13. MINERALOGY OF SEDIMENTS ENCOUNTERED DURING LEG 61, AS DETERMINED BY X-RAY DIFFRACTION[1]

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INTRODUCTION

Two holes (462, 462A) were drilled at Site 462 in the Nauru Basin, within an area formed at a fast-spreading Pacific-plate boundary 145 to 155 m.y. ago. Forty-eight sediment samples were received and analyzed by X-ray diffraction according to the methods described in Mann and Müller (1980). Carbonate contents were determined by the "*Karbonat-Bombe*" method of Müller and Gastner (1971).

The upper 447 meters of the sedimentary section at Hole 462 consists of mainly turbiditic, calcareous, and radiolarian oozes, cherts, chalks, and limestones, which are in turn underlain by volcanogenic and zeolitic sandstones and siltstones (447–561 m). Three sedimentary units have been distinguished; Unit IV—below 561 meters—is predominantly basalt and dolerite with interlayered sediments.

RESULTS (see Fig. 1)

Hole 462

Unit I is a turbiditic sequence consisting mainly of calcareous and radiolarian ooze (about 220 m) or chalk (below 220 m), Oligocene and younger. The upper part, up to Sample 462-19-4, 142–144 cm, shows large fluctuations in carbonate content (0–94.2%); quartz and feldspar occur in minor amounts and only occasionally (see Fig. 1 and Table 1). Clay minerals are not well crystallized throughout Units I and II.

Kaolinite and chlorite could not be resolved in most samples, and are therefore shown together in one figure (see columns "Chlorite" and "Kaolinite"). Sample 462-21-3, 78–80 cm is the first of a $CaCO_3$-richer part of Unit I, which gradually becomes chalk (upper Oligocene). The average carbonate content is about 80%. Smectite is the only clay mineral present, except in Sample 462-27-6, 86–88 cm, where minor chlorite/kaolinite contents were found.

Unit II (297–447 m) begins with an upper Eocene to lower Oligocene porcellanite at 297 meters, which is the uppermost recovered cherty rock within the chalk. Principal lithologies of this unit are cherts, firm radiolarian oozes, chalks, and limestones.

Two upper Eocene samples from radiolarian-rich parts yielded high amounts of opal-A and smectite as the only clay mineral. Quartz is present in small amounts. In Sample 462-36-2, 45–47 cm, calcite is present in significant amounts (~29%).

Unit III (447–561 m), upper Campanian–lower Maestrichtian to Cenomanian, is composed of chalks, volcaniclastic sediments, zeolitic claystones, and dark-colored sediments tentatively described as black shales. Chert does not appear here and the boundary between Unit III and Unit IV is at the sediment/basalt contact.

At the top of Unit III, nannofossil chalks occur; the $CaCO_3$ content is 52.5% (see Table 1: Sample 462-48-2, 59–61 cm). Sample 462-50-1, 132–134 cm, from a lower Maestrichtian volcaniclastic sandstone/siltstone sequence, is less carbonate-rich (24.4%), but comprises higher clay mineral contents in addition to 6% feldspar and 2.5% hornblende. Two additional samples of Core 50 show a range of carbonate-poor (5%) to carbonate-enriched (25%) mineralogies. In the carbonate-rich sample, illite has been detected, but smectite again predominates in the clay mineralogy (78% versus 22%). Generally, high percentages of clay minerals and/or volcanogenic components prevail throughout Unit III. Sample 462-51-1, 45–47 cm, upper Campanian, is from an interlayered volcaniclastic/limestone sequence, and contains 7.5% $CaCO_3$ in addition to 6% feldspar; smectite is the main constituent.

Core 52 is the uppermost core from Hole 462 in which clinoptilolite has been detected. This corresponds to a change in lithology from a volcanic breccia interbedded with marly limestones to claystone with some limestone layers. Main components of the analyzed samples are $CaCO_3$ and well-crystallized smectite.

Sample 462-53-1, 6–7 cm, a zeolitic claystone, yielded a considerable amount of clinoptilolite, whereas $CaCO_3$ and clay mineral contents decrease and amorphous material increases. The other samples in this part (Cores 53 to 57) of Unit III have intermediate to low zeolite contents, but are high in X-ray amorphous constituents.

In two samples (462-56-1, 64–68 cm; 462-57-3, 36–38 cm), quartz and illite occur and are probably of detrital origin. The first sample contains, in addition, palygorskite, which—according to shipboard analysis—usually appears with clinoptilolite, which, however, could not be detected here.

