17. INTERSTITIAL WATER STUDIES, LEG 24

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ABSTRACT

Interstitial water studies on Leg 24 were carried out on five of the eight holes drilled during this cruise of the *Glomar Challenger* in the northwest Indian Ocean. The sites analyzed are predominantly nannofossil oozes; however, the variable sedimentation rates, water depths, and amounts of terrigenous inputs cause a variety of changes in the interstitial water concentration. These changes can be explained in terms of diagenetic reactions of the pore fluids with the sediments. In addition, the pore fluids of Holes 232 and 232A are affected by the dissolution of a (postulated) buried evaporite.

INTRODUCTION

During Leg 24, as part of the Interstitial Water Program, squeezed pore water samples were collected at 50 meter intervals and the alkalinity, salinity, and pH were measured. The samples were then sent to DSDP for storage until more detailed chemical analysis could be completed by interested investigators. We decided to analyze the interstitial waters from this leg to try to relate their changes in chemical composition to the lithology and mineralogy of the sediments, and, in addition, to compare these changes to those measured on Leg 25 interstitial water samples obtained in the southwest Indian Ocean. Consequently, we selected five sites that we thought were representative of the areas sampled and showed interesting trends in shipboard interstitial water measurements.

METHODS

Shipboard sampling procedures are described in Chapter 1 of this volume, in the interstitial water section. Also described are the analytical methods for alkalinity, pH, and salinity. The analytical methods for laboratory analysis reported in this chapter are as described in Leg 25 Initial Reports (Gieskes, 1974) with the modifications noted below.

Chloride: Chlorinity was determined by a Mohr titration with $AgNO_3$ and K_2CrO_4 as indicator, the $AgNO_3$ standardized with IAPSO standard seawater.

Potassium: 0.1 ml of the sample was diluted with 20 ml of 5000 ppm La solution. Standards of 50-500 ppm K were prepared in 10,500 and 11,000 ppm Na solutions so that when diluted in the same manner as the samples, the standards would bracket the seawater sodium concentrations. Copenhagen IAPSO seawater and La Jolla Pier Water were used as additional standards.

Estimated accuracies and precision of the measurements are reported in Table 1.

RESULTS

Detailed descriptions of the sites are given in the various site reports, while the major lithologic features are recorded in the various figures to aid interpretation of the measured

TABLE 1 Estimated Accuracy and Precision of Analysis

| | Accuracy (%) | Precision (%) |
|-------------------------|-----------------|------------------|
| Alkalinity ^a | - | 5 |
| pH ^a | 0.2 (pH) | 0.1 (pH) |
| Ca | 2 | 0.2 |
| Mg | 2 | 0.2 |
| SO4 | 5 | 2 |
| Cl | 2 | 0.5 |
| SiO ₂ | 5 | 2 |
| Mn | 10 | 5 |
| Sr | 5 | 2 |
| K | 10 | 5 |

^aFrom the interstitial water chemistry section of Chapter 1, this volume.

chemical interstitial water gradients. Figure 1 represents the sedimentation rates for the sites investigated in this report (data from site reports, this volume).

Results are presented in Table 2 as well as Figures 2 through 19. The alkalinity and pH values are from shipboard analyses described in Chapter 1 (this volume). Sodium values were calculated from anion-cation balances using the measured values in Table 2.

DISCUSSION

The data reported are subject to uncertainties because of possible seawater contamination (Gieskes, 1974) and/or temperature of squeezing effects (cf Mangelsdorf et al., 1969; Bischoff et al., 1970; Fanning and Pilson, 1971; Sayles et al., 1973; Gieskes, 1973; Manheim, 1974). Seawater contamination effects are most easily seen in concentration gradients of dissolved Cl, Ca, Mg, and sulphate, where they would appear as anomalous points (closer to seawater values) on the otherwise smooth curves. For example, in Holes 232 and 232A, the possible seawater contamination for two points in the salinity measurements



Figure 1. Sedimentation rates at Sites 232, 235, 236, 237, and 238.

were noted in the shipboard report by the chemist (D. Graham, personal communication). Similar anomalous points were noted in the depth distribution of Cl, Ca, Mg, and sulphate (Table 2 and Figures 2, 3). Such large deviations in depth distribution were not noted in the other sites sampled, and we assume the values reported are not measurably affected by seawater contamination.

