BRST 667:
RRS Shackleton
Bransfield Strait
Geophysics
December 1966 - January 1967

67/19

BRST 667

Operations Report
Marine Geophysics on RRS Shackleton
1966-67 Season

The 1966-7 season was the eighth in which RRS Shackleton's Antarctic programme has included marine geophysical work and it is time that an annual rsport of the success or otherwise of the programme was instituted. We hesitate to call it a Cruise Report the accepted oceanographic term, for obvious reasons.

This season five people were specific participants in the programme. M.J. *Burns* and R. Rainbow of the British Antarctic Survey have spent the entire season aboard, and Birmingham University personnel spending two to three months aboard and flying out and back were P.F. Barker, H.A.D. Cameron and P.K. Earrington.

The proposed programme involved land gravity work, marine magnetic and bathymetric survey, single ship sonobuoy seismic -work, two ship seismic work with HMS Protector and the field testing of a seismic refection profiler built within the Geophysics Department at Birmingham. A large amount of magnetic and sonobuoy seismic work was completed but the 2-ship work was disappointing and the seismic profiler was not completely successful. Ice conditions were better than 1965-6.

1. Gravity Measurements.

The new Worden Gravity Meter No. 743 belonging to B.A.S was flown to meet the ship in Punta Arenas Chile, in early January with Barker and Harrington. The mater was read in Punta Arenas and at all bases, to strengthen the primary grid of stations established in previous seasons, and the links with tha world network through S. America. Only one new station was occupied at Larsen Harbour at the western end of the S. Orkney Is. The meter remained aboard when the Birmingham party left in March and was operated by Burns and Rainbow in the latter part of the season.

2. Magnetic and Bathymetric Measurements

The time Allocated to magnetic survey in the Ship's programme was perhaps rather large in view of the previous season's experience with the magnetometer, and the fact that its potential operators were in their first season with the ship, The magnetometer, a proton precession instrument built by Cambridge Consultants Ltd. and a replacement for an earlier machine which had been on semi-permanent loan from the Department of Geodesy and Geophysics at Cambridge University, had not produced a single good reading in the previous season. It was thought that the faults had been corrected during the summer of 1966 but a true laboratory evaluation at Birmingham had proved difficult on account of the high level of electromagnetic noise there (Droitwich, the Synchroton etc). Neither Burns nor Rainbow had seen the instrument working properly at sea

When routine signals from RRS Shackleton suggested that the magnetometer was again not functioning Cameron flaw down to meet the ship in Punta Arenas in December to repair it and remained until March.

With the magnetometer functioning properly an extremely profitable season's survey was completed A track chart is shown as Fig. 1 and shows as solid lines all ships tracks on which magnetic and bathymetric measurements were made. Dashed lines represent tracks with bathymetric data only, and the dotted lines in Bransfield Strait are where magnetic and bathymetric measurements were made in 1964-5.

(a) Bransfield Strait The principal survey was that in the Bransfisld Strait, between Deception I. and Elephant and Clarence Is. Total mileage steamed was 1750 n-miles at a track spacing of 3-4 miles The survey covered the extremely interesting 1,000 fathom trough running parellel to the S. Shetland Is. and the magnetic anomaly associated with the southern edge of the material underlying the main S. Shetland island group. Although it is not as obvious, it is hoped that the data when fully reduced will provide important information on the shape of the boundary between this group and that of Elephant and Clarence Is. whose geological structure is essentially different, being more like that of the S. Orknay Is.

(b) S. Orkney Is. Shelf A total of 1340 n-miles of data was obtained in this area on lines radiating from the islands and extending beyond the edge of the continental shelf. The lines provide information on the extent of the shelf to the east of the islands in an area about which little was known hitherto. The extent of a large west-east striking magnetic anomaly at about 61°30'S has also now been mapped; the area to the south of it is magnetically more disturbed and it represents a major structural change. This survey has also helped delimit the extent of the magnetic anomaly which is sometimes associated with the edge of the continental shelf around the S. Orkney Is.

(c) On-Passage Measurements About 7,000 miles of magnetic and bathymetric data was obtained while the ship was on passage between bases and ports of call. As in the past, it has bean possible to deviate from the shortest route in order to pass over areas of geophysical interest. In particular 2 days were spent in further examination of a feature in the middle of Drake Passage which shows many of the characteristics of an ancient mid-ocean ridge.

