The Role of ε-Fe_2O_3 Nano-Mineral and Domains in Enhancing Magnetic Coercivity: Implications for the Natural Remanent Magnetization

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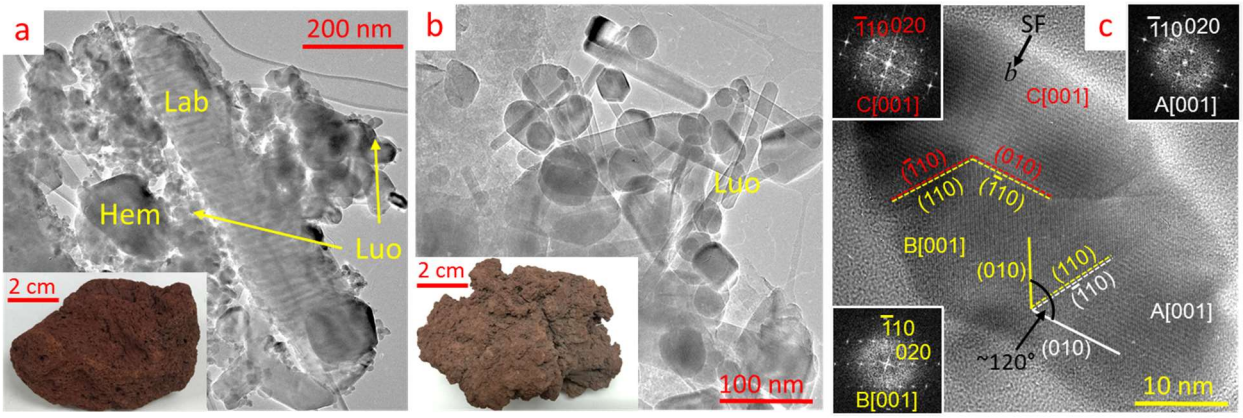

Figure S1. (**a**) Scoria hand specimen from the Menan Volcanic Complex, Idaho. The bright-field TEM image showing luogufengite (Luo) with hematite (Hem) and labradorite (Lab); (**b**) Basaltic rock hand specimen from Laguna del Maule volcano, Chile. The bright-field TEM image showing the rod-shape of luogufengite nano-minerals; (**c**) A high resolution TEM image with the fast Fourier transform (FFT) patterns of a luogufengite grain showing twin boundaries ($\bar{1}10$)//(010) between the neighboring crystals in the pseudo-hexagonal relationship and stacking fault (SF) of ***b***/3 along *b*-axis.

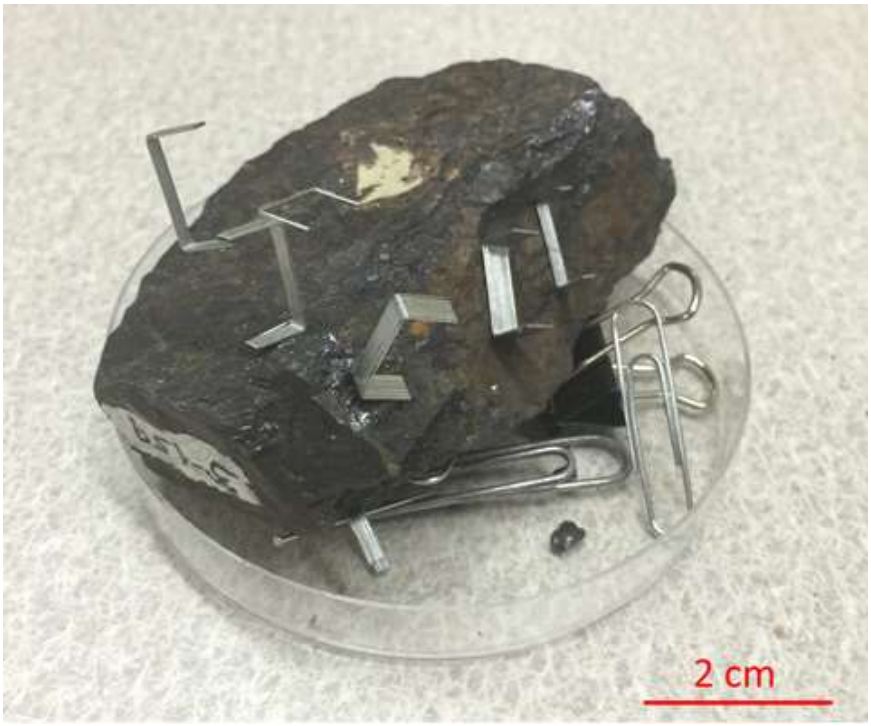

Figure S2. Hand sample of lodestone (natural magnet) collected from the magnetite deposit near Cedar City, Utah.

