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58. *DATA REPORT:* ISOTOPE GEOCHEMISTRY OF PORE WATER FROM THE SEDIMENTARY COVER AT LIMALOK, LO-EN, AND WODEJEBATO GUYOTS[1]

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INTRODUCTION

During Leg 144 to the western Pacific Ocean, interstitial water was collected from the pelagic cap and the suprabasaltic clay cover at Limalok (Site 871), Lo-En (Site 872), Wodejebato (Sites 873 and 874), MIT (Site 878), and Seiko (Sites 879 and 880) guyots. Shipboard analyses of water samples included determinations of salinity, pH, alkalinity, chlorinity, calcium, magnesium, sulfate, fluoride, silica, ammonium, sodium, potassium, strontium, rubidium, and lithium (Premoli Silva, Haggerty, Rack, et al., 1993, p. 23). The chemical composition of the interstitial fluids from the pelagic caps showed few modifications with depth, and most samples had a composition close to that of modern seawater. This suggested either contamination with modern seawater during drilling or pore-water flushing by advection of recent seawater through the highly porous pelagic caps. Shore-based stable isotope analyses (hydrogen, oxygen, and strontium isotopes) of the Leg 144 interstitial water samples were then conducted to clarify the character of this phenomena. Surface seawater samples were collected at each site and analyzed for comparison. This report presents the results of the isotopic analyses. Further discussion of the pore-water history for selected sites will be given in Israelson et al. (this volume).

ANALYTICAL TECHNIQUES

Interstitial water samples were retrieved from 5- to 10-cm-long, whole- or half-round core sections from the pelagic caps and from clay intervals at the base of the calcareous platform sequences in the guyots. Pore waters were extracted using the techniques described by Manheim and Sayles (1974). At Site 873, a sequential squeezing technique was applied to reject the first 30 mL of interstitial water. The resulting 5- to 10-mL samples of interstitial water were placed in glass vials and sealed for later analyses.

Oxygen isotope analyses were conducted at the Department of Geophysics, Niels Bohr Institute of Astronomy, Physics and Geophysics, University of Copenhagen, according to the standard CO_2-equilibration technique at 25°C (Epstein and Mayeda, 1953; Dansgaard, 1961). Hydrogen isotope analyses were performed at the Danish Center for Isotope Geology at the Geological Institute, University of Copenhagen. An aliquot of 1 µL of water was reduced with zinc in sealed quartz ampules at 700°C and the resulting hydrogen gas was analyzed in a Finnigan MAT 250 gas mass spectrometer. Oxygen and hydrogen isotope ratios are reported as δ-values relative to Standard Mean Ocean Water (SMOW). Reproducibility is better than 0.2‰ and 1‰, respectively, on the δ-scale. Strontium isotope analyses were conducted at the Department of Earth Sciences, University of Cambridge. Strontium was separated from 10-mL aliquots by conventional cation exchange chromatography. $^{87}Sr/^{86}Sr$ ratios were determined using a VG Sector 54 instrument that employed a three-collector multidynamic program. A mean of 150 ratio measurements were taken for each sample, and $^{87}Sr/^{86}Sr$ ratios were normalized exponentially to $^{86}Sr/^{87}Sr = 0.1194$. During the course of this work, the SRM 987 $SrCO_3$ standard gave $^{87}Sr/^{86}Sr = 0.710254 \pm 0.000024$ ($N = 23$), and an in-house modern coral standard gave $^{87}Sr/^{86}Sr = 0.709177 \pm 0.000024$ ($N = 25$).

RESULTS

Results of the isotope analyses and selected data from the shipboard analyses (Premoli Silva, Haggerty, Rack, et al., 1993) are presented in Table 1 and in Figures 1 and 2. The analyzed seawater samples have hydrogen and oxygen isotope compositions within the range of average Pacific Ocean surface waters (Ferronsky and Breznugov, 1989). Interstitial water from the pelagic cap at Site 871 (Fig. 1) increases systematically in deuterium content from top to bottom. A similar but much smaller trend can be observed in the ^{18}O content. The strontium isotope composition of the interstitial water is not significantly different from that of modern seawater ($^{87}Sr/^{86}Sr = 0.70925$; Capo and DePaolo, 1990; Andersson et al., 1992) except for Sample 144-871C-32R-3, 142–150 cm, from the variegated clay in Subunit IIIB, which is depleted in ^{87}Sr. This sample also has elevated Sr/Ca and lowered Mg/Ca ratios as compared with seawater (Table 1).