It has been shown that the effects of temperature of squeezing (see ref. above) on samples such as these, squeezed at room temperature $(25^{\circ}C)$, generally are an increase in concentration of monovalent cations and a decrease in concentration of divalent cations compared to cold squeezes $(5^{\circ}C)$. Sayles et al. (1973) noted that the largest increases upon warming were in potassium, and the data from Holes 232 and 232A and Sites 235 and 236 seem to reflect this: the seawater values above the sediment, extrapolated from the curves, give values approximately 36, 15, and 27 percent enriched relative to expected seawater values (10 mmole/1), respectively. Sites 237 and 238, with less terrigenous components (Thiede, this volume), do not show similar relative enrichment of extrapolated seawater values. However, the temperature of squeezing effects on

interstitial water will not obscure any gradients in the measured values (Sayles et al., 1973; Gieskes, 1973).

Storage of samples of high alkalinity has been shown to affect calcium concentration in non-acidified samples (Gieskes, 1973). However, since all sites had alkalinity values less than 12 meq/1, we assume Ca values are not affected by this problem.

CHEMICAL CHANGES IN INTERSTITIAL WATERS

In this section, the observed chemical changes in the interstitial water will be described briefly for each site. Attempts will be made to relate these changes to those in lithology, mineralogy, and general diagenetic effects.

Site 232 (Holes 232 and 232A)

This site lies in 1730 meters of water on the western edge of the Alulah-Fartak Trench and consists of nannofossil oozes with varying degrees of terrigenous components. The interstitial water changes reflect both diagenetic effects characteristic in sediments of high sedimentation rates and the influence of buried evaporites

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| TABLE 2 | | | | | | | | | |
|-----------------------------|-------------|--------------|------|-------|--|--|--|--|--|
| Concentrations of Dissolved | Elements in | Interstitial | Pore | Water | | | | | |

