19. INTERSTITIAL WATER STUDIES, LEG 73[1]

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ABSTRACT

Interstitial waters obtained from a transect east from the Mid-Atlantic Ridge on progressively older oceanic crust (Sites 519–522) indicate a general absence of concentration gradients in calcium and magnesium. The lack of gradients indicates little or no exchange of these seawater constituents with the underlying basalts. Only at Site 520, where there are increases in calcium and decreases in magnesium, do reactions in the silica-enriched zone appear to have affected interstitial water composition. At Site 524, on the eastern flank of the Walvis Ridge, large changes in calcium and magnesium occur as a result of reactions involving the volcanic materials that are both dispersed in the sediment column and present in the underlying basalts.

INTRODUCTION

During Leg 73 of the Deep Sea Drilling Project a number of sites in a transect east of the Mid-Atlantic Ridge were drilled on oceanic crust of progressively greater age (Fig. 1). In addition, one site was drilled on the eastern flank of the Walvis Ridge (Site 524, Fig. 1). Shipboard data on the interstitial water chemistry of all sites suggested no significant change in chemical composition from seawater except for small changes in Site 520, which was drilled in a sediment pond characterized by fairly high sedimentation rates (~50 m/m.y.), and large changes at Site 524. At the latter site sampling density was rather low, however, and we decided that further analysis of the chemical composition of the interstitial waters recovered during this leg would be restricted to the waters collected at Site 520 only.

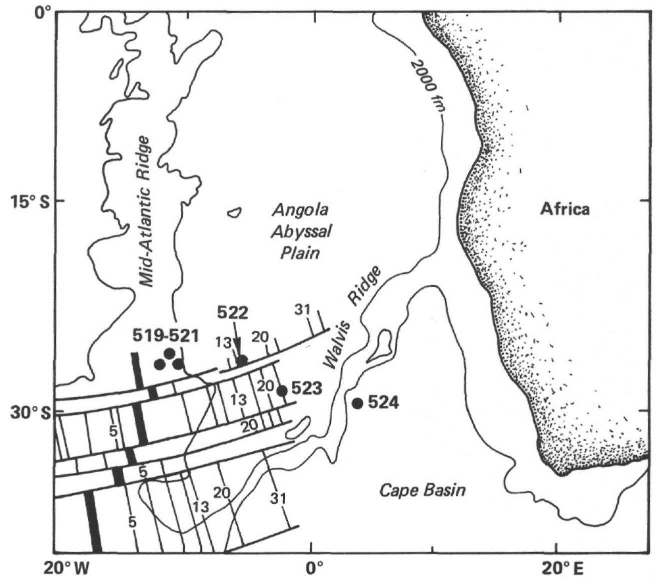

Figure 1. Map of drilling area, Leg 73.

RESULTS AND DISCUSSION

The data, including the shipboard measurements of pH, alkalinity, chloride, salinity, calcium, and magnesium, are presented in Table 1 and Figures 2 and 3. Measurements were carried out by using the methods described by Gieskes (1974), Gieskes and Lawrence (1976), and Gieskes and Johnson (1981).

Sites 519 to 523

At Sites 519 to 523, significant gradients in the concentration of calcium and magnesium are absent except at Site 520 and possibly Site 519. Similarly, Manheim et al. (1970) did not find significant gradients in sites drilled during a transect across the Mid-Atlantic Ridge at ~28°S. Recent rates of sedimentation in all these holes, except in Site 519 (~22 m/m.y.) and 520 (~50 m/m.y.) have been much less than 10 m/m.y., so the communication length (Gieskes, 1975) for diffusion is well in excess of the depth to basement—except at Site 520. The absence of concentration gradients can thus be understood in terms of either the absence of any reaction in the sediment column or the absence of a significant source of calcium or sink for magnesium in the underlying basement. The presence of such sources and sinks has often been used to explain concentration gradients in calcium and magnesium, as well as in $\delta^{18}O$ (Lawrence and Gieskes, 1981; McDuff, 1981). If a source for Ca existed in the underlying basalts, the flux would be too small to lead to a noticeable change in the overlying sedimentary pore waters.

The data obtained in Site 520 do show slight increases in dissolved calcium and depletions in magnesium, as well as evidence of sulfate reduction (decreases in sulfate and small increases in ammonia). A maximum in strontium is observed as a result of carbonate recrystallization reactions; a maximum in lithium also occurs in the siliceous zone. No clear basement signal is apparent for either calcium or magnesium. The observed increases in calcium and decreases in magnesium appear to be related to reactions that occur in the siliceous sediment of Unit 2 of the sediment column.

