

c3 The origin of till, outwash, varved clay, and loess

<glaciers, moraines, periglacial, drift >

Nullius in verba (On no man's word),¹ the British Royal Society motto, a precis of *Nullius addictus jurare in verba magister* (I am not bound to swear allegiance to the dogmas of any master) (a line in a poem by Horace),² is succinct and has been best translated: 'Take nobody's word for it; see for yourself.'³

A sediment deposited directly from glacial ice without the intervention of water is called *till*. Tills are conglomerates that show no layering or sorting. Those with a high proportion of fine grained material are called "boulder clays." Glaciers pluck the bedrock over which they move. Talus also falls on valley glaciers. Glaciers can transport a boulder as easily as a grain of sand. Clasts embedded in glacial ice scratch and polish each other and become faceted when the glacier holding them at its sides and base as tools, striates the bedrock against which it moves. Glacial grinding produces rock flour (clay-sized clasts). Different sized clasts transported in glacial ice can come to be deposited in no particular order either by ceasing to move at the glacier's base (lodgement till) or by being released directly in place from glacial ice where it thaws or evaporates (ablation till). Landscape features (ridges, irregular undulating land) built of till are called *moraines*. Meltwater that flows out of a glacier selectively carries away from tills it washes over different sized clasts. Streams of meltwater deposit gravels and sands as eskers, kames, kame terraces, and braided-channeled outwash plains, and where the meltwater flows through proglacial lakes, or ponds in swales, it deposits silt and rock flour.

Stratified outwash is an accumulation of gravels and sands that are carried into place as the bed load of braided streams of glacial meltwater. The sheetlike beds are characteristically cross-bedded.

Varved clay is an accumulation in proglacial lakes of yearly-couplets of lacustrine beds called *varves*: during the summer, silt (light gray in color) settles and accumulates and in the winter, when the lake is ice bound (frozen over), clay-sized material (dark gray in color) settles and accumulates.

"Drift" is a word that Murchison introduced in 1839 to replace *diluvium*, which unconsolidated sediments others had long (falsely) maintained, from the evidence of its strewn occurrence, recorded the Noachian flood. Murchison agreed that the "diluvium" had evidently accumulated in recent times but interpreted the same as having accumulated under the sea, its materials transported by icebergs that had melted as they drifted in marine currents. In his opinion, drift is exposed to view where land has risen.⁴ This "drift" notion gave a name to ideas earlier advanced by Lyell and was used by him.⁵ But Sedgwick in 1840 touring from Glasgow with visiting and lecturing Agassiz to Lyell's estate in Kinnordy via the parallel roads of Glen Roy, in an epiphany accepted Agassiz's prior interpretation of diluvium as glacial-ice transported sediments deposited directly on the land from ice or by meltwater flowing from it and found: "The hypothesis [Lyell's], which ascribes the distribution of the enormous masses of diluvial gravel existing in so many parts of our islands to the agency of a series of lakes, which from time to time have burst their barriers and descended to lower levels, may, therefore, at once be rejected as gratuitous."⁶ Lyell himself by 1863 no longer used the word *drift*.⁷

In its American forwarded usage, "drift" refers to unconsolidated sediments that were transported by, but not necessarily deposited directly from, glacial ice. Drift refers to till (landforms of which are moraines and drumlins), erratics, stratified outwash (landforms of which are eskers, kames, and outwash plains), ice-rafted debris (clasts dropped from melting icebergs), and varved clay.⁸

Loess (German *Löß*, loose) is a terrain-blanketing accumulation, a characteristic first emphasize to American geologists by Frederick William Sardeson (1866-1958),⁹ showing little or no stratification, of dust deflated from deserts and settled in vegetated areas. Loess of Holocene age, as is being deposited in China is unconsolidated silt (dust) composed mostly of quartz particles (0.015-0.05 mm diameter) blown out of the Gobi desert. Loess of Pleistocene age, up to 200 feet in thickness (often stream dissected into a rugged topography with steep slopes up to 70°) that covers wide areas in central U.S., northern Europe, Russia, China, and Argentina, is a loamy buff to yellowish-brown rock flour that was wind-blown out of (deflated from) stratified outwash.¹⁰ □