MAGNETIC SURVEY OF THE NENY BAY AREA, MARGUERITE BAY

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A MAGNETIC SURVEY of the Neny Bay area was carried out from the British Antarctic Survey station at Stonington Island on suitable days during the winter of 1963. Transport was provided by the various dog teams and their drivers, except for some of the detailed work near Roman Four Promontory which was undertaken by manhauling. The extent of the survey was limited by the distance which could be travelled during the short hours of daylight and by the poor sea-ice conditions which prevailed at the time.

Total field magnetic measurements were made at 76 stations with an Elsec proton magnetometer at an average station interval of about 1 km. (Fig. 1). All the magnetic stations

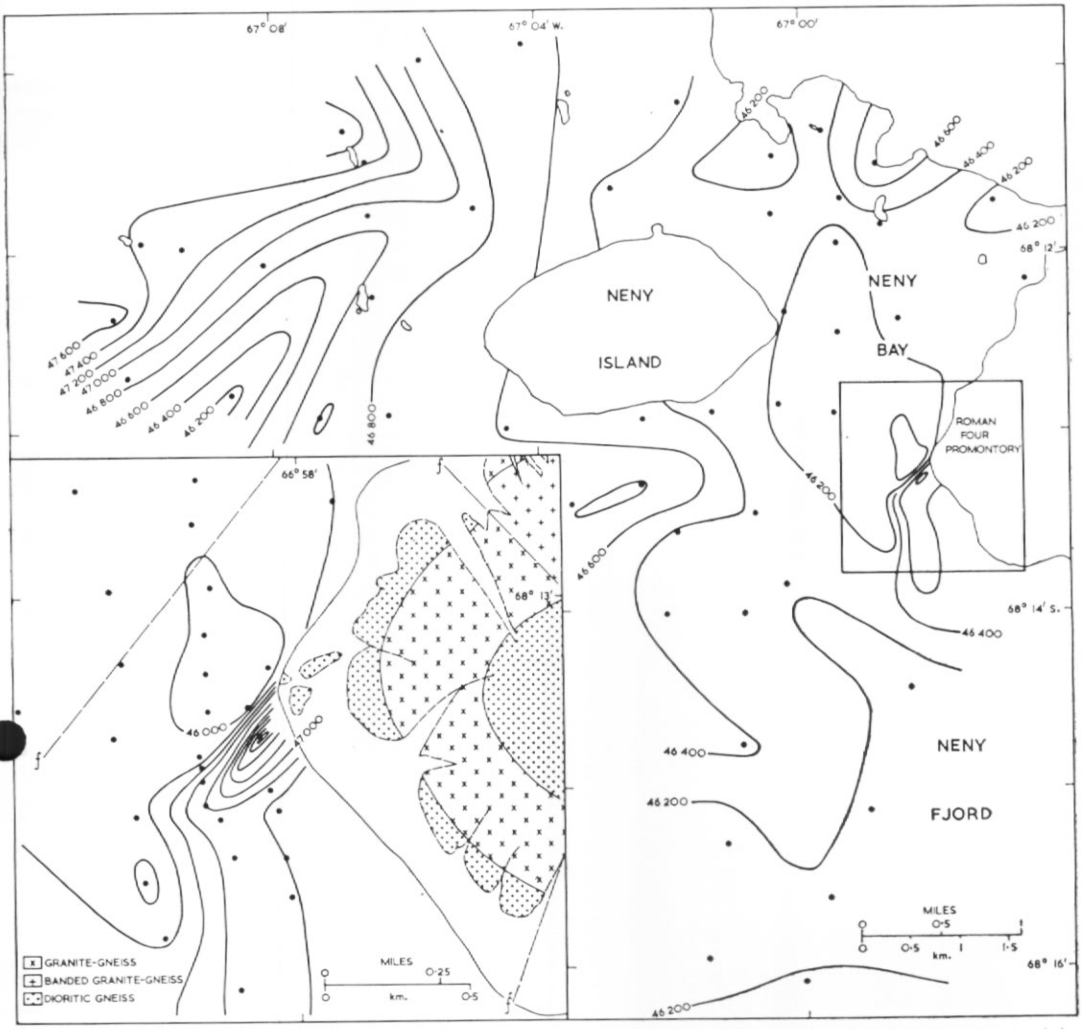

Fig. 1. Total field magnetic map of the Neny Bay area, Marguerite Bay. The magnetic contour interval is 200 gamma. The inset shows a detailed magnetic map in the vicinity of Roman Four Promontory. The geology is from Hoskins (1963). Faults are shown by broken lines.

were on sea ice and their positions were mainly fixed by plane-table methods on a scale of 1 : 25,000, using trigonometrical stations established during an earlier survey. Some of the points in the vicinity of Roman Four Promontory were fixed by a combination of plane-table methods and direct measurement. The estimated accuracy of the station positions is up to $\pm$20 m. in the northern part of the area, decreasing to $\pm$50 m. in the southern part, where the angle of intersection of the plane-table rays is more acute.

