# 9. X-RAY DIFFRACTION OF SOME SAMPLES FOR CLAY MINERALOGY FROM SITE 417, DEEP SEA DRILLING PROJECT LEG 51, WESTERN NORTH ATLANTIC

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## INTRODUCTION

Most sediments recovered on Leg 51 drilling are dominated by clay minerals. This is not surprising, given the age and depth of the site, its subsidence history below the calcium carbonate compensation depth (CCD) since mid-Late Cretaceous times, and the early pelagic sedimentation on a mid-oceanic ridge environment during Aptian to Cenomanian times. Clay minerals range from 65 to 90 per cent of the sediments, except in relatively rare calcareous interbeds and chert in the lowest sections.

This chapter briefly presents the occurrences and X-ray patterns of the most important clay-mineral assemblages based on samples from Holes 417A and 417D. Sampling was partly biased. That is, clay-mineral samples were taken from clayey sediments, avoiding cherts and chalks, and favoring unusual lithologies and thin clay beds rather than attempting to document an average, representative spectrum (see Müller, this volume). In spite of the sampling bias, the results show trends in the depositional environment. Rather than progressive downhole modification, caused by diagenetic changes, we see discrete jumps that correspond to some of the macroscopic, lithologic changes.

A series of 27 samples, listed in Table 1, were scanned with normal and glycolated smear mounts. Figures 1 and 2 are line drawings of the original X-ray diffraction data.

## DISCUSSION

The samples from Hole 417A, Core 1 through Core 6 (Quaternary through middle Miocene), have a very similar spectrum comprising equal portions of illite-montmorillonite-kaolinite and some chlorite. There is a persistent mixed layer smectite-illite for 11.2 to 12.6 Å. The 12.4 to 12.6 Å peak increases gradually in importance in this terrigenous spectrum from Core 8, Section 1 through Core 13, Section 1. It is within this series of pelagic clays that rhodochrosite crystals occur as the most common coarse-fraction mineral.

With the advent of clinoptilolite in Sample 417A-15-4, 61-62 cm, the proportion of illite and kaolinite decreases. The 12.5 Å peak has numerous shoulders. All the 12.1 to 12.6 Å broad peaks glycolize to a 16.9 to 17.6 Å montmorillonite. This trend continues to Core 20, Section 2. Nothing unusual was noticed in cores near the weathered basement.

At Hole 417D, there is general overlap in the first cores. But with Sample 417D-9-1, 78-82 cm, the spectrum becomes dominated by zeolite, clinoptilolite, and varying amounts of cristobalite. Some samples are dominated by illite, and kaolinite diminishes. The 12.5 Å smectite peak

**TABLE 1**
**Sample Listing, X-Ray Diffraction Study, Holes 417A and 417D**

| Sample (Interval in cm) |
|---|
| **Hole 417A** |
| 1-2, 32-33 |
| 1-3, 37-38 |
| 1-4, 40-41 |
| 2-2, 60-61 |
| 3-2, 19-20 |
| 5-2, 56-57 |
| 6-2, 50-51 |
| 8-1, 30-31 |
| 9-2, 39-40 |
| 11-2, 30-31 |
| 12-3, 46-50 |
| 13-1, 2-4 |
| 15-4, 61-62 |
| 16-2, 3-4 |
| 18-2, 62-63 |
| 19-2, 37-38 |
| 20-2, 46-47 |
| **Hole 417D** |
| 3, CC |
| 9-1, 78-82 |
| 9-2, 45-50 |
| 10-1, 40-48 |
| 10-2, 66-68 |
| 10-2, 72-73 |
| 11-1, 65-67 |
| 12-1, 43-45 |
| 12-1, 53-56 |
| 12-2, 119-127 |
| 12-4, 102-104 |
| 12-4, 122-125 |
| 13-1, 105-108 |
| 13-1, 125-127 |
| 13-2, 11-12 |
| 14-1, 50-53 |
| 14-1, 40-42 |
| 14-3, 93-94 |
| 14-5, 16-17 |
| 15-1, 54-57 |
| 16-1, 86-88 |
| 17-3, 85-87 |
| 18-1, 106-108 |
| 20-1, 2-4 |
| 20-1, 2-4 |
| 20-1, 82-83 |
| 20-1, 107-110 |
| 20-2, 7-9 |
| 21-1, 15-17 |
| 21-2, 32-33 |
| 21-3, 57-59 |
| 21-3, 98-99 |

