U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

PRINCIPAL FACTS FOR GRAVITY DATA IN THE BETHEL AND RUSSIAN MISSION 1° X 3° QUADRANGLES, ALASKA

By

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94-014-A, Documentation

94-014-B, Gravity Data on Diskette

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INTRODUCTION

Bethel and Russian Mission 1° x 3° quadrangles are located in southwestern Alaska near the mouth of the Kuskokwim River. The Russian Mission quadrangle now has about 266 gravity stations and the Bethel quadrangle has about 485 gravity stations.

Riverboat traverses along the Yukon River in the northern part of the Russian Mission quadrangle in 1967 were used to collect the first U.S. Geological Survey (USGS) gravity stations in the area of these quadrangles. A float-plane flight through the southeast corner of the Russian Mission quadrangle during the same time period added four stations. In 1969 a float-plane flight added one station to the east central Bethel quadrangle. In 1973 sciff work along the Kuskokwim and some of its sloughs and tributaries was utilized to add many gravity stations to the central part of the Russian Mission quadrangle and some gravity stations near the northern edge of the Bethel quadrangle. Float-plane work that year added about 35 gravity stations throughout the eastern two thirds of the Russian Mission quadrangle. Boat work on the Tikchic Lakes was utilized to establish six gravity stations to the southeast corner of the Bethel quadrangle in 1973. The Alaska Mineral Resource Appraisal Program (AMRAP) of the USGS for the Goodnews quadrangle, south of the Bethel quadrangle included the southern 15 minutes of the Bethel quadrangle. About 14 gravity stations were collected in this area during 1975 and 1976 with the use of a helicopter. Several float-plane flights in 1976 added six stations to the Bethel quadrangle. Ski-plane flights added 14 stations in the southwestern corner of the Bethel quadrangle and 12 stations in the southern corner of the Russian Mission quadrangle and the northwestern corner of the Bethel quadrangle in 1977. A total of 16 gravity stations were collected in the eastern Bethel and Russian Mission quadrangles in 1982. About 400 gravity stations were collected as part of the Bethel AMRAP program in the Bethel and Russian Mission quadrangles during 1987, 1988, and 1989. Most of these data were collected with a helicopter, but some were collected by using watercraft.

GRAVITY REDUCTION

Conversion to milligals was made by using factory calibration constants and a calibration factor which varies with each gravity meter and has been determined by multiple gravity readings over the Mt. Hamilton calibration loop east of San Jose, CA (Barnes and others, 1969). Observed gravity values were based on an assumed linear meter drift between successive base readings. Elevation control mostly was provided by using altimetry with backup control of map elevations either from bench marks, spot elevations, lake elevations, river gradients, tidal elevations, or contour interpolations. The use of a recording barometer and incorporation of barometric variations in the altimetry processing improved the accuracy of altimeter elevations. Altimeter elevations are probably accurate to within 15 m (50 ft) for 80% of the stations which is equivalent to a 3.0 mGal error in the simple Bouguer anomaly. Locations of gravity stations were plotted on 1:63,360 scale USGS topographic maps in the field with the exception of a few stations that were plotted on 1:250,000 scale maps. Terrain corrections were computed for the area from a radial distance of 0.39 km from the station to a radial distance of 166.7 km with a FORTRAN program (Plouff, 1977) and a digital terrain model. These data were processed through an isostatic reduction program (Jachens and Roberts, 1981) in order to suppress the effects of deep density distributions that buoyantly support the topography. The isostatic reduction assumes an Airy-Heiskanen model with the following parameters from the station to 166.7 km: density of topography above sea level, 2.67 g/cm^3; crustal thickness at sea level, 25 km; density contrast across the base of the model crust, 0.4 g/cm^3. From 166.7 km to a point on the opposite side of the Earth, isostatic corrections were taken off of maps by Karki (1961). These corrections were added to the output of the isostatic program of Jachens and Roberts (1981) to produce the isostatic correction.

Theoretical gravity at sea level is based on the Geodetic Reference System 1967 (GRS 67) (International Association of Geodesy, 1971, p. 58) for the shape of the spheroid. The datum for the observed gravity is the International Gravity Standardization Net 1971 (IGSN 71), (Morelli, 1974. p. 18). Observed gravities were calculated by adding the meter drift and earth-tide corrections to the milligal equivalent meter readings. Free-air anomalies are calculated by subtracting the theoretical gravity from the observed gravity and adding the free-air correction as defined by Swick (1942, p. 65). Simple Bouguer anomalies are calculated by the subtracting the Bouguer correction, which accounts for the attraction of rocks between the station and sea level using a rock density of 2.67 g/cm^3 from the free-air anomaly. Complete Bouguer anomalies are calculated by adding the terrain correction to the simple Bouguer anomaly. Isostatic anomalies are calculated by adding the isostatic correction to the complete Bouguer anomaly.