| Generalis | Depth | -11 | Alk | CI | so4 | Ca | Mg | K | Sr | Mn | SiO ₂ | Naa | S |
|-----------|-------|------|---------|--------|-----------|-----------|-----------|-----------|-----------|-------|------------------|--------|--------|
| Sample | (m) | рн | (meq/1) | (/00) | (mmole/1) | (mmole/1) | (mmole/1) | (mmole/1) | (mmole/1) | (ppm) | (mmole/1) | (-/00) | (*/00) |
| Site 232 | | | | | | | | | | | | | |
| 232-2-6 | 12 | 7.46 | 6.69 | 19.8 | 23.4 | 7.1 | 51.5 | 13.2 | 0.12 | 0.7 | 560 | 11.1 | 35.5 |
| 232-6-4 | 47 | 7.36 | 8.03 | 20.8 | 7.9 | 5.3 | 36.4 | 12.0 | 0.18 | 0.1 | 875 | 11.9 | 34.9 |
| 232-11-5 | 96 | 7.33 | 5.81 | 21.7 | 5.5 | 6.4 | 32.0 | 10.9 | 0.23 | 0.1 | 995 | 12.6 | 35.8 |
| 232-17-0 | 145 | 7.16 | 5.76 | 24.2 | 7.4 | 8.0 | 33.9 | 10.0 | 0.21 | 0.0 | 910 | 14.0 | 38.2 |
| 232A-6-6 | 216 | 7.00 | 4.40 | 27.4 | 8.7 | 16.1 | 32.7 | 9.2 | 0.44 | 0.7 | 965 | 15.8 | 44.6 |
| 232A-12-2 | 267 | 7.30 | 2.80 | 30.4 | 6.6 | 19.3 | 37.6 | 9.3 | 0.58 | 2.0 | 180 | 17.3 | 49.2 |
| 234A-15-2 | 295 | 7.50 | 2.13 | 25.3 | 15.4 | 17.0 | 39.3 | 7.7 | 0.41 | 1.3 | 170 | 14.4 | 43.2 |
| 232A-18-5 | 330 | 6.83 | 1.16 | 41.7 | 10.6 | 52.8 | 25.4 | 6.8 | 1.58 | 4.0 | 545 | 23.8 | 66.8 |
| 232A-21-6 | 359 | 6.90 | 0.91 | 42.1 | 3.2 | 44.2 | 37.0 | 8.3 | 0.83 | 1.8 | 355 | 23.5 | 67.7 |
| 323A-24-6 | 387 | 7.06 | 0.90 | 32.6 | 10.1 | 32.6 | 35.5 | 7.2 | 0.85 | 1.9 | 195 | 18.4 | 54.7 |
| Site 235 | | | | | | | | | | | | | |
| 235-2-6 | 18 | 7.28 | 10.35 | 19.7 | 18.1 | 6.1 | 50.3 | 10.7 | 0.14 | 2.7 | 935 | 11.0 | 34.9 |
| 235-7-3 | 119 | 7.62 | 11.50 | 19.8 | 3.1 | 6.0 | 38.2 | 7.2 | 0.29 | 0.4 | 245 | 11.1 | 33.3 |
| 235-11-5 | 274 | 7.73 | 2.35 | 20.0 | 1.4 | 7.1 | 29.6 | 3.7 | 0.29 | 0.4 | 130 | 11.3 | 32.7 |
| 235-13-3 | 373 | 7.85 | 1.39 | 19.8 | 3.2 | 11.8 | 31.8 | 1.2 | 0.14 | 0.5 | 30 | 11.0 | 32.7 |
| 235-14-2 | 430 | 7.58 | 0.76 | 19.9 | 2.7 | 16.8 | 29.5 | 1.5 | 0.13 | 0.8 | 30 | 10.9 | 32.2 |
| 235-15-3 | 498 | 7.78 | 0.65 | 20.5 | 2.7 | 13.2 | 28.1 | 1.4 | 0.27 | 1.6 | 20 | 12.0 | 33.6 |
| Site 236 | | | | | | | | | | | | | |
| 236-2-1 | 6 | 7.50 | 4.64 | 19.6 | 25.2 | 11.1 | 51.4 | 12.5 | 0.35 | 0.6 | 660 | 10.8 | 35.8 |
