9. INTERSTITIAL WATER STUDIES, LEG 72[1]

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ABSTRACT

Interstitial waters collected at Sites 515 and 516 during DSDP Leg 72 have been analyzed for major and minor constituents. At both sites increases in dissolved calcium and decreases in dissolved magnesium with depth imply reactions in the sediment column involving these constituents. It is suggested that these concentration changes are related to reactions involving biogenic silica transformation.

INTRODUCTION

During Deep Sea Drilling Project (DSDP) Leg 72, interstitial water samples were collected at two drill sites: Site 515 in the southern Brazil Basin (26°14.3′S, 36°30.2′W) and Site 516 on the upper flanks of the Rio Grande Rise (30°16.6′S, 35°17.1′W). The latter site is located in the vicinity of Site 357 of Leg 39 (Supko, Perch-Nielsen, et al., 1977). Interstitial water samples were obtained at Site 515 to a depth of 615 m (deepest sediment recovery 636 m); this site has an estimated basement depth of 1750 m. At Site 516 interstitial waters were collected to a depth of 649 m, well short of basement, which occurs at 1253 m. Because of the large unsampled sections above basement, the interpretation of the interstitial water concentration depth profiles is severely hampered. In this chapter we present the data obtained, with a brief discussion.

RESULTS AND DISCUSSION

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

Site 515 (Fig. 1)

Sedimentation rates at this site have ranged above 20 m/Ma during the last 10 Ma, and this typically results in an alkalinity maximum, caused by sulfate reduction processes (Gieskes, 1975, 1981). This is confirmed by the observed increases in dissolved ammonia. Data on dissolved calcium and magnesium indicate a linear correlation between concentration changes in these constituents (Fig. 3), but the depth profiles of both calcium and magnesium imply either reaction in the upper 500–600 m of the sediment column or an upward advective component. In view of the great thickness of the sediment column (~1750 m), upward advective flow is highly unlikely, nor will upward migration of interstitial waters as a result of compaction at greater depths sustain such a flow in a sediment column that has accumulated at rates of about 20 m/Ma (Einsele, 1977). We conclude that the main reactions responsible for the observed changes in calcium and magnesium occur in the siliceous sediments between 100–500 m. Uptake of magnesium far exceeds the production of dissolved calcium ($\Delta Ca/\Delta Mg \approx 0.36$; Fig. 3). Increases in dissolved strontium are relatively small, which in part results from the relative absence of calcareous material in these sediments. Studies of $^{87}Sr/^{86}Sr$ ratios of dissolved strontium may help to reveal the origin of this component (Hawkesworth and Elderfield, 1978). Dissolved silica reflects the relative presence of biogenic silica, and the large increase in dissolved lithium is probably related to the release of this constituent during silica diagenesis (Gieskes, 1981). Dissolved potassium appears to have a sink only in the deeper sections of this site.

Site 516 (Fig. 2)

Site 516 has been characterized by sedimentation rates between 5 and 20 m/Ma over the last 10 Ma. Relatively small depletions in dissolved sulfate occur, and dissolved ammonia shows a gradual increase with depth. As a consequence only a very slight increase in alkalinity occurs in the upper 300 m, followed by a rapid decrease, as a result of removal of bicarbonate, probably as calcium carbonate. Only a small increase in dissolved calcium occurs, but decreases in magnesium are relatively large. Changes in calcium and magnesium are not linearly correlated and appear to imply removal of magnesium in the sediment column. Dissolved silica values in Unit 2 are high, reflecting the presence of sponge spicules. The magnesium concentration–depth profile does not allow us to suggest that the main zone of reaction is located in Unit 2 or in the volcanically enriched Unit 4 below the section sampled for interstitial waters.

Dissolved strontium increases are large, reflecting carbonate recrystallization reactions (Baker et al., in 1982). Sources of lithium and sinks for potassium appear to be located in the deeper sediment sections.

In comparison with data collected at Site 357 (Supko, Perch-Nielsen, et al., 1977), increases in dissolved cal-

[1] Barker, P. F., Carlson, R. L., Johnson, D. A., et al., *Init. Repts. DSDP*, 72: Washington (U.S. Govt. Printing Office).

Table 1. Interstitial water chemistry, Leg 72.