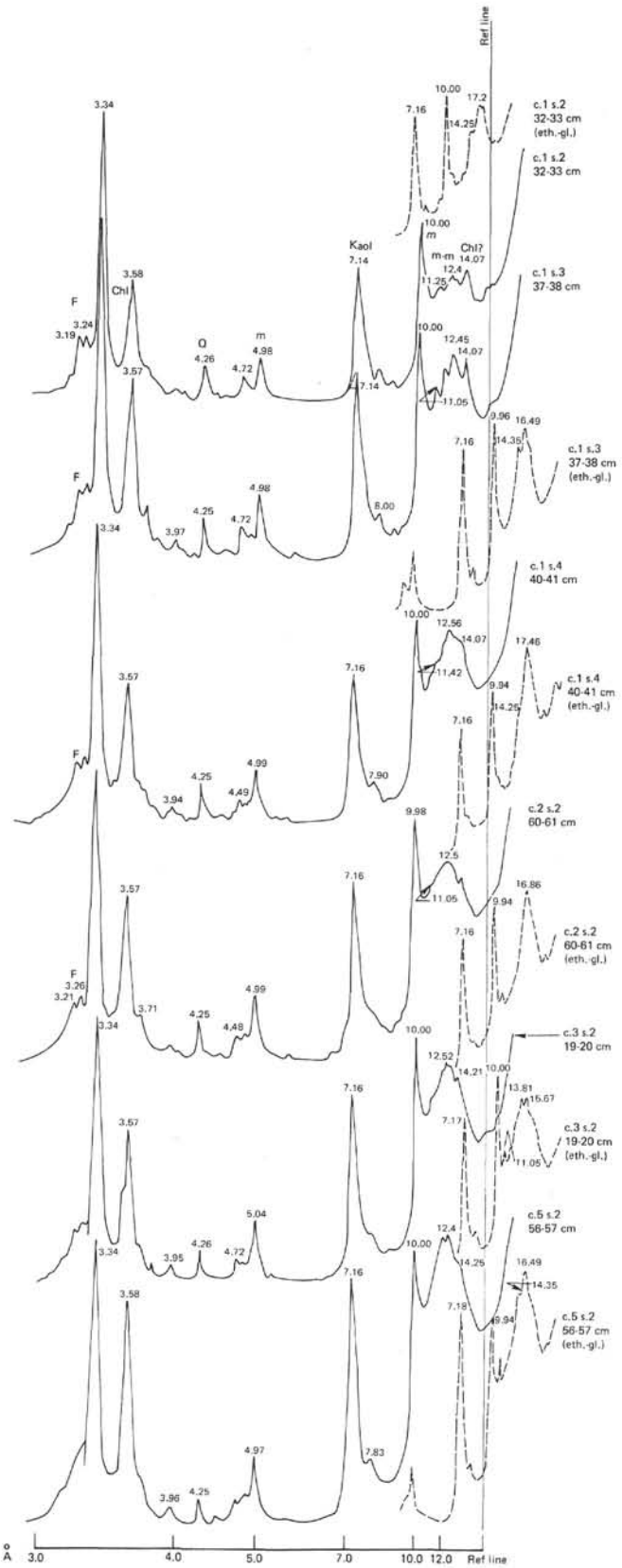


Figure 1. *X-ray diffraction diagrams, Hole 417A. Numbers near the peaks are d-spacings in Angstroms. Abbreviations: M: mica, M-M: mica-montmorillonite mixed layer, Chl: chlorite, Q: quartz, Clp: clinoptilolite, Kaol: kaolinite.*

