II. DEFORMATION OF STIFF AND SEMILITHIFIED CORES FROM LEGS 18 AND 28

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INTRODUCTION

Core induration and deformation has rarely been discussed at length in DSDP reports (see, however, Laughton, Berggren, et al., 1972, p. 12). Some of the attempts to systematize descriptions of induration and deformation by Leg 28 scientists are discussed in the Introduction chapter of this volume.

Deformation of soft sediments is similar to that in piston cores and is simple to visualize and interpret. Likewise, fracturing of lithified sediments presents few problems of interpretation. However, in stiff to semilithified sediments, deformation can be highly complex, especially where sediments of varying competence are adjacent. The origin of deformational structures in such sediments is often difficult to visualize and a matter of debate. A number of structures observed on Legs 18 and 28 are described briefly below.

Possible Tilting of Slightly Lithified Sediments by the Bit

Observed at Site 18-180 (Kulm, von Huene, et al., 1973, p. 409).

In Core 22, in an otherwise horizontal sequence of sediments, semilithified mudstones with silt laminae occur in cylindrical blocks, with bedding dipping uniformly at about 40°. Because the blocks have rotated about a vertical axis within the liner, the split core face usually cuts them oblique to the maximum dip, and apparent dips ranging from 0° to 40° are seen (Figure 1). No evidence was found that such dips are due to sediment slumping, a mechanism which would be most unlikely in that sedimentary environment. Seismic reflection data and undisturbed over- and underlying sediments of identical lithology preclude a tectonic origin for the dips. On these grounds, it was suggested that the deformation was the result of some kind of tilting by the bit, although there is no direct evidence for this hypothesis.

Reconstitution of Mudstone Under Bit Weight

Very well developed at Site 28-274.

High bit pressures may be sufficient to reconstitute sediment slurry into a semilithified mudstone, which can be lifted cleanly out of the split core liner, and is sufficiently compacted to require cutting with the band saw. This was very clearly developed in 28-274-43-4 (Figure 2). On a split polished face, blocks of undeformed sediment could be seen sheathed and separated by homogeneous mudstone. This reconstituted mudstone lost its strength with repeated wetting.

Dark Bowed Mudstone Laminae

Observed at Sites 18-175, 18-180, 28-272, 28-273, and 28-274 (Kulm, von Huene, et al., 1973, p. 172, 406).

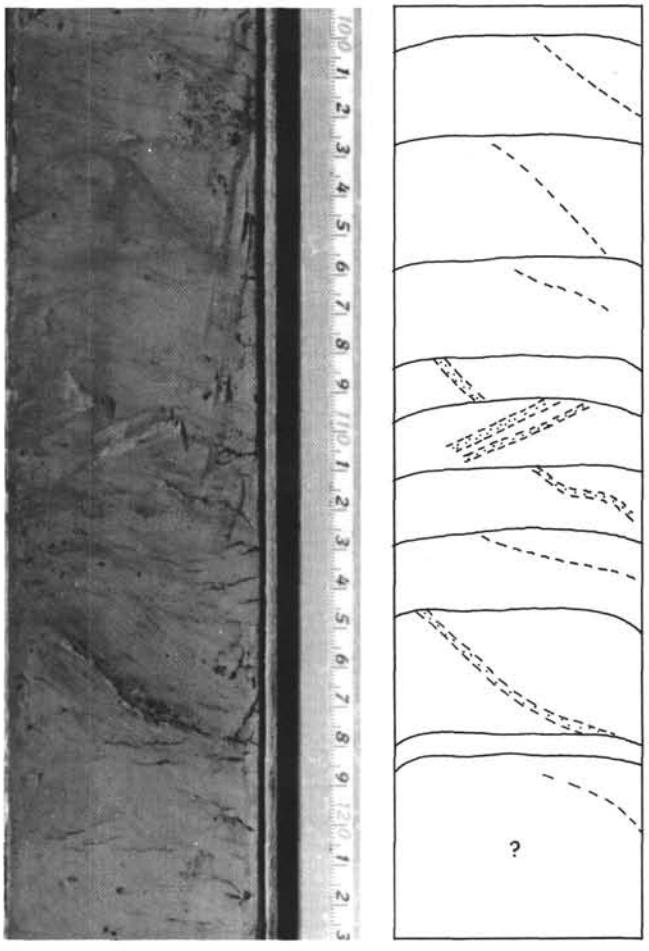

Figure 1. *Tilted and rotated lengths of semilithified mudstone separated by dark bowed mudstone laminae. Sample 18-180-22-1, 100-120 cm.*

