Ferromagnetic resonance spectroscopy characterization of the putative magnetofossils in red bedded cherts in the Inuyama area, Mino-Tanba belt, SW Japan

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Deep-sea sedimentary rocks in accretionary complexes are ideal for obtaining paleo-environmental information from pre-Jurassic lost oceans (e.g., mid-Panthalassia). Deep-sea bedded cherts of Triassic to Jurassic occur as allochthonous sheets/blocks within the Jurassic accretionary complex of the Mino-Tanba belt in SW Japan. In general, the deep-sea bedded cherts have the following three characteristics; (1) a vitric layer (“chert”) composed of *ca.* 95 wt.% silica derived from radiolarian tests and sponge spicules, (2) an argillaceous layer (“shale”) composed of fine-grained clay minerals, and (3) a red color showing the presence of hematite in both cherts and shales. Previous rock magnetic studies suggested that the red cherts in the Inuyama area contain biogenic magnetite. However, this is not easily reconciled with paleomagnetic data; remanence carried by magnetite is estimated to be younger than Cretaceous, which has been attributed to chemical origin of magnetite. To gain more information on the putative biogenic magnetite, we collected mid-Triassic bedded cherts in the Inuyama area and conducted ferromagnetic resonance spectroscopy (FMR) analyses. Spectra were obtained for the chert and shale beds in X-band (~9.87 GHz), and compared with simulated spectra of biogenic magnetite. The chert beds revealed relatively sharp absorption at ~200 mT with broad absorption between 300-500 mT. The absorption around 350 mT, which is expected for abiotic titanomagnetite, was small compared to known sediment. The shale beds did not show the absorption at ~200 mT. Rock magnetic measurements suggested that the shale beds do not contain much magnetite. Thus, we interpreted that the absorption at ~200 mT from the chert bed is due to the putative biogenic magnetite. Numerical simulations indicated that the spectra shape of the chert beds can be reproduced with a magnetosome configuration where magnetically hard [100] axes of magnetite align along the chain, with effective uniaxial anisotropy 8-9 times larger than the cubic magnetocrystalline anisotropy. A similar configuration has been reported for cultured *Desulfovibrio magneticus sp.* that produces bullet-shaped magnetite. Empirical evidence suggests that bullet-shaped biogenic magnetite tend to be formed under suboxic condition, broadly consistent with the geochemically inferred paleo-redox condition (oxic to suboxic) in the deep mid-Panthalassa during the mid-Triassic. Our results support the presence of biogenic magnetite in the mid-Triassic red chert in the Inuyama area, and we propose magnetosome configuration may be used as a paleo-redox indicator for bedded cherts. At the same time, the anomalous relative depletion of abiotic titanomagnetite and inconsistency with paleomagnetic constraints require further research to fully understand the mechanism and timing of the magnetite formation.

