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Physical controls on organic matter stability

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The chemical and biological properties that control soil organic matter stability are increasingly well-understood, but relatively little consideration has been given to the physical properties of organic matter that may control storage in terrestrial environments. A basic requirement of soil organic matter stability is that the organic matter remain within the landscape, yet surprisingly little is known about how the physical properties of terrestrial organic compounds may influence their stability or mobilization in overland flow.

Here we argue that physical properties of particulate organic matter, like density and porosity, play key roles in controlling organic matter storage in soils and marine sediments. Density acts to determine whether particulate matter sinks or floats, influencing whether materials remains on the landscape or are transferred through rivers to sediments. Pore structure and pore connectivity control the rate of water infiltration into particles, influencing density, oxygenation, and microbial access.

Processes that act to alter the density of particulate organic matter can be expected to alter the likelihood of delivery to rivers and eventually to the ocean. It seems evident that specific processes such as the infilling of pore spaces with hyphae, clays, or microbes will act to increase soil density; however, the magnitude and timescale of these types of processes remain unknown. Here we show preliminary data on density and porosity for natural terrestrial materials and discuss next experimental steps to understand the timescales of change of these properties.