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Biochar incorporated into topsoil a decade alters chemical composition of subsoil organic matter in a calcareous soil

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The role of biochar in carbon sequestration and carbon emission of farmland topsoil has been widely reported. However, it is not known whether biochar applied to surface soil will affect the stocks and properties of organic carbon in subsoil (deeper than 1 m) along with (aging) biochar vertical migration in soil, which is a key knowledge gap in assessing the impact of biochar on subsoil carbon cycle. This study investigated the effects of biochar migration on the subsoil organic carbon stocks, composition and structure 10 years after an investment of biochar application (60 t ha^{-1}) in topsoil. Our study showed that a single application of biochar to farmland soils significantly increased the stocks of top- and subsoil organic carbon over 10 years. Further, biochar treatment significantly increased the water-extractable dissolved organic carbon (WEOC) and base-extractable dissolved organic carbon (BEOC) in both top- and subsoil, and decreased the aromaticity and molecular weight of the BEOC in subsoil. The results of liquid chromatography-organic carbon detection and three-dimensional fluorescence showed that biochar application increased the humus composition and low molecular weight dissolved organic carbon in subsoil. In addition, compared to the trivial increase for topsoil, biochar treatment significantly increased the content of lignin phenol in subsoil. The results of the mineralization incubation experiment showed the CO_2 emission rate of topsoil was largely inhibited after long-term biochar amendment on topsoil. Dramatically, the CO_2 emission rate of subsoil was largely stimulated in the biochar-amended soil due to the input of dissolved organic carbon induced by biochar migration. This study revealed the mechanism that biochar migration induced the change of soluble organic matter components and lignin in subsoil after long-term biochar application. This study has significance for subsoil organic matter turnover and global climate change mitigation.