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SIMPLE BOUGUER GRAVITY AND AEROMAGNETIC MAPS OF THE SARATOGA TABLE QUADRANGLE, ANTARCTICA

By

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INTRODUCTION

During the 1965-66 austral summer we made reconnaissance gravity and magnetic surveys of the Pensacola Mountains and the adjacent ice-covered area, Antarctica. The gravity survey consisted of 397 observations on ice or rock and also seismic reflection measurements of ice thickness at 18 stations away from the mountains. Turbine helicopters were used and the work was coordinated with simultaneous geologic amd topographic work by the U.S. Geological Survey. Reconnaissance aeromagnetic profiles were also flown perpendicular to the general northeast strike of the Pensacola Mountains. The objective of the geophysical surveys was to complement the geologic mapping in an effort to understand the tectonic development of the Pensacola Mountains and their relationship to the transition from West to East Antarctica. Behrendt, Meister, and Henderson have (1966) discussed preliminary results of the geophysical work.

GRAVITY SURVEY

We used one Worden and two LaCoste and Romberg geodetic gravimeters. The Pensacola survey base station at Camp Neptune (Schmidt Hills quadrangle) was tied four times, over a period of several hours each, to the McMurdo base station (Behrendt and others, 1962). An additional check on the base station was a reoccupation of one of the 1957 IGY (International Geophysical Year) traverse stations on bedrock in the Dufek Massif (Behrendt, 1962). A difference of +0.9 mgal was observed when gravity at the base station was compared with that at the IGY traverse station; this difference is acceptable considering that the older data were all tied to North America by ship and land-surface vehicle (Behrendt and others, 1962) over a period of months and years. All gravity observations in this survey were tied to the Pensacola base station within a few hours, and errors in observed gravity are negligible.

Absolute elevations are considered accurate within ±25 m (±5 mgal) and relative elevation within ±10 m (±2 mgal). Two seismic reflections from the water-ice contact at the base of the Ronne Ice Shelf northwest of the Dufek Massif allowed a determination of sea-level elevation based on hydrostatic equilibrium. Corrections were made for changes in seismic velocity resulting from density increase in the upper ice shelf (Thiel and Behrendt, 1959) and absolute elevation accuracy was estimated conservatively, at the reflection stations, as ±10 m. The reflection stations were tied, one by vertical angle and one by altimetry, to the Pensacola Mountains control net. The elevations at stations in the survey were obtained from altimeter data corrected for temperature and for barometric pressure variations at a central control station. In addition, 97 gravity stations were at control points where vertical angle observations were made as part of the topographic mapping control. The standard deviation of the unadjusted altimetry data at the vertical angle stations is ±12 m. All altimeter elevations were adjusted by use of the 97 vertical angle stations as control.

Positions of gravity stations located at points in the topographic control net are accurate to tenths of seconds; and stations away from the mountains where graphic solutions of astronomical observations were made, are accurate to about one-tenth minute. Therefore, latitude-correction errors are negligible.

The largest source of error, and the most difficult to evaluate, is the terrain effect. Terrain corrections could not be made in the usual manner, because of insufficient detail on the best maps (1:250,000-scale, 200-m contour interval) available. A large unknown effect due to subglacial terrain could not have been corrected for, even if larger scale maps had been available. The corrections could be as great as several tens of milligals in certain cases but experience suggests that they should be no more than 10 mgal for most stations. We attempted to allow for terrain effects in contouring the maps by assuming that all corrections for stations on rock would be positive and that complete Bouguer anomaly (unknown) must be at least as positive as simple Bouguer anomaly.

MAGNETIC SURVEY

Total magnetic intensity measurements were made along the flight paths indicated on the magnetic map. We used an Elsec Wisconsin proton precession magnetometer (Wold, 1964), flown in a LC-117 aircraft at a constant

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barometric elevation of 2,100 m. Trimetrigon photography, available at the time of the survey, provided position control in the area of the mountains. Dead reckoning and solar observations, adjusted to photographically identified indicated points, were the only control at the northwest and southeast ends of the flight paths over the featureless ice sheet. Consequently, position errors are variable but are minimal near the control points. Some paths crossed no identifiable rock outcrops and these have greater position errors. A reliable estimate of quantitative error is difficult to obtain, but probably errors at the ends of the flight paths are several kilometers. Diurnal control was obtained from a base line connecting the profiles. No flights were made during magnetic storms.

The residual values shown by the contours were computed by removing the main earth field as a smoothed curve along each flight line profile. We consider that this rather crude method is justified for the data in this map because of the high-amplitude anomalies and coarse contour intervals used. The original profiles across this sheet were published in an earlier report (Behrendt and others, 1966).

DISCUSSION

SIMPLE BOUGUER GRAVITY MAP

Behrendt, Rambo, Henderson, and Meister (1973) discussed the approximately 80-mgal positive anomaly associated with the Dufek intrusion in the Dufek Massif and Forrestal Range. This map of the Saratoga Table quadrangle indicates the approximate contact between the Dufek intrusion and older Paleozoic sedimentary rocks to the south. Gravity values are obviously much higher over the intrusive than over the sedimentary rocks. The regional gravity decreases from 82 mgal to -90 mgal from northwest to southeast in the Pensacola Mountains. On the basis of the regional gravity, a much lower value than the +10 mgal shown at the seismic reflection station near the east edge of the map at 83° 33′ S. was to be expected. Another seismic station east of this quadrangle also has an anomalously high Bouguer anomaly. We attribute this several-tens-of-milligals anomaly to a buried extension of the Dufek intrusion, an interpretation that is supported by the magnetic results.

AEROMAGNETIC MAP

In the Saratoga Table quadrangle anomalies ranging from 1,100γ to- 500γ are associated with the Dufek intrusion which extend northward into the adjoining Cordiner Peaks and Davis Valley quadrangles. There is a 200γ anomaly over the ice sheet southeast of the Forrestal Range which we interpret as an extension of the Dufek intrusion. The lower amplitude is probably the result of deeper burial beneath the ice of the magnetic rocks. Behrendt, Meister, and Henderson (1966) indicated 0- to 500-m elevation for the bedrock in this area, compared with the 2,100-m flight elevation. East of the Forrestal Range in the northern part of this quadrangle, the bedrock is as low as -1,000 m, which may mask any additional anomalies. As noted previously, the gravity data also suggest denser rock in this area.

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