

## Supplementary Materials

### **Valleyite: A new magnetic mineral with the sodalite-type structure**

Huifang Xu <sup>a\*</sup>, Seungyeol Lee <sup>a</sup>, Hongwu Xu <sup>b</sup>, Ryan Jacobs <sup>c</sup>, and Dane Morgan <sup>c</sup>

<sup>a</sup> NASA Astrobiology Institute, Department of Geoscience, University of Wisconsin–Madison, Madison, Wisconsin 53706, USA

<sup>b</sup> Earth and Environmental Sciences Division, Los Alamos National Laboratory, Los Alamos, NM 87545, USA

<sup>c</sup> Department of Materials Science and Engineering, University of Wisconsin-Madison, Madison, Wisconsin 53706, USA

\*Corresponding author:

Prof. Huifang Xu

Department of Geoscience

University of Wisconsin-Madison

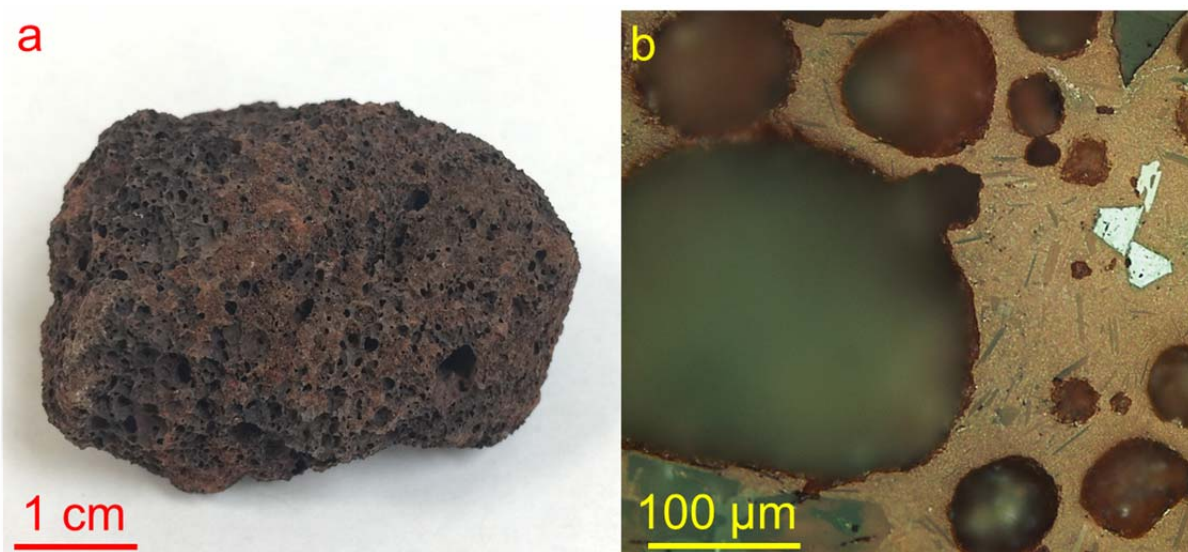
1215 West Dayton Street, A352 Weeks Hall

Madison, Wisconsin 53706

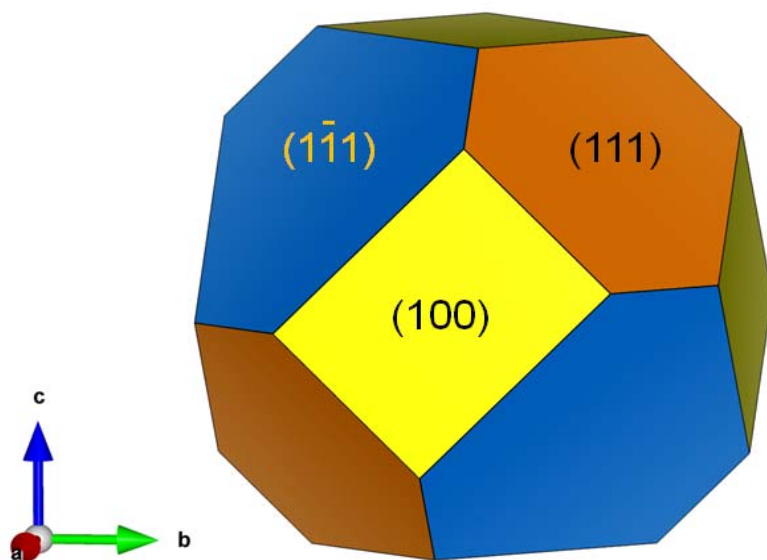
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Fax: 1-608-262-0693

