36. REMARKS CONCERNING GLAUCONITIC MATERIALS COLLECTED DURING LEG 48

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ABSTRACT

Different components were collectively described as glauconite in the shipboard studies of cores from Sites 403 and 404. Distinction of these components by careful and detailed analysis allows reconstruction of the initial environment of deposition. Two types are present. A green facies due to chloritized micas that indicate subaerial exposure and alteration and an authigenic glauconie formed in the oceanic realm far from subaerial exposure. The mineralogic nature of the authigenic marine minerals studied here may be correlated with a brief and geologically insignificant period of deposition. All available data suggest that the North American and European continents have not contributed to these sediments.

From the preceding studies (Odin, 1975), it seems clear that the green pellets derive from an initial pelletal framework, composed of pellets, grains, debris, and tests of various chemical compositions. In the interstices of the framework the glauconite-like minerals have grown and evolved. The nature of the initial framework, its alteration, and the mineralogy of the authigenic minerals are useful indicators of the sedimentary environment.

QUANTITATIVE STUDY

Five to 15 grams of bulk sediment were washed on a 50 μm sieve, dried and dry sieved on 500, 160, and 100 μm mesh. The paramagnetic pellets were separated in 4 to 8 fractions and all were weighed. The percentages of these fractions are given in Figures 1 and 2.

From Site 403, Sample 28-1, 61 cm contains sparse gray-green debris. In Samples 29-4, 34 cm and 33-3, 35 cm, there was no glauconie[1] in the separated fractions. The sediments of Core 29 yielded a green clayey fraction resulting from the disaggregation, during washing, of unconsolidated green pellets.

Green grains which are often present in Cores 34, 35, and 40 consist of chloritized greenish mica flakes. With the exception of Sample 40-1, 148 cm, there is no typical glauconie in these layers. It previously may have been confused with crystalline green minerals (hornblende?) observed in the washed fraction. The sand fraction also is green in color in this instance.

From Site 404, various layers are glauconie-rich but Samples 13-4, 29 cm; 13-2, 71 cm; and 18-1, 91 cm yielded only scarce glauconitized green pellets. The glauconies are apparently absent in layers older than Core 18, but abundant green micas often show a "glauconitic aspect," e.g., Cores 21, 22, and 23. Where the green pellets are abundant, the total chemical composition of the sediments becomes fixed due to the high iron content (25% Fe_2O_3) and the low ratio of Al_2O_3:Fe_2O_3 (less than ⅓) in this micaceous clay. This relationship explains some notable geochemical variations.

QUALITATIVE STUDY

Origin of the Glauconies — Their Initial Framework

At Site 403, tests of microfauna comprise most of the initial framework. In Core 28, a greenish rock debris is present whereas some green micas and quartz (glauconitized) are present in Samples 29-3, 37 cm and 40-1, 148 cm.

At Site 404, a green infilling of tests is common in Cores 11, 16, and 17, whereas in Sample 18-1, 9 cm, abundant micas and green quartz are probably glauconitized. Numerous green pellets were observed in thin sections of Sample 16-2, 104 cm. Although pseudo-oolitic in appearance, they are actually unfilled foraminiferal tests such as observed in the indurated layer of Core 12. The test is often green with a thin fibroradiating skin. Structures similar to oolites have been observed in Recent sediments (Lamboy-Odin, 1975) but their genesis is not compatible to that of an oolite because the pellets are not moved by submarine currents.

The thin sections were made from paramagnetic layers not containing abundant glauconie (Cores 403-29, 403-41, and 404-26). Therein, several coarse particles of amorphous material exhibit a green microcrystalline structure in the pores that may indicate initial glauconitization of volcanic fragments. These observations suggest that the coarse green pellets (greater than 500 μm) are derived from mineral and volcanic debris. Glauconitization is just beginning for the largest grains and is complete in the smallest (often 2 to

[1]Use of the word "glauconite" is ambiguous, e.g., there are glauconite-like grains without any trace of the mineral glauconite. The French word "glauconie" has therefore been used in discussing green pellets of various mineralogic compositions including amongst them glauconite mineral.