Core-section (interval in cm)	Sub-bottom depth (m)	pH	Alk. (meq/l)	S (g/kg)	Ca (mM)	Mg (mM)	Cl (g/kg)	Sr (μM)	Li (mM)	K (mM)	SO_4 (mM)	NH_4 (μM)	Si (μM)
Hole 515													
2-2, 140–143	42	7.59	3.95	35.2	14.7	44.9	19.48	79.4	26.9	10.9	—	311.4	256.8
Hole 515B													
1-3, 140–150	99	7.40	3.88	34.4	17.1	38.1	19.51	103.9	80.1	12.3	22.7	300.7	187.3
6-3, 144–150	147	7.16	4.84	34.1	18.3	32.9	19.28	110.9	200.0	10.8	—	572.4	615.7
11-5, 140–150	197	7.21	5.88	34.1	20.0	26.7	19.38	124.4	283.3	11.7	20.6	824.0	1204.5
16-2, 140–150	240	7.90	7.09	34.1	21.1	23.3	19.41	125.5	325.1	11.8	15.8	841.5	572.0
21-4, 140–150	291	7.91	7.10	33.6	22.2	20.1	19.31	—	383.8	11.2	14.7	2002.0	577.5
26-1, 140–150	334	7.50	4.38	32.3	22.2	18.2	19.68	—	—	—	—	—	—
31-4, 140–150	386	7.87	6.52	33.3	24.1	15.2	19.51	163.2	430.8	9.6	12.8	972.0	515.9
36-4, 140–150	433	7.92	6.33	33.3	25.8	14.0	19.41	182.0	446.4	8.5	11.1	1038.4	654.5
39-5, 140–150	463	7.68	1.30	33.0	22.8	12.4	19.58	184.9	469.0	9.7	—	—	621.0
41-5, 140–150	482	7.90	4.16	33.0	24.4	12.1	19.55	189.3	457.1	8.8	—	1433.8	607.8
56-5, 140–150	529	7.99	3.20	32.7	25.8	11.5	19.28	151.2	501.9	9.0	—	1335.6	265.0
51-3, 140–150	574	8.05	—	31.6	24.9	10.6	19.21	171.2	—	—	9.1	1164.0	124.0
55-5, 140–150	615	—	—	31.1	25.4	11.0	18.17	199.7	309.8	4.1	—	1080.0	164.0
Hole 516A													
1-2, 144–150	3	7.32	2.69	35.2	10.9	58.4	19.14	72.6	11.2	10.8	0	—	95.4
12-2, 140–150	50	7.22	2.93	35.2	12.0	55.4	19.34	290.3	40.2	10.1	0	—	90.1
Hole 516F													
2-6, 140–150	188	7.14	3.83	35.2	14.7	44.2	19.48	537.3	—	9.9	24.8	198.0	723.3
7-2, 140–150	229	7.07	3.81	35.2	15.2	41.8	19.51	610.6	125.7	9.1	25.0	280.3	743.7
13-2, 140–150	286	7.07	4.29	37.7	16.0	38.3	19.51	628.6	133.4	9.1	—	257.0	839.2
19-3, 140–150	364	7.29	2.70	35.2	15.8	36.5	19.64	604.9	200.0	9.0	22.6	429.3	524.7
25-3, 140–150	402	7.36	1.38	35.2	15.4	33.3	19.88	623.1	245.4	10.4	22.5	520.0	298.5
30-5, 140–150	452	7.69	0.58	35.2	15.9	30.3	20.15	712.2	255.5	8.8	—	585.5	114.4
35-3, 140–150	497	7.42	1.69	35.2	16.0	32.2	20.01	652.8	340.7	9.1	22.5	540.8	192.4
51-3, 140–150	649	7.31	—	35.2	17.1	25.6	20.15	713.3	313.3	6.9	—	668.0	166.0

cium are slightly larger at Site 357, but decreases in magnesium are more pronounced at Site 516.