Two zeolitic mudstone samples of Core 58, which are only 0.38 meters apart, have rather differing mineralogies. Sample 462-58-3, 131–133 cm is relatively rich in quartz (21.5%), whereas opal-CT occurs in Sample 462-58-4, 19–21 cm, which also contains smectite (<2 μm fraction) instead of illite.

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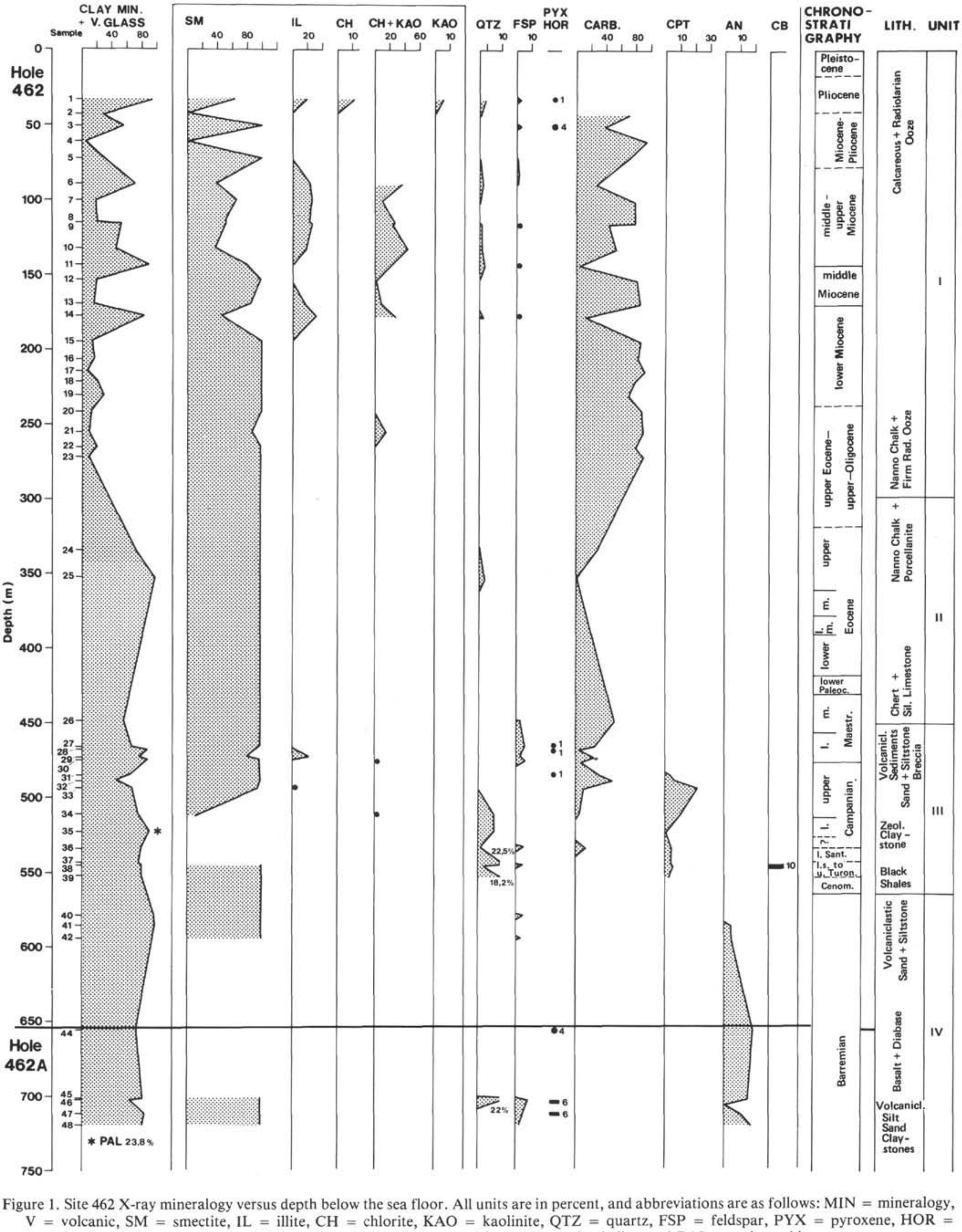

Figure 1. Site 462 X-ray mineralogy versus depth below the sea floor. All units are in percent, and abbreviations are as follows: MIN = mineralogy, V = volcanic, SM = smectite, IL = illite, CH = chlorite, KAO = kaolinite, QTZ = quartz, FSP = feldspar, PYX = pyroxene, HOR = hornblende, CARB = carbonate, CPT = clinoptilolite, AN = analcime, CB = cristobalite, and PAL = palygorskite.