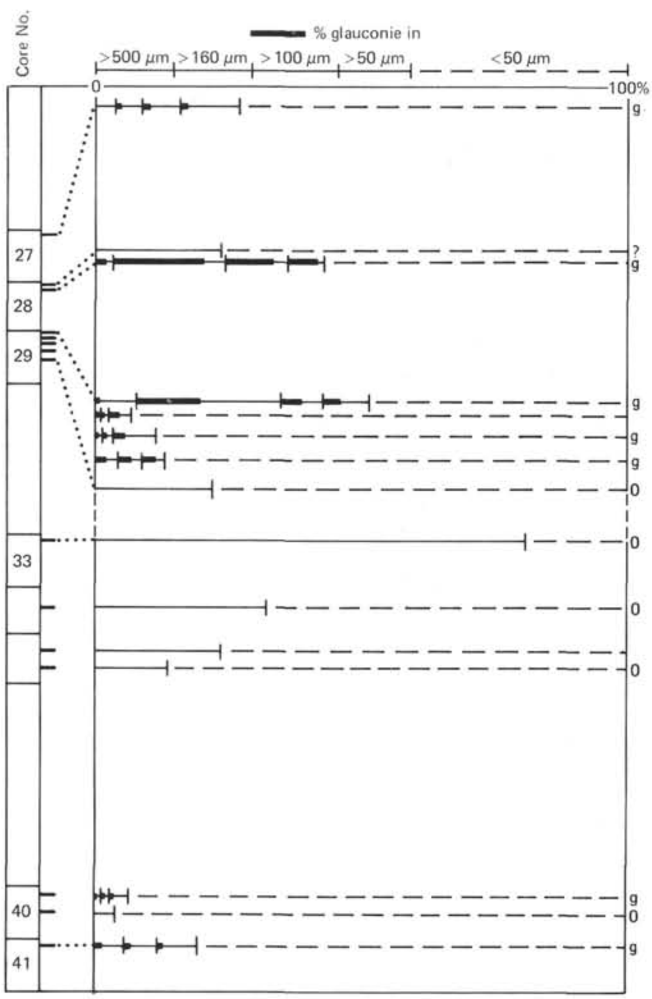

Figure 1. *Percentages of fractions sampled Hole 403, Leg 48. Each studied sample is noted on the left column. The per cent of the coarse fraction is on the left side; the finest fraction is on the right side The detail of the fractions is given for samples containing glauconitic pellets (glauconie = black thick line). When glauconitic minerals are mineralogically recognized, the letter "g" is noted on the right column. If there is no glauconie seen morphoscopically in the sample, the letter "o" is noted.*

300 μm). The small green pellets (less than 160 μm) are derived from glauconitization of the infilling of foraminiferal tests. The tests are usually dissolved except for indurated calcareous samples which are green but never dark green. In this finest fraction, small glauconitized micas are sometimes present.

Infilled foraminiferal tests and microporous, poorly crystallized minerals such as clay and carbonate provide the best initial framework. Feldspar, mica, and quartz crystals are rarely or slightly glauconitized reflecting, in order, slower glauconitization (Odin, 1975). These observations and the absence of dark green pellets suggests an incomplete and short evolution of the pellets.

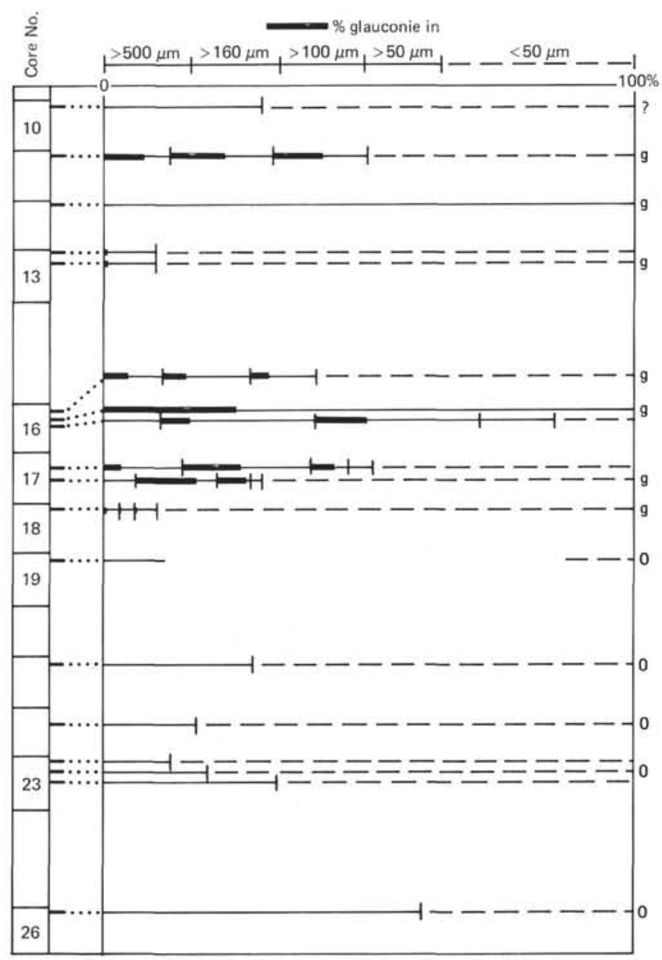

Figure 2. *Percentages of fractions sampled, Hole 404, Leg 48. (See Figure 1 for explanation.)*

Chemical Mineralogy of the Green Pellets and Debris

The study of numerous Recent to Jurassic glauconies has led first to a distinction between inherited (initial) minerals and authigenic marine minerals and second to a distinction between different authigenic minerals so that the glauconitic minerals form a continuous range between a smectitic and a micaceous end-member. During the evolution of the pellets, the inherited minerals are altered and disappear while the authigenic ones are growing. Recrystallization with time is shown by the replacement of smectite (14Å) by more closed phyllites (13, 12, 11 . . . Å) and then by more ordered phyllites. The components of the glauconie thus offer a measure of their history. Diffractograms can be regarded as a qualitative measurement of elapsed time.

