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Plate 1. Details of Methods, Terminology and Additional References Thereto

The aim of the ~20 m sampling scheme was to cover the upper 800 meters of the CRP-3 core as evenly as possible and in sufficient detail to describe the presence and alteration states of diagenetic mineral assemblages detectable via SEM analysis. During the drilling of the CRP-3 core and its routine processing at the Crary Science and Engineering Center (CSEC), McMurdo Station, Antarctica, an unusual greenish color was noted in otherwise "clean" and well sorted sandstones between 540 and 789.77 mbsf (Cape Roberts Science Team, 2000, pp. 90 and 194). The second author of the present paper noted during his routine examination of thin-sections and nannofossil smear-slide preparations that these appeared to coat the sand grains and to display a "box-work" or "honey-comb" structure reminiscent of some authigenic clay minerals. Concurrent x-ray analysis conducted on site indicated that the clay mineral in question is smectite (*ibid.,* tab. 4.5).

Following the drilling season, Wise et al. (2001) conducted a preliminary survey of the core using the scanning electron microscope (SEM), scanning transmission electron microscope (STEM), and light microscope (LM) in order to ascertain the morphology and probable extent of the clay mineral phase in question, and confirmed the presence of smectite overgrowths, particularly within the sandier layers of the sequence.

Based on their pilot study (labeled a "Progress Report" in the title of their paper), a total of 46 samples were eventually selected for the present study approximately at the interval stated above (20 m). It soon became apparent as we looked at these, however, that zones with low permeability provided no free space in which authigenic minerals could grow, hence they could not be distinguished in the SEM in such cases. Therefore, in selecting samples, we took when possible samples from the more sand-rich, porous intervals. These we could distinguish by inspection of the visual core descriptions (Cape Roberts Science Team, 2000, Supplement), the 70 thin sections used in the study by Wise et al., and our own observations of the archive halves of the cores housed at the Antarctic Marine Geology Research Facility at FSU.

Preparations for the SEM were made by fracturing the rock and mounting one or more of the fragments on 10-mm diameter stubs using fast-drying metalic paint. Where sandstones were poorly consolidated, specially constructed, 28-mm-wide dish-shaped holders with raised rims were used to catch any grains that spalled off the sample during examination.

The primary instrumentation used was a JOEL 5900 digital SEM with an attached energy dispersive spectrometer (EDS). The EDS was used for semiquantitative elemental analysis to aid mineral identification, particularly for crystals and sediment grains larger than 10 μm.

Each specimen was examined in its entirety and representative micrographs were taken of features pertinent to the study. Well over 500 micrographs were taken during the course of the study along with numerous elemental scans using the EDS.

The differences between the clay coats and quartz or feldspar grains upon which they grew are readily distinguishable in the SEM, often due to the higher emission of secondary electrons from the thin authigenic smectite platelets versus the solid quartz or feldspar sand grains (e.g., Wise et al., figs. 4c and 5b). It was not unusual for the clay coats to undergo a small amount of shrinkage from desiccation (e.g., Wise et al., 2001, fig. 4c), sometimes even becoming slightly detached from the underlying quartz or feldspar grains.

Following standard SEM practice, the thicknesses of clay coats and the dimensions of any other objects were measured in the center of the field of view along the horizontal ("x") axis of the specimen stage to prevent errors due to foreshortening (as would occur if measurements were made along the "y" axis). To measure the thicknesses of clay coats, specimens were tilted to expose a cross-section view through the clay coat.

The classification and development sequence for clay coats followed that of Pittman, et al. (1992). These authors grew smectite coats on sand grains in a hydrothermal reactor and defined four stages in the experimental development of the clay coats. As they illustrated diagrammatically (Pittman et al, 1992, fig. 19), the process begins with the formation of isolated clay wisps in random orientation followed by the coalescence of these discrete clay platelets to form a non-porus "root system" tangential to the grain surface. From there the clay platelets grow primarily tangential to the grain surface to form a mircroporus polygonal box-work pattern that infills to become denser while remaining only one-layer thick by the final growth stage. As defined in the paper, we use the term "basal thickness" to describe any root system and platelet growth less than 1 μm in height.

The construction of the permeability profile reproduced in our Figure 8 is explained in detail by Wise et al (2001, pp. 288-290). The complete caption of that figure reads as follows:

> Permeabilities based on core plug measurements for the composite CRP-1/2/3 section as a function of depth using the current CRP-3 depths (in mbsf) as a reference frame. Permeabilities are systematically higher below about 200-400 mbsf, which corresponds to the zone of authigenic smectite precipitation (arrow).

The classification of sandstone lithofacies associations and terminology follows that of the Cape Roberts Science Team (2000, pp. 193-195) as subsequently updated by Barrett (2001). As used in these authors, the term "clean" sandstones characterizes Lithofacies Associate 4 (340-580 mbsf) whereas the term "muddy sandstones" is applied to Lithofacies 3 (767.70-580 mbsf). In reference to Lithofacies Association 3, the Cape Roberts Science Team (2000, p. 194) further state, however, that:

> Although the sandstones appear muddy macroscopically, microscopical examination of some samples suggests that the clay cement filling the interstices between grains is diagenetic and derived from post-depositional fluids (see section on Diagenesis), rather than it being modified primary matrix. Thus, at the time of deposition many of the sands were probably clean.

In view of our research results, we refer to these Lithofacies Association 3 sandstones that are now coated by authigenic smectite as “formerly clean sandstones”.

Additional References Cited

Barrett, P. R (2001), Grain-size analysis of samples from Cape Roberts Core CRP3, Victoria Land Basin, Antarctica, with inferences about depositional setting and environment, Terra Antarctica, 8, 245-254.

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