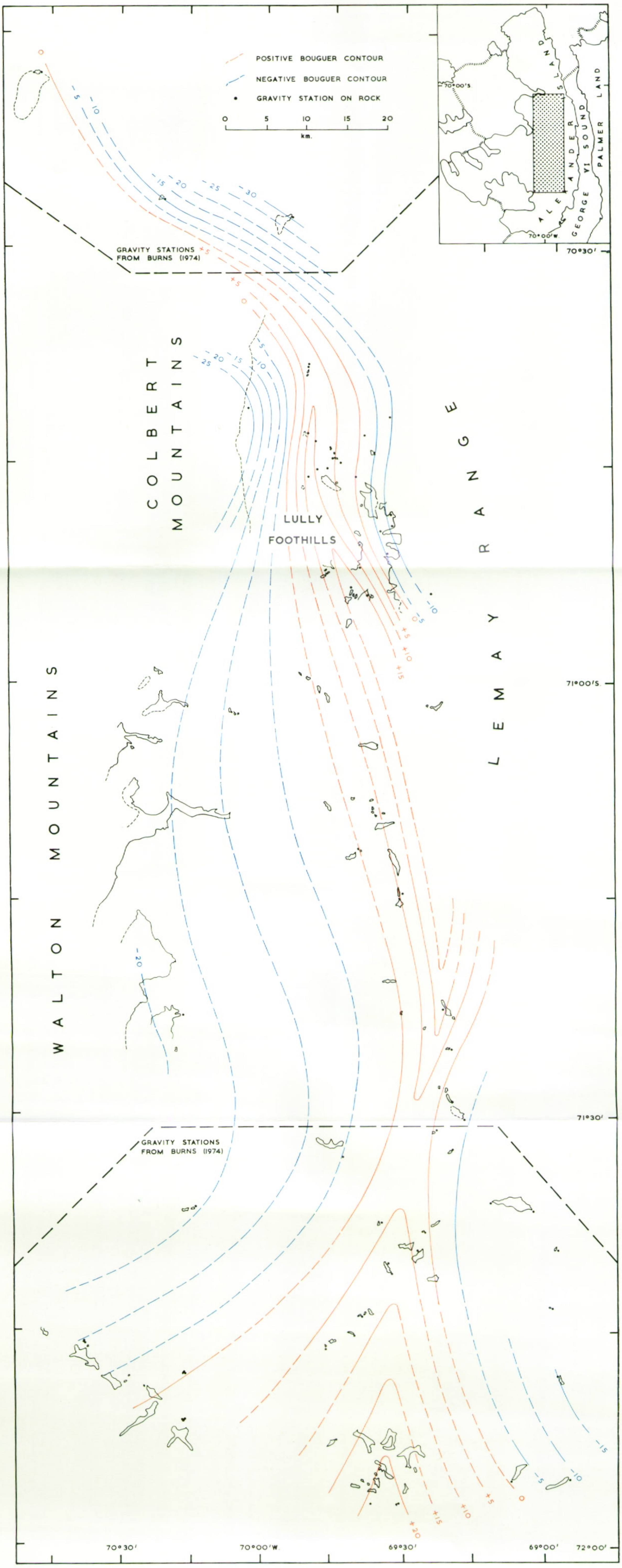

Fig. 1. Bouguer anomaly map of the central nunatak area of Alexander Island. Contour interval 5 mgal.

A LINEAR BOUGUER ANOMALY IN CENTRAL ALEXANDER ISLAND

By P. F. BUTLER

ABSTRACT. A gravity survey in central Alexander Island has revealed the existence of a significant linear Bouguer anomaly extending in a north–south direction and almost parallel to George VI Sound. It is possibly associated with a structural scheme of block faulting in the area.

THE gravity survey described here is a continuation of the British Antarctic Survey's reconnaissance gravity and magnetic investigations in the Antarctic Peninsula. It was carried out in Alexander Island during 1970–71 as part of the programme of the author and F. M. Burns. Alexander Island is the largest of the islands lying off the western coast of the Antarctic Peninsula and it is separated from the mainland by the distinctive trough feature of George VI Sound. It is about 400 km. in length and 300 km. wide at its broadest, and it is dominated by a north–south linear geomorphology.

This paper deals with survey procedure and associated errors, and discusses a linear Bouguer anomaly overlying the central nunatak area of the island (Fig. 1).

SURVEY PROCEDURE AND ANALYSIS

The survey was carried out using dog-sledge transport. Since the area had not been topographically surveyed, a plane-table map was prepared during the course of the work to fix station positions. This was linked with another map to the south for which geographical coordinates had already been established by astrofix.