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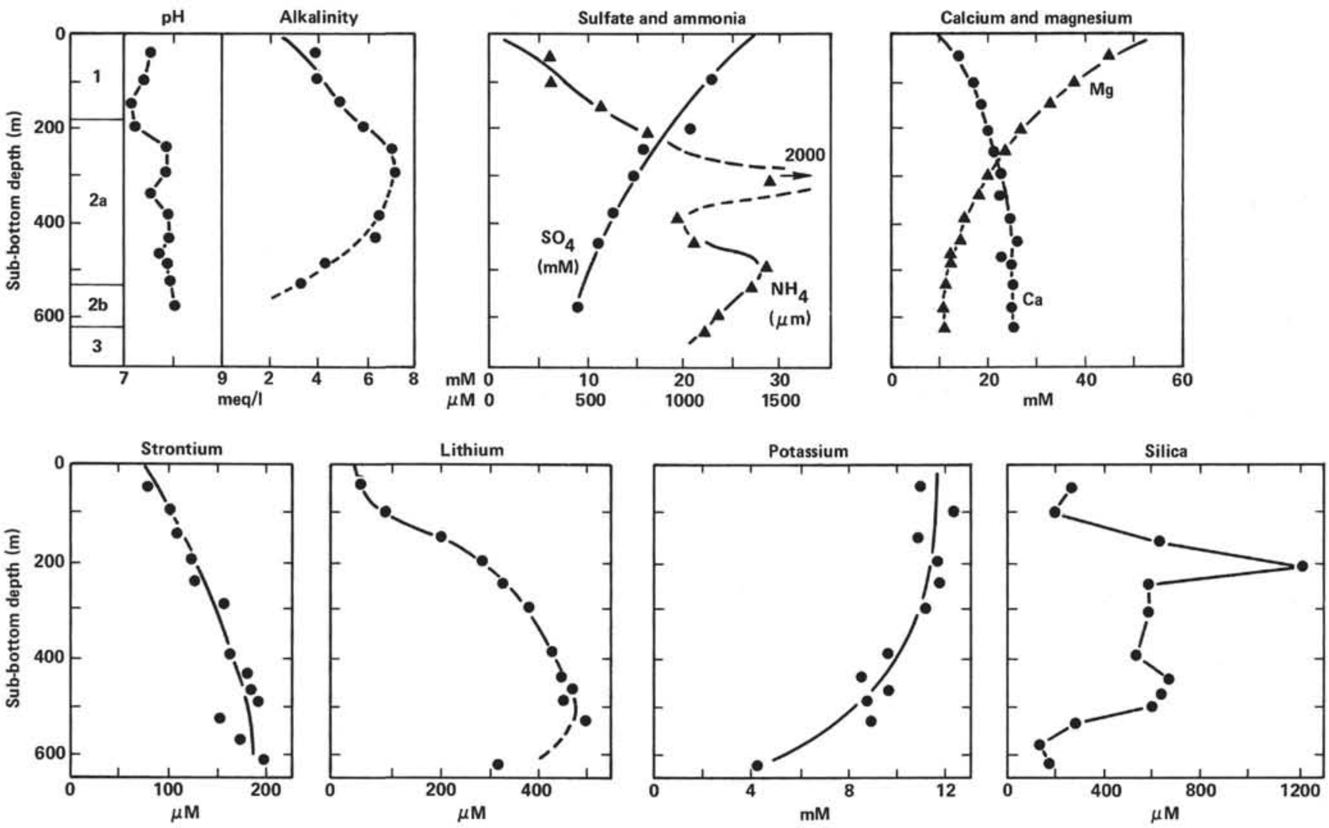

Figure 1. Interstitial water composition, Site 515. Lithologic Unit 1: grayish brown terrigenous mud with occasional nannofossil-rich and some foraminifer-rich layers; Unit 2: dark greenish gray siliceous mud grading into siliceous and terrigenous mudstone; Subunit 2a more siliceous than 2b; Unit 3: greenish gray, calcareous mudstone.

