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Mineralogy of Particulate Matter Suspended in Sea Water

Abstract. *X-ray diffraction analysis of the particulate matter of water samples from the Caribbean Sea, one from the surface and one from a depth of 768 meters, shows that the material has a mineral composition comparable to that found in deep-sea sediments of the area. The minerals found in the water samples include illite, the most abundant clay; kaolinite; chlorite; talc; mixed-layer clay; quartz; feldspar; and amphibole. Kaolinite and chlorite are more abundant relative to illite in the sediments than in the suspended material.*

The mineralogy of particulate matter suspended in water from the Caribbean Sea was determined for a surface sample at 12°06′N, 74°53′W (Fig. 1, location A), and for one at a depth of 768 m at 13°21′N, 64°19.5′W (Fig. 1, location B). Comparisons were made with sediment from the tops of piston cores, C 7-15 at 3515 m and C 7-7 at 3171 m, taken below the water samples. The suspended material was separated from 190 liters of sea water by means of a continuous-flow centrifuge. The weight of the analyzed sample of particulate material from 768 m was 48.9 mg (about half the total sample of suspended matter obtained). No such estimate could be obtained for the surface sample because of rust contamination from the water sampler. The mineral grains were of extremely fine size, and largely masked by organic detritus and exoskeletons. After appropriate chemical pretreatment (described below), an abundant mineral assemblage was found in the residues of both samples.

Repeated centrifuging and decanting with distilled water washed out salts and soluble organics. The carbonates were destroyed with a buffered solution of sodium acetate (*1*), the organic solids were decomposed and the manganese oxides were dissolved by hydrogen peroxide (*1*), the free iron oxides were removed by the citrate-bicarbonate-dithionite method (*1, 2*), and finally the amorphous alumina and silica were dissolved (*1, 3,*). A size separation (greater than 2 μ and less than 2 μ) was performed, and the fractions were water-sedimented onto glass slides to enhance basal lattice reflections of the layer silicates during x-ray diffraction analysis.

The weight of the mineral residue remaining after pretreatment of the suspended particulate material was on the order of a few milligrams, about 8 mg for the sample from 768 m. This material yielded diffraction spectra usable for identification purposes, but of limited value for quantitative estimates. Sometimes in x-ray diffraction analysis of the very fine layer-silicate particles, the plate-like crystals of finite thickness do not yield distinct diffraction maxima, a situation which may be thought of as extreme broadening of certain peaks. The very minute quantity of material also places limitations on the quality of the diffraction spectra.

Illite occurred in greatest abundance (probably more than 50 percent of the mineral residue) in the surface-water sample (Fig. 2, C 7-10). Second in importance was a layer-silicate mineral with peaks at 9.41 and 3.12 Å, tentatively identified as talc on the basis of comparison with x-ray powder data (*4*), with ASTM card 13-558, and with a specimen from Gouverneur, N.Y. (International Talc Co.). An uncertainty exists because pyrophyllite, the dioctahedral analogue of talc, has two strong basal spacings approximately at 9.2 and 3.04 Å (*4, 5*), also given by ASTM cards 2-0613 and 12-203. Lesser quantities of kaolinite, quartz, feldspar, amphibole, and a trace of mixed-layer clay also occurred in the surface-water sample. The occurrence of talc and amphibole in the surface-water sample and the proximity of the Magdalena River suggest a source in the metamorphic terrain of the Andes. Because of the limited quantity of material suspended in the surface-water sample, a size separation at 2 μ was not practicable.

