Anaerobic methane oxidation promotes deep diagenesis and blurs manganese based geochronology in Arctic Ocean sediments

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We tested the hypothesis that Mn-enriched layers in Arctic Ocean sediments are reliable time markers for interglacial periods, using a diagenetic model. Diagenesis is fuelled by two sources of organic carbon, particulate organic matter (POM) settling to the sediment surface and methane diffusing up from deep gas hydrate deposits. POM and particulate Mn are only supplied to the sediment during interglacial periods. The model includes oxidation of organic carbon and soluble reduced Mn by O_2, reduction of oxidized Mn via anaerobic methane oxidation, transport of dissolved O_2 and Mn by diffusion, and transport of solid components by burial. O_2 is supplied from an overlying invariant reservoir. The effects of anaerobic CH_4 oxidation are simulated by prescribing reducing conditions in the lowest layer of the model. Oxidized Mn advected into this layer is reduced to soluble reduced Mn, which diffuses upwards and is reoxidized and reprecipitated by O_2. The upward flux of reduced Mn is a function of the rate at which oxidized Mn is advected into the reduction layer at the bottom of the model and is not synchronous with events at the sediment-water interface. Model runs reveal that the O_2 penetration depth fluctuates between 2 m (during interglacials) and the depth of the reducing layer (during glacial periods). Precipitation of upward diffusing manganese generates secondary manganese enrichments that cannot be distinguished from the primary enrichment created by burial of manganese-rich interglacial sediment layers. Caution is advised when using manganese enrichments as a time marker where sediments contain gas hydrates.