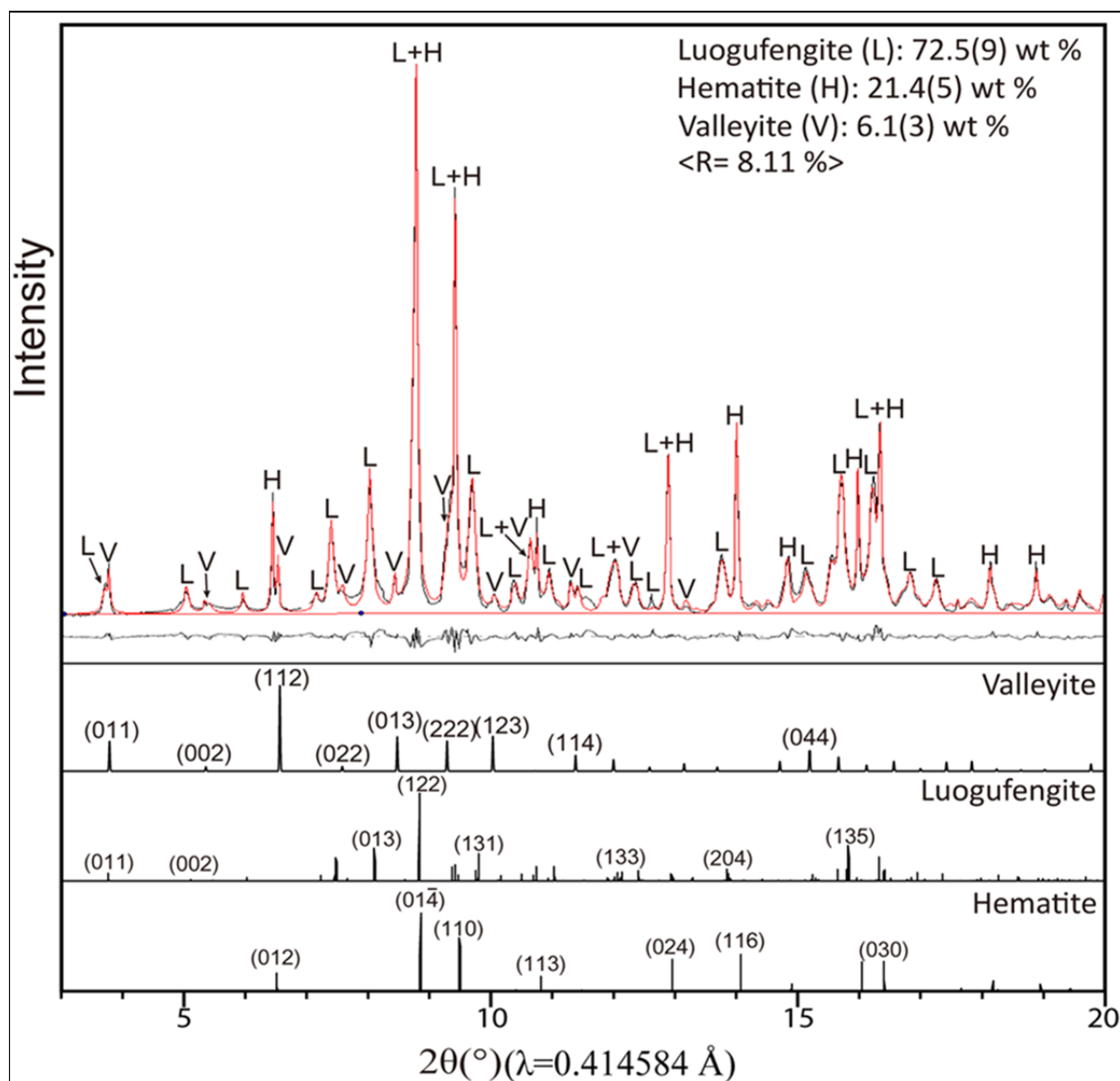
Email: [hfxu@geology.wisc.edu](mailto:hfxu@geology.wisc.edu)



