December 2014 Date of Issue: December 18

Superconductivity Web21

Published by International Superconductivity Technology Center
KSP, Kawasaki, Kanagawa 213-0012 Japan Tel:+81-44-850-1612, Fax:+81-44-850-1613

Feature Article: SQUID Application
- Development of HTS Gradiometer Using 2-SQUID Rotation Mechanism

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Metallic ore deposits are magnetized by the Earth's magnetic field. This influences the terrestrial magnetic field measured at the ground surface. An underground exploration technique that investigates changes in the Earth's field is commonly referred to as magnetic prospecting. Since the Earth's field varies between several tens of nT (magnetic quiet day) to several hundreds of nT (geomagnetic storm) in a day, measuring the Earth's field should not be about determine nominal values, but instead ascertain the magnetic changes between the two sites. To this aim, a prototype HTS gradiometer comprising of two rotating SQUIDs was fabricated, allowing absolute values of magnetic gradient to be measured.

Due to a principle of feedback operation of SQUID, the measurement does not determine absolute magnetic field values, but instead measures only relative changes from a certain offset value. Since the offset value differs according to an individual SQUID, a simple calculation of the difference cannot be used to produce an absolute value of the magnetic gradient. To address the discrepancies with a SQUID measuring absolute values, we have investigated a method employing two SQUIDs that measures the magnetic signals at remote sites alternately, thus eliminating global changes in the measured magnetic fields, as shown in Figure 1.

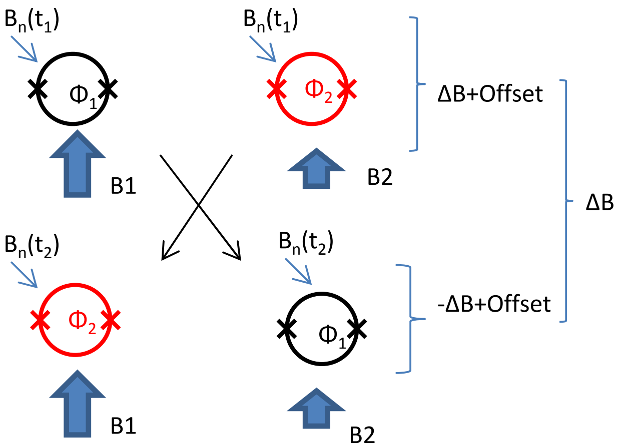

Fig. 1 Diagram showing the measurement principle

Mobile measurements made at two sites using the same SQUID can cancel the measured offset values, thereby allowing an absolute value of the difference of two signals to be measured. Also, conducting simultaneous measurements of the difference between two SQUID output signals allow global variations in the magnetic field to be eliminated.

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Figure 2 provides an overview of the prototype system. The technique involves two SQUIDs that are continuously rotating concentrically allowing their positions to be altered. Two HTS-SQUID magnetometers (detection coil diameter 13.5x13.5 mm), facing towards the vertical direction (rotation axis direction) are each cooled by their respective dewars. Each dewar has a self-revolving mechanism, transporting the dewar on the rotating stage whilst the in-plane direction remains unchanged. An ultrasonic motor is used for rotation since it offers reduced magnetic noise characteristics, operated externally utilizing an infrared remote-control command. An FLL circuit (Hitachi-manufactured) with the wireless LAN interface is mounted onto the dewar and simultaneously feeds rotational positions and SQUID signals to a PC. Real-time subtraction can therefore be performed on a PC. The continuous rotation enables simultaneous measurements of dBz/dx and dBz/dy with averaging technique.

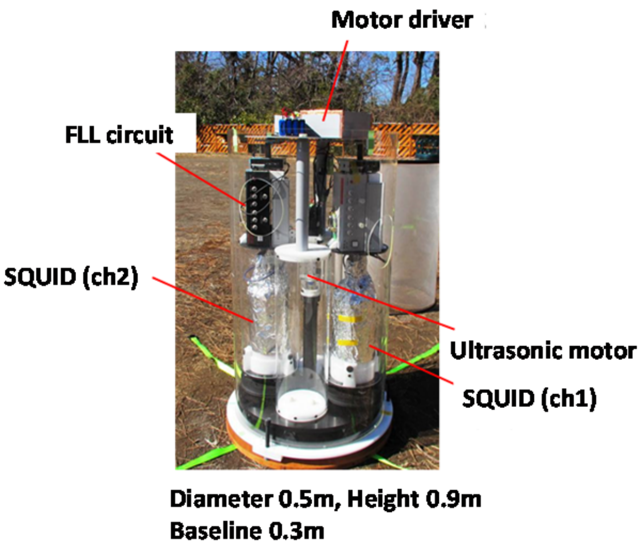

Fig. 2 Prototype HTS gradiometer using 2-SQUID rotation mechanism

This research was supported by Japan Oil, Gas and Metals National Corporation (JOGMEC), as part of a mineral exploration technology development project funded by the Ministry of Economy, Trade and Industry.

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