GREIGITE LAYER FORMATION BY NON-STEADY STATE SEDIMENTATION - A CASE STUDY FROM THE GULF OF MEXICO (IODP HOLE U1319A)

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Greigite (Fe_3S_4) is an authigenic iron sulfide mineral widely distributed in sulfidic sedimenttary environments. It is often described as a reaction intermediate from Fe monosulfide (FeS) to pyrite (FeS_2) despite the fact, that its mixed Fe^{2+} and Fe^{3+} valence states and crystal lattice resemble those of magnetite (Fe_3O_4). Exploiting greigite's specific ferrimagnetic properties (e.g. gyromagnetism), particles of SD to PSD domain state can be quite safely identified with environmental magnetic diagnostics. In the marine realm, greigite occurs e.g. in gas hydrate systems, anoxic basins, turbidites and high-accumulation organic-rich muds of estuaries, river fans and coastal seas. Typical single or multiple enrichment layers suggest a close linkage of greigite precipitation and/or preservation to (paleo-)redox zonation and accumulation history.
Successions of greigite layers were recently discovered in the 160 m mostly turbiditic late Pleistocene sediment sequence of IODP Hole U1319A of Brazos-Trinity intraslope basin IV in the northwestern Gulf of Mexico (Fu et al. 2008). Some of these layers are localized just below the modern iron redox boundary, while others group around modern and past sulfate-methane transitions. In search of formation mechanisms, two conceptual reaction models invoking non-steady deposition were postulated: The “oxidation model” explains greigite formation by partial oxidation of iron monosulfide near the iron redox boundary during periods of downward shifting oxidation fronts. The “sulfidization model” predicts single or twin greigite layers by incomplete transformation of iron monosulfide with polysulfide around the sulfate methane transition zone. The stratigraphic record provides evidence that both greigite formation processes presently act at respective depths of 3–4 and 12–14 mbsf. The numerous 'fossil' greigite layers were most likely preserved by rapid upward shifts of the redox zonation preventing longer contacts with high H_2S concentrations. They should denote past stagnant SMT positions during high-stand hemipelagic conditions. Six diagenetic stages evolving from a pristine, magnetite-dominated to a greigite-dominated magnetic mineralogy can be distinguished by combination of diagnostic hysteresis and remanence parameters.

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