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NOTES

SCANNING ELECTRON MICROGRAPHS OF CLAYSTONE ALTERING TO FLINT CLAY

Key Words—Claystone, Flint clay, Illite/montmorillonite, Kaolinite, Scanning electron microscopy.

The sequential development of flint clay (kaolinite) by progressive alteration of a claystone which originally contained expandable, mixed-layer illite/montmorillonite was well described and documented with X-ray powder diffractograms by Hughes and White (1969). Such geologic field evidence for the genesis of flint clay, also traced by parallel mineralogic changes, is convincing evidence that alteration (diagenesis) during deposition is a major mode of origin of flint clay. This note illustrates, using scanning electron micrographs, those genetic changes by showing the representative texture and morphology of the clay at three stages in its transformation.

MATERIALS

The micrographs in this report were taken of drill-core specimens kindly supplied by Dr. W. A. White. The specimens were alternate cores of the St. David Cyclothem of Pennsylvanian age from Sangamon County, Illinois. The cyclothem was described by Hughes and White as a "deposit [that] is mineralogically different from most flint clays, which are chiefly kaolinite, in that it contains clay minerals that are expandable and the nonclay mineral pyrite . . . . The clay minerals in the claystone facies equivalent to the flint clay body are poorly oriented and are chiefly mixed-layer illite-montmorillonite and illite" (Hughes and White, 1969, p. 292).

SCANNING ELECTRON MICROSCOPY

A scanning electron micrograph (SEM) illustrative of the expandable phase in these cores is shown in Figure 1. The ragged and partly curled edges of the clay flakes exhibit the typical "corn flakes" or "maple- and oak-leaf" texture of expanding clay minerals, such as smectite. Hughes and White (1969) stated that "The smectite that is most completely expanded and gives the sharpest (001) peak is associated with zones containing the most highly disseminated organic content." An X-ray powder diffractogram of this clay (glycolated) is shown in Figure 2A. When heated to 200° (A-200°), the clay collapsed to give a broad reflection from 8.6 Å to 9.6 Å. Although the principal purpose of this note is to show the changes in the clay minerals (smectite, illite, kaolinite), other minerals, such as quartz and calcite, are also prominent in the samples. For exhaustive and quantitative identifications of the mineral assemblage, including dolomite, ankerite, siderite, gypsum, and pyrite, the paper by Hughes and White may be consulted.

As smectite and/or mixed-layer illite/montmorillonite decreased in the clay, the illite phase (nonexpanding material in the glycolated sample) increased as is shown by Figure 2B. The morphology of the illitic phase (Figure 3) shows loss of most of the smectite texture. The morphology of illite varies widely with the genetic environment, i.e., whether the clay crystallized from solution in a pore within a sandstone, or altered from a probable expanding clay-mineral precursor. The morphology shown in Figure 3 is reasonably similar to that displayed by the illite from Fithian shale (Borst and Keller, 1969).

For a second clay in the sequence, Hughes and White (1969) wrote "The Sangamon County deposit was compared with a flint clay deposit of the same age in Williamson County in southern Illinois . . . ." A micrograph of a sample from the middle member of the Williamson County flint clay is shown in Figure 4, and its diffractogram in shown in Figure 2C. Kaolinite is predominant, with minor illite, and essentially no expanding clay mineral (glycolated specimen) is present. The SEM (Figure 4) shows small, tightly compacted stacks of kaolinite with the typical texture of flint clay (Keller, 1976, 1981) interspersed within a matrix that appears to be transitionally inherited from its 2:1 clay-mineral precursor. For comparison, Figure 5 is an SEM (diffractogram in Figure 2D) of a "standard," medium hard, flint clay used in the manufacture of refractories. It is essentially all kaolinite and is devoid of ancestral material or texture. It occurs in Lincoln County, Missouri, immediately west of Sangamon County, Illinois.

SEMs of the Sangamon and Williamson County clays thus demonstrate textural accordance with the conclusions of Hughes and White (1969) that their described flint clay originated by the alteration of a 2:1 clay-mineral precursor.

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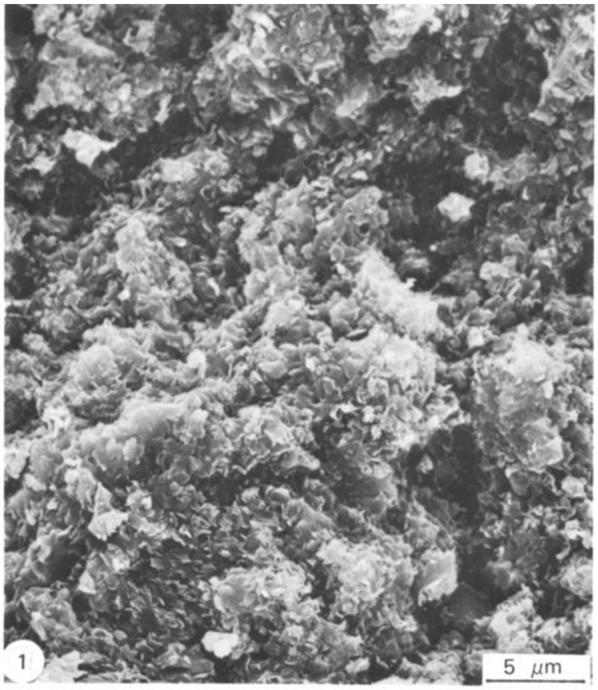