| 236-8-5 | 72 | 7.43 | 4.32 | 19.7 | 25.2 | 13.7 | 46.6 | 10.7 | 0.98 | 0.4 | 605 | 11.1 | 36.0 |
| 236-17-5 | 157 | 7.17 | 5.05 | 19.9 | 23.5 | 19.3 | 43.6 | 9.7 | 0.98 | 22.0 | 465 | 11.0 | 35.5 |
| 236-23-4 | 212 | 7.39 | 3.87 | 20.0 | 23.4 | 24.4 | 42.7 | 7.8 | 0.86 | 5.6 | 1100 | 10.9 | 35.5 |
| 236-26-6 | 244 | 7.31 | 4.62 | 20.0 | | 27.3 | 39.7 | 7.2 | 0.82 | 1.4 | 1110 | 10.9 | 35.8 |
| 236-29-1 | 263 | 7.64 | 2.06 | 20.0 | 23.4 | 40.4 | 32.1 | 6.4 | 0.50 | 14.8 | 685 | 10.7 | 36.3 |
| 236-32-2 | 295 | 7.53 | 1.17 | 20.1 | 22.9 | 53.4 | 25.7 | 5.6 | 0.47 | 14.9 | 650 | 10.4 | 36.8 |
| 236-33-3 | 304 | 7.37 | 0.87 | 20.7 | 23.4 | 52.3 | 23.8 | 5.8 | 0.46 | 13.3 | 530 | 10.9 | 36.3 |
| Site 237 | | | | | | | | | | | | | |
| 237-4-5 | 34 | 7.37 | 2.77 | 20.0 | 28.9 | 11.2 | 55.0 | 10.5 | 0.15 | 0.6 | 305 | 11.1 | 36.3 |
| 237-10-6 | 92 | 7.15 | 2.98 | 20.1 | 26.6 | 14.0 | 48.9 | 10.9 | 0.42 | | 765 | 11.2 | 36.3 |
| 237-13-6 | 120 | 7.17 | 2.89 | 20.1 | 26.8 | 15.0 | 48.7 | 10.7 | 0.42 | 0.4 | 560 | 11.2 | 36.0 |
| 237-20-4 | 174 | 7.20 | 3.01 | 20.1 | 26.2 | 15.5 | 47.9 | 11.5 | 0.43 | 4.2 | 500 | 11.1 | 36.0 |
| 237-23-4 | 214 | 7.12 | 3.08 | 19.8 | 25.2 | 16.2 | 45.4 | 10.2 | 0.45 | 5.2 | 605 | 11.0 | 35.8 |
| 237-32-3 | 296 | | 3.07 | 20.0 | 24.7 | 17.8 | 42.3 | 10.6 | 0.74 | 0.3 | 825 | 11.2 | 36.0 |
| 237-41-2 | 381 | | 0.50 | 20.1 | 23.2 | 21.0 | 37.7 | 13.4 | 0.62 | 0.6 | 220 | 11.1 | 35.8 |
| Site 238 | | | | | | | | | | | | | |
| 238-2-6 | 19 | 7.33 | 3.43 | 19.4 | 28.2 | 9.5 | 53.9 | 10.5 | 0.23 | 0.7 | 750 | 10.8 | 35.2 |
| 238-10-5 | 92 | 7.36 | 3.83 | 19.8 | 27.5 | 10.4 | 51.3 | 10.7 | 0.59 | 0.2 | 715 | 11.1 | 36.0 |
| 238-19-5 | 176 | 7.29 | 3.56 | 19.4 | 25.7 | 11.2 | 47.4 | 12.0 | 0.75 | 0.2 | 810 | 10.9 | 34.9 |
| 238-28-6 | 263 | 7.25 | 3.77 | 19.5 | 25.5 | 12.0 | 46.4 | 11.5 | 0.76 | 0.5 | 935 | 11.0 | 34.9 |
| 238-38-6 | 358 | 7.31 | 5.34 | 19.4 | 25.7 | 12.2 | 46.9 | 11.8 | 0.81 | 2.3 | 717 | 10.9 | 34.9 |
| 238-47-4 | 440 | | 3.34 | 19.6 | 26.2 | 11.4 | 48.9 | 12.4 | 0.43 | 0.5 | 435 | 11.0 | 35.8 |
| 238-53-5 | 498 | | 2.70 | 19.8 | 27.6 | 10.7 | 51.5 | 10.7 | 0.17 | 1.1 | 465 | 11.1 | 35.8 |