[1] Hsü, K. J., LaBrecque, J. L., et al., *Init. Repts. DSDP,* 73: Washington (U.S. Govt. Printing Office). This work was supported in part by NSF Grant OCE-8023966.

Table 1. Interstitial water chemistry, Leg 73.

Core-Section (interval in cm)	Sub-bottom depth (m)	pH	Alkalinity (meq-dm^{-3})	S (g/kg)	Ca (mM)	Mg (mM)	Cl (g/kg)	Sr (μM)	Li (μM)	K (mM)	SO_4 (mM)	NH_4 (μM)	Si (μM)
Hole 519													
7-2, 140–150	27–32	7.4	2.95	37.4	10.6	49.9	19.6	—	—	—	—	—	—
17-2, 133–150	66–71	7.4	2.96	35.5	10.8	53.3	20.1	—	—	—	—	—	—
27-2, 112–122	110–115	7.4	3.07	35.5	11.5	51.8	20.1	—	—	—	—	—	—
Hole 520													
3-6, 140–150	108–117	7.43	3.21	35.4	12.5	49.5	19.75	517.3	36.5	10.4	27.0	153.0	407.7
9-4, 140–150	256–266	7.61	5.29	35.2	14.2	45.2	19.17	439.6	43.7	11.2	24.6	229.3	824.5
12-1, 140–150	285–305	7.67	5.28	35.2	15.0	45.7	19.07	368.6	45.5	9.6	25.0	240.3	722.9
16-4, 140–150	313–323	7.70	5.38	35.2	14.9	46.2	19.41	368.6	45.5	9.6	25.0	240.3	722.9
21-2, 94–104	346–352	7.49	4.70	37.4	14.6	47.4	20.39	310.2	35.0	10.6	30.2	0	614.2
Hole 521													
7-2, 140–150	26.30	7.28	2.74	36.0	10.8	52.9	19.80	—	—	—	—	—	—
17-2, 140–150	66–72	7.31	2.73	35.5	10.4	51.4	19.77	—	—	—	—	—	—
Hole 521A													
17-3, 0–9	68–71	7.29	2.58	35.5	10.2	51.3	19.51	—	—	—	—	—	—
Hole 522													
2-2, 140–150	3–7	7.26	2.80	35.5	10.3	52.9	19.78	—	—	—	—	—	—
17-2, 140–150	64–69	7.28	2.52	36.6	10.6	51.3	19.07	—	—	—	—	—	—
22-2, 140–150	86–90	7.21	2.37	38.2	10.4	52.2	19.27	—	—	—	—	—	—
31-2, 140–150	122–126	7.20	2.29	36.6	10.3	52.4	19.21	—	—	—	—	—	—
Hole 523													
8-1, 144–150	30–34	7.34	2.58	38.0	10.7	49.9	19.37	—	—	—	—	—	—
21-2, 144–150	73–77	7.24	2.49	35.5	10.5	53.7	19.61	—	—	—	—	—	—
30-2, 143–150	107–111	7.28	2.29	36.8	10.8	51.5	19.20						
Hole 524													
4-3, 140–150	50	7.46	1.94	35.5	9.9	55.5	19.71	—	—	—	—	—	—
11-5, 140–150	131	7.10	0.39	39.3	27.9	38.6	19.64	—	—	—	—	—	—
15-1, 140–150	154	7.48	0.92	36.6	35.8	34.9	19.64	—	—	—	—	—	—
21-5, 140–150	215	7.47	0.81	35.2	47.9	29.6	19.41	—	—	—	—	—	—
25-6, 140–150	246	7.50	1.12	34.1	52.0	27.4	18.70	—	—	—	—	—	—

Site 524

The chemistry of the interstitial waters at Site 524 indicates steep gradients in calcium and magnesium below a sub-bottom depth of 50 m (Fig. 3). Changes in calcium and magnesium are not linearly correlated. Uptake of magnesium is indicated in the volcaniclastic sediments of Units 2 and 3. The underlying basalts provide a significant source for dissolved calcium. Similarly, large concentration gradients in calcium and magnesium were observed in the Walvis Ridge sites drilled during Leg 74. We intend to carry out further work on the strontium isotopic composition of the pore fluids of Site 524 as well as of those collected during Leg 74. Such data will help to develop a more complete interpretation of the contribution of volcanic matter to reactions involving the exchange of calcium and magnesium between the solid phases and interstitial waters (Hawkesworth and Elderfield, 1978).