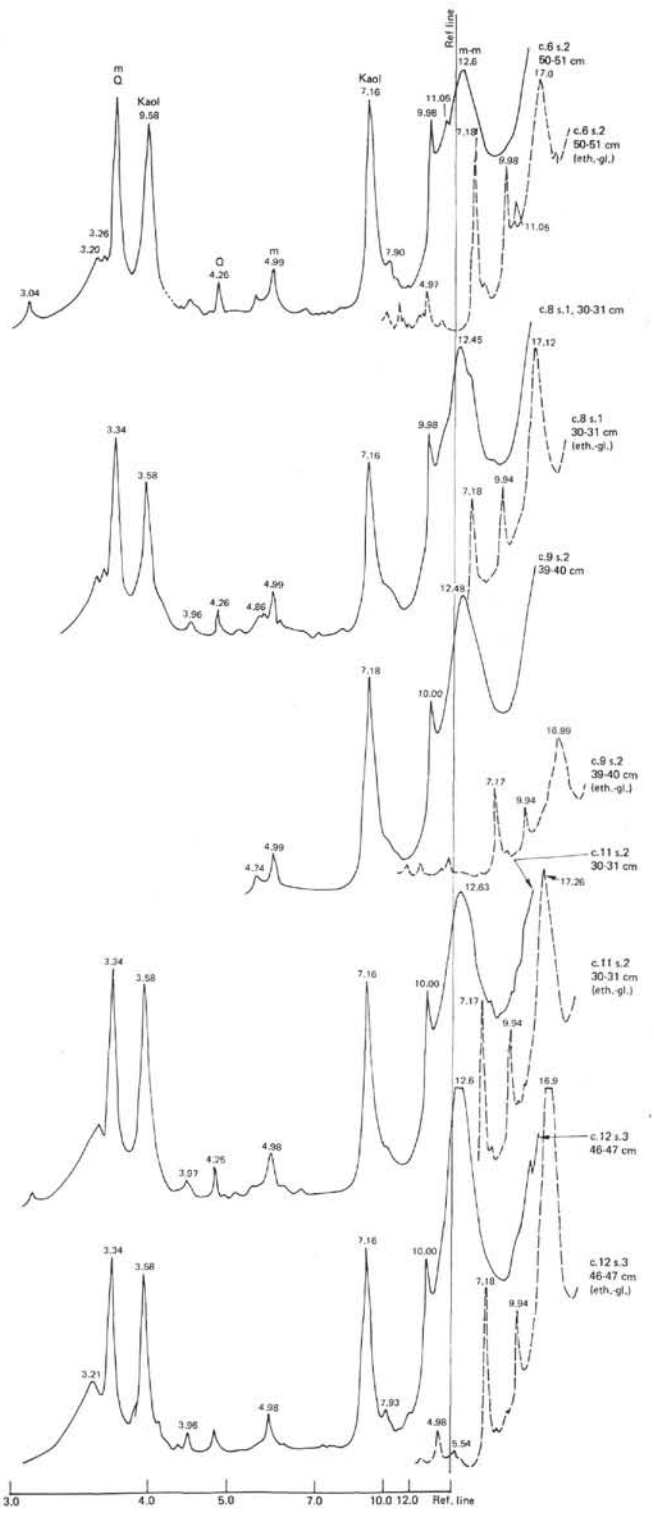


Figure 1. *Continued.*

separates into a more dominant 17.0 Å peak. This general trend continues through Core 12. A persistent 11.05 Å shoulder is present. In Sample 417D-12-4, 102-104 cm, a discrete waxy, white monomineralogic layer occurs, consisting of a single 11.79 Å and 4.27 Å designated montmorillonite, but this could be palygorskite.

Smectite increasingly becomes more abundant than illite in Core 13. In hard, brown claystones from Core 14, a