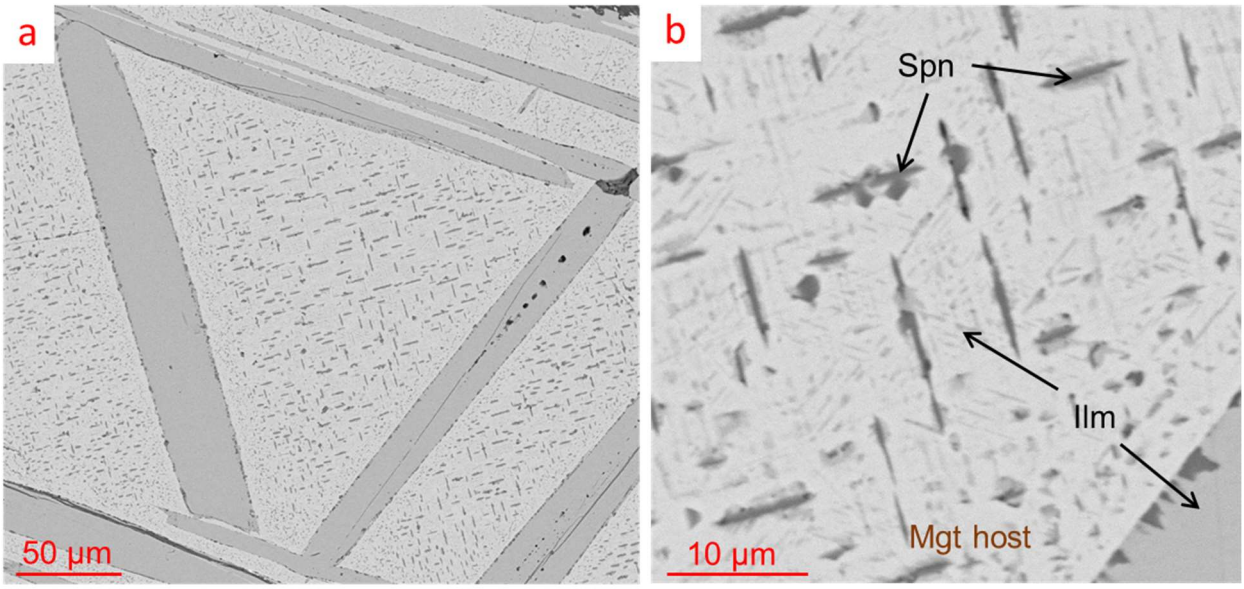

Figure S3. BSE image of ilmenite-magnetite series of Fe-Ti oxides from the Skaergaard layered mafic intrusion in Eastern Greenland. (**a**) The coarse exsolution lamellae of ilmenite are the early stage of precipitation. (**b**) Exsolution lamellae of ilmenite (Ilm) and spinel (Spn) are associated with the host magnetite (Mgt) along the {111} planes.

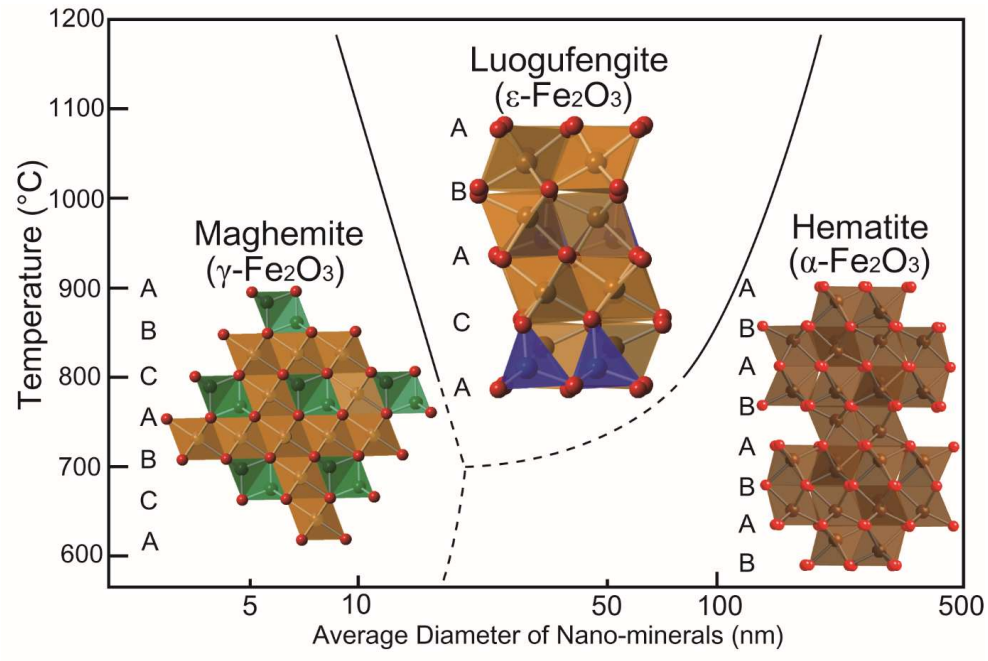

Figure S4. A size-dependent phase map of iron (III) oxide polymorphs of maghemite, luogufengite, and hematite. Luogufengite is an intermediate product between maghemite and hematite (Lee et al. [1]).

