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Experimental Results of an SEM Study of Clay Fabric

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The fabrics of flocculated sediments of illite, kaolinite and illite mixture were examined by scanning electron microscopy. The result showed that card house association is predominant in illite experiments, while book house flocculation is more common in the mixture. The fabric of kaolinite is dominated by a 3-dimensional network of face-face oriented flakes, whereas the edge-face and edge-edge flocculations are abundant in illite fabrics. The difference in the network structure was interpreted in terms of the influence of residual charges on the edges and faces of flakes in addition to the general van der Waals forces.

INTRODUCTION

O'Brien, Arakawa, Suito[1] in their study of the fabric of freezedried flocculated clay observed that such clay consists of a porous texture of random flakes. This paper expands upon that work by presenting scanning electron micrographs of the fabric of air dried flocculated illite and illite-kaolinite sediment. Electron micrographs show that similar flocculated fabrics are preserved in both air-dried and freeze dried clays. The main purpose of the paper is to present photographs of flocculated clay fabric sedimented in the laboratory under controlled conditions and to speculate as to the cause of the flocculated fabric.

EXPERIMENTAL

Three laboratory experiments were performed to observe the fabric of air-dried flocculated clay. Dilute suspensions of clay were allowed to sediment, consolidate under their own weight, and to air dry. Two experiments are extensions of work previously reported by O'Brien[2] and the results concur with his findings. One gram and five grams of grundite illite and a mixture of three grams of grundite illite and one gram of Georgia kaolinite were dispersed in 0.5 l of distilled water containing 5 ml of dilute NH_4OH dispersing agent (suspensions remained dispersed for two days). The pure illite suspensions were flocculated by being mixed with salt water solutions of 27 g. NaCl per 0.5 l. The illite-kaolinite mixture was mixed with an artificial sea salts solution commonly used in marine aquaria. The concentration of the sea salts solution was adjusted to 27 g. of NaCl per l. Flocculated suspensions were allowed to drip slowly into sedimentation tubes. After the clay settled, the clear water was siphoned out and more

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sediment added. After sufficient clay mass had built up, the sediment was allowed to consolidate under its own weight-usually 3 months. Then the remaining water was siphoned out and the clay air dried-usually another 3 months. This procedure was employed to minimize fabric distortion possibly caused by rapid burial, consolidation, or air drying. After drying, the samples were removed, fractured along a horizontal surface and gold shadowed for viewing in a JEOL scanning electron microscope.

OBSERVATIONS AND CONCLUSIONS

Figures 1–5 show the fabric of the flocculated sediment. Striking is the porous nature and also the random orientation of individual flakes (*e.g.* Fig. 2) and domains of flakes (*e.g.* Fig. 4). Using the terminology of Sides and Barden[3], the gross fabric seems to be one possessing both bookhouses (salt flocculated) and cardhouses. The

