Marine geology and geophysics

Heat flow in the east Scotia Sea

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One and one-half days of station time were allotted for heat-flow measurements and gravity coring on the Vulcan-5 cruise aboard R/V *Melville* during December 1980. We hope eventually to collect sufficient heat-flow values in the eastern Scotia Sea to be able to analyze the thermal structure of a presently active back-arc basin. Barker (1972) first correlated magnetic anomalies in this area, and the east Scotia Sea remains the only presently active back-arc basin where correlated magnetic anomalies unquestionably are present.

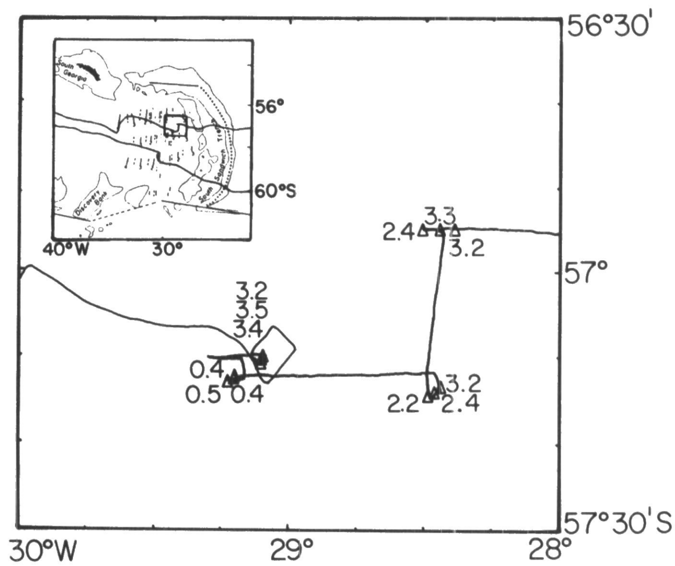
A previous cruise to this area (Zlotnicki et al. 1980) had difficulty obtaining usable heat-flow data in the central Scotia Sea, primarily because of difficult sea bottom conditions. The next cruise, aboard R/V *Atlantis II* in March 1980, attempted heat-flow measurements to the west of the active spreading center in the east Scotia Sea. Only three heat-flow measurements were successful on that cruise because of equipment problems and a general lack of adequate sediment cover. All of the measurements indicated low to extremely low heat flow [10–70 milliwatts per square meter or 0.25–1.80 microcalories per square centimeter-second (heat flow unit)] (Loy et al. in preparation).

On the Vulcan-5 cruise we wanted to attempt heat-flow measurements to the east of the presently active ridge since seismic reflection data from previous cruises indicated a reasonable sediment cover. Since the *Atlantis II* cruise had collected three heat-flow values within 2 kilometers of each other on what was identified as anomaly 2 (2-million-year-old crust), we took our first group of three stations near what might be the eastern half of anomaly 2 (see figure). From that station we moved west, although we did not move as far as we had hoped to because of opposing wind and drift. The third group of three stations was approximately 30 kilometers to the east, and the last group was 20 kilometers north of the third group.

On the R/V *Melville* cruise we used a 4-meter-long Bullard-type heat-flow probe with a new Von Herzen digital recorder in it. The Bullard probe was fitted with a pinger telemetry system that transmitted the digitally recorded heat-flow data so that they could be recorded on the 12-kilohertz receiver on board the ship. The heat-flow instrument also recorded internally on a high-density cassette tape. Because power drain was low, the instrument was able to operate for 23 hours without interruption for battery recharging, even though it was telemetering data to the 12-kilohertz recorder on board the ship.

Penetrations for the first two groups of stations were 3 meters or more, indicating that an excellent survey can be done in the eastern half of the east Scotia Sea. The last group of stations, which are closest to the active volcanic arc, had reduced penetration but still yielded a good heat-flow value at each attempt.

Heat-flow values are a product of the measured thermal gradient obtained from the resistances measured by the thermistors spaced along the probe and the thermal conductivities measured on gravity cores. Gravity cores were successful at



Location map of heat-flow measurements taken on Vulcan-5 cruise aboard R/V *Melville* in the east Scotia Sea. Values shown are in heat-flow units (HFU). Inset map taken from Hill and Barker (1980) shows R/V *Melville* tracks through east Scotia Sea.