Table 1. X-ray mineralogy of Leg 61 sediments.

			Bulk Mineralogy = 100%								Clay Mineralogy = 100%			
Core-Sec., Interval (cm)	Sample	Depth (m)	Clay Minerals and Volcanic Glass	Quartz	Feldspar	Pyroxene	Hornblende	Carbonates	Other	Clinoptilolite	Smectite	Illite	Chlorite	Kaolinite
Hole 462														
4-3, 106–108	1	33.07	93.1	3.9	~2	—	1	—	—	—	62.5	18.7	12.8	6.0
5-3, 140–142	2	42.91	28.5	1	—	—	—	70.5	—	—	—	—	—	—
6-2, 82–84	3	50.33	54.9	—	2.6	4	—	38.5	—	—	100	—	—	—
7-3, 60–62	4	61.11	5.8	—	—	—	—	94.2	—	—	—	—	—	—
8-4, 99–101	5	72.50	30.0	<1	<1	—	—	68.6	—	—	100	—	—	—
10-3, 87–89	6	89.88	70.5	1.9	<1	—	—	26.3	—	—	39.0	24.4	36.6[a]	
11-4, 25–27	7	100.26	19.5	<1	—	—	—	79.5	—	—	65.6	25.0	9.4[a]	
13-1, 69–71	8	115.20	20.8	<1	—	—	—	78.2	—	—	50.6	23.4	26.0[a]	
13-1, 147–149	9	115.98	53.7	1.7	<1	—	—	43.6	—	—	50.0	26.0	24[a]	
14-6, 72–74	10	132.23	44.9	1.3	—	—	—	53.8	—	—	36.9	19.4	43.7[a]	
16-1, 6–8	11	143.07	89.0	3.2	~2	—	—	5.8	—	—	78.4	—	21.6[a]	
17-1, 120–122	12	153.71	19.0	—	—	—	—	81.0	—	—	100	—	—	—
18-5, 110–112	13	169.11	14.7	—	—	—	—	85.3	—	—	84.0	17.5	8.5[a]	
19-4, 142–144	14	177.43	82.6	2.6	~2	—	—	82.6	—	—	43.4	30.4	26.1[a]	
21-3, 78–80	15	194.29	12.8	—	—	—	—	87.2	—	—	100	—	—	—
22-5, 88–90	16	206.89	16.7	—	—	—	—	83.3	—	—	100	—	—	—
23-4, 60–62	17	214.61	7.7	—	—	—	—	92.3	—	—	100	—	—	—
24-2, 127–128	18	221.77	20.5	—	—	—	—	79.5	—	—	100	—	—	—
25-2, 82–84	19	230.83	28.9	—	—	—	—	71.1	—	—	100	—	—	—
26-3, 41–43	20	241.42	10.3	—	—	—	—	89.7	—	—	100	—	—	—
27-6, 86–88	21	255.87	9.4	—	—	—	—	90.6	—	—	85.9	—	14.1[a]	
28-6, 120–122	22	265.71	20.0	—	—	—	—	80.0	—	—	100	—	—	—
29-4, 110–112	23	272.11	8.8	—	—	—	—	91.2	—	—	100	—	—	—
36-2, 45–47	24	334.96	70.3	<1	—	—	—	28.7	Opal A	—	100	—	—	—
38-1, 97–99	25	352.98	96.8	3.2	—	—	—	—	Opal A	—	100	—	—	—
48-2, 59–61	26	449.10	55.1	—	2.4	—	—	52.5	—	—	100	—	—	—
50-1, 132–134	27	467.33	67.1	—	6.0	—	~2.5	24.4	—	—	100	—	—	—
50-2, 145–147	28	468.96	86.6	—	5.4	3.0	—	5.0	—	—	100	—	—	—
50-6, 70–72	29	474.21	73.0	—	~2	—	—	25.0	—	—	78.0	22.0	—	—
51-1, 45–47	30	475.96	86.5	—	6.0	—	—	7.5	—	—	97.5	—	2.5[a]	
52-1, 124–127	31	486.26	63.1	—	—	~1	—	32.5	—	3.4	100	—	—	—
52-3, 65–68	32	489.67	45.4	—	—	—	—	50.0	—	6.6	100	—	—	—
53-1, 6–7	33	494.56	66.1	—	—	—	—	~10	—	24.0	97.3	2.7	—	—
54-3, 51–52	34	512.51	74.1	10.1	—	—	—	4.4	—	11.4	12.5	85.0	2.5[a]	
56-1, 64–68	35	323.16	89.9	10.1	—	—	—	—	—	—	6[e]	70.2[e]	—	—
57-3, 36–38	36	534.87	78.3	—	4.0	—	—	13.7	—	4	100	—	—	—
58-3, 131–133	37	544.82	74.5	21.5	—	—	—	—	—	4	—	100	—	—
58-4, 19–21	38	545.20	79.4	2.6	3.0	—	—	—	10[b]	5	100	—	—	—
59-3, 11–13	39	552.62	79.8	18.6	—	—	—	—	—	2	100	—	—	—
63-1, 23–25	40	579.74	96.0	—	4.0	—	—	—	—	—	100	—	—	—
64-1, 56–58	41	586.06	96.0	—	—	—	—	—	4[c]	—	100	—	—	—
65-1, 9–10	42	594.60	93.4	—	~2	—	—	—	4.4[c]	—	100	—	—	—
Hole 462A														
1-3, 39–41	43	81.40	9.0	—	—	—	—	91.0	—	—	50	—	50[a]	
32-1, 70–71	44	656.20	71.2	—	—	—	4	—	4[d] 20.8[c,d]	—	—	—	—	
40-1, 90–95	45	702.93	82.3	2.3	—	—	—	—	15.4[c]	—	100	—	—	—
40-1, 142–144	46	703.43	64.0	22.0	8.0	2	4	—	—	—	100	—	—	—
41-7, 132–135	47	712.32	84.0	—	4.0	—	6	—	6[c]	—	100	—	—	—
42-1, 59–62	48	720.61	80.0	—	~2	—	—	—	18[c]	—	100	—	—	—