At Hole 872C (Fig. 2), deuterium and ^{87}Sr content are inversely correlated. The strontium isotope composition of interstitial water from the middle Miocene interval is similar to that of middle Miocene seawater (Israelson et al., this volume). The trends in both strontium and hydrogen isotope compositions of interstitial water from the pelagic cap below the middle Miocene interval are reversed, and both approach the composition of modern seawater.

The interstitial water samples from Site 873 were obtained by sequential squeezing of the pelagic sediments. All isotope data from this site are well within the range of present-day seawater (Table 1). The only exception is the sample from the clay at the bottom of the sedimentary sequence at Hole 873A, which is strongly depleted in ^{87}Sr and has raised Sr/Ca and lowered Mg/Ca ratios. This sample may be interpreted as interstitial water strongly affected by reactions with rocks of basaltic origin.

Only limited data are available from Sites 874, 877, 878, 879, and 880. Water samples from the pelagic caps at these sites are indistinguishable from modern seawater. However, interstitial waters from clay and volcaniclastic sediments are significantly depleted in ^{87}Sr, as compared with modern seawater.

CONCLUSIONS

The only guyot preserving a probable signal from original, syndepositional seawater is Lo-En. This pelagic cap will be discussed in Israelson et al. (this volume). All other pelagic samples are strongly affected by modern seawater, either from relatively recent advection of seawater into the pelagic cap or from the drilling operation.

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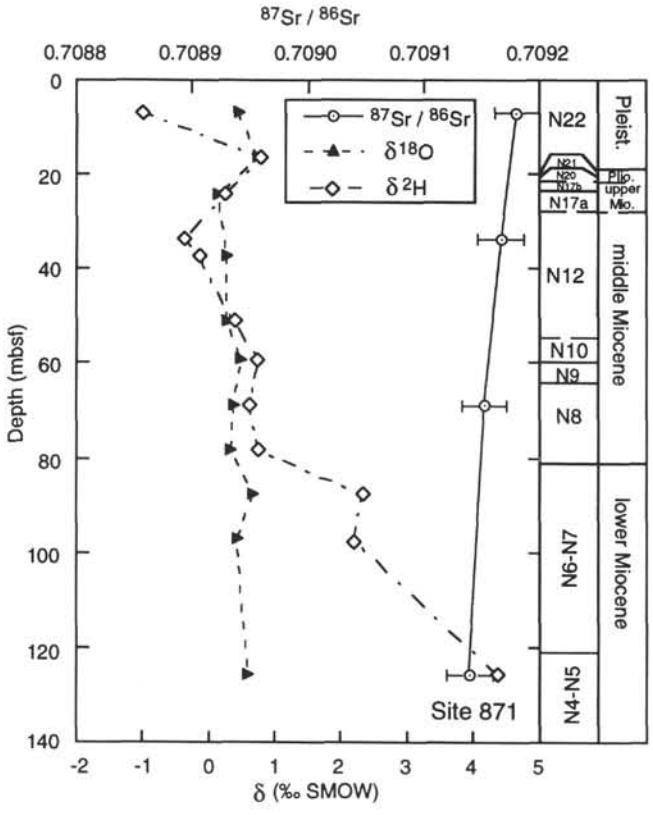

Figure 1. Variation with depth of hydrogen, oxygen, and strontium isotopes from interstitial water in the pelagic cap at Site 871. Foraminifer biostratigraphy according to Pearson (this volume).