3. 2-Dship Seismic Refraction Measurements

The 2-ship seismic programme is oparatad in collaboration with H.M.S. Protector which fires the charges while RRS Shackle-ton acts as recording ship. This season's scheduled programme involved the shooting of six reversed lines, on tht S. Orkney Is. Shelf, in the trench to the north and on ths ridge to the west, in a period of 12 days. In the event this time was cut to five days.

In these five days three lines were attomptad. These lines are shown in figure 2 as dashed lines. The weather was poor throughout and the quiet listening conditions essential for 2-ship seismic work present on only one day, when the most southerly line was shot. Data on the other two lines were of rather poor quality and the lines should

really be re-shot. The officers and men of HMS Protector, particular the net-deck party deserve all credit for successful firing in conditions in which, had not the time available been so short, both ships would have been hove to waiting for better weather. The successful line was situated a little way south of the onset of the west-east magnetic anomaly mentioned in section 2b above. Preliminary results indicate a body of velocity 7km/sec at the shallow depth of 2-3 miles, which tallies with the magnets

4. Sonobuoy Seismic Refraction Measurements

Much difficulty was experienced in making the sonobuoys work at the baginning of the season. The buoys had been soaked and the cable destroyed in the forward hold of RRS Shackleton in November 1965. The replacement hydrophons cable was redesigned for greater flexiblility but thereby lost the moderate amount of screening that it had. The carrier frequency being picked up at the hydrophone input had the effect of reducing the sensitivity by 30-40 db. A makeshift external screen reduced this problem but the successful operation was further hindered by interference at carrier wave (27 Mc/s frequencies from S. American transmissions which reached the S. Orkney Is. area by ionospheric paths. This phenomenon reduced the range of the buoys to 6-10 miles so that the information likely to be obtained would be confined to the upper, sedimentary layers. The sonobuoy work was therefore performed entirely on the S. Orkney Is. shelf in shallow waters. In most cases the lines (shown solid in fig 2) were shot split from a single solobuoy with a high density of shots at the shorter ranges. Although only 2 tons of exlosives were ussd out of 7½ tons carried, the higher charge sizes were not needed because of the range limitations and in fact 260 shots were fired in the equivalent of 10 reversed profiles a greater number than in any other season. Two firing cables were lost overboard through breaks, the second one on the last shot of the season. A reasonable identification of the geological formations exposed ashore with some of the seismic velocities has been achieved and these velocitie s can be followed well to ths south of the islands. Preliminary qualitative results indicate the presence of a sedimentary basin to the south of tha S. Orknzy Is. containing sediments of cretaceous and younger ages.

5. The Seismic Reflection Profiler

This instrument, having a modified Mufax weather chart recorder and an "Air Gun" compressed air source, had been built at Birmingham during the summer of 1966 and was tested for the first time around the S. Orkney Is. this year. The air compressor, which takes 20 cu f. of air per minute to 3,000 p.s .i. performed properly, although some o. the valves in the system and an automatic *unloader gave* trouble. The air gun itself worked satisfactorily once the air supply had been limited by a small orifice to ensure the operation of a vent relief valve. It would discharge every 13 seconds or so at 2,500 psi and from measurements on the depth and the bubble pulse frequency seamed equivalent to about 1/5 lb of TNT. The sub-bottom reflections of this explosion are detected by an array of hydrophonss towed in an

oil-filled hose 1,000 ft or so astern of the ship. This hose was made up on board, and unfortunately never functionad properly mainly because of leakage of salt water into compartments with exposed electrical connections. besides this, however the snake was thought Wholly to big for successful shipboard handling and its basic re-design is probable. The satisfactory operation of the remainder of the instrument was checked by towing a single hydrophone such as is used in sonobuoy and 2-ship refraction work, although its lack of streamlining and non-directional nature reduced tha signal to noise ratio. Also, a day was Spent over the S. Orkneys trench with the air gun suspended beneath an oil drum and tha ship drifting with a hydrophone streamed as when receiving 2-ship seismic signals. sediment penetration of up to 1 mile was achieved despite rough weather but the interpretation of the records is complicated by the presence of side echoes owing to the non-directional nature of the hydrophona.

