Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

BAO01-14 会場:105 時間:5 月 28 日 16:45-17:15

A reinvestigation of ALH84001 magnetite using SQUID microscopy
A reinvestigation of ALH84001 magnetite using SQUID microscopy

BUZ, Jennifer[1] ; KIRSCHVINK, Joseph[1*] ; KOBAYASHI, Atsuko[2] ; THOMAS-KEPRTA, Kathie[3] ; CLEMETT, Simon[3]
BUZ, Jennifer[1] ; KIRSCHVINK, Joseph[1*] ; KOBAYASHI, Atsuko[2] ; THOMAS-KEPRTA, Kathie[3] ; CLEMETT, Simon[3]

[1]California Institute of Technology, Pasadena USA, [2]Earth/Life Science Institute, Tokyo Institute of Technology, Meguro, Japan, [3]ESCG at NASA/Johnson Space Center, Houston TX, USA, [4]Earth/Life Science Institute, Tokyo Institute of Technology, Meguro, Japan
[1]California Institute of Technology, Pasadena USA, [2]Earth/Life Science Institute, Tokyo Institute of Technology, Meguro, Japan, [3]ESCG at NASA/Johnson Space Center, Houston TX, USA, [4]Earth/Life Science Institute, Tokyo Institute of Technology, Meguro, Japan

The ˜4 Ga Martian meteorite ALH84001 has fine grained magnetite crystals embedded in carbonate blebs along its fracture surfaces (McKay, 1996). Some of these magnetites are strikingly similar (in grain size, morphology, and composition) to those made by magnetotactic bacteria on Earth (Thomas-Keprta et al. 2009). Great debate has raged concerning the origin of the putative biological magnetites. Until recently careful magnetic examination of the magnetite in the carbonate blebs was not possible due to a lack of instrument sensitivity. The ultra-high resolution scanning SQUID microscope (UHRSS) now allows us to study the magnetization of individual carbonate blebs that have been extracted from the meteorite. We are also able to visualize magnetization along fracture surfaces and within the bulk rock by scanning thin slices of the meteorite with the UHRSS.

Two leading hypotheses exist to explain the magnetites found within the carbonate blebs: high-temperature shock deformation leading to the decomposition of iron-bearing carbonate minerals to form magnetite (Treiman and Essene, 2011), and the sedimentary deposition of previously-formed, mature magnetite in an aqueous micro-environment as would be the case for a biogenic origin (Thomas-Keprta, 2009). A well-established paleomagnetic technique which can distinguish between these two hypotheses is the Fuller test of natural remanent magnetization (NRM) (Fuller et al. 1988) which probes the efficiency of the magnetization. If the magnetites grew in a solid state process inside the carbonates (like is suggested by Treiman and Essene (2011) they would be unable to physically rotate as they become stably magnetized and would have a highly efficient magnetization. If the magnetites were detrital (as would be expected from a biological origin scenario) the magnetization would be three orders of magnitude less efficient because the particles would be subject to Brownian motion as they are deposited. Additionally, the susceptibility of Anhysteretic Remanent Magnetization (ARM susceptibility) can be measured for the carbonate blebs. The ARM susceptibility measures the inverse of the effective r.m.s. field strength between magnetic particles (Cisowski 1981). We expect high ARM susceptibility for magnetites formed in situ because they would be evenly spaced as they form and therefore not highly interacting. However, magnetite particles falling through a water column will clump together as they fall (Kobayashi et al. 2006) and will have a low ARM susceptibility.

In order to conduct these paleomagnetic tests on the magnetites found within the carbonates and avoid interaction from other magnetic particles in the bulk rock, we extracted the carbonate blebs by carefully flaking them from the fracture surfaces using a non-magnetic needle. We then glued these blebs to magnetically clean microscope slides. We scanned the microscope slides with the UHRSS and were able to observe quantifiable magnetization from the individual blebs. The Fuller test of NRM requires demagnetization of the sample followed by application of an isothermal remanent magnetization (IRM). We have begun demagnetization of the sample. Thus far we observe a clear single magnetic component from NRM to 8 mT followed by chaotic changes in magnetic direction and approximately uniform strength (Figure 1). At this stage it is unclear whether multiple magnetization components will be recovered, our demagnetization is ongoing. Separately, we have measured slices of the ALH84001 bulk rock and observed heterogeneous magnetization, consistent with the work done by Weiss et al. (2000). We have also observed clustering of dipoles within the bulk rock, especially along fracture surfaces. Clustering of dipoles may indicate that multiple deposition or alteration events occurred or that portions of the meteorite have been fractured after emplacement/formation of the carbonates.

キーワード: Martian Life, ALH84001, Rock Magnetism, Paleomagnetism, Biogenic Magnetite, Meteorites
Keywords: Martian Life, ALH84001, Rock Magnetism, Paleomagnetism, Biogenic Magnetite, Meteorites

BAO01-14　会場:105　時間:5 月 28 日 16:45-17:15