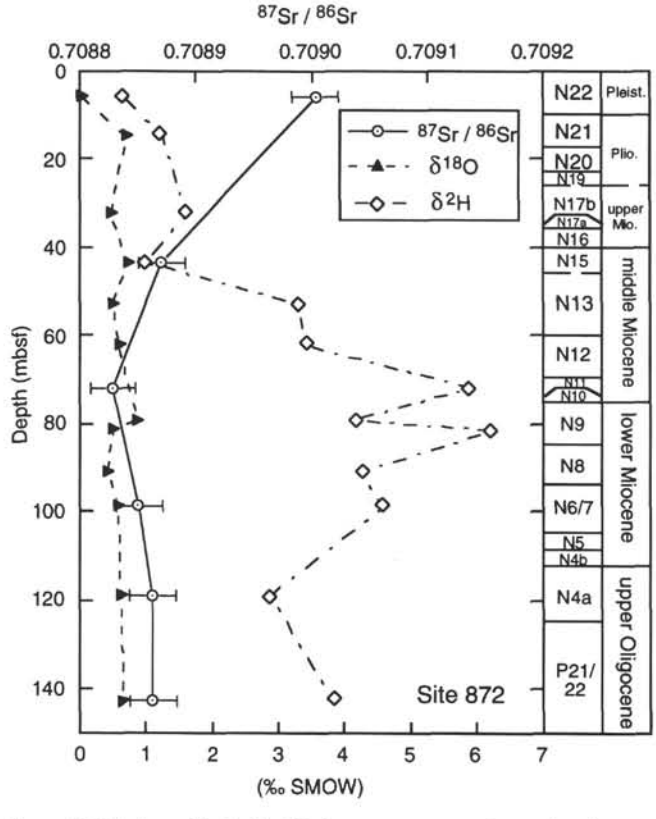

Figure 2. Variation with depth of hydrogen, oxygen, and strontium isotopes from interstitial water in the pelagic cap at Site 872. Foraminifer biostratigraphy according to Pearson (this volume).

Interstitial water from the intra- or suprabasaltic clays have strontium isotope compositions, suggesting exchange reactions with basalts or basaltic weathering products (cf. Elderfield and Gieskes, 1982). Oxygen and hydrogen isotope compositions do not, however, point to any meteoric origin of these waters, and the samples probably reflect modified seawater.

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*Abbreviations for names of organizations and publications in ODP reference lists follow the style given in *Chemical Abstracts Service Source Index* (published by American Chemical Society).

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Table 1. Interstitial-water composition, Sites 871–880.