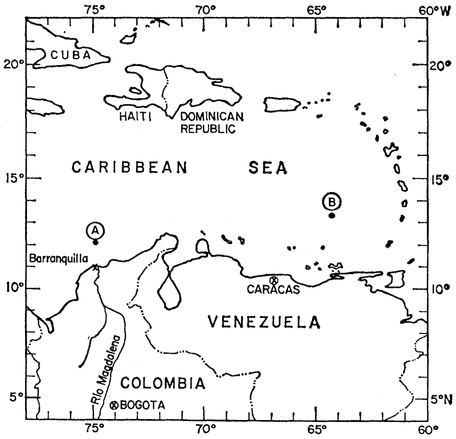
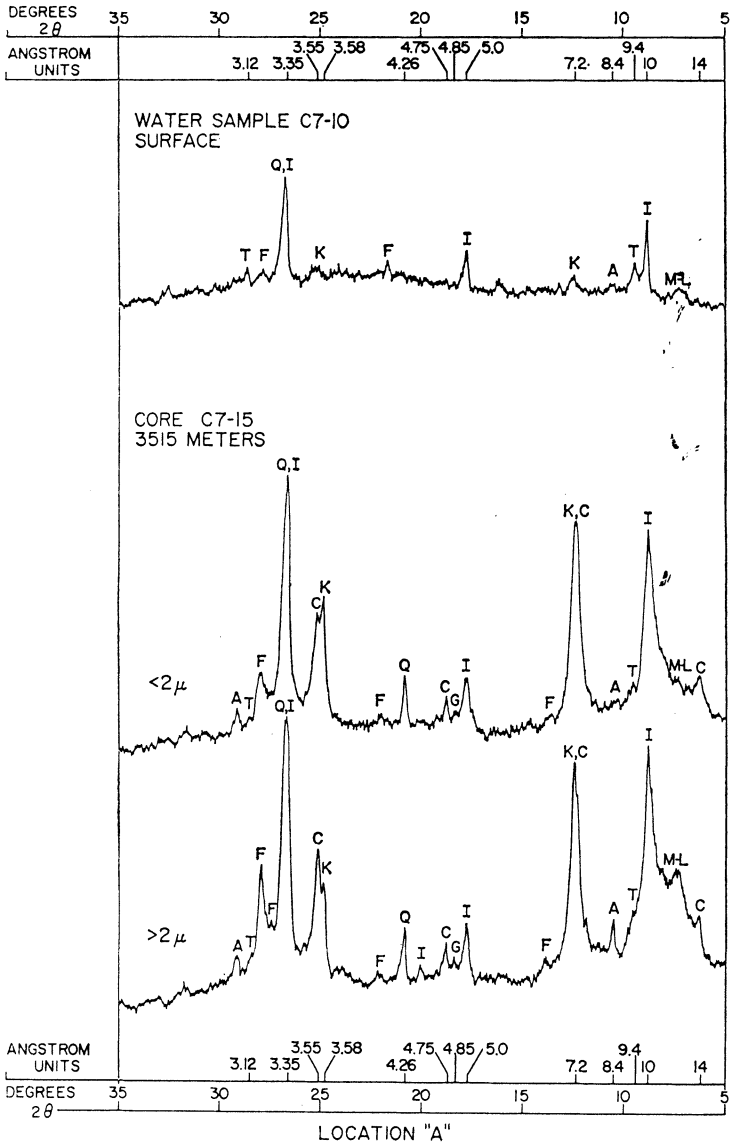


Fig. 1. Location map of samples from the Caribbean Sea for clay mineral study. Location A, 12°06′N, 74°53′W: surface-water sample C 7-10 and core C 7-15 at 3515 m. Location B, 13°21′N, 64° 19.5′W: water sample C 7-4 at 768 m and core C 7-7 at 3171 m.

Illite is also abundant in the deep-sea sediment (C 7-15) below the surface-water sample (Fig. 2), in both the greater than 2-μ and the less than 2-μ fractions. A distinct difference, however, between the mineral content of the material suspended in water and that of the bottom sediment occurs in the increase of the layer silicates with 7-Å spacings, kaolinite and chlorite. The manner in which the 7-Å peak skews to the right and the occurrence of a small peak at 7.4 Å in the greater than 2-μ fraction suggest the occurrence of another layered silicate mineral, either halloysite, known to form as a weathering product of volcanic debris on land, or a serpentine mineral, commonly found in metamorphic terrain. The lack of additional diagnostic peaks prevents a more complete identification. Talc and mixed-layer clay are present as minor constituents. Quartz, feldspar, and amphibole are plentiful, and a trace amount of gibbsite appears in both fractions.