The gravimeter used was a Worden Master, No. 556. It was transported in the field by elastically suspending the carrying case in a bamboo cradle attached to a Nansen sledge. Although this helped to protect the instrument from the rigours of sledge travel, large drift rates, both positive and negative, were encountered and gave rise to inaccuracies somewhat greater than in a conventional survey. Logistic considerations also reduced the frequency of return to base stations, which again decreased the overall accuracy. In an attempt to minimize these errors, a careful record was kept of both travelling and overnight static drift rates and the survey was planned to re-occupy as many of the gravity stations as possible, including those established during other surveys.

The gravimeter was returned to the United Kingdom for re-calibration immediately following the field season. The rate of change of scale factor with temperature was taken from the calibration curve supplied by the manufacturers and a linear extrapolation was made for the low temperatures experienced during the survey.

The survey was linked to the Antarctic Peninsula gravity network through the gravity stations at Stonington Island and Fossil Bluff. Absolute gravity values for these two stations had been established by Kennett (1965) as 982·5094 and 982·6641 cm. sec.$^{-2}$, respectively.

For computation of the Bouguer correction, an average rock density of 2·67 g. cm.$^{-3}$ was used, thus keeping in line with previous work in the area.

Station elevations were obtained barometrically, using Wheeler and Baromec barometers together with a continuous pressure reference taken from the meteorological record at the Fossil Bluff field station. Conditions of the International Standard Atmosphere were assumed to prevail between the base station and the field gravity stations when calculating heights from pressure differences. When the stations were at differing temperatures, the temperature of the air column between them was assumed to vary according to the normal lapse rate, and the height difference was appropriately corrected.

Parts of the survey area were up to 80 km. from the Fossil Bluff meteorological station and separated from it by a high mountain range. Atmospheric conditions tended to be localized and, although it is difficult to estimate how much the actual conditions of the air column vary from the idealized, it is calculated that there may be an absolute error of up to $\pm$35 m. in the station heights. This would produce a maximum error of $\pm$6 mgal in the Bouguer anomaly. The errors introduced through calibration and drift of the gravimeter are each less than $\pm$2·0 mgal, and that due to uncertainty of position contributes less than

$\pm$1·0 mgal. The lack of accurate topographical maps has precluded the application of terrain corrections for most stations; therefore, in the interpretation less emphasis has been placed on stations which are close to large topographical features, where terrain errors may reach an estimated maximum of 5 mgal.

Thus, except for stations close to the Lemay Range, the maximum standard error in the absolute Bouguer anomaly is estimated at little more than $\pm$5 mgal; however, the error in values between adjacent stations is considerably less, and is an estimated $\pm$1·5 mgal. Fig. 1 shows the contoured values for stations on rock, together with additional contours based on the data of Burns (1974) to the north and south.

Discussion

The geological reconnaissance of a large area of Alexander Island carried out by Bell (1974) has demonstrated that in the northern part of the island the last tectonic event was one giving rise to major north–south faults, suggesting block faulting along the length of the island approximately parallel to George VI Sound (Fig. 2). In particular, in the north-east, tightly folded and sheared (?) Carboniferous sediments forming the Douglas Range are upthrown to the east by at least 2,000 m. against a horizontally bedded, (?) late Cretaceous tuffaceous sequence in the Elgar Uplands. It is thought that another fault of opposite throw lies between the Elgar Uplands and the Lassus Mountains, delineating the Elgar Uplands as a block downthrown relative to the Douglas Range. About 100 km. to the south, Grikurov (1971) worked in the eastern Lully Foothills and found them to be composed of "pre-Mesozoic sediments", presumably comparable to the sediments of the Douglas Range. From air observations, he described the Colbert Mountains as "pyroclastics", and Bell has confirmed that they are comparable to those of the Elgar Uplands; therefore, a similar fault can be expected to separate these two sequences. A further 100 km. southward, Grikurov described the Scarlatti–Holst–Titania Nunataks as being formed of the pre-Mesozoic sediments, and again to the west, the Walton Mountains as being pyroclastic rocks.

