Reports

Source and Deposition of Clay Minerals in Peorian Loess

Loess is one of the most remarkable of the Pleistocene deposits. It is associated with and covers to varying depths and extent most of the major sheets of glacial drift. The origin of loess, however, has been debated. Scheidig (*1*) lists some 20 hypotheses that have been advanced at one time or another to explain its presence and distribution. Chamberlain (*2*) has advanced the most widely accepted theory to explain the origin of loess in the upper Mississippi Valley. He considered the loess as a wind deposit emanating from the flood plains of the major Pleistocene rivers. His concept was that proloess materials were deposited from glacial melt waters on the flood plains of the rivers. After drying, these materials were picked up by strong winds and redeposited as loess on the adjacent uplands.

Chamberlain's theory implies that the mineralogy of the unaltered loess and that of the associated unaltered tills should be similar, including the clay minerals. Studies of clay minerals (*3–5*), however, have shown that the principal type of clay in calcareous Peorian loess in Illinois, Kansas, Nebraska, Iowa, and Missouri is montmorillonite, whereas, illite and some chlorite are the principal clay minerals in tills of Wisconsin age over a broad area (*3, 6, 7*). Some explanations given to account for this difference in mineralogy follow: (i) the montmorillonite clay now found in Peorian loess resulted from weathering of the illite and chlorite in the calcareous material after deposition; (ii) the clay and silt minerals of Wisconsin age weathered to form montmorillonite before and/or during transport; and (iii) the montmorillonite was differentially picked up by the silt particles from the river flood plains, thus concentrating this type of clay in Peorian loess.

On the basis of studies of clay mineral in soils developed entirely from tills of Wisconsin age, explanations i and ii above were considered unlikely. For instance, Beavers *et al.* (*3*) found that only small amounts of montmorillonite (maximum 10 percent) had formed in soils developed from Tazewell and Cary age tills and that no montmorillonite had formed in calcareous tills of the same age. Similar results were found by Bidwell and Page (*6*). Explanation iii cannot be ruled out, although I believe that the bulk of the sediments carried by the Illinois and Wabash rivers during the time of deposition of Peorian loess were of Wisconsin age and that illite was the principal clay mineral in the sediments. The influence of local flood-plain clay sediments is indicated by the tendency of illite clay to concentrate in calcareous Peorian loess in Illinois (5 to 20 percent) near the major rivers (*3, 5*).

I postulate that the bulk of the clay minerals in Peorian loess did not come from local flood plains but that these minerals were carried in by strong winds from widely scattered sources throughout the central United States. The problem is essentially one of deposition of the fine clay. I suggest the following as a possible mechanism that may account for the deposition of fine clays carried from afar, along with local flood plain silts. The air-borne clay minerals were electrostatically attracted and adsorbed onto the larger silt-sized particles that were blown from local flood plains, and then the clays and silts were deposited together.

Charge spectrometer studies of quartz and standard clay minerals, as well as of clays and silts from Peorian loess, show that these materials have a tendency to take on strong electrostatic charges (*5*). It is well established that dust storms are highly electrified, the friction of the particles providing a source of electricity. Boning (*8*) advanced the theory that a part of the charge developed in dust clouds was the result of friction between particles of different sizes. That particles of silt and clay minerals have different electrostatic charges is suggested not only by the fact that the two kinds of particles are different in size but also by the fact that their crystalline structure and dielectric properties are different.

Dallavalle (*9*) states: "Fine dust particles may be swept upward by turbulent wind and kept in motion by it so that the effect of gravity is nullified." Even today, Illinois receives clay from western storms that occasionally cause the sun to appear hazy. When these fine air-borne clays are brought down by snow or rain, they fall in sufficient concentrations to cover clean surfaces with buff-colored clay particles. We also know that fine clay-size material from bomb blasts and volcanoes is carried long distances by wind, even across continents and oceans.

A unique property of loess is its unstratified nature. Thin sections of Peorian loess adjacent to the Wabash, Mississippi, and Illinois rivers show that the materials possess a fine porous fabric with the larger silt-sized grains connected with intergranular braces of a light ocher color consisting of very fine silt with clay minerals evenly disseminated throughout. A homogeneous and unstratified deposit would not be expected to result from the normal settling of silts and clays. Here again it appears that some mechanism other than the normal settling forces was operative and that the silt and clay did not settle independently.

The electrostatic adsorption and deposition of fine clay by local flood plain silts could explain the distribution of the montmorillonitic type of clay throughout the Peorian loess area as well as the unstratified nature of the loess deposit.

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References and Notes

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Artifact in Spectrophotometry Caused by Fluorescence

Recent publications (*1*) have called attention to the possible occurrence of artifacts in difference spectra. These false readings, which generally appear as

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