In the water sample taken at a depth of 768 m (Fig. 3, C 7-4), illite is again the most abundant clay mineral, occurring with kaolinite, chlorite, and a minor amount of mixed-layer clay. Talc



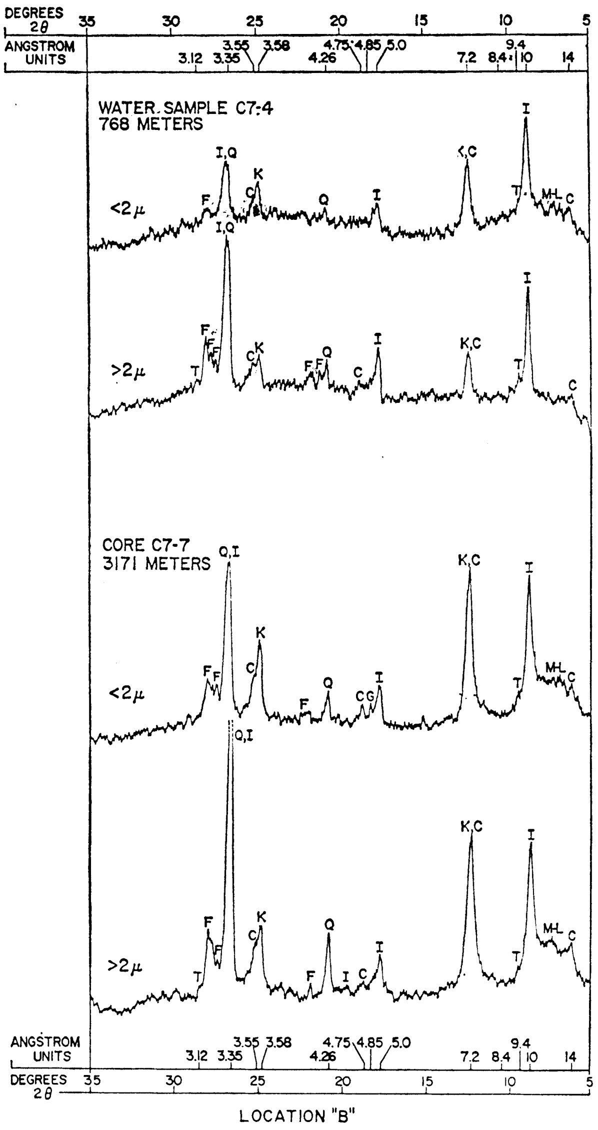


Fig. 2 (left). X-ray diffraction patterns of mineral assemblages in surface sea water and bottom sediment from the Caribbean Sea, location A. *C*, chlorite; *M-L*, mixed-layer clay; *I*, illite; *T*, talc; *A*, amphibole; *K*, kaolinite; *G*, gibbsite; *F*, feldspar; *Q*, quartz. Fig. 3 (right). X-ray diffraction patterns of mineral assemblages in deep sea water and bottom sediment from the Caribbean Sea, location B. *C*, chlorite; *M-L*, mixed-layer clay; *I*, illite; *T*, talc; *K*, kaolinite; *G*, gibbsite; *Q*, quartz; *F*, feldspar.

appears to be more plentiful in the greater than 2-μ fraction, along with quartz and feldspars.

Comparison of the clay mineral content of the bottom sediment (Fig. 3, C 7-7) with that suspended in sea water again reveals an increase in kaolinite and chlorite relative to illite. The general mineral assemblage is otherwise similar, except for the appearance of a minor quantity of gibbsite in the deep-sea sediment. Talc diminishes and amphibole disappears in suspension in sea water and in bottom sediment at location B (Fig. 1). The difference in distribution of these minerals reflects the influence of proximity to source area on pelagic deposition.

The discovery of a near-surface and a near-bottom light-scattering layer at several Atlantic stations (*6*) calls for analysis of the suspended mineral grains in the light-scattering layers and comparison with the bottom sediment. Mineral analysis of suspended particulate material in sea water should be useful, not only in defining the origin of the material causing turbidity in the sea but also in the larger problem of the source and mode of transport of deep-sea sediment grains.

Marian B. Jacobs
Maurice Ewing

*Lamont Geological Observatory,
Columbia University,
Palisades, New York*

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