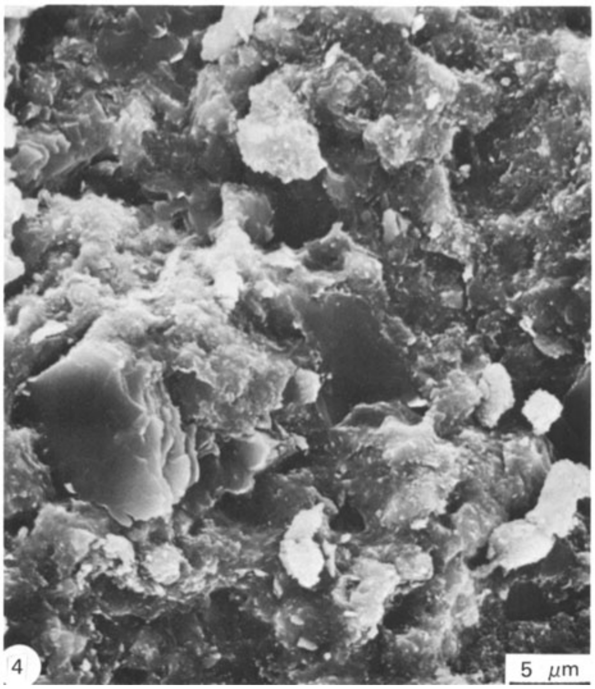

Figure 1. Scanning electron micrograph of Core SC 59-5, Sangamon County, Illinois. The texture is similar to the "corn flakes" texture characteristic of many smectites.

Figure 3. Scanning electron micrograph of illitic transitional specimen, SC 67-1.

Figure 4. Scanning electron micrograph of middle member, flint clay, Williamson County, Illinois.

Figure 5. Scanning electron micrograph of a "standard" flint clay mined for refractories near Whiteside, Lincoln County, Missouri.

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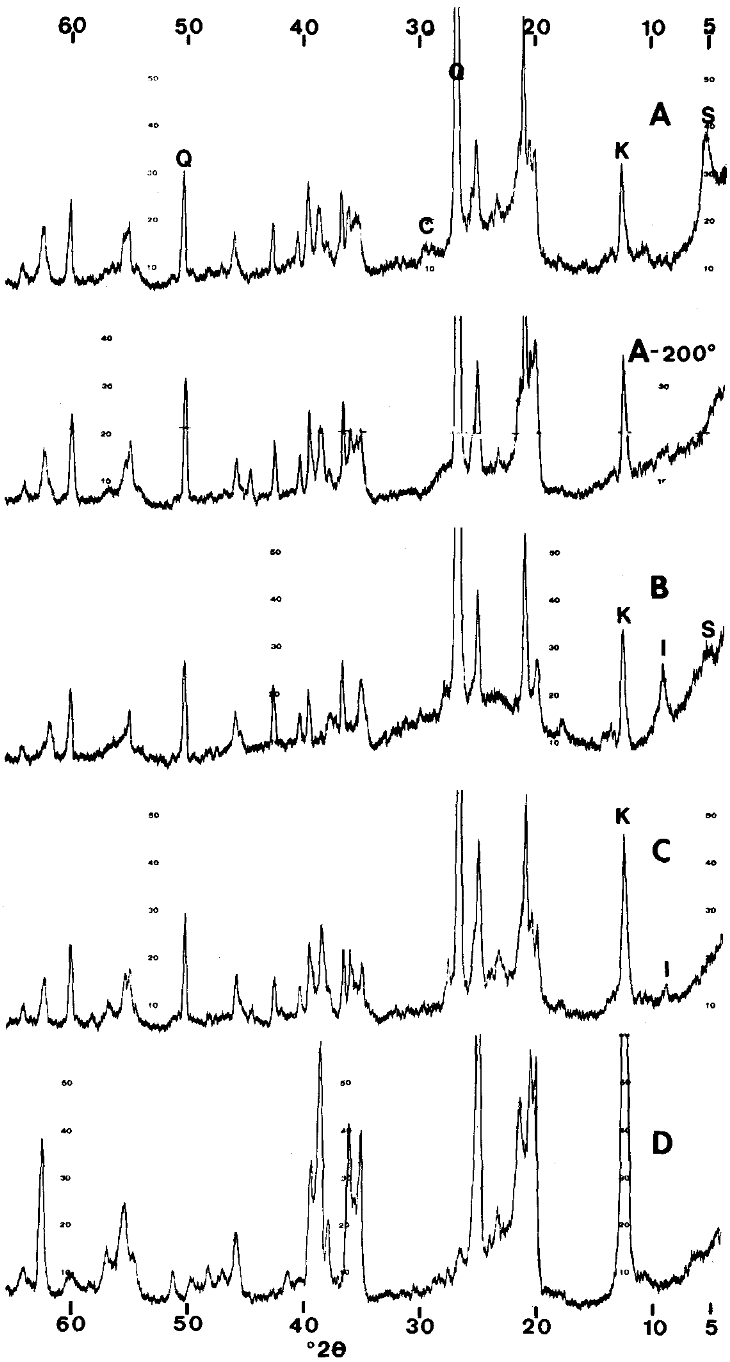

Figure 2. X-ray powder diffractograms of the specimens shown in Figures 1, 3, 4, and 5; A, B, C, and D respectively. A-200° represents sample A heated to 200°C. CuKα radiation. Q = quartz; C = calcite; K = kaolinite; S = smectite; I = illite.

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