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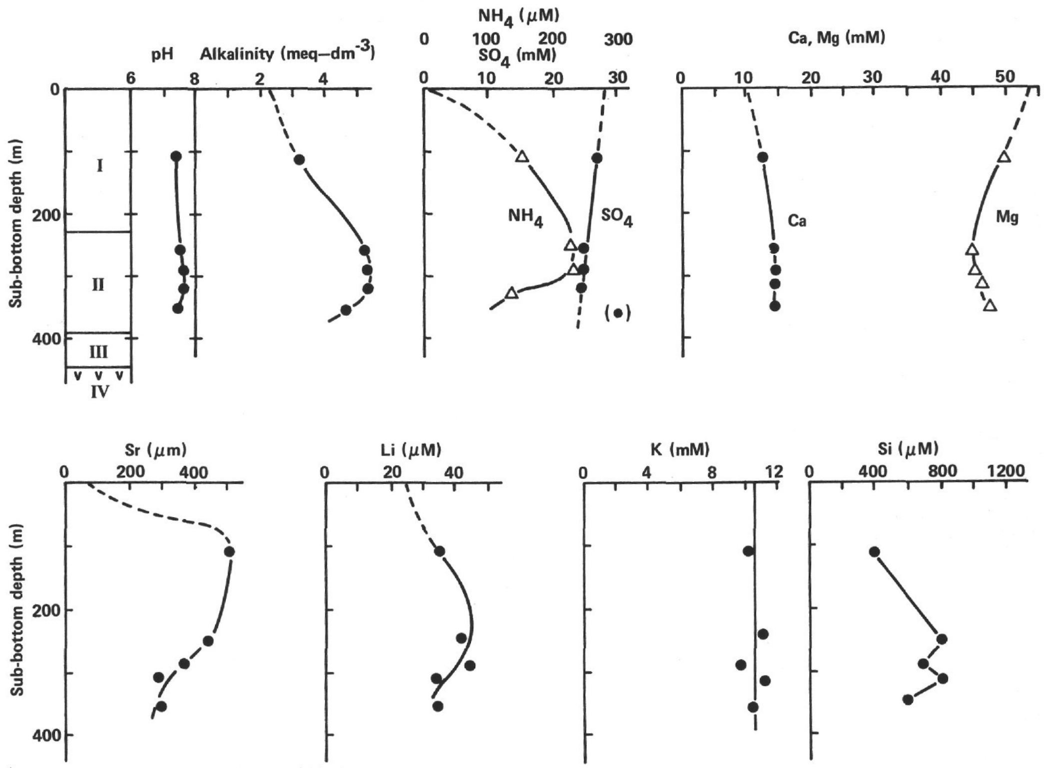

Figure 2. Interstitial water chemistry, Site 520. Lithology is as follows: I = nannofossil ooze; II = nannofossil oozes at 285 m, marls at 300 to 310 m, and diatomaceous oozes at 390 m, respectively; III = nannofossil marl and claystone; IV = basalt.

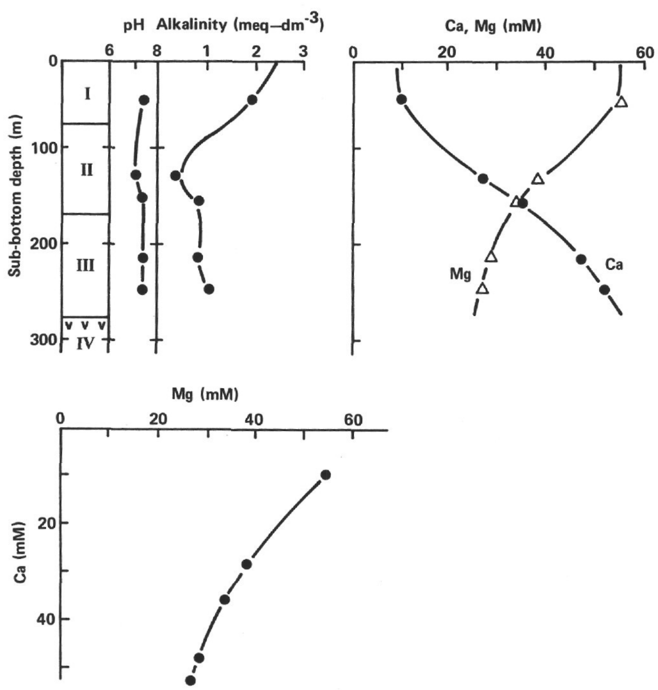

Figure 3. Interstitial water chemistry, Site 524. Lithology is as follows: I = nannofossil ooze and chalk; chert occurs at ~40 m and 72 m; II = nannofossil marls and volcaniclastic sandstones; III = ash, nannofossil claystone, and sandstones; IV = basalts, volcanic breccias, and claystones.