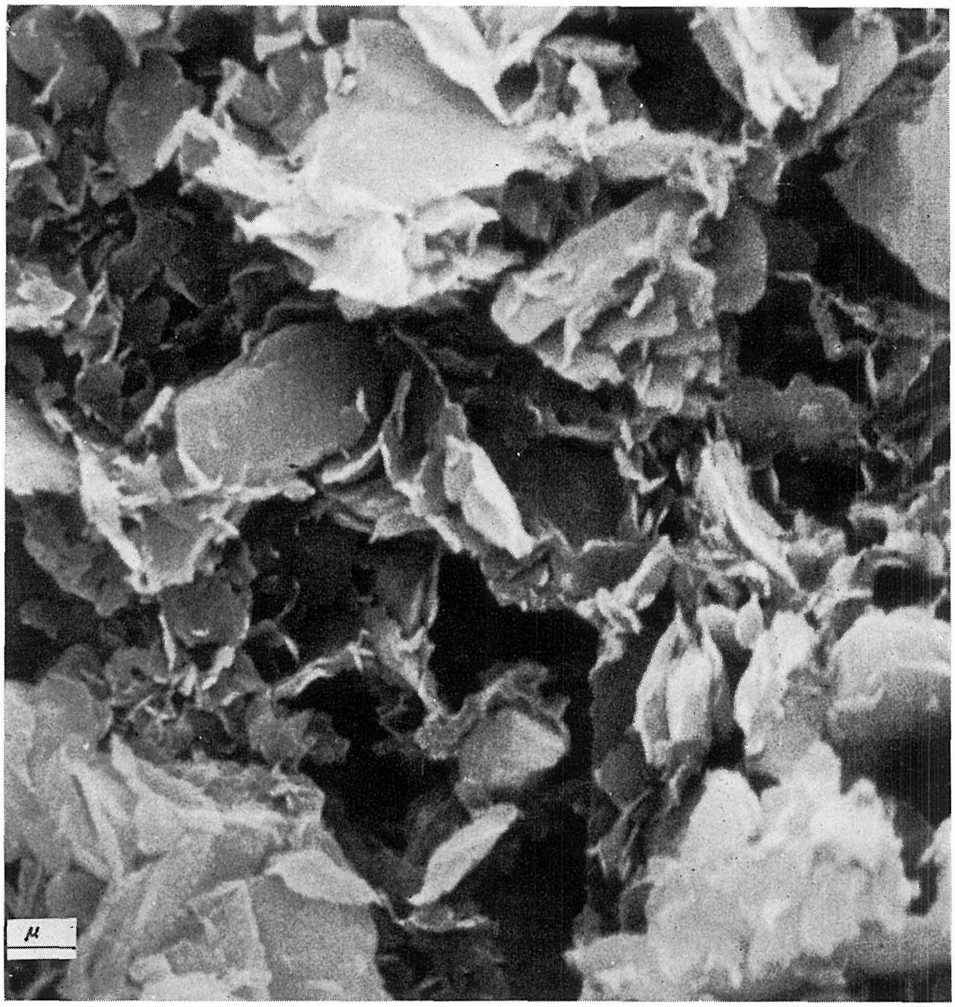

Fig. 1. Scanning electron micrograph of flocculated illite (1 gm./*l*. illite in salt water, 27 gm./*l*. NaCl). Edge-face and edge-edge flocculation is apparent.

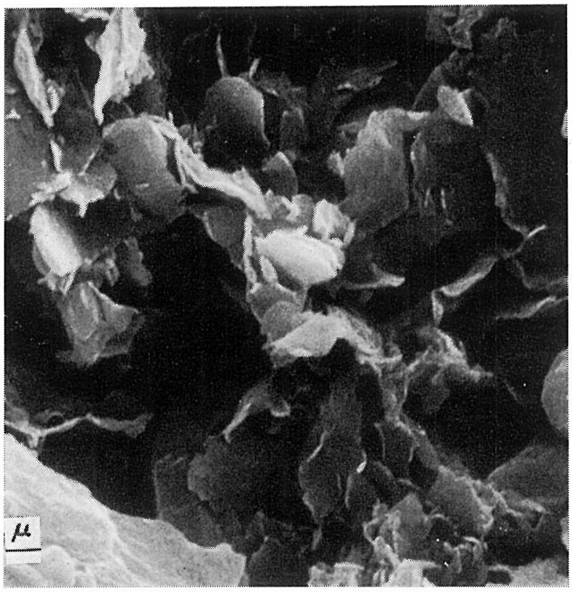

Fig. 2. Scanning electron micrograph of flocculated illite (1 gm./l. illite in salt water, 27 gm./l. NaCl). Edge-face and edge-edge flocculation is apparent.

Fig. 3. Scanning electron micrograph of flocculated illite (5 gm./l. illite in salt water, 27 gm./l. NaCl).