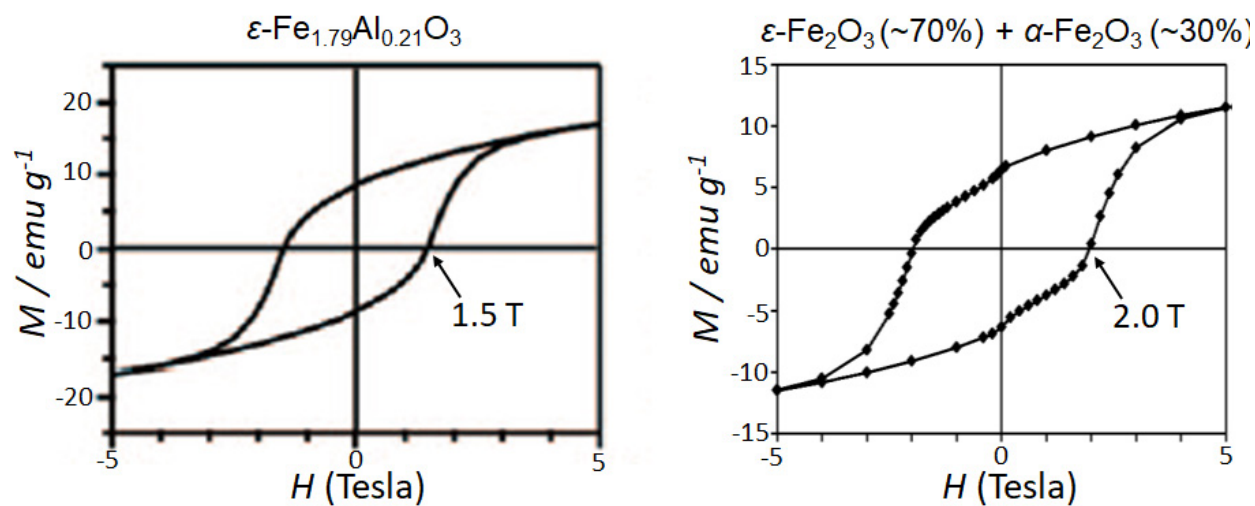
**Figure S1:** (a) A brown scoria hand specimen showing porous texture with vesicles covered by brown oxide minerals of valleyite, luogufengite, hematite and maghemite. (b) Polished surface of a scoria thin section shows brownish coating of the oxides on the vesicle surfaces. Glassy groundmass of the scoria contains crystals of magnetite and platy labradorite. The image was recorded under reflected light.



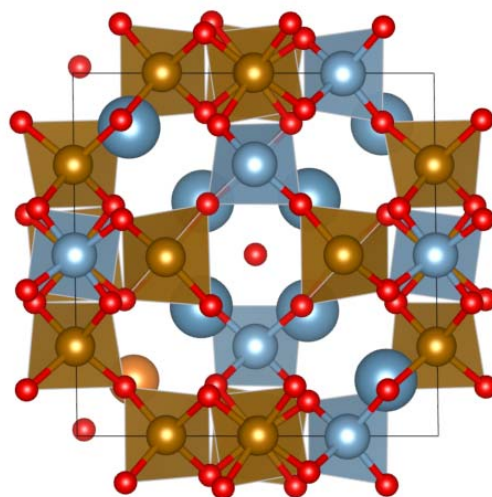
**Figure S2:** Proposed ideal morphology of valleyite with crystallographic forms of {100}, {111} and {111̄}.



**Figure S3:** Synchrotron XRD pattern of the sample consisting of valleyite, luogufengite and hematite, prepared from thermal decomposition of nontronite at 850 °C.



**Figure S4:** Room-temperature magnetic hysteresis loops of (a) synthetic Al-bearing  $\epsilon\text{-Fe}_2\text{O}_3$ , and (b) mixture of pure  $\epsilon\text{-Fe}_2\text{O}_3$  (~70 %) and hematite (~30 %). The effect of 15 % hematite on the hysteresis loop of luogufengite is expected to be very minor. The data are from Ohkoshi et al. (2005).



**Figure S5:** Proposed crystal structure model for the DFT calculations. The displayed composition is  $(\text{Ca}_{3.5}\text{Mg}_{0.5})(\text{Fe}_4\text{Al}_2)\text{O}_{13}$ . The large blue, large orange, small blue (in shaded tetrahedra), small brown (in shaded tetrahedra) and small red spheres denote Ca, Mg, Al, Fe and O atoms, respectively.

## Reference

- Lee, S., Shen, Z., and Xu, H. (2016) Study on nanophase iron oxyhydroxides in freshwater ferromanganese nodules from Green Bay, Lake Michigan. *American Mineralogist*, 101, 1986-1995.
- Ohkoshi, S. I., Sakurai, S., Jin, J., and Hashimoto, K. (2005) The addition effects of alkaline earth ions in the chemical synthesis of  $\epsilon$ -Fe<sub>2</sub>O<sub>3</sub> nanocrystals that exhibit a huge coercive field. *Journal of applied physics*, 97(10), 10K312.