Density measurements on rock samples from the sediments of the Douglas Range give a value of 2·75 g. cm.$^{-3}$, while an average value for tuffaceous rocks of the northern Alexander Island type (personal communication from C. M. Bell) is 2·63 g. cm.$^{-3}$, giving a density contrast of 0·12 cm.$^{-3}$. The severe terrain in the survey dictated a rock-station density insufficient to justify sophisticated interpretation of the Bouguer anomaly. However, the anomaly is sufficiently defined in the area between the Colbert Mountains and the Lully Foothills to suggest tentatively that, using a contrast of 0·12 g. cm.$^{-3}$, it could be interpreted as a fault with a considerable upthrow to the east (Grant and West, 1965). Farther eastward, within the Douglas Range, there may be an associated westerly upthrow. It seems possible, therefore, that faults related to the structure described in the north of the island may extend southward over much of the island's length, and in a direction almost parallel to that of George VI Sound.

Marine profiling has shown the existence of a sediment-filled trench along the western margin of Graham Land (Hayes and Ewing, 1970). In the north, forming a north-western front to the South Shetland Islands, the trench is a very pronounced feature and is assumed to be the site of subduction of an oceanic tectonic plate beneath the Graham Land ridge (Barker, 1970; Barker and Griffiths, 1972) though it has probably been inactive since at least 4 m. yr. ago (Barker, in press). In northern Alexander Island, the pyroclastic rocks are (?) late Cretaceous and are post-dated by the north–south faulting, which Bell (1975) believes is late Cenozoic in age. Therefore, the author suggests that as the assumed subduction zone became inactive the crust could have re-stabilized by uplift and resulted in the block faulting of Alexander Island and George VI Sound.

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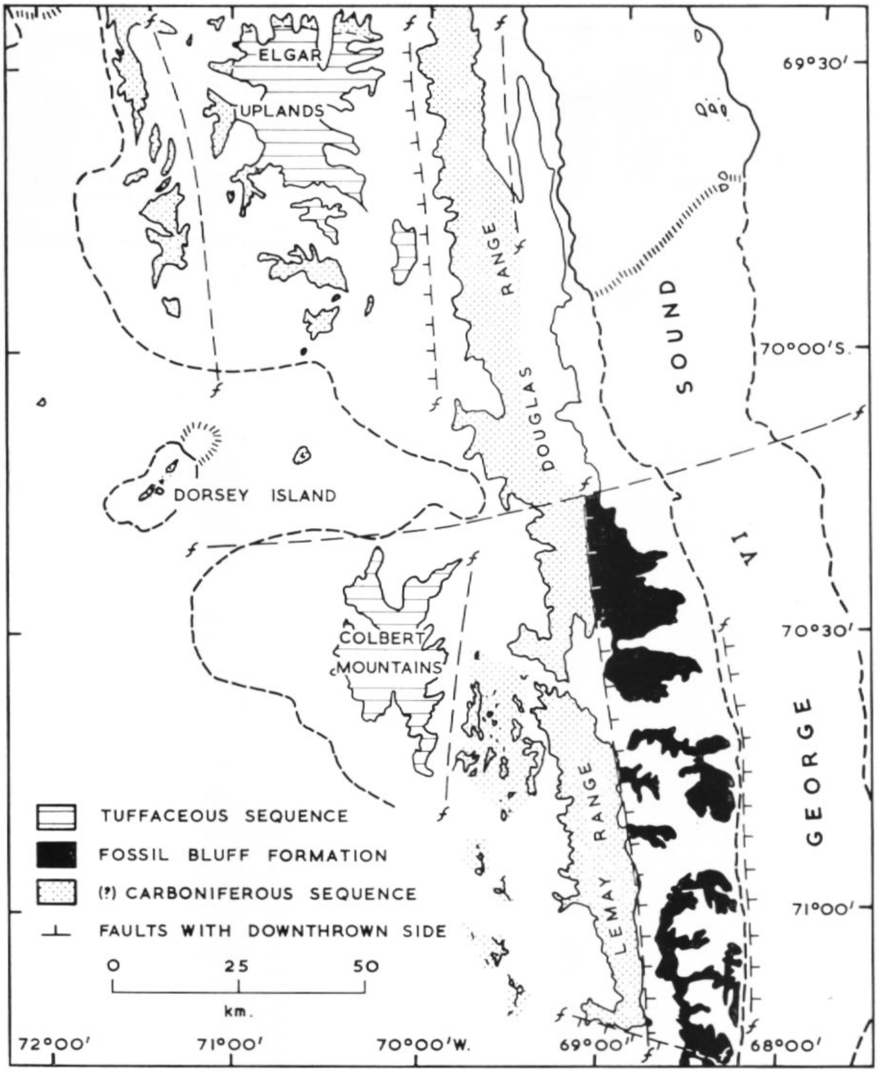

Fig. 2. Geological sketch map of central Alexander Island (after Bell, 1975).

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