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Natural lamellar remanent magnetization: Low-temperature properties and models of remanence acquisition

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Natural lamellar remanence of rock units from Modum (Norway) is carried by uncompensated magnetic layers at interfaces between nanoscale exsolution structures of antiferromagnetic (AFM) hematite and ilmenite. Low-temperature measurements, below the ilmenite AFM-ordering temperature, prove that the moments, which carry the NRM, also participate in the exchange coupling at the hematite-ilmenite interfaces. Therefore, the NRM is not carried by defect moments or stress-induced moments, which occur in normal bulk hematite. A closer look at the NRM-induced LT loops shows that exchange bias acts in both field directions, though one direction is clearly predominant. This observation could be interpreted as a frozen equilibrium of different proportions of oppositely directed lamellar moments. A quantitative evaluation indicates that the remanence acquisition must have been extremely efficient. Lamellar aggregation, and the formation of exchange-coupled clusters may explain the observed high efficiency of lamellar remanence acquisition. Due to the apparent non-linear remanence acquisition, we conclude that NRM carried by lamellar moments should not be used for paleointensity estimates of terrestrial or extraterrestrial material.