Acknowledgements

Thanks are due to Sir Vivian Fuchs, Director of the British Antarctic Survey for the extansiva facilities provided and to Captain D.H. Turnbull of RRS Shackleton for his unfailing co-operation in what were at times trying circumstances. Ready help was forthcoming from all offficers, crew and B.A.S. personnel aboard RRS Shackleton when needed and it would be invidious to mention names. Thanks are due also to Captain Sandford and the officers and man of HMS Protector for their co-op eration during the 2-ship seismic work.

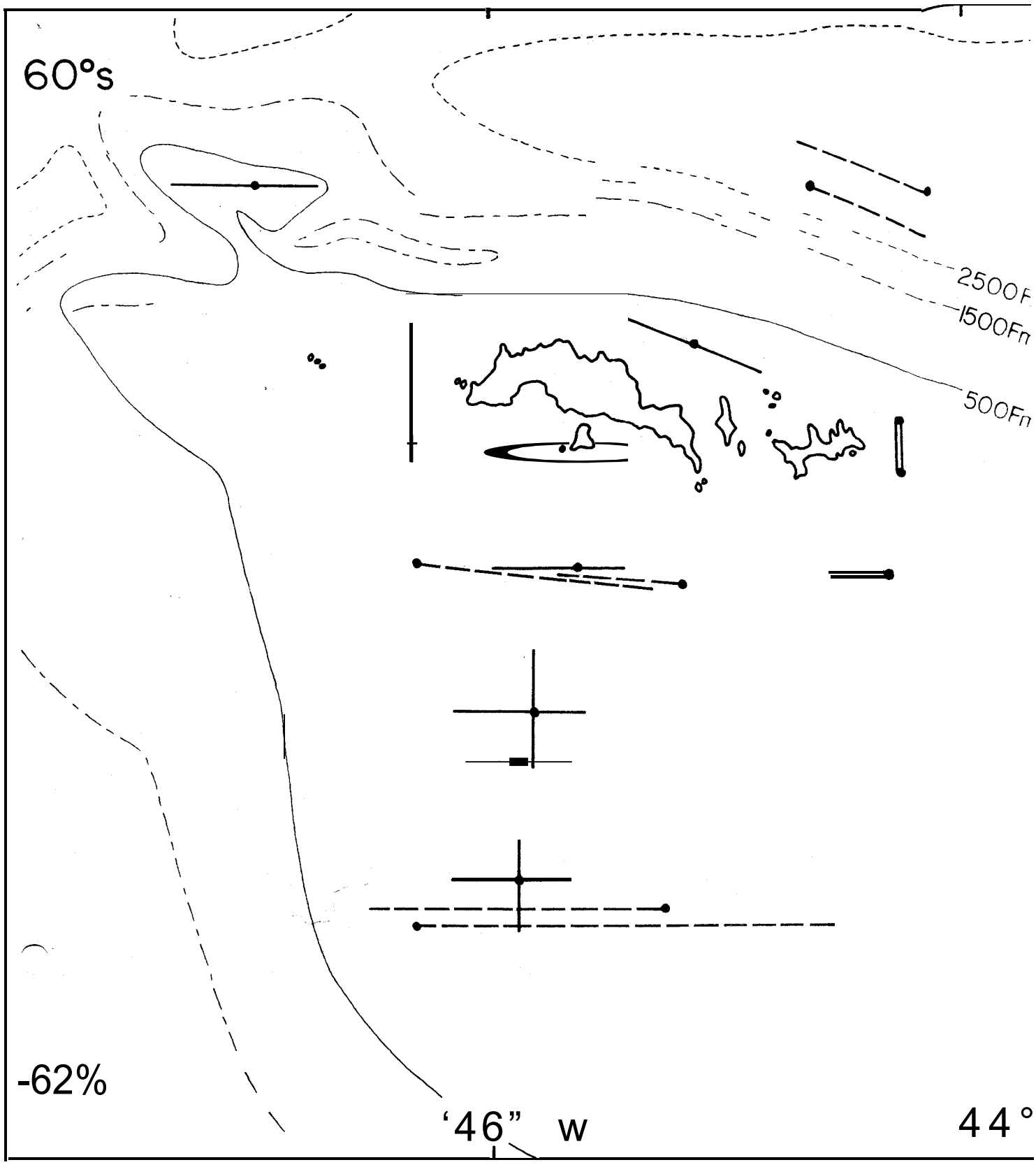

Fig.2 Seismic Lines 1966-7

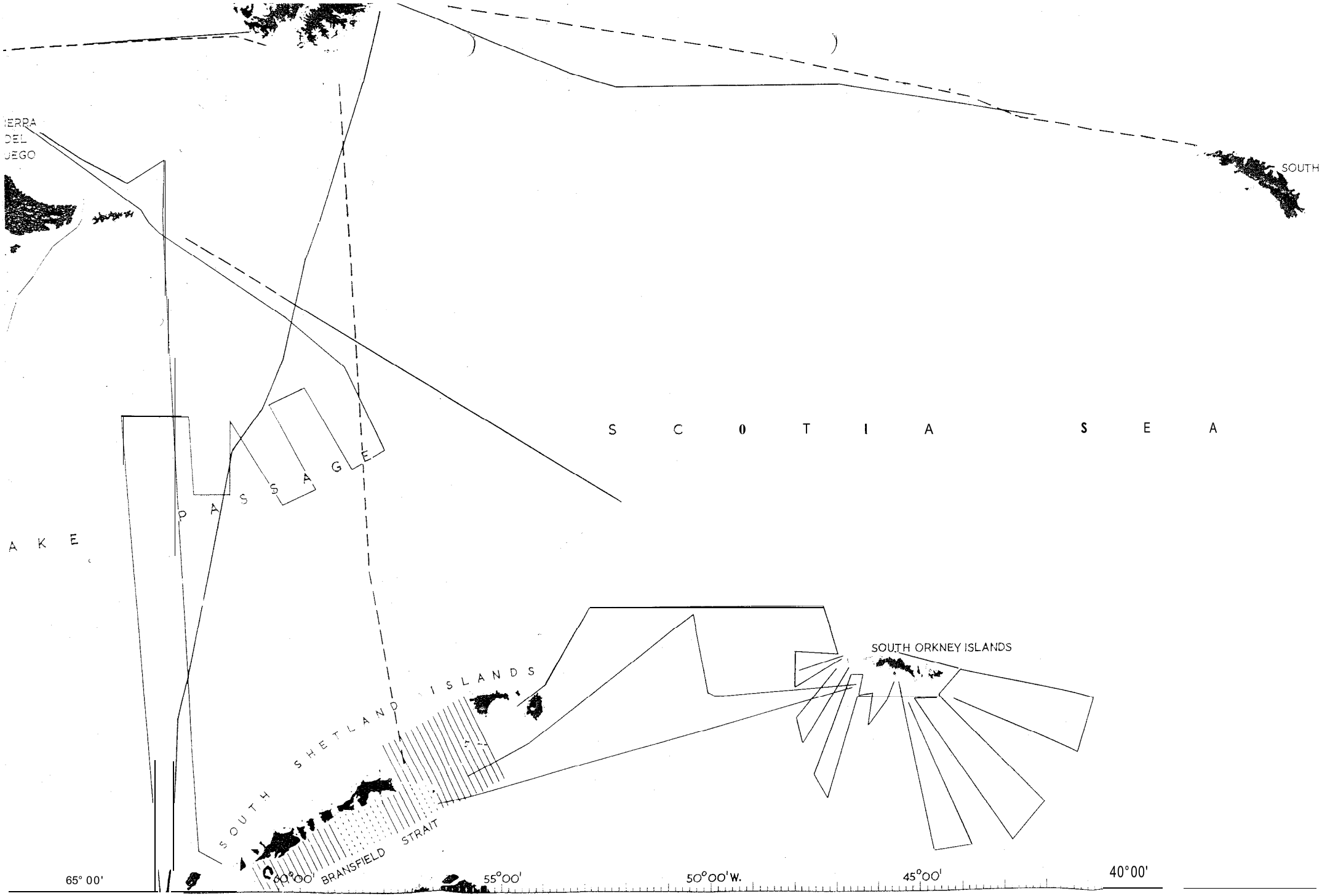

Fig. 1 Magnetics and Bathymetry 1966-7