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Relationship of pores to the fate and distribution of newly added carbon

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Pores create a transportation network within a soil matrix, controlling the flow of air, water, and movement of microbes; i.e., factors that, in turn, control soil carbon dynamics. Computed microtomography (μCT) allows for the visualization of pore structure at micron scale, but quantitative information on contribution of pores to fate and protection of soil carbon, essential for modeling, is still lacking. This study uses the natural difference between carbon isotopes of C3 and C4 plants to determine how the presence of pores of different sizes affects spatial distribution patterns and fate of newly added carbon after one-month incubation. We considered two contrasting soil structure scenarios: soil with the structure kept intact and soil for which the structure was destroyed via sieving. For the experiment, soil was collected from 0-15 cm depth from a 20-year continuous maize (*Zea mays* L., C4 plant) experiment into which cereal rye (*Secale cereale* L., C3 plant) was planted. Intact soil fragments (5-6 mm) were procured after 3 months rye growth in a greenhouse. Pore characteristics of the fragments were determined through μCT imaging. Each fragment was sectioned and total carbon, total nitrogen, δ^{13}C, and δ^{15}N were measured. The results indicate a general trend of overall loss of C3 carbon during incubation for all studied pore sizes in both treatments. This loss was most drastic in destroyed structure soil. In destroyed structure soil, prior to incubation, greater presence of 40-90 μm pores was associated with higher levels of C3 carbon, pointing to the positive role of these pores in transport of new C inputs. Nevertheless, after incubation, the association became negative, indicating greater losses of newly added C in such pores. In soils of both destroyed and intact structures, after incubation, higher levels of total carbon were associated with greater abundance of 6.5-15 μm pores, indicating a preservation of carbon associated with these pores. Long-term agricultural management options that increase the abundance of 6.5-15 μm pores, while decreasing the abundance of 40-90 μm pores, may promote soil carbon protection while minimizing losses of newly added carbon.