^aCalculated from anion-cation balance.



Figure 2. Salinity and alkalinity of interstitial water, Site 232.

similar to those reported in Legs 13 (Sayles et al., 1972) and 23 (Manheim et al., 1974).

Thus the upper 200 meters show a maximum in alkalinity (Figure 2), a slight decrease in Ca, and a rapid depletion of sulphate (Figure 3), all of which are related to the process of bacterial sulphate reduction (Berner et al., 1970; Gieskes, 1973; Hartman et al., 1973; Sholkovitz, 1973) and possible CaCO₃ precipitation.

Dissolved silica values are high (875 to 995 μ mole/1) between 47 and 216 meters, reflecting abundant radiolarian fauna (see site report, this volume).

Below 200 meters, the interstitial water concentrations suggest the influence of buried evaporites affecting the gradients of dissolved species. Both salinity and chlorinity show smooth increases to 300 meters and then increase to 66.8 percent and 44.7 percent, respectively. We have drawn



Figure 3. Concentration of chloride in sediment interstitial water, Site 232.

a smooth curve through the points and circled the points that suggest seawater contamination. The three suspect samples showed deviations from smooth curves in all elements. During Leg 23 at Site 227, anhydrite and halite were recovered below 282 meters (Ryan et al., 1972). Manheim (in press) describes chlorinity gradients at this site increasing to 160 g/kg in the anhydrite and gypsum layers and suggests this value as saturation for C1. Extrapolation of Holes 232 and 232A C1 curves to this value would place the evaporite layers at a depth of ca. 900 meters! It is possible that faulted (?) lithified sandstone and siltstone layers, such as those at 300 and 400 meters, prevent smooth diffusion of C1 and thus the evaporites could be at a much shallower depth. Such evaporites could be part of fault or slide blocks or, as suggested by R. L. Fisher (personal communication), may be components of sand layers derived from the continental margin.

Dissolved Na values (Table 2), calculated from anion-cation balance equations, show increases in the lower part of this hole consistent with the suggestion of evaporites (halite) affecting the interstitial waters of this site.

The more reactive interstitial water components are influenced by diagenetic reactions which, in addition to seawater contamination, obscure the effects of evaporites (Sayles et al., 1972; Manheim, 1974). The sulphate values are depleted relative to standard seawater (Figure 4), while Sayles et al. (1972) found up to five-fold increases in sulphate due to buried evaporites. However, the high organic carbon content (Appendix I, this volume), together with observed pyrite and H_2S (Thiede, this volume), would suggest that reduction of sulphate to sulfide rapidly



Figure 4. Concentrations of dissolved sulfate in interstitial water, Site 232.

removes sulphate formed by the dissolution of gypsum at this site.

Dissolved Ca values show enrichment (52.8 mmole/1) in the lower part of the hole, but trends are obscured by seawater contamination. Dissolved K values show depletion with depth (to 6.8 mmole/1), as is often observed in rapidly deposited terrigenous sediments.

Site 235

This site is located in 5100 meters of water in the Somali Basin east of Chain Ridge. It is characterized by a high sedimentation rate and varies in lithology from nanno clays to nanno oozes. As in the upper portion of Holes 232 and 232A, the interstitial water chemical composition is characteristic of holes with high sedimentation rates $(25m/10^{6}yr; Figure 1)$ and high organic carbon content (up to 0.6%). Thus, the alkalinity shows a maximum (11.5 meq/1) and then gradual decreases (Figure 5) along with a large initial depletion in sulphate (Figure 6). As in Holes 232 and 232A, these changes are related to bacterial sulphate reduction and possible CaCO₃ precipitation.

The changes in chemical composition of the interstitial water are very small at this site. After a small decrease, Ca





Figure 5. Salinity and alkalinity of interstitial water, Site 235.

increases a small amount with depth while Mg shows a slight decrease (Figure 7). Dissolved Sr slightly increases to 0.3 mm/1 in a section in which aragonite is reported in X-ray mineralogy analyses (Cook, this volume), probably from pteropod fragments (Thiede, this volume). Dissolved silica concentration is high in Sample 235-2-6; the lithologic description notes the presence of abundant radiolarians and sponge spicules in this portion of the core.

Dissolved K decreases to 1 mmole/1, which is typical of sediments with terrigenous components.

Site 236

This site is situated in 4487 meters of water north of the Seychelles; the characteristic sediments are nanno chalk oozes and clays. From Figure 1 we see that the sedimentation rate has been very low at this site, e.g., less than 5 m/10⁶ yr. Such holes usually show no maximum in alkalinity but, rather, a gradual decrease in this property with depth (Figure 8).