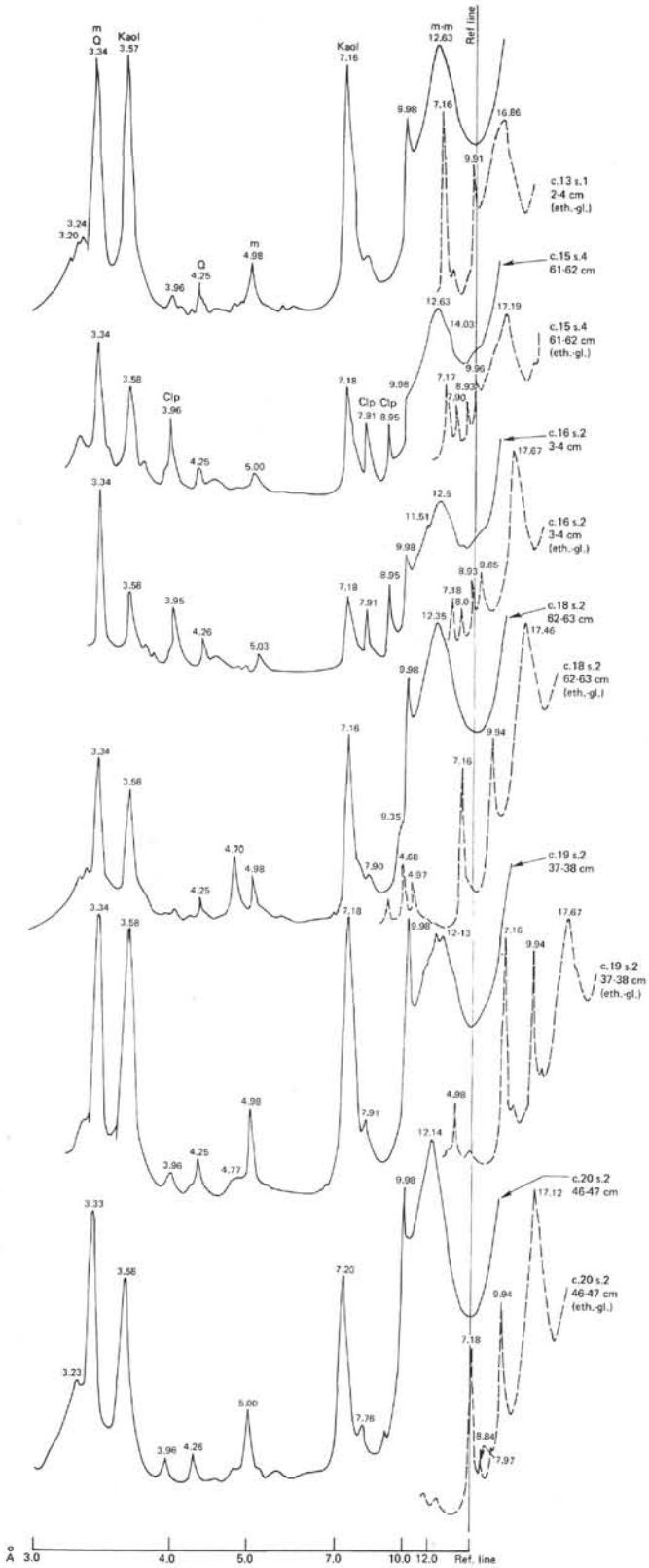


Figure 1. *Continued.*

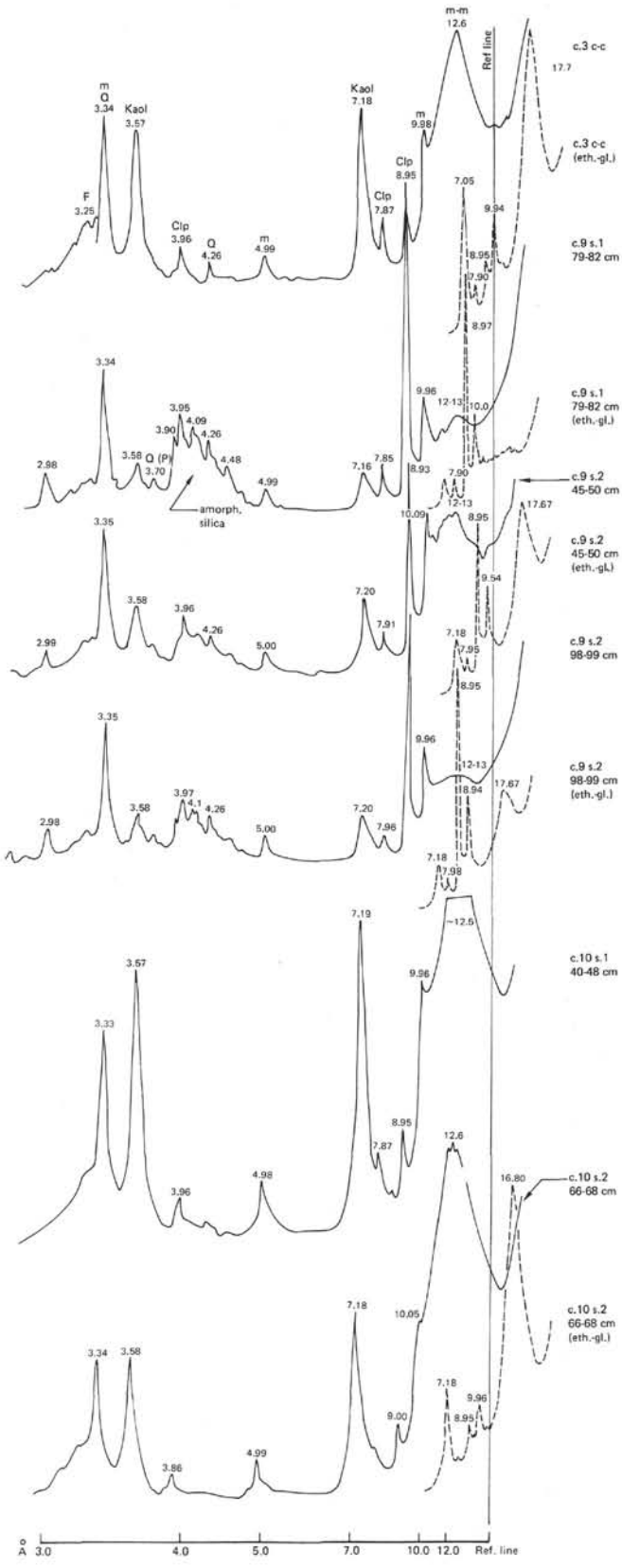


Figure 2. *X-ray diffraction diagrams, Hole 417D. See Figure 1 for explanation of abbreviations.*

