岩石磁気イメージングのための SQUID 顕微鏡の開発

河合 淳 [1]; 小田 啓邦 [2]; 宮城 磯治 [3]; 佐藤 雅彦 [4]; 藤平 潤一 [5]; 宮本 政和 [1]
[1] 金沢工大・電子研; [2] 産総研・地質情報; [3] 産総研; [4] 九大・比文・地球変動講座; [5] （株）フジヒラ

Development of a scanning SQUID microscope for magnetic imaging of rock samples

Jun Kawai[1]; Hirokuni Oda[2]; Isoji Miyagi[3]; Masahiko Sato[4]; Junichi Fujihira[5]; Masakazu Miyamoto[1]
[1] AEL, KIT; [2] IGG, GSJ, AIST; [3] GSJ,AIST; [4] Division of Earth Sciences, SCS, Kyushu Univ.; [5] FUJIHIRA

Scanning superconducting quantum interference device (SQUID) microscope (SSM) is a useful tool to image very weak magnetic fields with high spatial resolution. The first practical SSM was developed by J. Kirtley and J. Wikswo in IBM (1999). Since then, some groups have developed and improved SSMs for various applications. L. Fong and F. Baudenbacher et al. (2005) developed an SSM with a monolithic SQUID, and applied to geological sample scanning. H. Oda et al. (2011) succeeded in imaging of the magnetic stripes of hydrogenetic ferromanganese crusts related to geomagnetic reversals using the SSM. In this project, we have developed an SSM to image vertical magnetic fields of the thin section of various rock samples such as sediments, volcanic rocks and meteorites for geological studies. We designed a hollow-structured cryostat to realize reliable SQUID assembly and repeatable adjustment of the vacuum separation from the sample. The SQUID based on niobium is a single-washer magnetometer with the pickup area of 200 x 200 square micrometers and the size of the chip is 1 mm x 1mm. The SQUID chip is mounted on a conical sapphire rod and electrically connected to the non-magnetic electrodes with silver paste. The electrodes are patterned on the surface of the sapphire rod using metalization technique. The sapphire rod is connected to a copper block, which is thermally anchored to the liquid helium reservoir with copper bundle wires. The copper block is connected to a rigid shaft through a flexure spring, and the shaft extends through the hollow of the cryostat to the spindle placed on the top flange at room temperature. Rotating the spindle, the SQUID chip can be simply moved up and down with an accuracy of ˜5 micrometers in the movable range of 1 mm. A 40-micrometer thick sapphire window separating the sample from the vacuum space can be adjusted toward the SQUID using a bellows structure. With this mechanism, we have achieved the separation of 800 micrometers between the SQUID and the sample, so far. Our goal of the separation is 200 micrometers or shorter with more careful assembly. The liquid helium capacity of the cryostat is about 10 litters and the SQUID can be maintained at operation temperature for 72 hours. The field resolution of the SQUID was 1.7 pT/rtHz at 100 Hz in a flux locked loop (FLL) operation. In this talk, we will introduce the progress of our SSM project, showing the performance and a scanning demonstration result of artificially magnetized natural zircons with magnetite inclusions.