The depth distribution of dissolved sulphate shows a slight linear decrease (Figure 9) consistent with the low sedimentation rates and low organic carbon content (0.1%). Sample 236-2-1 is puzzling because a value much closer to seawater values (28 mmole/1) would be expected at a

Figure 6. Concentrations of dissolved sulfate in interstitial water, Site 235.

depth so close to the sediment-seawater interface in a slowly deposited sediment.

The changes in concentration of dissolved Ca and Mg are linear and show an increase in gradient in Unit 5 below 250 meters (Figure 10). This increase may be the result of lower permeability of this section (nanno chalk with chert) compared to the nanno oozes above. Unfortunately, no shipboard porosity measurements were made in the lower part of the hole.

The excellent correlation of Ca with Mg (Figure 11) suggests diagenetic reactions that involve uptake of Mg and release of Ca, although the increase in dissolved Ca concentration is greater than the loss of dissolved Mg ($\Delta Ca/\Delta Mg = 1.7$). We suggest the formation of high magnesium silicates from the alteration of volcanic ash is responsible for such changes, similar to those reported at Site 239 ($\Delta Ca/\Delta Mg = 1.8$; Gieskes, 1974).

Except for the lowermost sample (236-33-3), calculated dissolved Na gradually decreases, in addition to Mg, and may also be involved in this same reaction. Clinoptillolite and palygorskite have been reported in X-ray mineralogy samples in the lower part of the hole (Cook, this volume), an association von Rad et al. (1972) described as probably authigenic.

The changes in concentration of dissolved silica again reflect the influence of biogenic amorphous opal. Abundant radiolarians and sponge spicules were reported between 206 and 244 meters (site report); corresponding dissolved silica

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Figure 7. Dissolved calcium and magnesium concentrations in interstitial water, Site 235.

values are ca.1100 μ mol/1 (Figure 12). Dissolved silica values drop to 600 μ mole/1 below this section in Unit 5, in which cherts occur.

Dissolved Sr values strongly reflect the presence of aragonite in X-ray mineralogy samples at 38 and 109 meters (Cook, this volume), probably in the form of shallow-waterderived calcareous fragments reported by Thiede (this volume). Slow recrystallization would cause Sr^{++} ion release to the pore fluids.

The depth distribution of Mn is puzzling (Figure 13). High values (up to 22 ppm) were measured in Units 3 and 5. Other studies (Gieskes, 1974) have noted the increase of dissolved Mn related to a decrease in sulphate and have postulated the increased mobility of Mn under reducing conditions. However, the dissolved Mn values for this site do not show such correlation with sulphate and probably



Figure 8. Salinity and alkalinity of interstitial water, Site 236.

reflect local concentration gradients in the sediments. At the same time, iron oxides were reported in the lithologic descriptions (see site report, this volume) in Unit 4 (where dissolved Mn values were relatively low) as well as in Units 3 and 5. It is possible that these low values are the result of post-sampling errors caused by oxidation of the Mn in these non-acidified samples.

Site 237

This site is situated on the saddle between the Seychelles and Saya de Malha Bank in 1622 meters of water. The sediments recovered consist of nanno chalk oozes and lithified silicified nanno chalk oozes (see site report, this volume). The sedimentation rates are less than 10 m/10⁶ yr down to 200 meters, where they increase to 25 m/10⁶ yr (Figure 1).

The depth distribution of alkalinity for this site shows almost no change down to the lowest sample at 381 m (Figure 14). Dissolved sulphate values decrease almost linearly with depth (Figure 15). Such linear gradients in holes of low sedimentation are probably diffusion gradients.

Similar to Site 236, the changes in Ca and Mg show good correlation, although the overall changes are not as large





Figure 9. Concentration of dissolved sulfate in interstitial water, Site 236.

(Figures 16 and 17). Again, this may be the result of formation of authigenic clay minerals, as discussed under Site 236, yet in contrast, the ratio $\Delta Ca/\Delta Mg$ is 0.57. Perhaps different authigenic minerals are involved in the loss of dissolved Mg and gain of dissolved Ca in this site compared to Site 236. Unfortunately, no X-ray mineralogy samples are available for comparison.