In the absence of local records for diurnal variations of the magnetic field, observations were made at the beginning and end of each day's work at a base station near the coast of Stonington Island. This provided a rough indication of the prevalent magnetic activity, and it was also hoped that correlation would be possible with the continuous records of the magnetic elements kept at the Argentine Islands observatory, 370 km. away to the north. Subsequent examination of these records revealed that the correlation was in fact poor, so they could not be used as a basis for diurnal corrections in the Neny Bay area. However, they provide an indication of the greatest effect to be expected during each day's work. The maximum amplitude of the diurnal change in the total field averaged over the period of the survey was 21 gamma/day. The maximum amplitude recorded at the Argentine Islands observatory during the working period was 55 gamma and the biggest daily change measured at the Stonington Island base station was 42 gamma. It is therefore reasonably safe to assume that the maximum error in the measured field values is about $\pm$25 gamma. These values are shown on the magnetic map (Fig. 1) and contours have been drawn at intervals of 200 gamma.

In the less magnetically disturbed areas covered by the survey, the contours have an approximate north—south trend and in general they decrease in numerical value eastwards. Both these features are opposed to the regional trend for the area given by Vestine and others (1947, fig. 150(A)), which is north-west to south-east increasing towards the south-west. The average total field value, after due allowance for secular change, is also about 1,500 gamma higher than that listed by Vestine and others (1947, table 53).

The two most interesting features are the steep anomalies in the western part of this area (Fig. 1) and the large anomaly in the vicinity of Roman Four Promontory (Fig. 1, inset). The western anomalies seem to be composed of several discrete parts but there are insufficient data to be able to comment in detail on their origin. From the meagre soundings available in the vicinity, it appears that the anomalies are not directly related to the submarine topography but must be due to a deeper source. The sharpness of the anomalies, however, precludes a depth greater than a few hundred feet to the disturbing body.

The Roman Four Promontory anomaly has been surveyed in rather more detail, although there is still insufficient information for a rigorous interpretation. The anomaly consists of a north-east to south-west trending part which extends from the coast for about 400 m. and then turns abruptly to a north–south direction. The first part has an amplitude of 1,800 gamma and it is associated with an extensive "low" area to the north-west. The survey was not continued to the south-east, so it is not known whether there is a corresponding area of low field values there. The alignment of the anomaly is approximately parallel to the north-west coast of the promontory. The amplitude of the north–south trending part is 750 gamma, the low area being smaller and lying to the west of the positive anomaly, but again the survey was not continued near enough to the coast of Roman Four Promontory to delimit the eastern side of the anomaly.

Interpretation of the anomalies was attempted by comparing the half-width of each anomaly with theoretical parameters for idealized sources given by Smellie (1956). Curves for a single dipole source and a line of dipoles source were successively tried but there was no agreement between observed and theoretical values. Since Smellie's curves apply only to sources which are magnetized in the present direction of the Earth's field, the discrepancy probably means that the source of the anomaly is strongly magnetized in a different direction. No satisfactory quantitative interpretation can therefore be carried out with the data available. It is, however, unlikely that the depth to the top of the source of the anomalies is greater than about 100 m. below sea-level for the northern one and about 350 m. for the south-western one.

It is difficult to interpret these findings in terms of the known geology. Several geologists have, in the past, investigated this part of Marguerite Bay and the most recent account, which also describes the detailed geology of Roman Four Promontory, is given by Hoskins (1963).

He has shown that the promontory consists of a succession of Basement Complex gneisses. The western part is composed of dioritic gneiss dissected by a sheet-like intrusion of granite-gneiss, whilst the eastern part consists of granite-gneiss and banded granite-gneiss. Minor intrusions, originally dykes, are now represented by discontinuous lenses of amphibolite. There is also a small intrusion of metagabbro. Hoskins has presented several modal analyses of these rocks but in most cases the percentage of iron ore (not necessarily magnetite) is only about 1 per cent. The metagabbro is the only exception, with an iron ore content of 5 per cent.

The rocks of Roman Four Promontory are affected by several major faults. One fault is thought to continue through Neny Island and Millerand Island, effectively dividing the area into two petrological units with dioritic gneiss predominating west of the fault and granite-gneiss to the east. Subsequent block faulting occurred throughout the area during the emplacement of the Andean Intrusive Suite, which is represented a few kilometres away to the north-east and also to the south. A major fault line is considered to trend parallel to the north-west coast of the promontory.

Although no measurements were made on land, the peak of the northern anomaly appears to continue through the coastal outcrops of Roman Four Promontory near the Argentine navigation beacon. These consist of dioritic gneiss with a small outcrop of biotite-gneiss on the coast but there is no apparent change within the exposures which would satisfactorily account for the large anomaly. It is therefore presumably due to a polarization contrast at a shallow depth which is obscured by a thin cover of dioritic gneiss. If Hoskins's modal analyses of the gneisses are representative of the bulk of the rocks of Roman Four Promontory, there would not appear to be sufficient contrast in magnetite content between any of the gneisses to cause the anomaly. The metagabbro could provide the necessary contrast to the gneisses but it is only known to occur in small quantities. The pronounced linearity of the two anomalies is suggestive of a cause such as two dyke-like bodies, the one trending north-east to south-west and the other north to south. Both of these trends are the same as those of major fault lines in this area, and it is conceivable that the anomalies are caused by dykes intruded in association with the faults. Since there is no magnetic disturbance associated with Hoskins's postulated north-east to south-west trending fault, it is quite possible that this is much nearer to the coast than he has shown it on his map and that magnetic rocks associated with it give rise to the anomaly. Alternatively, the anomalies may delimit the edges of an uplifted block of dioritic gneiss and granite-gneiss surrounded by material of considerably lower magnetite content, which is not represented in the outcrops of Roman Four Promontory.

Clearly, much more detailed work remains to be done before a positive interpretation can be completed. It is to be hoped, however, that the present conclusions will provide an indication of the problem and the possible line of approach.

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