Distribution of Cadmium in North Atlantic Deep-Sea Sediments

THERE is little information available on the concentration of the volatile, biologically toxic, element cadmium in deep-sea sediments. We present here some data on its distribution in a series of North Atlantic deep-sea sediments.

The material analysed, which included associated sea salt, was taken from the top portions of various NAVADO[1] cores, and Cd was determined on a dithizone extract of a digest of the sample using an atomic absorption carbon rod atomization technique. Sampling locations and the Cd contents of the cores are given in Table 1. The more important findings are,

Table 1 Sampling Location and Analytical Data from North Atlantic Deep-Sea Sediments

Core	Location	Total carbonate content (wt. %)	Cd content (p.p.b.)	
			Total sediment	Carbonate-free basis
C 2	16° 02′ N, 29° 43′ W	54	120	260
E 3	22° 04′ N, 35° 34′ W	1	40	40
E 6	21° 48′ N, 56° 41′ W	1	40	40
E 7	22° 06′ N, 69° 05′ W	5	275	290
F 1	25° 06′ N, 70° 22′ W	12	315	360
F 3	25° 12′ N, 57° 24′ W	10	200	220
F 4*	24° 55′ N, 49° 15′ W	58	300	710
F 5*	24° 49′ N, 39° 28′ W	77	215	935
F 7	25° 11′ N, 19° 44′ W	66	315	925
G 3*	27° 41′ N, 49° 10′ W	51	295	600
G 4	27° 49′ N, 65° 54′ W	2	490	495
H 6	30° 53′ N, 23° 08′ W	63	190	515
I 1	33° 52′ N, 12° 56′ W	59	285	695
J 2	36° 39′ N, 63° 10′ W	42	250	435
J 3	37° 46′ N, 55° 00′ W	32	305	450
J 4*	37° 27′ N, 38° 00′ W	89	115	1,035
J 5*	37° 15′ N, 27° 40′ W	74	230	885
K 6	39° 14′ N, 69° 19′ W	35	95	145
L 4*	43° 03′ N, 23° 16′ W	55	300	665
L 5*	43° 01′ N, 17° 14′ W	88	150	1,230
M 3*	45° 59′ N, 32° 11′ W	45	250	455
W 1	49° 10′ N, 41° 32′ W	13	100	115
N 2*	48° 52′ N, 34° 12′ W	32	580	850
N 3*	48° 40′ N, 24° 31′ W	20	370	460
N 4	48° 55′ N, 17° 12′ W	60	265	660
O 2	52° 00′ N, 17° 50′ W	13	190	220
P 2	55° 09′ N, 22° 45′ W	49	190	380
P 3*	55° 56′ N, 35° 30′ W	45	300	545
Q 1	57° 59′ N, 10° 04′ W	44	40	70
Q 3*	57° 56′ N, 29° 08′ W	57	220	510
R 2	60° 54′ N, 13° 05′ W	50	40	80
R 3*	60° 58′ N, 20° 58′ W	26	145	195
R 4*	61° 04′ N, 32° 30′ W	32	320	470
S 3*	64° 02′ N, 28° 57′ W	5	190	200
T 3	68° 36′ N, 06° 55′ W	36	200	310
Average; all deep-sea sediments				225
Average; deep-sea clays (<30% total carbonate)				215
Average; deep-sea carbonates (>30% total carbonate)				235

* Sediments from the Mid-Atlantic Ridge and ridge flank system.

first, the average Cd content of the North Atlantic deep-sea sediments analysed is 225 p.p.b. (p.p.10^9). This is close to the average of 271 p.p.b. Cd given for two deep-sea sediments from the North Atlantic[2]. Second, the average Cd content of our samples containing >30% total carbonate is 235 p.p.b., compared to 215 p.p.b. for samples containing <30% total carbonate; there is little difference, on average, between the Cd contents of sediments containing a large proportion of carbonate shell material and those consisting predominantly of lithogenous components.

We have suggested[3] that because deep-sea carbonates and deep-sea clays contained similar amounts of Hg it was incorrect to use calculated carbonate-free values to assess geographical trends in the distribution of this element. Subsequent analyses showed that the relatively high Hg content of carbonate shell material justified this approach. To investigate further the

association between Cd and carbonate material a number of shells were separated from 12 of the deep-sea sediments; the range of Cd contents in the shells was <5 to 120 p.p.b., with an average of 55 p.p.b. Our material consisted predominantly of the shells of foraminifera, and the average of 55 p.p.b. Cd may be compared with that of 28 p.p.b. found in the shells of near-shore marine organisms[2]. It is apparent, therefore, that although some carbonate shell can contain ~100 p.p.b. Cd, shell debris in general acts as a diluent on the Cd present in non-carbonate components, such as the clay minerals.

Third, both in the total sediment samples, and on a calculated carbonate-free basis, there is a tendency for higher Cd contents to be found in mid-ocean areas. For example, the average carbonate-free Cd content for these samples from the Mid-Atlantic Ridge and ridge flank system (see Table 1) is 650 p.p.b., compared to 335 p.p.b. for sediments from other localities. Sediments from the mid-ocean ridge system contain, on average, more total carbonate than those from other localities. The average Cd content of shell material from ridge samples (55 p.p.b.) is the same as that from non-ridge samples (55 p.p.b.), and if allowance is made for carbonate-associated Cd it is apparent that the non-carbonate fractions of mid-oceanic ridge sediments are significantly richer in Cd than those from other Atlantic deep-sea localities.

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Cathodoluminescence in Deformed Diamond

WE describe here, for the first time, changes in the cathodoluminescence of diamond, caused by deformation. Fig. 1—a scanning electron micrograph—shows part of a polished (100) surface of a diamond. This surface had been prepared for another experiment by polishing in the [001] direction with 0–1 µm powder, and then in the [010] direction with a nominal 4–8 µm powder. The surface damage shown in Fig. 1 appeared during polishing with the coarser powder. The area is approximately square in outline with sides about 30 µm long, but two of the four sides appear fore-shortened, as the surface was tilted in the microscope to bring out detail. The damage is similar to the ring cracks produced on diamond surfaces by loading them with a ballbearing. An analysis of these ring cracks[1,2] shows that the damage consists primarily of a cone crack, spreading outward and downward from the surface, which is held open by debris when the load is removed. The stone is thus left in a state of elastic strain, particularly in the region within the surface crack.

We also viewed the same surface in the cathodoluminescence mode of the scanning microscope, by observing photon emission from the diamond. This particular diamond (unlike many