Most of the regional gravity data collected in Alaska use altimetry for elevation control. Elevations taken from USGS topographic maps are also recorded. Terrain corrections were always calculated using the map elevation because the digital terrain used for making terrain corrections was made from the topographic maps. Bouguer corrections are also based on the elevation of the gravity station. Where altimeter measurements are made at a gravity station, simple Bouguer anomalies are calculated both for map and altimeter elevations. A station's elevation preference is chosen based on the type of map elevation and the quality of the altimeter survey. Stations that are located at bench marks or near sea level are almost always reduced with map elevations as the primary elevation. Most other decisions whether to use map elevations rather than altimeter elevations are based on such things as altimeter drift, whether a recording altimeter base was used, the distance the stations were from the base, the type of map elevation, and the accuracy of the station position. The gravity file on the diskette includes the station name, latitude, longitude, primary elevation, observed gravity, accuracy codes, free air anomaly, simple Bouguer anomaly based on the primary elevation, terrain correction, complete Bouguer anomaly based on the primary elevation, isostatic anomaly based on the primary elevation, secondary elevation, and simple Bouguer anomaly based on the secondary elevation. The difference between the primary and secondary simple Bouguer anomalies generally reflects the accuracy of the gravity data.

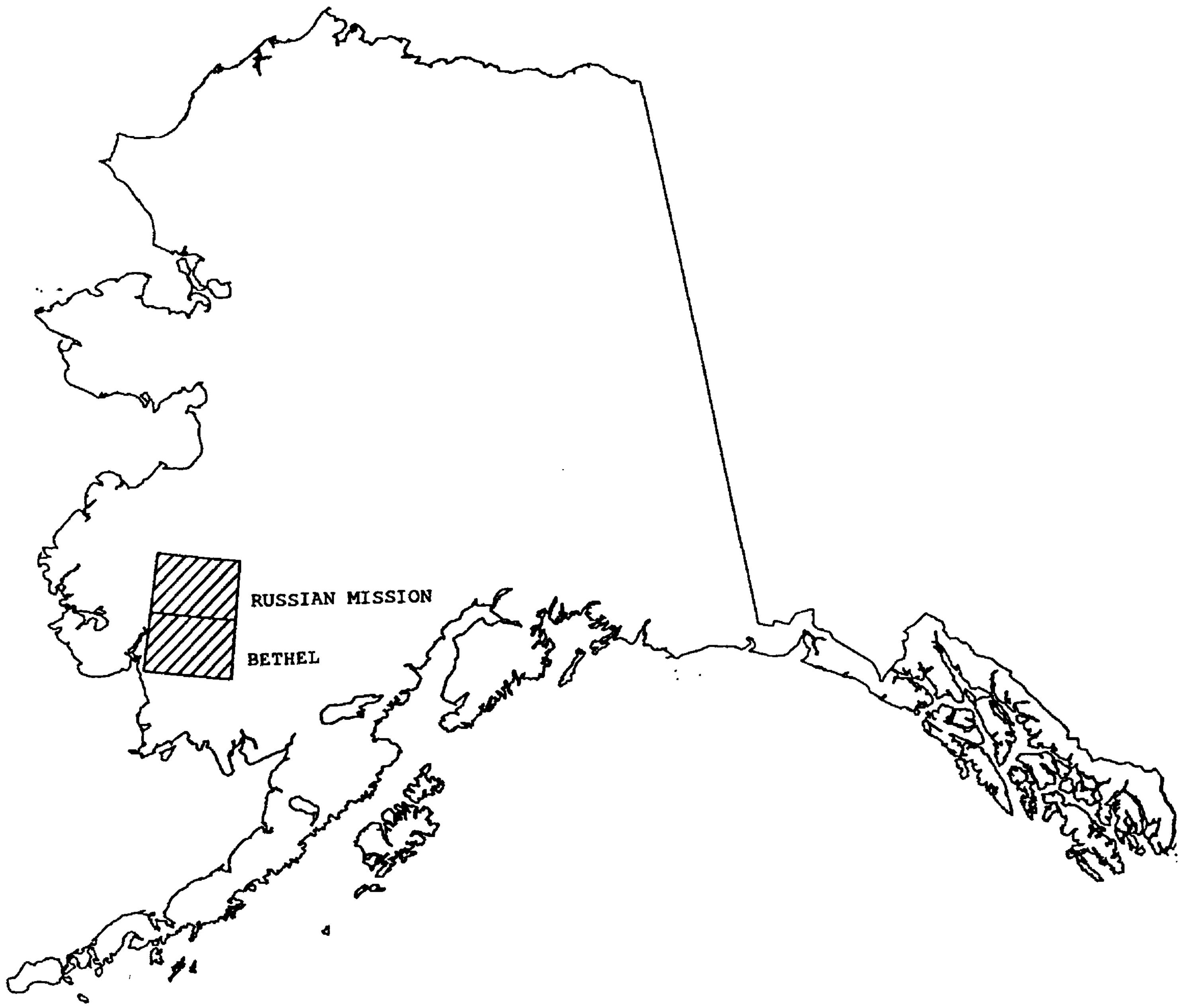

FIGURE 1. –Index map of Alaska showning the boundaries of Russian Mission and Bethel 1° x 3° quadrangles.

