Luogufengite: An Fe_2O_3 nanomineral with unique magnetic property

Huifang Xu[1,*], Seungyeol Lee[1], and Hongwu Xu[2]
[1]NASA Astrobiology Institute, Department of Geoscience, University of Wisconsin – Madison, Madison, Wisconsin 53706, USA (hfxu@geology.wisc.edu)
[2]Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, NM 87545, USA (hxu@lanl.gov)

Luogufengite, Al-bearing ε-Fe_2O_3, is a new member of Fe_2O_3 polymorphs discovered in late Pleistocene basaltic scoria from the Menan Volcanic Complex nearby Rexburg, Idaho. It is an oxidized product of Fe-bearing basaltic glass at high temperature and coexists with maghemite and hematite. Luogufengite has an euhedral or semi-euhedral crystal shape with its size ranging from ~20 to ~120 nm. It is an intermediate phase between maghemite and hematite. The mineral has a space group of $Pna2_1$; its unit-cell parameters refined from synchrotron X-ray powder diffraction data are a = 5.0647(3) Å, b = 8.7131(6) Å, c = 9.3842(5) Å, and Z = 4 (calculated density = 4.905 g/cm^3) with the doubled hexagonal (ABAC) packing of oxygen atoms. The crystals display (110) twins with twin boundaries of (110), (100), and (130) due to their pseudo-hexagonal symmetry. This nanomineral also occurs as oxidation products (maintaining an epitaxial relationship with the host minerals) of Fe-bearing olivine and enstatite at high temperature. Luogufengite is an important mineral that records paleomagnetism of volcanic rocks because of its large magnetic coercivity. This unique magnetic property of the mineral may explain the observed unusually high remanent magnetization in some igneous and metamorphic rocks and even Martian rocks with high remanent magnetization. Some intergrowths of magnetite with ilmenite exsolution lamellae or hematite with magnetite lamellar precipitates have luogufengite-like 2-D crystalline characteristics with the doubled hexagonal packing at the interface between cubic and rhombohedral structures. Luogufengite-like nano-domains at the magnetite / hematite interfaces might be responsible for the large coercive field of lodestones that are partially oxidized magnetite with hematite micro-precipitates.

The name has been approved by Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association, (IMA 2016-005). The mineral was named after a Chinese mineralogist, Professor Luo Gufeng (born in 1933), who has passionately taught crystallography and mineralogy at Nanjing University of China for more than 60 years.