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Seismic Stratigraphy and Heat Flow of Powell Basin

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During February and March 1993, seismic reflection, magnetic and gravity data [1490 n.m.], heat flow and piston cores were collected by *RVIB Nathaniel B. Palmer* in Powell Basin to the east of the tip of the Antarctic Peninsula (Fig. 1). As had been found in the past (King and Barker, 1988), there are no identifiable marine magnetic anomalies in Powell Basin. The observed anomalies are very low amplitude and not lineated in any discernible direction. The gravity measured aboard ship agress extremely well with the gravity derived from Geosat satellite altimetry data (Sandwell, 1992).

For the seismic reflection work, two experimental hydrophone arrays were provided by Innovative Transducers Inc. (ITI) of Dallas, Texas. Since the ITI streamer was short (400m) in relation to the depth of Powell Basin and the sub-bottom reflectors (3 - 5 km), producing insignificant moveout, the data were recorded single-channel. From two to four, 2.46 L [150 in^3] GI (Generator-Injector) guns manufactured by Seismic Systems, Inc. of Houston were used as a seismic source pressured at 12.4 Megapascals [1800 psi]. With three or more guns firing, a moderate resolution (~15 m) image of Powell Basin sediments, up-to-2 sec thick, was obtained. With four guns operational, a crisp basement reflector was seen while with three guns only a vague basement reflector could be seen. Unfortunately, problems with the towing apparatus for the guns resulted in only two guns being operational about 40% of the time. With only two guns operational, effective penetration was limited to about one second.

Powell Basin is relatively flat, with a few large seamounts or ridges of up to one second of relief. Evidence of a buried spreading center is seen in a few lines. There are anomalous seamount-like features near the western margin of the South Orkney block. A transform fault seems to parallel the northwestern margin of the basin. Some structural deformation may also be seen in crossings of the basin margins, indicative of slumping of sediment near the base of the slope. Powell Basin is distant from significant sources of terrigenous sediment at present. Deposits on the basin floor are dominated by hemipelagic and pelagic sediments with occasional interruptions of thin-bedded, probably mud-dominated turbidites. Minor terrigenous material is undoubtedly provided to the basin by melting icebergs. A number of point diffractors possibly representing large glacial erratics were noted. The presence of turbidites is mainly attested to by the wedgelike thickening of individual stratal packages near the eastern and western basin margins. Toward the center of the basin, the constant thickness of most stratigraphic

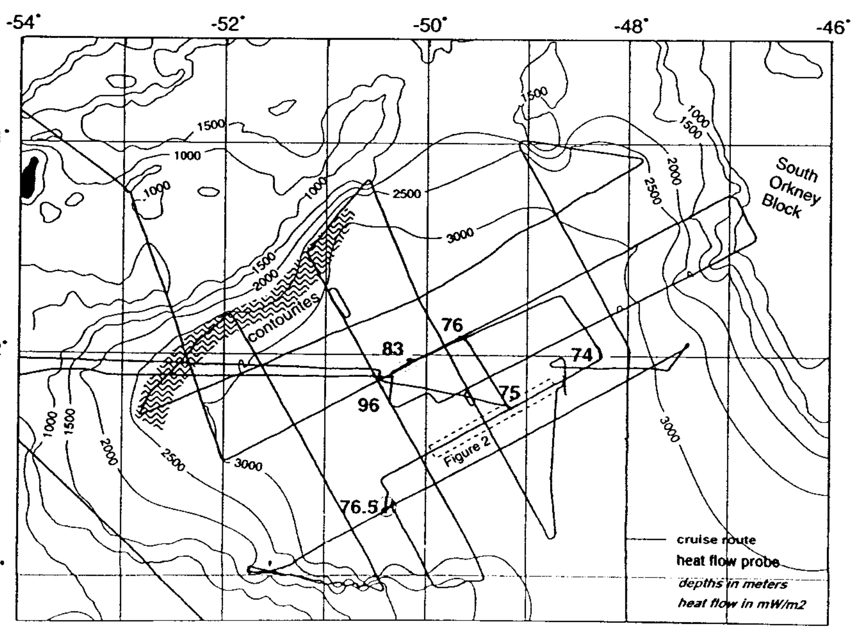

Fig. 1 - Track chart of *RVIB Nathaniel B. Palmer* during the February-March 1993 cruise NBP93-1. Depth contours are shown as light weight lines every 500 m. Additional depth contours taken from GEBCO digital data. Heat flow values are shown in milli-watts per meter^2. Clarence Island is on the northwest corner of the map. Region of contourites is shown by a wavy pattern. The seismic line shown in figure 2 is indicated by the dashed box.

