and others (1989).

Additional processing can be performed on isostatic residual maps to remove, at least to first order, the gravitational effects of compensating masses supporting dense bodies within the crust. (The isostatic correction has removed the compensating masses supporting topographic loads.) This additional processing results in a "decompensative gravity anomaly map" as described by Cordell and others (1991). This processing has not been applied to the grid described in this report.

The construction of an isostatic residual gravity map requires, in addition to an isostatic model, a Bouguer gravity data set to which the isostatic correction is applied and a topographic data set to define the geometry of the compensating masses in the model. Bouguer gravity data came from the gridded digital data set used to prepare the Decade of North American Geology (DNAG) gravity anomaly map of North America (Committee for the Gravity Anomaly Map of North America, 1987). For the offshore areas where this grid contains free-air gravity anomalies, Bouguer anomalies were computed using 5-minute average elevations from a world topographic data set obtained from the National Oceanic and Atmospheric Administration (NOAA) Data Center in Boulder, Colorado, USA. The resulting Bouguer gravity grid has a 6-km by 6-km interval based on the DNAG transverse Mercator projection. The model Airy-Heiskanen isostatic root, used to calculate the isostatic correction, was also defined by the 5-minute average elevations obtained from the NOAA Data Center.

The digital grid of isostatic residual gravity of North America has the following specifications:

columns	1495
rows	1430
x_0	-4480 km
y_0	700 km
dx	6 km
dy	6 km
projection	DNAG transverse Mercator
central meridian	long. 100° W.
base latitude	lat. 0°

The grid is stored by rows, beginning at the lower left corner of the map area. x_0 and y_0 are the projected coordinates of the lower left grid point; dx and dy are the intervals between columns and rows, respectively. Grid elements with values greater than 1×10^{38}

denote locations for which no gravity values were available in the starting grid used to prepare the gravity anomaly map of North America.

The grid is available in a binary form called "Branch of Geophysics Standard Grid format" as well in a compressed (using the Unix *compress* command) ascii form. A description of the Standard Grid format is given in Appendix A. The uncompressed ascii version can be converted to binary Standard Grid form using a Fortran77 program called *ascii2sg.f* which is described in Appendix B. This program could be modified to convert the grid to other binary or ascii formats if desired.

To obtain the database by anonymous ftp, contact Robert W. Simpson (telephone 415-329-4865; FAX 415-329-5163; E-mail simpson@gold.wr.usgs.gov) or Robert C. Jachens (telephone 415-329-5300; E-mail jachens@mojave.wr.usgs.gov).

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APPENDIX A - STANDARD GRID FORMAT

The Branch of Geophysics "standard format" for binary storage of two-dimensional arrays consists of two basic parts: (1) a single header record that provides descriptive parameters about the two-dimensional array and (2) multiple records containing the gridded data.

A. Header record:

The header record contains the following parameters (assuming the x-axis is parallel to rows and the y axis is parallel to columns):

ID: 56 ascii characters of identification,
PGM: 8 ascii characters identifying the origin of the data,
NCOL: Number of columns of data (integer),
NROW: Number of rows of data (integer),
NZ: NZ = 1 (integer),
COL1: The x coordinate of the first column (real),
DCOL: The spacing between columns (real),
ROW1: The y coordinate of the first row (real),
DROW: The spacing between rows (real),
IPROJ: The projection code (integer) (12=DNAG),
CMER: The central meridian in degrees (real), and
BLAT: The base latitude in degrees (real).

Parameters COL1, DCOL, ROW1, and DROW should have consistent units (e.g., km).

B. Data records:

Each data record contains one dummy value followed by one row of the grid. Hence, the total record length is NCOL+1 words. Note that the first element of the array is the lower, left-hand corner of the grid; rows are entered one at a time from bottom to top.

The following Fortran code would read a standard grid:

```
DIMENSION GRID(500,500)
CHARACTER ID*56,PGM*8
.
.
OPEN(10,FILE='JUNK.GRD',
& STATUS='OLD',FORM='UNFORMATTED')

READ(10)ID,PGM,NCOL,NROW,NZ,COL1,DCOL,ROW1,DROW,
& IPROJ,CMER,BLAT
DO 100 J=1,NROW
  READ(10) DUMMY,(GRID(I,J),I=1,NCOL)
100 CONTINUE

CLOSE(10)
```

APPENDIX B - PROGRAM `ascii2sg.f` FOR CONVERTING ASCII FORM.