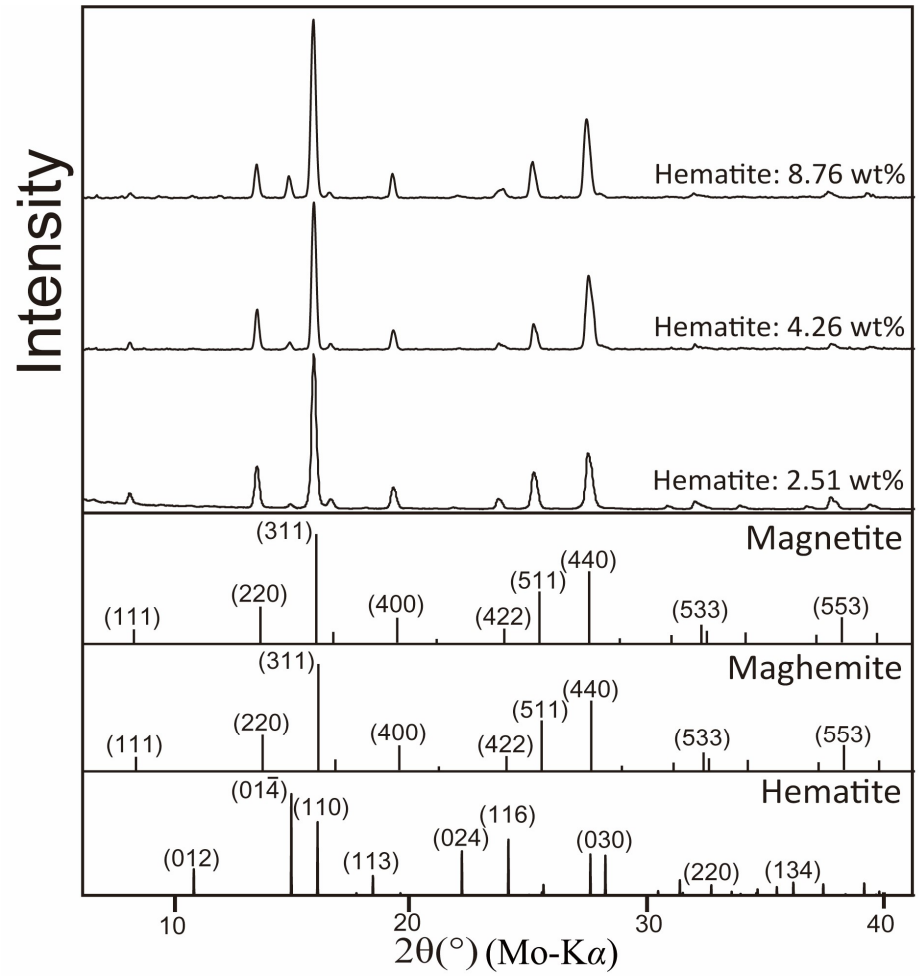

Figure S5. Three powder XRD patterns of lodestone with different hematite concentrations. Weight percentages of hematite were calculated by the Rietveld refinement method.

Table S1. Atomic coordinates of luogufengite.

Space group *Pna2*$_1$				
Atom	**Occupancy**	**x**	**y**	**z**
Fe1	Fe 1.00	0.1941(3)	0.1569(4)	0.5789(6)
Fe2	Fe 1.00	0.6844(5)	0.0228(3)	0.7893(7)
Fe3	Fe 0.73 Al 0.27	0.1878(3)	0.1531(6)	0.0000(2)
Fe4	Fe 0.80 Al 0.20	0.8081(4)	0.1602(2)	0.3044(6)
O1	O 1.00	0.9812(3)	0.3356(3)	0.4396(5)
O2	O 1.00	0.5106(2)	0.4953(3)	0.4154(5)
O3	O 1.00	0.6477(3)	0.9869(7)	0.1961(6)
O4	O 1.00	0.1569(5)	0.1568(6)	0.1902(3)
O5	O 1.00	0.8325(5)	0.1705(4)	0.6651(3)
O6	O 1.00	0.5391(4)	0.1717(2)	0.9423(6)

Lattice parameters: a = 5.0647(3), b= 8.7131(6), c = 9.3842(5). Reference: (Xu et al. [2])

References

1. Lee, S.; Xu, H.F. Size-dependent phase map and phase transformation kinetics for nanometric Iron(III) oxides ($\gamma \rightarrow \varepsilon \rightarrow \alpha$). *J. Phys. Chem. C* **2016**, *120*, 13316–13322.
2. Xu, H.F.; Lee, S.; Xu, H. Luogufengite: A new nano-mineral of Fe_2O_3 polymorph with giant coercive field. *Am. Mineral.* **2017**, *102*, 711–719.