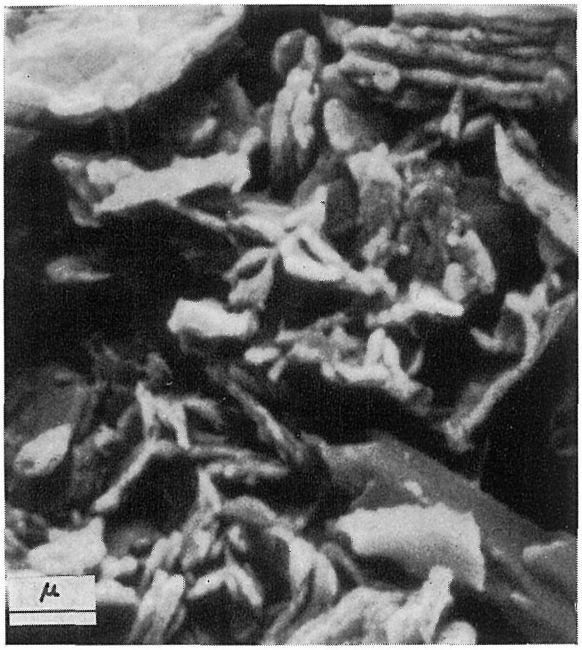

Fig. 4. Scanning electron micrograph of flocculated clay mixture (3 gm./*l*. illite plus 1 gm./*l*. kaolinite in synthetic sea water). Notice domains of face-face flocculation.

Fig. 5. Scanning electron micrograph of flocculated clay mixture (3 gm./*l*. illite plus 1 gm./*l*. kaolinite in synthetic sea water).

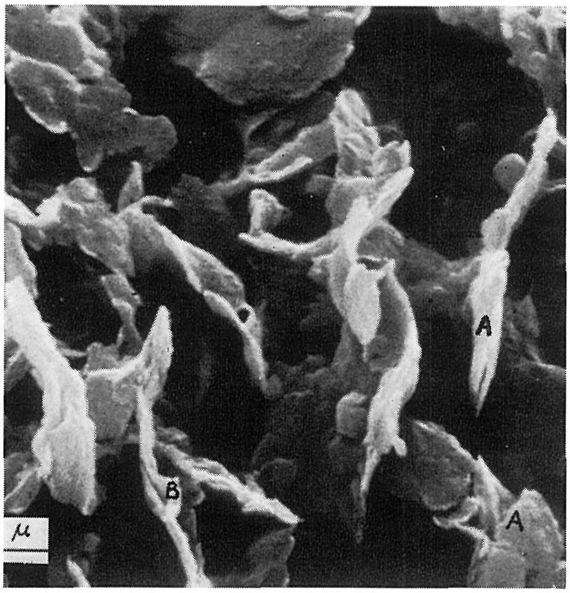

Fig. 6. Scanning electron micrograph of freeze-dried flocculated illite (100 gm./l. illite in distilled water. Notice edge-face flocculation of individual particles at A and face-face flocculation at B.

latter fabric is characterized by single particle edge-face or edge-edge arrangements. In their study of the fabric of illite slurries, Sides and Barden found a scarcity of edge-face contact and a dominance of the bookhouse fabric.

In this study, on the other hand, the authors noticed a predominance of single particle or cardhouse association in the illite experiments (Figs. 1～3). The difference in the results compared to those of Sides and Barden could be due to the fact that the latter used slurries of high concentrations while the authors studied the fabric of sedimented clays. Bookhouse flocculation, however, is more common in the experiment with a mixture of clays (Fig. 4～5). The face-face domains are interpreted to be composed mainly of kaolinite flakes. O'Brien[4] studied uncompressed flocculated kaolinite and illite prepared by a freeze-drying technique and observed that the fabric of kaolinite is dominated by a 3-dimensional network of face-face oriented flakes while the illite fabric showed some face-face orientation but an abundance of edge-face and edge-edge flocculation (Fig. 6). It seems likely that the illite fabric is a result of the influence of residual charges on the edges and faces of the individual flakes while the kaolinite fabric is dominantly influenced by van der Waals forces of attraction. This explanation was used by O'Brien to explain the fabrics produced in freeze-dried flocculated clay. Due to the similarity in fabrics of air-dried and freeze-dried clays, the same explanation seems valid.

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