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走査型 SQUID 顕微鏡システムの開発と初期測定結果
Development of scanning SQUID microscope and initial results

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Scanning superconducting quantum interference device (SQUID) microscope (SSM) is a useful tool to image very weak magnetic fields with high spatial resolution. Fong et al. (2005) developed an SSM with a monolithic SQUID and applied to scan magnetic field produced by geological thin sections. Oda et al. (2011) succeeded in imaging of the magnetic stripes of hydrogenetic ferromanganese crusts using the SSM at Vanderbilt University developed by Fong et al. (2005) and could provide age model by correlating to the standard geomagnetic polarity timescale. In this project, we have developed an SSM to image vertical magnetic fields over thin sections of various rock samples 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 process 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. 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 ~250 micrometers between the SQUID and the sample, so far. The field resolution of the SQUID was 1.1 pT/rtHz at 100 Hz in a flux locked loop (FLL) operation. In this talk, we will introduce the development of our SSM project and describe the performance of the system. Further, we will present some initial mapping results conducted on various geological samples, such as volcanic rocks, sediments, etc. The project is supported by JSPS KAKENHI Grant Number 25247073.

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