# Enhancement of Soil Carbon Sequestration by Amendment with Fly Ash

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ABSTRACT

Degraded lands (e.g., mine sites, highway rights of way, eroded lands) typically are depleted of organic-C. Progress in the reclamation of these lands can be measured, in part, by the return of soil organic-C levels to those seen in undisturbed, otherwise similar, soils. Moreover, such reclamation has the added benefit of sequestering significant amounts of C, thus helping buffer the transition to a hydrogen-based energy system. Our research seeks to understand the process by which organic-C is sequestered by soils (i.e., humification) and to develop practical approaches for enhancing the rate at which this sequestration occurs. We have focused on a model humification reaction involving a common phenoloxidase enzyme (tyrosinase) and organic monomers (polyphenols, hydroxybenzoic acids, and amino acids). We have noted a synergetic effect on the reaction rate when highly porous silica or manganese-oxide minerals are present in addition to the enzyme. As the porous silica bears some similarity to the cenospheres commonly found in fly ash, we also tested the effects of four alkaline fly ashes {Class C (sub-bituminous), Class F (bituminous), Class F [bituminous with flue-gas desulfurization (FGD) products], and Class F (lignitic)} on the reaction. The presence of FGD products completely halted the reaction, and the bituminous ash showed no benefit over an ash-free control. The sub-bituminous and lignitic fly ashes, however, increased the reaction rate by several-fold. In addition to their physical properties, the strong synergetic effect of these ashes may stem from their high Cu contents, as Cu activates tyrosinase.