Diffractograms were made on powder when approximately 50 mg of separated pellets were available. Interpretation of the diffractograms shows that the more evolved pellets contain only authigenic phyllitic minerals. These are glauconitic smectites in Samples 27-1, 29 cm and 28-1, 94 cm from Site 403, and in Sample 16-1, 87 cm from Site 404 with a typical 14Å (swelling) peak. In other samples from Site 403 (29-1, 32 cm and 29-3, 37 cm) and Site 404 (16-2, 117 cm and 17-2, 90 cm), authigenic phyllites exhibiting peaks between 11 and 13Å are present. The most evolved glauconie, found in Sample 17-3, 91 cm from Site 404, was fine green in color and contained 11Å phyllites; gray smectite was found in the clay fraction of this sample. These data suggest that an important controlling factor in glauconitization is the presence of pelletal supports. Their evolution is internal and not external despite the existence of a priori favorable chemical components. The glauconitization is not dependent on an initial chemical component but on the physicochemical microenvironment.

The presently observed glauconitic minerals are characterized by weak (hkl) peaks and are disordered phyllites indicating that they are less evolved. The evolution of the initial support has not been long enough to yield a micaceous mineral since the step 11Å phyllites require the order of 10^4 years (Odin, 1975). The absence of abundant glauconie in well-defined layers shows that sedimentation has never been interrupted for a geologically long interval.

The ferriferous authigenic minerals contain little potassium (e.g., 2 to 3%) in the smectitic phyllites and 4 to 4.5 per cent K_2O in the 11Å phyllites. However, relatively abundant pellets will lead to a higher total K content and thus to higher gamma ray activity in the sediment. In this case, micas are apparently more abundant in glauconie-free layers (e.g., Site 403 Cores 33, 34, 35, and 40; Site 404 Cores 21, 22, 23, and 26). The mica-rich layers contain green particles which X-ray analysis shows to be typical chloritized micas. These green particles suggest nearby subaerial alteration and subsequent burial in coarse sediments.

During the magnetic separation of the green pellets, other minerals and lithic particles were found (e.g., Site 403, 29-4, 34 cm, 41-1, 86 cm, and Site 404, 26-1, 3 cm). X-ray diffractometry in the powdered pellets shows smectites and strongly diffracting sodic plagioclases. Analcime occurs in the pellets of Samples 403-41-1, 86 cm. The paramagnetism of these particles is probably due to poorly crystallized magnetite. Thin sections prepared using araldite inclusion show frequent opaque minerals and lava particles that are partly green especially in the anfractuosities of the debris. Glauconie is clearly forming from the volcanic fragments. Inclusions of various blue and green colors often showing a fibroradiating structure are probably zeolites.

DISCUSSION

The presence of abundant glauconie is characteristic of marine sediments deposited and modified in the open sea by two competing geochemical reactions reflecting continental and marine influences. This first is characterized by Si-Fe ions and the latter by K^+. The geochemical reactions are found today on the outer part of the shelf in depths of 100 to 300 meters and sometimes on deeper marine ridges. The alteration, crystal growth, and recrystallization are typical of a region with only ionic transport situated far from "continental" deposits. However, the absence of well-developed glauconies shows that a long break in deposition did not take place over the interval studied here.

Considering the absence of glauconitized coprolites and molluskan tests characteristically derived from the neritic zone, and reworked during transgressions, it can be inferred that stable coasts have not contributed to the coarse sediments. The glauconitization is here independent of a transgressive phase.

From the recognizable glauconitized foraminiferal tests and amorphous volcanic particles, a submarine ridge of volcanic origin can be postulated lying beyond the influence of the American and European continents during the early Eocene. This model of "oceanic" sediment deposition is supported by the rare earth spectrum of the clays (Courtois and Chamley, in press). The smectites, exclusive components of the clay fraction, are derived from alteration of nearby volcanic material.

Two models may therefore be considered to account for the green components of the sediments. Where glauconies are present, subaerial outcrops are rare or absent so that subaerial alteration does not take place and the slow sedimentation rate permits the development of glauconitic smectites. However, if subaerial outcrops are present, micas are deposited and altered to chlorites which are transported seaward. In this case, the sedimentation rate is too rapid to permit glauconitization.

Volcanic rock debris forms the principal point of *in-situ* glauconitization. These results can be compared with observations at other glauconitic outcrops of Paleogene age in Europe. During the early Eocene (52 to 45 m.y. B.P.), glauconies were abundant in the English-Belgian-Paris Basin, e.g., the Argilesde Varengeville, Sables de Cuise, sands from Aalter, the London Clay, and Lower Bracklesham Beds. Further to the south, the Marnes à *Xanthopsis* of the Aquitaine Basin also contain glauconies. Most of these glauconies are little evolved probably reflecting the brevity of the marine influence on the initial framework. This can be seen in the low K content. Dependent upon area, the accompanying clay minerals may be a mixture of kaolinite, smectite, and illite. Pelletal chlorite has not been recognized, but glauconitized micas and infillings of foraminiferal tests are frequent in the Aquitaine Basin. In contrast, zeolites are common, e.g., clinoptilolite is often found in the 2 to 10 μm washed sediments of the Paris Basin.

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