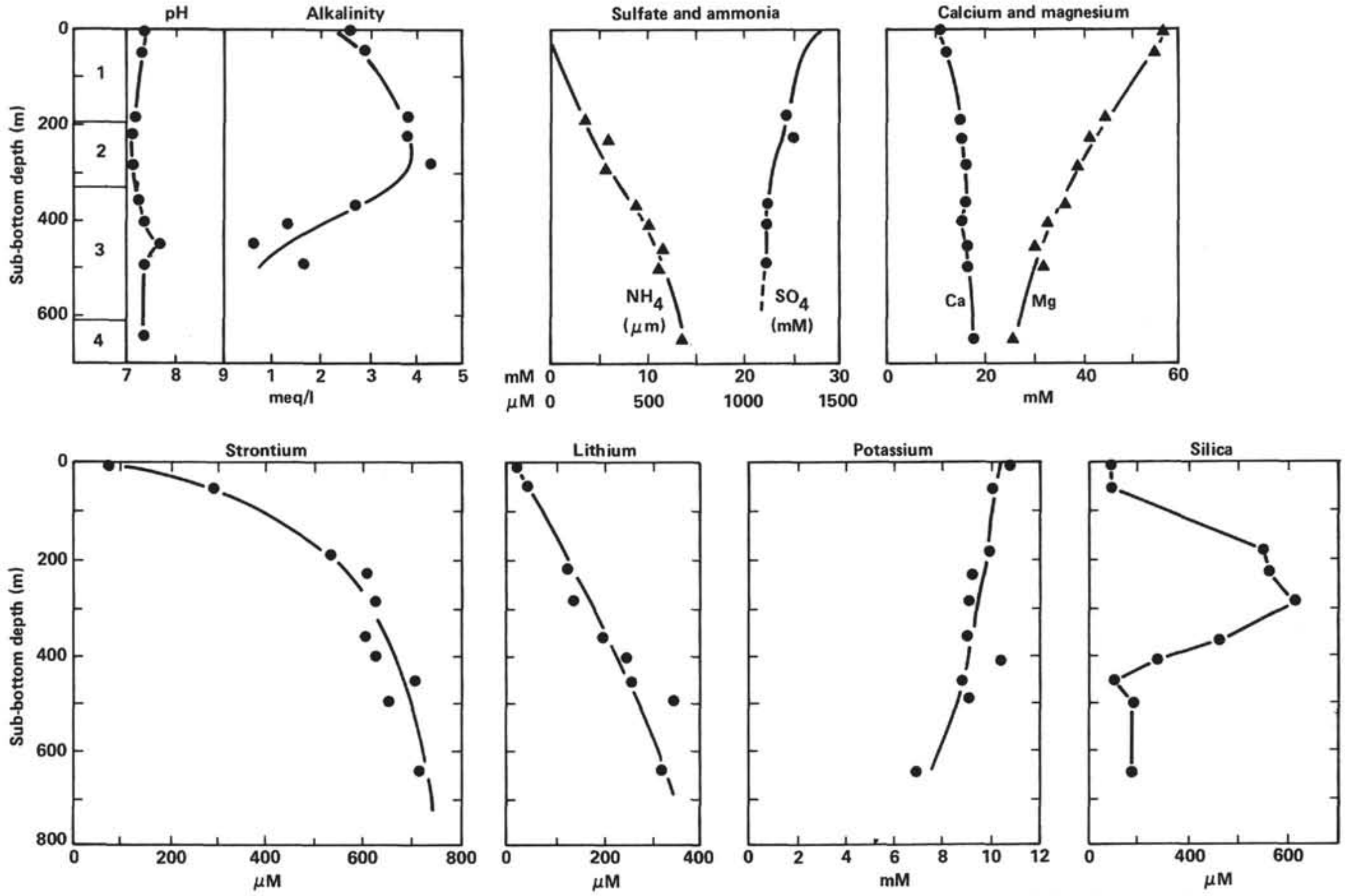

Figure 2. Interstitial water composition Site 516. Lithologic Unit 1: calcareous oozes; Unit 2: nannofossil and foraminiferal-nannofossil chalks; sponge spicules ~10% and some chert; Unit 3: nannofossil and foraminiferal-nannofossil chalks; Unit 4: limestone.

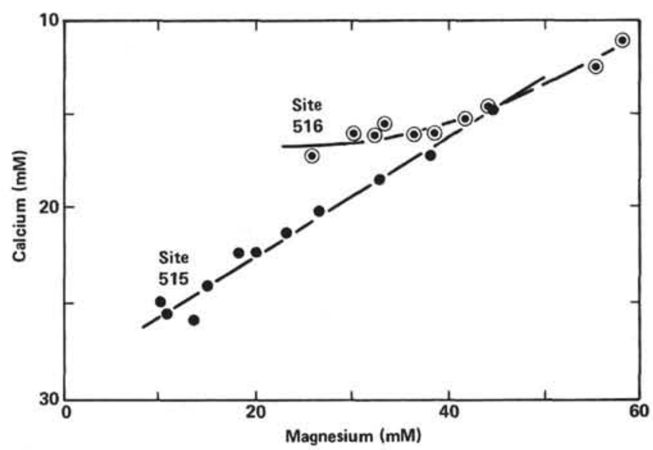

Figure 3. Calcium–magnesium correlation, Sites 515 and 516.