Quantification of macrobenthic effects on diagenesis using a multicomponent inverse model in salt marsh sediments

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ABSTRACT: Using a multicomponent inverse model, we quantified the rates of organic matter (OM) remineralization and the relative importance of major terminal electron acceptors [Fe(III)-(oxy) hydroxides and SO^{+}_{4}] in salt marsh sediments with varying degrees of bioturbation and vegetation at Skidaway Island, Georgia. The model determined the rates of OM diagenesis by seeking simultaneous agreement between measured and model-calculated depth-concentration profiles of multiple major redox species while using the biological transport parameters determined from direct field observations. The OM degradation rates are found to be greater and penetrate deeper in sediments with vegetation or bioturbation than in sediments with limited macrobenthic components, in which organic matter degradation is restricted to the immediate vicinity of water-sediment interface. The results also confirmed previous observations that Fe(III)-(oxy)hydroxides are much more important than sulfate as terminal electron acceptors in the heavily bioturbated station and provided the numerical values to the depth-dependent relative importance. Solid-phase Fe is recycled as a terminal electron acceptor >=30 times in the bioturbated station, because biological mixing repeatedly moves reduced Fe(II) back into the aerobic environment, where it is reoxidized to form Fe(III)-(oxy)hydroxides and is reused as a terminal electron acceptor. Vegetation appears to have little influence on net solute transport, but it stimulates microbial activities and significantly enhances the remineralization of OM at depths.