[a] Not separated, because of very small amounts.
[b] Cristobalite.
[c] Analcime.
[d] 4% pyrite.
[e] Rest palygorskite.

Sample 462-59-3, 11–13 cm (upper Albian to Cenomanian), from a zeolitic mudstone sequence which has alternating reddish brown and dark grayish brown laminae ("black shales"), contains about 19% quartz, minor amounts of clinoptilolite and smectite as the main component.

The following samples of Cores 462-63–462-65 are from sediments interlayered between basalt sills. Two samples contain analcime but no clinoptilolite. This compositional characteristic indicates the well-known association of analcime with basic volcanic rocks (Kastner and Stonecipher, 1978). On the other hand, clinoptilolite "seems to be able to form from both volcanic and non-volcanic precursors" (Kastner and Stonecipher, 1978). Smectite becomes more abundant in these volcaniclastic siltstones, and is well crystallized.

No basalt samples from Unit IV have been analyzed.

Hole 462A (see Fig. 1 and Table 1)

At Hole 462A, the same sediments as in Hole 462 were penetrated to a depth of 617 meters. Sample 462A-1-3, 39–41 (Unit I) belongs to the calcareous ooze suite and consists almost exclusively of $CaCO_3$; only minor admixtures of smectite and chlorite/kaolinite are present. Sample 462A-32-1, 70–71 cm (Unit III) is a greenish black zeolitic siltstone overlain by a basalt sill. Here about 21% analcime and 4% pyrite occur. The clay mineral suite consists of smectite and vermiculite(?). This sample, as well as the following ones (Cores 462A-40–462A-42), belongs to the Maestrichtian to Barremian volcanogenic and zeolitic sandstone/mudstone sequence.

Two samples of Core 462A-40—upper Aptian dark gray laminated claystones with plant remains—contain smectite as the main mineral, whereas no pyrite could be detected. Quartz in differing amounts is present, in addition to analcime or feldspar + pyroxene + hornblende.

Sample 462A-41-7, 132–135 cm is a greenish gray claystone with abundant smectite and some analcime, hornblende, and feldspar. Sample 462A-42-1, 59–62 cm has a similar composition, but is richer in analcime.

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