Heat-flow stations taken on Vulcan-5 expedition, R/V *Melville*

Station number	Position of station[a] °S Latitude	°W Longitude	Depth (corrected meters)	Penetration (meters)	ΔT (°C per meter)	Heat flow[b] HFU	(mW/m²)
3	57°11.0'	29°06.5'	3,357	3.6	0.19	3.2	(134)
4	57°11.3'	29°06.3'	3,353	3.2	0.20	3.4	(143)
5	57°11.0'	29°06.2'	3,353	3.1	0.20	3.5	(145)
7	57°12.7'	29°12.2'	3,361	>4?	0.03	0.4	(17)
8	57°13.0'	29°12.2'	3,361	4+	0.03	0.4	(18)
9	57°13.5'	29°13.5'	3,363	~4	0.03	0.5	(23)
11	57°13'	28°28'	3,330	2.3	0.19	3.2	(133)
12	57°14.9'	28°28.2'	3,334	2.1	0.14	2.4	(99)
13	57°14.7'	28°29.1'	3,334	2.0	0.13	2.2	(94)
15	56°55.1'	28°26.4'	3,277	1.1	0.20	3.3	(139)
16	56°55'	28°24'	3,290	1.1	0.19	3.2	(134)
17	56°55.0'	28°30.9'	3,340	1.1	0.14	2.4	(102)

[a]Positions are given to the nearest tenth of a degree for stations that were in progress while a satellite fix occurred, and to the nearest degree if no satellite fix occurred between stopping the ship and getting underway.

[b]Heat-flow calculations assumed a thermal conductivity of 0.71 watt per degree Celsius-meter. HFU = heat-flow unit, 1 microcalorie per square centimeter-second; mW/m² = milliwatt per square meter.

only two out of four attempts on this cruise. The thermal conductivities were extremely uniform and were similar to those found on the *Atlantis II* cruise in March 1980. For the preliminary heat-flow calculations listed in the table, an assumed thermal conductivity of 0.71 watt per degree Celsius-meter ($1.7 \cdot 10^{-3}$ calorie per centimeter-second) was used. The digital tape reader had some problems, so all of the thermal gradients have been calculated using the 12-kilohertz record. When the high-density tape reader is fully functional (it is still in final development stages), the thermal gradients will be recalculated; it is unlikely they will change significantly, but even so the values listed in the table should be considered preliminary.

The initial results are extremely encouraging with regard to the thermal cooling of oceanic crust created above a descending slab. Data from stations 3 through 9 show the expected large variation in closely spaced stations near a ridge, which is indicative of hydrothermal convection in the oceanic crust. The values from stations 11 through 17 show a more consistent pattern indicative of a more uniform insulating sediment cover which should minimize large variations and give a more uniform value. Enough additional measurements should show a coherent pattern that can be compared to heat-flow patterns at mid-ocean ridges.

We thank Captain Arsenault and the crew of R/V *Melville*, whose willing assistance and cheerful dispositions made this an extremely successful cruise. D. Goldstein and G. Pelletier finished the new digital heat-flow recorder 2 minutes before it was flown to Valparaiso, Chile.

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Pliocene/Pleistocene erosional unconformity of the western South Georgia Basin

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Major unconformities in the late Cenozoic record spanning the interval from middle Pliocene through middle to late Pleistocene time have been detected in various areas of the southern ocean (Ciesielski et al. in press; Fillon 1975; Kennett and Watkins 1976; Ledbetter and Ciesielski in press; Watkins and Kennett 1972; Weaver and McCollum 1974). Causes of these hiatuses appear to be related to climatic variations which have influenced bottom currents in the southern ocean since late Cenozoic time (Ciesielski and Wise 1977; Kennett and Watkins 1976; Ledbetter and Ciesielski in press).

In his analysis of the diatom stratigraphy of Deep Sea Drilling Project hole 328, Gombos (1977) reported evidence of a hiatus spanning the Plio/Pleistocene boundary in the western section of the South Georgia Basin, just east of the Falkland Plateau off the tip of South America (51°S 38°W). He states,