A low temperature acquisition of magnetic remanence in the Nojima pseudotachylyte

Tomohiro Kitagawa[1]; Norihiro Nakamura[2]

[1] DGES., Tohoku Univ; [2] Geo-Environmental Sci., Tohoku Univ.

http://www.dges.tohoku.ac.jp/igps/nakamura.htm

The Nojima fault rocks are thin alternating layers of very fine gouge (dark gray, cohesive) and pseudotachylyte (black, brittle), derived from the adjacent ilmenite-series granite. Each layer is thinner than a few millimeters, and corresponds to one seismic slip event. Previous X-ray diffraction study shows that the black-color pseudotachylyte indicates the crystallization of mullite and the broad peak diffraction pattern, suggesting the pseudotachylyte is of melt origin (peak temperature of 1250C). In the bulk sample with these alternating layers, the natural remanent magnetization (NRM) is 400 times more intense than in the granite. This higher remanence has been explained through a frictional melting experiment by the production of submicron-sized ferromagnetic magnetite (Fe_3O_4) from mafic minerals during the melt-quenched event (more than 1000C). Therefore, the black-color pseudotachylyte should record thermal remanence during each seismic event in the alternating layers of the Nojima fault rocks. However, there has been no paleomagnetic study of the pseudotachylyte by the layer-by-layer. Here, we examine the NRM of black-color pseudotachylyte by the layer-by-layer analysis through step-wise thermal demagnetization and scanning electron microscopy (SEM) observation, in order to evaluate claims that the magnetite was formed by frictional melting. 32 measurements of the thermal demagnetization were performed in total. The pseudotachylyte samples of 12 in whole measurements show very weak intensity (near SQUID detection limit) and unstable demagnetization patterns, while the rest of the samples indicate a relatively strong intensity and a stable demagnetization pattern. SEM observation reveals that a remanence carrier is submicron-size inclusions of iron. In these stable samples, five subsamples (25%) unblocked the NRM in 450-530C, indicating that the interior of the pseudotachylyte has not been above these temperature. This low unblocking temperature result suggests that the production of ferromagnetic magnetite is not necessary to be melted, but can be made by heating the gouge to moderate temperature (450-530C). If the magnetic mineralogy of the pseudotachylyte is a ferromagnetic maghemite (gammma-Fe_2O_3), however, the low unblocking temperature corresponds sole to phase transformation of maghemite to antiferromagnetic hematite. Therefore, the identification of magnetic mineralogy determines the origin of the low unblocking temperature, affecting a thermal history of the Nojima fault rocks.