A distinctive type of lamina occurs in stiff to semilithified sequences of terrigenous sediments. Laminae are typically 1 to 2 mm thick, bowed over a distance of about 2 cm, and spaced at intervals of 1 to 10 cm (Figure 3). Dark gray in color (around N5), they consist predominantly of clay and are generally softer than the main sediment sequence. Often, the laminae thicken towards the margins of the core. (Observed variations include laminae that are bowed only on one side of the core, discontinuous lenticular laminae, laminae with very rare coarse sand or granules, and laminae with small structures like flame structures at the base, but these are all very unusual.) Thin sections of such laminae from Sites 273 and 274 show they are lithologically similar to surrounding sediments, ranging

Figure 2. *Indurated mudstone reconstituted from sediment slurry under bit weight. This mudstone was cut with the band saw, lifted out of the core liner, and washed clean under running water. Sample 28-274-43-4.*

from clays to sandy muds. Detrital grains are mostly oriented subparallel to bedding, but there is no evidence of intense shearing.

In 18-180 and 28-274 (associated with the phenomenon described above), such bowed laminae separate blocks of stratified sediment which are not bowed. The laminae are continuous with a marginal sheath of reconstituted mudstone in 28-274-43-4. In these cases, the laminae are clearly of deformational origin, and their shape is reminiscent of the common convaco-convex contacts between drilled blocks of lithified rock. In 28-274-29-4, a bowed dark lamina appears to cut a clast in a stiff reconstituted brecciated mudstone and is therefore also demonstrably deformational in origin. Most of the other developments of this structure at first sight appear sedimentary in origin, but their close resemblance to the obviously deformational structures, and their occurrence in a wide range of lithologies and water depths, suggests that they too are deformational.

Alternation of Very Stiff or Slightly Lithified with Stiff Sediment

Observed at Site 28-267, and many other sites.

An extremely common type of deformation occurs where layers of slightly lithified and stiff sediment alternate. Typically, the slightly lithified sediment occurs in blocks 2 to 20 cm in length, apparently undeformed except for some brittle fractures, separated by stiff sediment with much plastic deformation. This structure was carefully examined in the lower part of 28-267B, where deformation of the stiff sediment changes from very intense to slight moving up the core. The GRAPE shows

Figure 3. *Dark bowed mudstone laminae, separating blocks of semilithified mudstone, and merging with reconstituted mudstone mantling parts of the core (most clearly visible at a). Sample 28-274-43-4.*

there has been little or no increase in water content associated with the deformation. In other cores (e.g., in the lower part of 28-274), the least deformation of stiff sediment appears to be at the lower end of the core.

Introduction of Pebbles Which Have Slumped Downhole

Observed at Site 28-274.

The upper hundred meters at Site 28-274 is generally soft to stiff, and contains many pebbles and granules and some manganese nodules. Pebbles and granules are not found in undisturbed sediment below Core 14. However, in Cores 21 through 31, and in Core 34, concentrations of pebbles and rare manganese nodules are found in an apparent sediment slurry (drilling breccia) at the top of each core. Occasional pebbles are found up to 6 meters below the top of the core either in highly disturbed soft sediment, or along the edge of the core against the liner. The rest of the sediment is stiff, with some blocks of very stiff or slightly lithified sediment. In places, such slightly lithified blocks are found higher in the core than the lowest pebbles. On geologic grounds, it is most unlikely that the pebbles are in place in this part of the sequence. During core retrieval, downhole slump-

ing occurs, but material finer than pebbles is washed away by the circulating water. Most of the pebbles accumulating at the bottom of the hole are thus recovered at the top of the next core. Some that are temporarily lodged between the cones of the bit are only gradually released into the cored sediment, and are thus under-and overlain by apparently undisturbed sediment.

REFERENCES

Kulm, L. D., von Huene, R., et al., 1973. Initial Reports of the Deep Sea Drilling Project, Volume 18: Washington (U.S. Government Printing Office).

Laughton, A. S., Berggren, W. A., et al., 1972. Initial Reports of the Deep Sea Drilling Project, Volume 12: Washington (U.S. Government Printing Office).