Dissolved Sr shows a gradual increase with depth and thus appears to be related to the recrystallization of carbonate. The higher values at 296 and 381 meters may also reflect the presence of aragonitic shallow-water-derived fossils (Thiede, this volume). Similarly, the dissolved silica values reflect the presence of siliceous microfossils: radiolarian and sponge spicules occur frequently to dominantly at depths of ca. 100 and 300 meters (Thiede, this volume). As in Site 236, high dissolved silica values (825 μ mole/1) are associated with siliceous microfossils immediately above chert-bearing sediments with low

Figure 10. Dissolved calcium and magnesium concentrations in interstitial water, Site 236.

dissolved silica values (220 μ mole/1). However, because of the absence of siliceous microfossils it is not possible to state whether chert or clay minerals exert a dominant influence on the dissolved silica values.

Dissolved Mn values again show no correlation with sulphate or alkalinity and probably reflect local concentration gradients in the sediments.

Site 238

This site is located near the junction of the Chagos-Laccadive Ridge and the Central Indian Ridge in about 2900 meters of water. The sediments consist of pelagic, calcareous nannofossil oozes and chalks, with high concentrations of volcanic ash, zeolites, and iron oxides in the lowermost unit above basalt (site report). This site has had sedimentation rates of $25m/10^6$ yr to a depth of 275 meters, below which a slight decrease to $15 \text{ m}/10^6$ yr may have occurred (Figure 1).



Figure 11. Correlation of dissolved calcium and magnesium concentrations in interstitial water, Site 236.

The alkalinity is essentially linear, with little change with depth (Figure 18), while dissolved sulphate is slightly depleted to a depth of 267 meters (Figure 19). Below 267 meters the sulphate gradually increases to 27.6 mmole/1. This trend is contrary to that which would be expected in a site with low sedimentation rates at depth; in fact, the trend is similar to that in Site 242 which Gieskes (1974) explained as a diffusion gradient of sulphate in the lower part of the hole to those sediments above, in which sulphate reduction had been more complete (and sedimentation rates slower). The possibility of slight seawater contamination for the samples in Unit 2 cannot be ruled out.

The concentrations of dissolved Ca and Mg show smooth small changes with depth. The reversals in trend of samples in Units 2 and 3 (if real and not the result of slight seawater contamination) may be the result of diagenetic reactions involving clay minerals and zeolites in Units 2 and 3. However, the changes are too small to justify such interpretations.

The distribution of dissolved silica seems to be maintained by the frequent occurrence of siliceous microfossils throughout the hole (Thiede, this volume). Dissolved silica values are lower (440 μ mole/1) in the lower section of the site in which volcanic ash and zeolites are reported.



Figure 12. Concentration of dissolved silica in interstitial waters, Site 236.

To summarize, the measured chemical gradients can be interpreted in relation to lithology, sedimentation rate and possible diagenetic reactions of the sediments. Since the sediments are dominantly nannofossil oozes and chalks, characterization of the chemical changes in pore waters can be made based on the sedimentation rate and the presence of terrigenous material, clays, authigenic minerals, and biogenic sediments. Alkalinity and sulphate seem to be most strongly influenced by changes in sedimentation rate. Ca^{++} and Mg^{++} seem to be influenced dominantly by silicate reconstitution, Sr^{++} and silica concentrations by biogenic deposits, and Mn^{++} by local concentrations of manganese in the sediments.

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Figure 13. Distribution of dissolved manganese in interstitial waters, Site 236.

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Figure 14. Salinity and alkalinity in interstitial water, Site 237.



Figure 16. Concentration of dissolved calcium and magnesium in interstitial waters, Site 237.

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Figure 19. Concentration of dissolved sulfate in interstitial water, Site 236.

Figure 18. Salinity and alkalinity of interstitial waters, Site 238.