Nuggets of History Under Our Feet

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Twelve thousand years ago, western Iowa was a very different place. The last of the Pleistocene ice sheets were receding, and the melting water created the Missouri River channel. The prevailing winds from the west blew particles of fine glacial debris into huge dunes and rolling hills resulting in the loess deposits of western Iowa. University of Iowa botanist and naturalist, Bohumil Shimek, published in the 1890s, first recognized the hills and bluffs of western Iowa were formed by the winds as the glaciers were receding. As the newly deglaciated prairie grasslands advanced, they created a fertile prairie landscape, which today is known as the "Loess Hills."

The wind-blown loess contained a significant amount of calcium carbonate (up to 8% in some soils) in the form of the mineral calcite. This is easily confirmed by dripping dilute hydrochloric acid on a soil sample and watching the effervescence (bubbles and foam) that appears. This reaction results when carbon dioxide is released from the calcite minerals in the soil upon dissolution by the acid.

Another characteristic of loess is that it was deposited in thick layers (over 90 ft) in areas immediately adjacent to the Missouri River flood plain with shallower depths further east. The soils of the region consist predominantly of the Moody, Crofton, and Nora series in some counties and the Ida and Monona series in others. These soils are calcareous due to calcium carbonate in the glacial parent material. Although considerable work has been conducted on the organic carbon fraction in soils due to its importance in soil fertility, the inorganic component (i.e. carbonate) has received much less attention.

These soils have another interesting characteristic in that they contain calcium carbonate nodules (aka loess dolls or lime concretions) at various depths in the soil profile. These nodules can range in size from small pebbles to the size of a golf ball. These nodules obviously did not blow in with the wind, but were formed in place after the loess was deposited.

There is interest in these nodules because carbonate minerals form one of the largest reservoirs of carbon on the planet. Large-scale carbonate mineral formation draws down atmospheric carbon dioxide concentrations. Carbonate minerals are stable reservoirs of atmospheric carbon on time scales of hundreds, thousands, and even millions of years. The post-glacial formation of carbonate nodules in loess could have played a role in the long-term balance between atmospheric carbon and climate. Furthermore, if formation pathways are better understood, loess soils might offer a possibility for more contemporary carbon sequestration.

A major focus of this study is to understand the biological and chemical processes that result in carbonate nodule formation including the carbon source used in their formation. Recent carbon-14 dating results suggest the nodules are a few thousand years old, but much younger than the glacial landscape. Other isotopes of carbon (carbon-12 and carbon-13) indicate the nodules may be formed from original soil calcite that

dissolved and re-precipitated. The research team also is looking for evidence of biological processes, such as growth of nodules around plant roots.

Once some of the basics on how carbonate nodules formed are understood, the team can begin to ask further questions. Is it possible to stimulate nodule growth today? Are there land management practices that dissolve, maintain, or grow the nodules? How much soil carbon is stored in this inorganic form in Iowa's soils?

Next time you're in the Loess Hills, take a moment to look for carbonate nodules, which often are visible in roadcuts or slopes (Figure 1). These may well represent both new and old possibilities for storing soil carbon.

Figure 1. Calcium carbonate nodules from loess soils. Scale bar in cm. Investigations show loess nodules from western Iowa consist primarily of calcite as well as smaller portions of other calcium carbonate minerals including aragonite. Also present is a magnesium-containing variant, dolomite.