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11.2 CLAY MINERALOGY IN VOLCANOGENIC SEDIMENTS

Hervé Chamley and Ghislaine Giroud d'Argoud, Centre d'Océanographie, Luminy, 13288 Marseille, France

ABSTRACT

The clay minerals of volcanic glass-rich sediments from Hole 373A and Site 376 are the same as those of their associated sediments. This confirms previous suggestions that submarine evolution of clay minerals from volcanogenic sediments is an unusual occurrence.

Volcanogenic sediments from DSDP Leg 42A were studied by X-ray diffraction in order to determine if any postburial clay modification occurred in this peculiar depositional environment. Clay mineral compositions were determined for sediments from Sites 372 (East Menorca Rise, Cores 34 to 46); 373A (Central Tyrrhenian abyssal plain); and 376 (Florence Rise, west of Cyprus). The investigation of 48 samples from Site 372 did not confirm the presence of volcanic components as expected from initial shipboard descriptions of the lower Miocene clayey muds at the base of this section. Hence, those results will not be discussed here (see Mélières et al., this volume).

The data from the mineralogical study of the less-than-2 micron noncalcareous particles are summarized in Tables 1 and 2 (values in percentages). The average values for "common" sediments, without volcanic components, are from analyses of the Pleistocene from Site 132 (DSDP Leg 12) for the Tyrrhenian Sea (Chamley, 1975a), and of sediments from Site 376 itself for the Levantine Basin.

Layers rich in volcanic glass occur at both sites (e.g., Samples 373A-1-1-111 cm, 376-1-5 90 cm, 376-3-1, 128 cm). They are generally poor in clay minerals, whose relative abundances therefore cannot easily be determined. The horizons chiefly contain sandy glass:

TABLE 1
Tyrrhenian Sea, Pleistocene, Hole 373A Clay Mineralogy (%)

Sample (Interval in cm)	Illite	Chlorite	Mixed-Layer	Smectite	Kaolinite	Attapulgite
Volcanogenic sediments						
1-1, 111	+	+	–	+	+	–
1-1, 127	35	10	10	35	10	traces
1-2, 136	35	10	10	35	10	–
1-3, 146	25	10	15	40	10	traces
Common sediments (average values Site 132)	30	10	15	35	10	traces

TABLE 2
Florence Rise, Pleistocene, Site 376 Clay Mineralogy (%)

Sample (Interval in cm)	Illite	Chlorite	Mixed-Layer	Smectite	Kaolinite	Attapulgite
Volcanogenic sediments						
1-5, 90	+	+	?	++	+	–
1-5, 95	5	5	5	80	5	?
1-5, 98	5	5	5	80	5	traces
3-1, 128	+	+	?	+	+	?
3-1, 134	5	5	traces	80	5	5
Common sediments						
1-5, 106	5	5	traces	80	5	5
3-1, 146	5	5	traces	80	5	5

as splinters in Hole 373A and with both splintered and fibrous forms in Site 376. The levels without significant sand fractions contain clay mineral assemblages, the composition and crystallinity of which are quite similar to those of the under- and overlying "normal" sediments. It follows that there is no evidence of argillaceous diagenesis within a volcano-sedimentary environment at either drill site.

In order to place the present results in a more general context, we discuss below the much debated question of the early submarine transformation of volcanic materials to clay. Early studies carried out in the Tyrrhenian Sea lead workers to postulate the formation of clay minerals from volcanogenic minerals or ash. For example: The submarine exfoliation of biotite into illite in deep-sea pyroclastic sands (Norin, 1953); the transformation of glasses into montmorillonite, mixed-layer montmorillonite-illite, then illite and even chlorite in near-coast sands off Capri and Sardinia (Grim and Vernet, 1961); the formation of kaolinite, illite, quartz, calcedonite, and analcime in recently deposited ashes of the Gulf of Naples (Müller, 1961).

Later works commonly link the genesis of smectite (= montmorillonite) from volcanic materials. However, such a petrogenesis has not been clearly demonstrated. Moreover, a distinction is rarely made between submarine evolution and a continental transformation, by the weathering of a volcanic terrain producing smectite, which is ultimately, carried to the sea by river discharge (see Quakernaat, 1968). Thus Chamley et al. (1962) and then Nesteroff et al. (1963) suggested that the montmorillonite increase towards the south of the Tyrrhenian Sea could result from the development of volcanic rocks in this area, and such an idea is supported and developed by Tomadin (1973, 1974a, b).

The above authors envisage a comparable relationship between smectite and volcanic rocks in the Central Mediterranean (see also Sartori and Tomadin, 1974), as well as in some sectors of the Eastern Mediterranean. In most cases, it is very difficult to distinguish between the different types of smectites in sediments (see Arrhenius, 1963; Griffin et al., 1968), all the more so because these minerals are available in abundance in numerous sedimentary rocks along the periphery of the Mediterranean (Chamley, 1971; Emelyanov, 1972). Valette (1972a), as well as Huang and Stanley (1972) and Pierce and Stanley (1975), consider the montmorillonite of the Alboran Sea to be the result of local volcanic evolution, but other workers believe it could also be inherited from the Atlantic by way of the Gibraltar Strait (Auffret et al., 1974; Mélières, 1974).

Some well-documented occurrences of authigenic mineralogical growth are known in the sediments of volcanic regions, and these would seem to support the previous results obtained in the Tyrrhenian Sea around 1960. Such is the case for palagonite or hyaloclastite formation, the genesis of spadaite and then saponite, zeolites with calcite and opal in Sicily (Honnorez, 1967), and the genesis of trioctahedric smectite with zeolites and calcite in Sicily and Campania (Cristofolini et al., 1973). Also, in the caldera of Santorini (Aegean Sea), clay-sized pumaceous ashes are transformed into smectite during burial, with the aid of silica from diatoms and radiolarians (Chamley and Millot, 1972). On the other hand, clays from the marine environs of Vulcano (Eolian Islands) do not seem to be clearly related to volcanism (Valette, 1972b).

The ash- or glass-bearing levels interbedded in common deep-sea sediments, similar to the ones considered here from DSDP Leg 42A, rarely show any characteristic authigenic clay mineral growths. It is commonly observed that the smaller smectite particles are in fact greatly diluted by the influx of the volcanic material. Other examples of this occurrence can be quoted: For example, pyroclastic layers in the eastern Mediterranean described by Ninkovich and Heezen (1965) and Keller and Ninkovich (1972), and studied mineralogically by Chamley (1971, 1975b) and Robert (1974); and volcanogenic sediments of DSDP Site 132 (Leg 13, Tyrrhenian Sea) described by Chamley (1975a).

The data presented here for the Leg 42A sediments agree with those results from the literature discussed above that suggest that the authigenic formation of clay minerals in the Mediterranean volcano-sedimentary environment is not common. Such a petrogenesis is particularly unlikely in beds lacking siliceous fossil material or small volcanic particles with large surface areas as is the case in these sediments from Hole 373A and Site 376.

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11.3 TURBIDITES AT SITE 374: THEIR COMPOSITION, PROVENANCE AND PALEOBATHYMETRIC SIGNIFICANCE

Jens Müller, Werner Hieke, and Frank Fabricius, Lehrstuhl für Geologie, Technische Universität, München, West Germany

ABSTRACT

Pleistocene sediments cored at Site 374 in the Messina Abyssal Plain contain a number of turbidite deposits. Within these, two kinds of mineralogical associations were recognized. The first is low in carbonate with high amounts of quartz and feldspars, while the