

Shock melt vein as a pristine paleomagnetic recorder and time-temperature relation of iron-nickel and high-pressure mineral

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Giant collisions between parent-bodies are the most common shock events in a protoplanetary disk system. Dynamic shock remagnetization alters remanence vectors in meteorites, so that it makes extraterrestrial paleomagnetism hopeless. Heavily shocked meteorites of shock stages S5 and S6, however, contain a shock-induced melt veins (SMVs), which might have reset the remanence of an asteroidal thermal metamorphism at the time of giant collisions against a chondrite parent-body. Here we present micropaleomagnetic and petrologic studies of SMVs in L6S5 Tenham chondrite with c.a. 1mm thick black veins enclosing high-pressure minerals such as ringwoodite, by SQUID magnetometer. Paleomagnetic data show that the high temperature (high T) stable components (200-650C) of SMVs formed a cluster even from different portions of SMV, whereas the stable high T component of surrounding host rock showed a scattered orientation under stereonet projection. Magnetic force microscopy and backscattered electron images confirmed framboidal or sinusoidal kamacite and taenite assemblage in iron-sulfides as the remanence-carrying mineral in SMVs. Hysteresis data of SMVs revealed the presence of single domain (SD) FeNi metals with $M_r/M_s=0.1$ and $H_{cr}/H_c=2$, although these parameter are only applicable to magnetite. Because the metastable ringwoodite in SMVs back-transforms partly to olivine at 200C for 1000Ma (metamorphism) or at 900C for 100s (post-shock heating), the preservation of ringwoodite suggests that SMVs have been under relatively low temperature. Magnetic time-temperature relation for SD FeNi metals suggested that the metamorphic condition corresponds to the laboratory unblocking temperature of 500C for kamacite and 365C for taenite. There is no such unblocked component only at 200C in our thermal demagnetization experiments. The post-shock condition is possible to remagnetize the SMVs and host rock simultaneously. However, there is discrepancy of high T remanence component between SMVs and the host rock, suggesting no such short duration thermal event. Therefore, the SMV's remanence is a characteristic shock-induced thermal remanence that has newly been acquired during hypervelocity collision, and could have preserved an ancient magnetic field at the time of hypervelocity collisions. In the presentation, I will also present a latest result for SMVs in DHO007 eucrite.