Core, section, interval (cm)	Depth (mbsf)	Lithology	$^{87}Sr/^{86}Sr$	$\delta^{18}O$ SMOW (‰)	$\delta^{2}H$ SMOW (‰)	Salinity (‰)	Mg (mM)	Ca (mM)	Sr (μM)	Sr/Ca ratio	Mg/Ca ratio
Site 871 seawater	Surface		ND	0.56	1.1	35.0	53.7	10.5	91	8.66	5.11
144-871A-											
1H-5, 113–118	7.0	Nfo	0.709178	0.43	–1.0	35.0	54.1	11.0	94	8.56	4.93
2H-6, 145–150	16.5	Nfo	ND	0.73	0.8	35.0	53.5	11.0	101	9.18	4.86
3H-5, 143–150	24.4	Nfo	ND	0.13	0.2	35.0	50.8	10.8	98	9.04	4.69
4H-5, 140–150	33.9	Nfo	0.709166	0.11	–0.4	35.0	54.3	10.8	96	8.92	5.05
5H-2, 0–5	37.5	For	ND	0.26	–0.2	35.0	54.2	11.0	98	8.88	4.91
6H-4, 140–150	51.4	For	ND	0.26	0.4	35.0	50.9	11.1	103	9.31	4.60
7H-3, 142–150	59.4	For	ND	0.47	0.7	35.0	54.1	11.0	98	8.93	4.93
8H-3, 142–150	68.9	For	0.709152	0.36	0.6	35.0	53.9	11.0	101	9.15	4.88
9H-3, 143–150	78.4	For	ND	0.32	0.7	35.0	54.2	11.2	101	9.03	4.84
10H-3, 145–150	88.0	For	ND	0.65	2.3	35.0	54.3	11.2	106	9.44	4.84
11H-3, 143–150	97.4	For	ND	0.41	2.2	35.0	51.6	11.1	ND	ND	4.66
14H-3, 143–150	125.9	For	0.709139	0.58	4.4	35.0	55.0	11.1	100	9.04	4.98
1H-5, 113–118	7.0	Nfo	0.709178	0.43	–1.0	35.0	54.1	11.0	94	8.56	4.93
144-871C-											
32R-3, 142–150	426.9	Pkst	0.708136	ND	3.6	35.0	51.8	13.0	127	9.75	3.98
33R-2, 145–150	441.0	Clay	ND	0.40	0.4	34.0	50.8	12.4	117	9.41	4.08
Site 872 seawater	Surface		ND	ND	ND	35.0	53.3	10.7	91	8.54	5.01
144-872A-											
1H-4, 145–150	6.0	Nfo	0.709003	0.03	0.6	35.5	53.1	11.7	109	9.28	4.52
2H-5, 145–150	15.0	Nfo	ND	0.69	1.2	35.5	53.7	12.1	109	8.98	4.42
4H-4, 145–150	32.5	Nfo	ND	0.45	1.6	35.5	53.8	12.3	115	9.34	4.37
5H-5, 140–150	43.5	For	0.708870	0.72	1.0	35.5	54.0	12.0	105	8.77	4.51
6H-5, 140–150	52.9	For	ND	0.48	3.3	35.5	52.9	12.2	106	8.70	4.34
7H-5, 140–150	62.4	For	ND	0.58	3.4	35.5	54.1	12.2	109	8.95	4.44
8H-5, 143–150	71.9	For	0.708828	ND	5.9	35.5	54.0	12.2	111	9.08	4.42
9H-4, 69–71	79.2	For	ND	0.85	4.1	35.5	ND	ND	ND	ND	ND
9H-5, 143–150	81.4	For	ND	0.49	6.3	35.5	54.0	12.0	105	8.76	4.50
10H-5, 140–150	90.9	For	ND	0.41	4.2	35.5	52.2	12.0	106	8.84	4.36
11H-4, 143–150	98.9	For	0.708851	0.57	4.6	35.5	53.4	12.1	104	8.62	4.43
14H-5, 142–150	118.9	For	0.708862	0.61	2.9	35.5	53.5	11.7	106	9.09	4.59
17H-2, 143–150	142.9	For	0.708862	0.65	3.8	35.5	53.8	11.6	107	9.19	4.62
Site 873 seawater	Surface		ND	0.51	0.7	35.0	53.0	10.3	91	8.87	5.17
144-873A-											
13R-3, 140–150	169.9	Clay	0.705702	ND	ND	35.0	23.3	51.9	1405	27.07	0.45
144-873B-											
1H-4, 134–139	5.4	Nfo	0.709192	0.11	–0.4	35.0	53.1	10.7	102	9.58	4.99
2H-5, 135–142	13.7	Nfo	ND	0.46	–0.1	35.0	53.0	10.5	100	9.53	5.06
3H-5, 145–150	23.0	Nfo	ND	0.33	0.3	35.0	50.4	10.5	96	9.12	4.78
4H-4, 143–150	30.9	Nfo	0.709155	0.52	–0.1	35.0	53.4	11.0	95	8.67	4.88
5H-4, 135–140	39.6	For	ND	0.62	0.2	35.0	53.2	10.9	93	8.52	4.87
6H-4, 143–150	50.0	For	0.709164	0.26	1.6	35.0	51.5	11.0	97	8.80	4.68
Site 874 seawater	Surface		ND	0.53	1.5	35.0	54.0	10.5	91	8.71	5.17
144-874B-											
21R-1, 140–150	164.2	Clay	0.708646	1.51	3.3	36.0	50.9	13.5	116	8.60	3.77
22R-2, 140–150	175.3	Clay	0.708512	ND	ND	35.5	50.7	14.2	122	8.60	3.57
Site 877 seawater	Surface		ND	ND	ND	35.0	64.2	10.6	91	8.58	6.05
144-877A-											
20R-3, 140–150	186.7	Volc	0.708841	ND	ND	35.0	63.0	11.4	100	8.80	5.54
Site 878 seawater	Surface		ND	ND	ND	35.0	54.0	10.5	91	8.64	5.13
144-878A-											
1R-2, 143–150	2.5	Nfo	0.709191	0.09	–0.6	35.0	49.8	11.0	100	9.13	4.55
79R-CC, 18–27	738.2	Clay	0.708336	ND	ND	35.0	46.2	13.9	106	7.61	3.32
86R-1, 118–129	799.8	Clay	0.705862	–0.30	–2.7	36.0	24.8	58.5	266	4.55	0.42
Site 879 seawater	Surface		ND	ND	ND	35.0	ND	ND	ND	ND	ND
144-879A-											
20R-4, 140–150	185.3	Clay	ND	0.34	0.9	34.0	ND	ND	ND	ND	ND
Site 880 seawater	Surface		ND	ND	ND	35.0	ND	ND	ND	ND	ND
144-880A-											
1H-5, 142–150	7.4	For	ND	0.42	–1.9	ND	ND	ND	ND	ND	ND
2H-6, 142–150	8.9	For	ND	0.30	0.3	34.0	ND	ND	ND	ND	ND

Notes: For = foraminifer ooze, Nfo = nannofossil foraminifer ooze, Pkst = packstone, and Volc = volcaniclastics. ND = no determination. Salinity, magnesium, calcium, and strontium concentrations are from Premoli Silva, Haggerty, Rack, et al. (1993).