The format for the ascii version of the data grid can be inferred from the following listing for program `ascii2sg.f`:

```
cccccccccccccccccccccccccccccccccccccccccccccccccccccccccccc
c      ascii2sg.f

c      Converts a grid file from ascii to
c      binary Standard Grid format.

      character*80 infile, outfile
      character id*56,pgm*8
      dimension row(5000)
      integer iunit,ounit
      parameter (iunit=21, ounit=22)

c      Open ascii input version:
      print *, ' Ascii Infile:  '
      read '(a)', infile
      open (iunit, file=infile, form='formatted',
&        status='old')

c      Open binary output version:
      print *, ' Binary Outfile:  '
      read '(a)', outfile
      open (ounit, file=outfile, form='unformatted',
&        status='new')

c      Read ascii version header information.
      read(iunit,1001) id,pgm
1001 format(a56,a8)
      read(iunit,1002) ncol,nrow,nz
1002 format(6x,i8,8x,i8,6x,i8)
      read(iunit,1003) xo,dx,yo,dy
1003 format(4(5x,e14.8))
      read(iunit,1004) iprj,cm,bl
1004 format(12x,i4,6x,e14.8,6x,e14.8)
      read(iunit,1005) rot,xcen,ycen
1005 format(6x,e14.8,7x,e14.8,7x,e14.8)

c      Write binary header.
      write(ounit) id,pgm,ncol,nrow,nz,xo,dx,yo,dy,
&      iprj,cm,bl,rot,xcen,ycen

c      Read ascii grid row by row and write to binary.
      do 50 j=1,nrow
          call rdrowasc (iunit,ncol,row)
          call wrrowbin (ounit,ncol,row)
50      continue

      close(ounit)
      close(iunit)
      stop ' '
```


Isostatic Residual Gravity

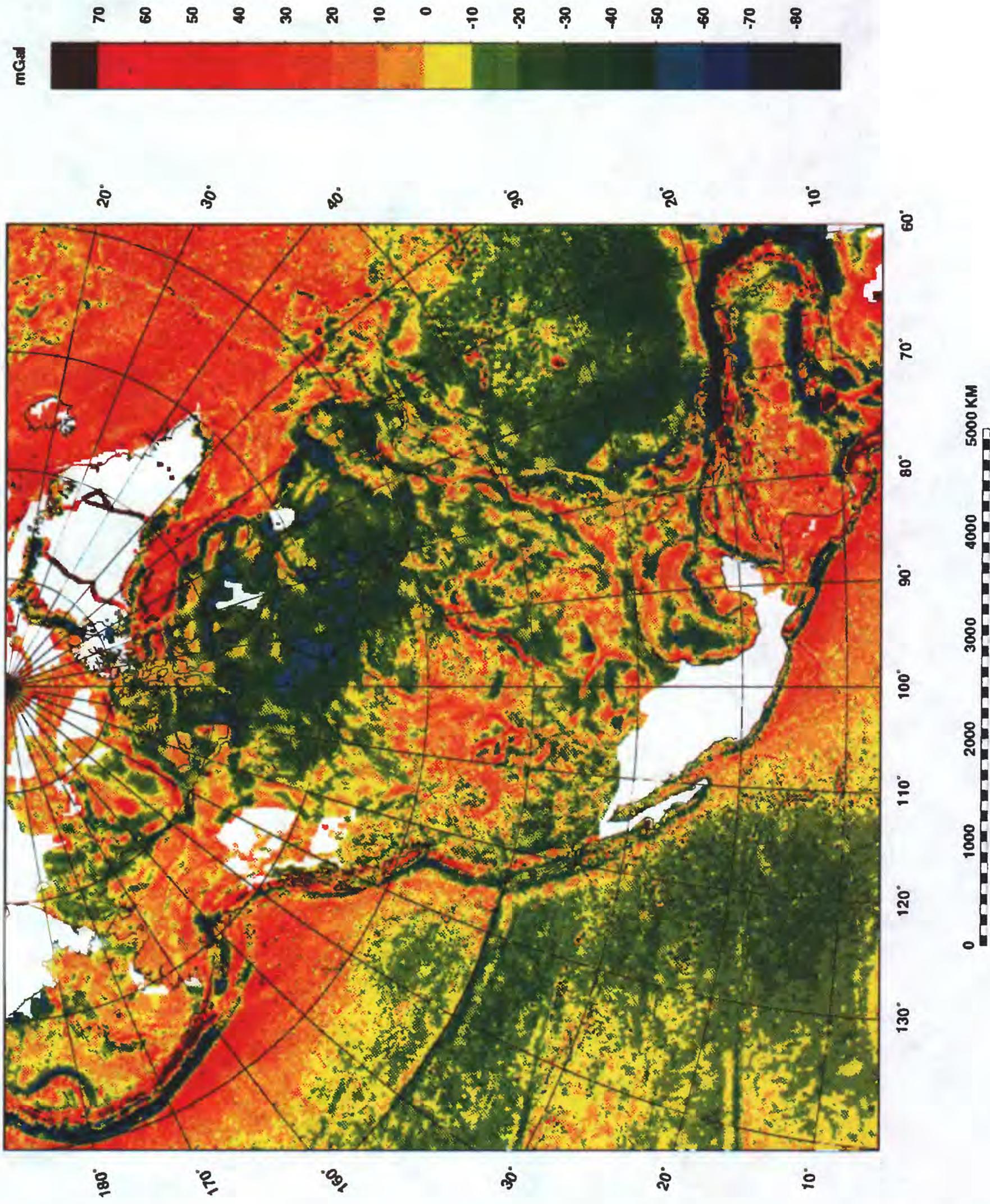


Figure 1