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3. Data Report: Measurements of Radiogenic Heat Production on Basement Samples from Sites 1067 and 1068[1]

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ABSTRACT

Mean values of radiogenic heat production are derived from measurements of radioelements on the following rock types: amphibolite (0.358 ± 0.118 μW/m³) and tonalite gneiss (0.802 ± 0.039 μW/m³) at Site 1067 and serpentinized peridotite (0.0108 ± 0.0003 μW/m³) at Site 1068. The results for serpentinized peridotite and amphibolite are consistent with previous measurements on samples from Sites 897 and 900. These results suggest that the thin continental crust in this region would contribute very little to the conductive heat flow.

INTRODUCTION

Previous heat flow measurements have suggested an increase of 16 ± 9 mW/m² in the vicinity of Ocean Drilling Program (ODP) Leg 149 Site 900 (Louden and Mareschal, 1996) and in the region immediately landward along profile *Lusigal* 12 (Louden et al., 1997) relative to values farther seaward. One possibility is that this increase could indicate enhanced values of radiogenic heating within the basement rocks. However, measurements of radioelements on metagabbro samples from Site 900 (Louden and Mareschal, 1996) were too low to explain this increase. To investigate whether the Site 900 samples were indeed fully representative of the upper crust in this region, new measurements of

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radiogenic heat production from near Site 900 were made on additional samples cored at Sites 1067 and 1068 during Leg 173.

RESULTS

Using the shipboard core descriptions (Whitmarsh, Beslier, Wallace, et al., 1998), the authors identified 18 core locations that appeared to be typical of the different principal types of basement rock encountered at Sites 1067 and 1068. Subsequently, 10- to 20-cm^3 rock samples were taken by the ODP core curator in Bremen, Germany, and mailed to the authors. The rocks were unusually homogeneous and, with few exceptions, contained less then 10% veins of serpentine (lizardite? and chrysotile?), brucite, calcite, chlorite, epidote, Fe oxyhydroxide, quartz + plagioclase, sulfides, and talc. Only Sample 173-1068A-26R-1 (Piece 3G), which had the lowest heat output, included a large vein.

Concentrations of radioelements and the resulting values of radiogenic heat production given in Table T1 were determined following methods described by Mareschal et al. (1989). Samples were crushed to a fine powder and neutron activated. After irradiation, the concentrations of U, Th, and K were measured by gamma-ray spectrometry. For some samples, the K concentration was also measured using a standard X-ray spectrometry technique. The overall reproducibility was verified by measuring different aliquots of the same sample and was better than 5%. The undifferentiated amphibolite (nine samples) and tonalite gneiss (three samples) from Site 1067 have mean heat productions of 0.358 ± 0.118 (σ = 0.355) and 0.802 ± 0.039 $\mu W/m^3$ (σ = 0.068), respectively, whereas the serpentinized peridotite (six samples) from Site 1068 have a mean of 0.0108 ± 0.0003 $\mu W/m^3$ (σ = 0.0007). These results are similar to the amphibolite (0.213 ± 0.086 $\mu W/m^3$) and serpentinite (<0.01 $\mu W/m^3$) samples previously measured from Leg 149 at Sites 900 and 897, while the tonalite samples have generally lower values than the continental granodiorite and sandstone samples (1.66 ± 0.093 $\mu W/m^3$) dredged from Galicia Bank (Louden and Mareschal, 1996).

T1. Measurements of radiogenic heat production on samples of acoustic basement, p. 4.

CONCLUSIONS

Wide-angle seismic measurements made along an east-west profile across the basement high sampled during Legs 149 and 173 at Sites 900, 1067 and 1068 and the region immediately landward, ~8 km north of the sites, indicate crust of continental affinity that is ~2–3 km thick above a serpentinized upper mantle (Chian et al., 1999). Given such a reduced crustal thickness and the values of radiogenic heat production reported here and at Site 900, only ~2–3 mW/m^2 (15%) of the increased heat flow can be attributed to enhanced radiogenic heating if the averages from the tonalite samples are representative of this crust, with the amount decreasing if the crust is a mixture of tonalite and metagabbro.

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Table T1. Measurements of radiogenic heat production on samples of acoustic basement, Sites 1067 and 1068.

Core, section, interval (cm)	Piece	U (ppm)	Th (ppm)	K (%)	Heat output ($\mu W/m^3$)	Lithology from shipboard core description
173-1067A-						
14R-1, 49-53	6A	0.360	0.980	0.458	0.1979	Foliated amphibolite; 1%-5% veins
14R-1, 84-86	7	0.977	7.198	0.216	0.7769	Tonalite gneiss; 1% veins
15R-1, 24-26	5	0.801	12.675	0.542	1.1404	Foliated amphibolite; 1%-5% veins
15R-1, 62-65	11	0.620	9.879	0.318	0.8797	Tonalite gneiss; 1% veins
16R-1, 14-19	4	1.590	4.719	0.050	0.7501	Tonalite gneiss; 1% veins
16R-2, 33-36	1C	0.364	1.070	0.450	0.2046	Foliated amphibolite; 5% veins
19R-3, 64-68	7	0.258	0.916	0.435	0.1650	Amphibolite 65%-anorthosite 25% breccia; 20% veins
20R-1, 54-57	4	0.160	1.030	0.268	0.1346	Amphibolite 75%-anorthosite 15% breccia; 10% veins
22R-2, 114-117	6	0.565	8.890	0.072	0.7771	Weakly foliated amphibolite 60%-100%, felspathic material 5%-20%
23R-2, 55-57	1B	0.355	1.613	0.267	0.2264	Amphibolite (metagabbro) 85%, anorthosite 10%; 3% veins
23R-4, 18-20	1	0.349	1.868	0.376	0.2511	Amphibolite (metagabbro) 85%, anorthosite 10%; 4% veins
23R-5, 27-30	3	0.266	0.265	0.493	0.1258	Amphibolite (metagabbro) 85%, anorthosite 10%
21R-2, 12-15	1	0.030	0.030	0.012	0.0109	Serpentinized peridotite; changed color
173-1068A-						
23R-2, 7-10	1	0.030	0.030	0.007	0.0105	Serpentinized peridotite; 2% veins
24R-2, 58-62	4A	0.030	0.030	0.028	0.0121	Serpentinized peridotite; 1% veins
26R-1, 72-77	3G	0.030	0.030	0.001	0.0100	Serpentinized peridotite; 5%-8% veins; sampled large vein
26R-1, 112-115	4B	0.030	0.030	0.007	0.0105	Serpentinized peridotite; 5%-8% veins
29R-3, 60-63	1C	0.030	0.030	0.013	0.0109	Serpentinized peridotite; 1%-5% veins