

THE SIGNIFICANCE OF THE FRAMBOIDAL MAGNETITE IN MURCHISON METEORITE. Xu Ren^{1,2}, Hong Tang¹, Yang Li¹, Yuan Guo¹, Zhuang Guo^{1,3}. ¹Institute of Geochemistry, Chinese Academy of Sciences, Guiyang, China; ²University of Chinese Academy of Sciences, Beijing, China; ³Northwest university, Xi'an, China. E-mail: liyang@mail.gyig.ac.cn

Introduction: Fluid actions play an important role in the early evolution of organics and minerals on ancient asteroids. Nevertheless, the evolution of early aqueous activities, chemical species as well as redox condition on ancient asteroids are still unclear.

Our work focus on the formation of framboidal magnetite in Murchison meteorite. The research indicated that the solution becomes more and more alkaline and changed from sulfur-rich to oxygen-rich with the evolution of aqueous activity on Murchison meteorite's parent bodies.

Sample and analytical techniques: The meteorite was observed and analyzed by the FEI Scios dual-beam

shape of magnetite still the same with pyrite. Metasomatic pseudomorph texture is a typical product of aqueous activity.

Previous studies have shown that troilite can form pyrite in the solar system environment, and these initial pyrite components may be form the framboidal pyrite by four consecutive processes [3]: 1. Nucleation and growth of initial iron monosulfide microcrystals; 2. Reaction of the microcrystals to greigite (Fe_3S_4); 3. Aggregation of uniformly sized greigite microcrystals, i.e., framboid growth; 4. Replacement of greigite framboids by pyrite. In the early stage of the formation of framboids pyrite, Mg^{2+} and Ca^{2+} in solution

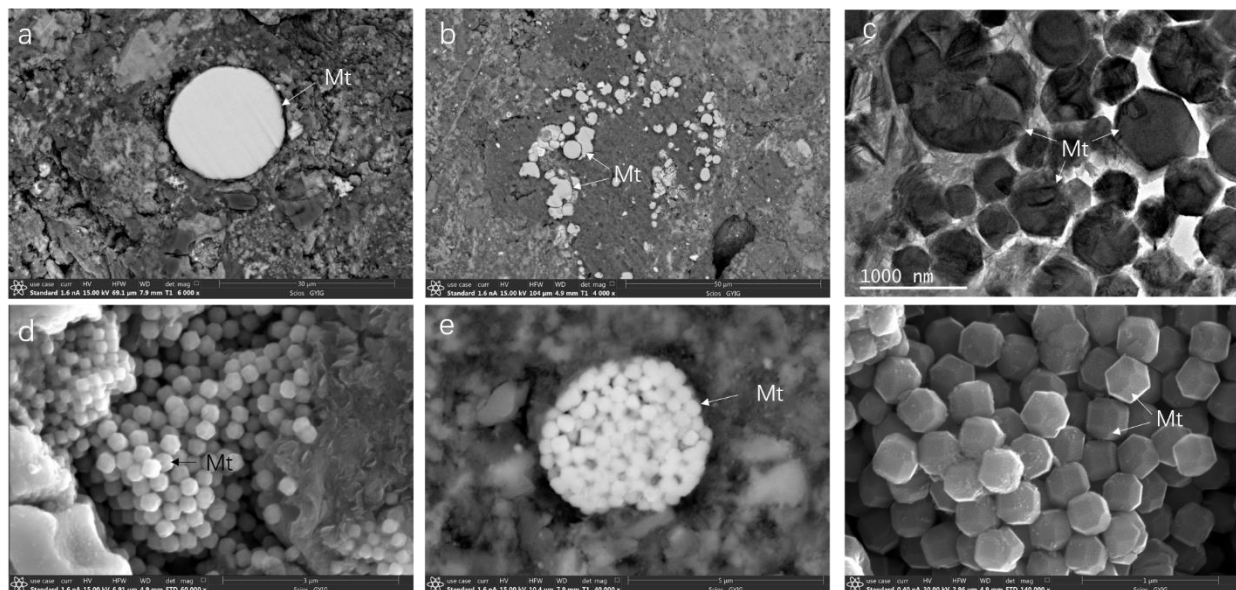


Fig 1. (a)(b) BSE images of different magnetite in Murchison meteorite. (c)(d)(e) BEM images of the framboidal magnetite in Murchison meteorite. (f) TEM images of framboidal magnetite in Murchison meteorite.

scanning microscope (SEM&FIB). The cross section of framboidal magnetite was prepared by the focus ion beam and analyzed by FEI Talos field-emission scanning transmission electron microscope.

Results: Magnetite is the signature of the early aqueous activity on carbonaceous chondrite parent bodies. Different kinds of micro-nanosized magnetite particles were discovered in the matrix of Murchison, Fig 1. In addition, we found a part of the framboidal magnetite with the same crystal shape with framboidal pyrites. We think it might be the metasomatic pseudomorph texture and it indicates that framboidal pyrite was replaced by the magnetite, but left the crystal

precipitated firstly [4].

We analyzed the formation mechanism of framboidal magnetite from three aspects: material source, framboidal pyrite formation process and metasomatic process and explained its significance for the early aqueous activity evolve on carbonaceous chondrite parent body's surface. And the resulting solution then became relatively enriched in iron ions, the pH of the solution gradually increase and the solution becomes more and more alkaline which favoured the direct precipitation of magnetite. On the other hand, after sublimation of water, sulphur could leach from pyrrhotite and be replaced by oxygen and the

solution changed from sulfur-rich to oxygen-rich [1]. These two conditions made the solution from the conditions of pyrite formation to the conditions of magnetite formation. Thus, the solution rich in magnetite component is replaced by the framboidal pyrite to form the framboidal magnetite, which has the crystal shape of pyrite and the chemical composition of magnetite.

Discussion: The reason for the solution changed from sulfur-rich to oxygen-rich actually still not perfectly explained. It would be difficult to eliminate all sulphur from the system in a solution. After sublimation of water, sulphur could leach from pyrrhotite and be replaced by oxygen. Colloidal crystals would then be formed from pyrrhotite [1]. In such a case, fine microstructures of the polyhedral morphology would not be preserved and the magnetite should contain voids

at the centre of the particles as a result of volume reduction and diffusion of iron from inside to outside to form oxides [5], as reported terrestrial magnetite's formation from pyrite [6]. It needs to be confirmed in the further study.

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