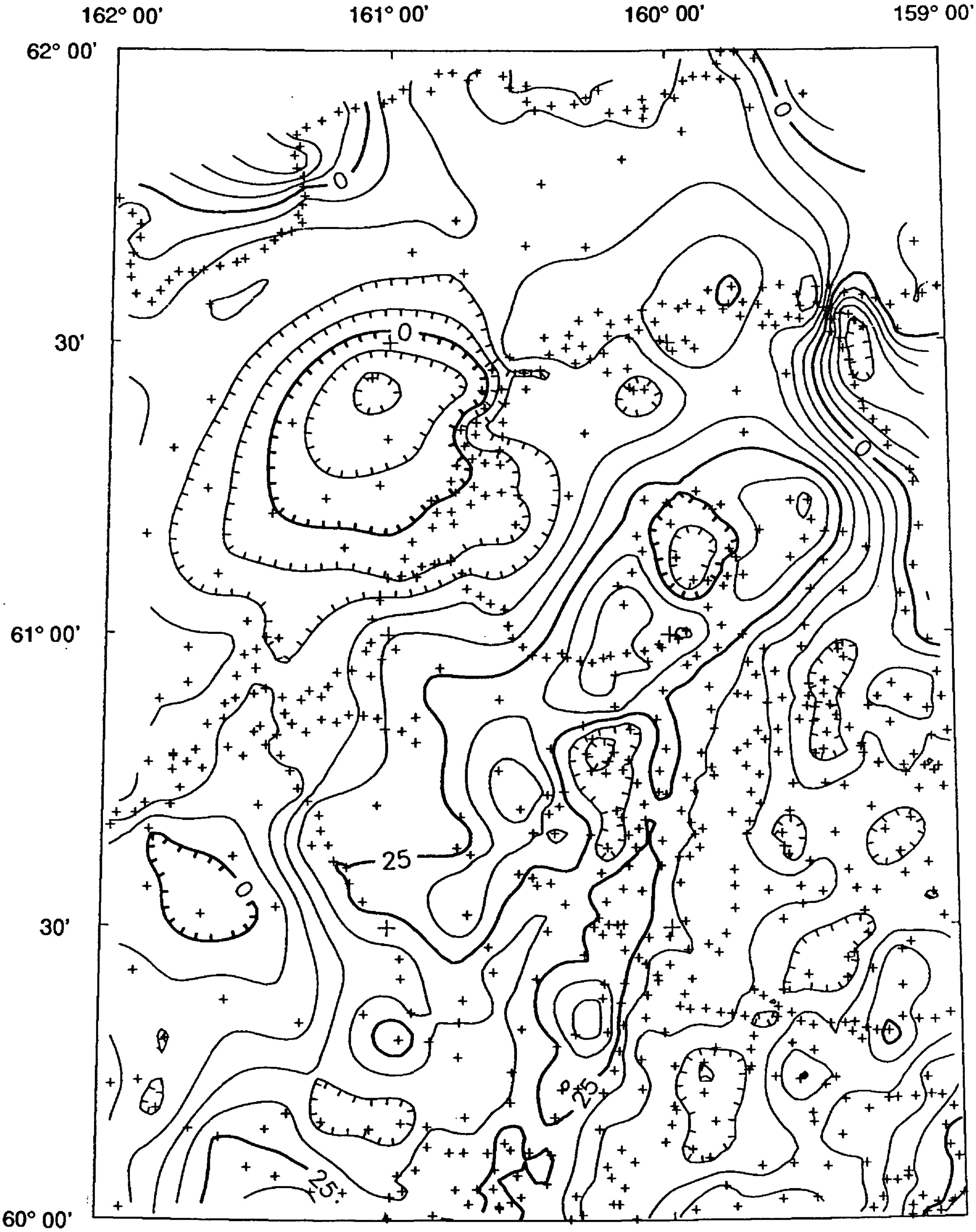

FIGURE 2. –Isostatic anomaly contour map with locations of gravity stations. Contour interval 5 milligals.

READING DISKETTE

The data described in this report are available as Open-File Report 94-014-B. These data are in ASCII format on a $3\frac{1}{2}$-inch, high-density, and double-sided diskette formatted for IBM personal computers. The diskette requires the following hardware: (1) an IBM personal computer or compatible computer operating PC-DOS or MS-DOS, and (2) a double-sided $3\frac{1}{2}$-inch high-density disk drive.

The diskette contains 2 files:

readme.txt, description of the gravity data, explains format of records;

betrus.iso, isostatic gravity file

REFERENCES CITED

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Plouff, Donald, 1977, Preliminary documentation for a FORTRAN program to compute gravity terrain corrections based on topography digitized on a geographic grid: U.S. Geological Survey Open-File Report 77-535, 45 p.

Swick, C.H., 1942, Pendulum gravity measurements and isostatic reductions: U.S. Coast and Geodetic Survey Special Publication no. 232, 82 p.

Sample of BETRUS.ISO

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