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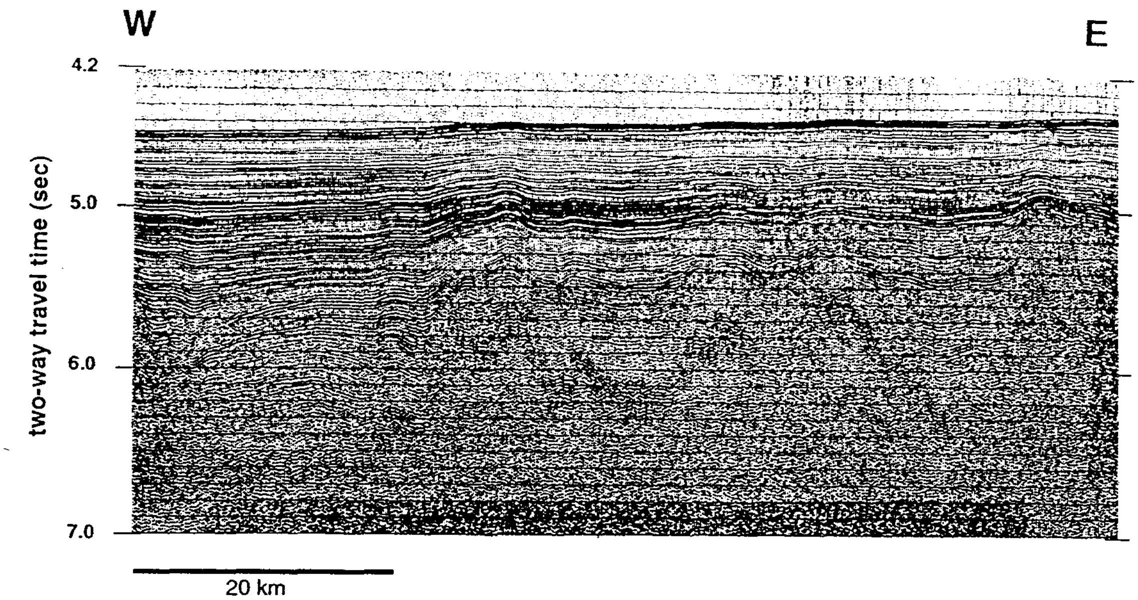

Fig. 2 - Seismic profile as indicated in figure 1. Vertical scale is in two-way travel time in seconds. Basement is seen as a flat reflector at 6.5 s near the eastern end of the profile. Particularly bright reflectors are seen between 5.0 to 5.2 s in the center of the figure.

horizons, even over structures with moderate relief, points to the dominance of the blanket-like deposition of pelagic sediments. At the northern and southern margins of the basin, the parallel strata which dominate the basin center continue right up to and abut the steep walls of the fault-bounded basin margin.

The seismic facies of the basin fill are dominantly continuous parallel, variable amplitude reflectors (Fig. 2). Some reflectors can traced over very long distances, upwards of 150 km or more. There are very high-amplitude reflectors in the 0.6-1.0 sec range below the seafloor. On a number of lines, particularly those near the margin of the South Orkney microcontinent, reflector-free or chaotic intervals up to 100 ms thick are observed. These appear to be large debris flows and are not considered to be evidence of transitional crust. Perhaps the most interesting depositional features are found in the northwestern corner of the basin. These are interpreted to be contourites, the depositional product of themohaline bottom currents. On the seismic sections, these deposits appear similar to large climbing ripples. They appear to be migrating, nonerosional bedforms of about two kilometers in wavelength and tens of meters in amplitude. The contourites are undoubtedly produced by a gyre that is an offshoot of the clockwise Weddell Sea gyre. Between the contourites and the steep, northeast margin of the Powell Basin is what appears to be base of slope slumping that may be active.

Seven multi-penetration heat flow measurements were taken in Powell Basin. The results are shown on figure 1 and are listed in mW/m^2. The values are remarkably consistent and the individual values (3 to 5, spaced 1 km apart) for each station, were nearly identical. The highest value, 96 mW/m^2, nearly overlies a basement high that may be the extinct spreading center. An age versus heat flow calculation, assuming a background heat flow of 76 mW/m^2, yields an Early Oligocene age. A sedimentation correction to the heat flow might produce a slightly older age of latest Eocene. When both the observed heat flow and the sediment thickness of Powell Basin is compared with that of Jane Basin (Lawver et al., 1991) directly to the east of the South Orkney microcontinent, Powell Basin appears to be about 10 m.y. older. An age of earliest Oligocene or Late Eocene is in keeping with the both the observed heat flow and sediment thickness of the basin.

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