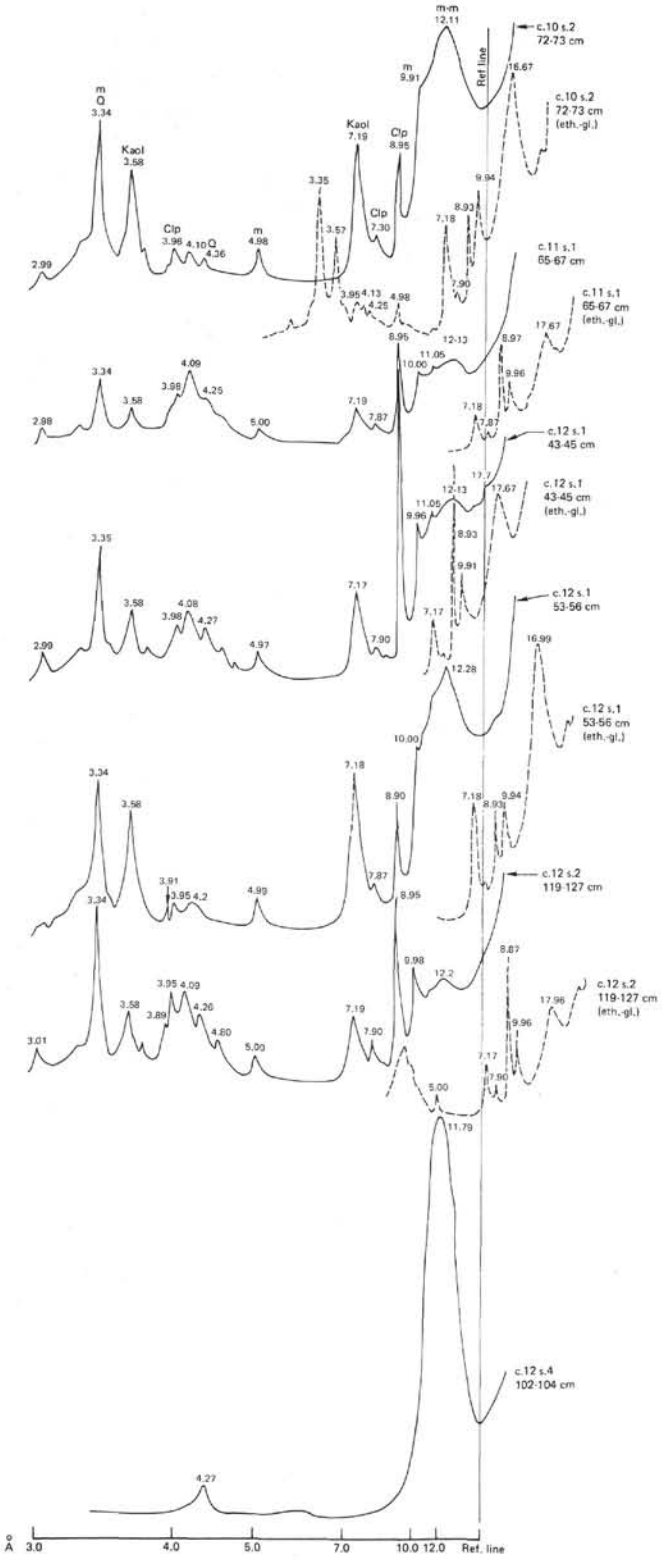


Figure 2. *Continued.*

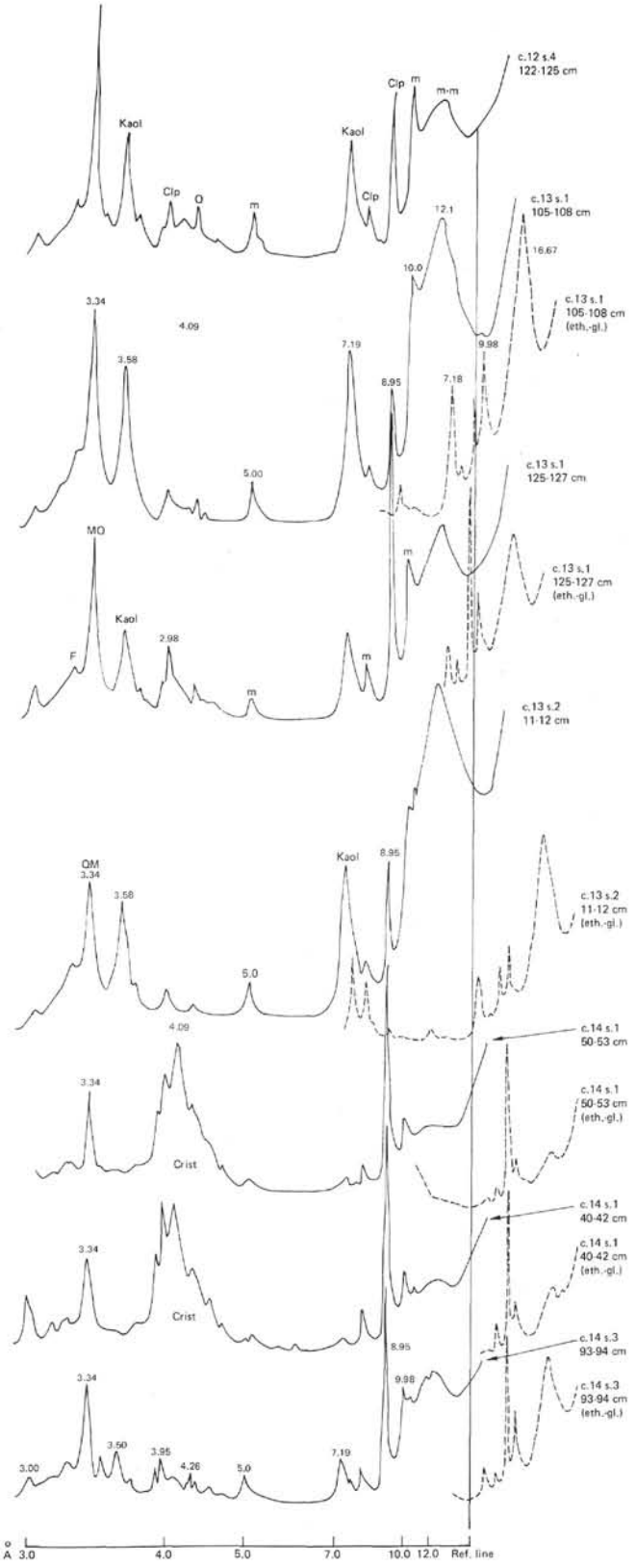


Figure 2. *Continued.*

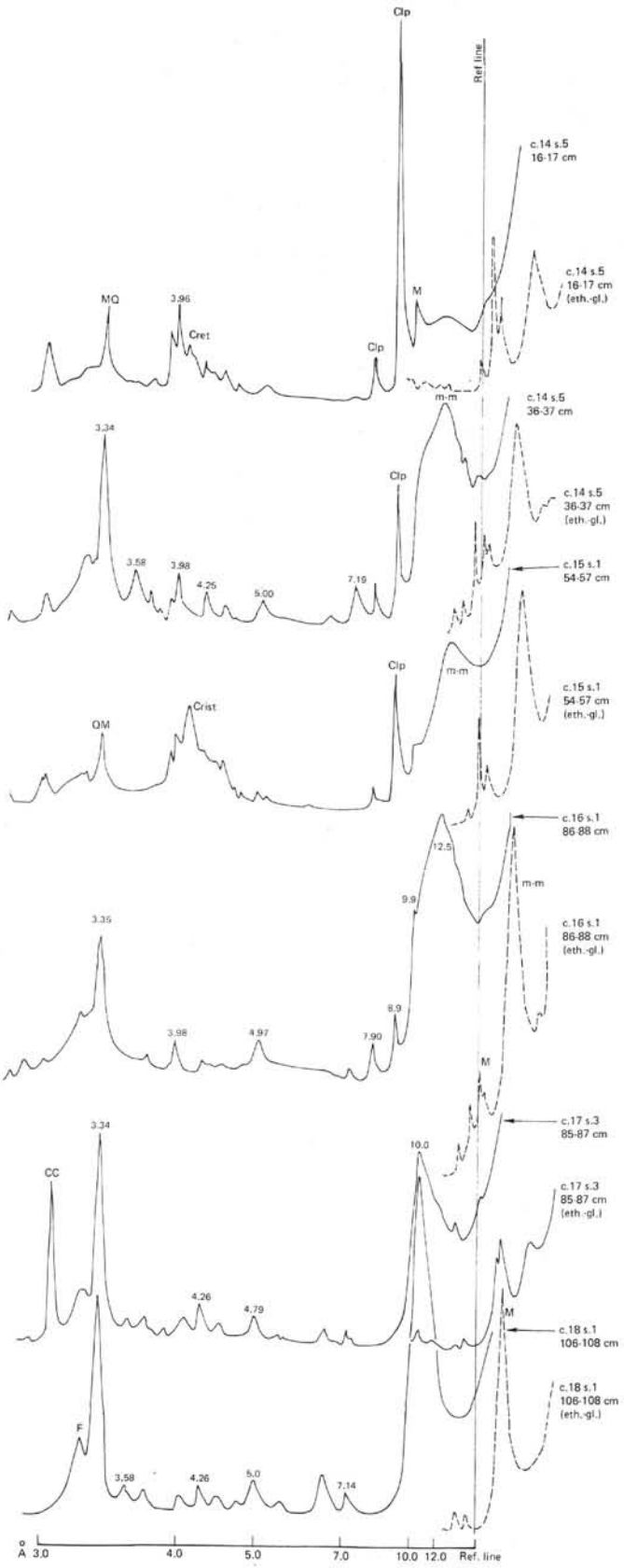


Figure 2. *Continued.*

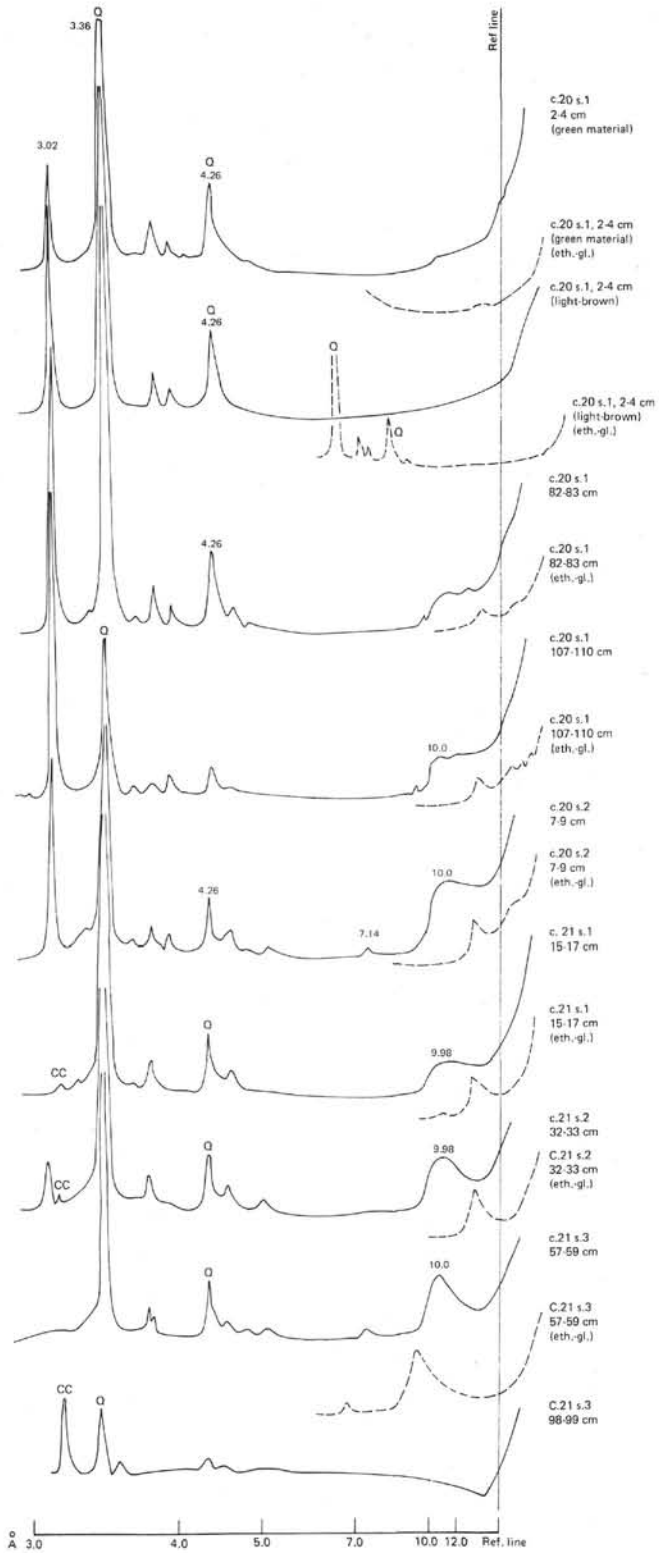


Figure 2. *Continued.*

rising amount of cristobalite suppresses the clay mineral signal. This marks the boundary of reducing black and green clays. Below Core 16, smectite (mixed layer?) dominated the spectrum, and we observed palygorskite appearing at the expense of smectite, in conjunction with illite. This is

an unusual assemblage, since palygorskite could be derived from nearshore, hypersaline lagoon settings (Chamley, in press).

With the reappearance of carbonate in Sample 417D-17-3, 85-87 cm, strong illite peaks become markedly skewed asymmetrically toward smectite. Samples below this zone have ill-defined clay spectra owing to the dominance of quartz and calcite.

Overall, the results are consistent with a terrigenous origin for Cenozoic clays; but in the Cretaceous sediments, complications indicate either more authigenic components or more changing climatic influences. The upper part of the section is rich in kaolinite which is typical for the equatorial part of the Atlantic Ocean. Hydromicas are dominant in the upper parts, whereas montmorillonite becomes dominant in deeper parts.

## REFERENCE

Chamley, H., in press. North Atlantic clay sedimentation and paleoenvironment since the Late Jurassic. *In* Talwani, M., Ryan, W. B. F., and Hayes, D. (Eds.), *Second Ewing Symposium,* March 1978, New York.