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Development of High-Resolution HTS-SQUID Magnetometer for Observation of Magnetic Signals from Earthquake-Piezomagnetic Effects

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Electromagnetic changes associated with earthquakes have been investigated previously. For decades, researchers have studied the seismomagnetic effects[1,2]. From continuous observations, our research group reported a successful result which is “co-faulting” Earth’s magnetic field variation due to piezomagnetic effects caused by earthquake rupturing (i.e., earthquake(EQ)-piezomagnetic effects)[3]. This is an important finding: observation of EQ-piezomagnetic effect may lead us to a new system for super-early warning of earthquake detection.

However, additionally the observed result also suggested that the geomagnetic field accompanying fault movement are very small variations of some hundreds pT. Therefore, to develop an extremely high-resolution magnetometer system is so important, that our research group has developed a new geomagnetic observation system with low running cost and higher resolution at Iwaki observation site in Fukushima, Japan: we introduce high-temperature-superconductor based superconducting-quantum-interference-device (HTS-SQUID) as a magnetometer for a long-term geomagnetic observation.

The sampling-frequency of our magnetometer system is 50 Hz (0.02 s) which are higher sampling frequency than our conventional observation system using a flux-gate. Our system observed the orthogonal three-vectors of geomagnetic field vibration. The clock of this system is synchronized with a GPS signal. These observed data are uploaded to the web server through the mobile network.

Through our evaluation, it is clarified that the resolution of our HTS-SQUID magnetometer systems is about a few or several pico-tesla. We obtained the observation results of geomagnetic field changes associated with the earthquake generated near our observation point using our high-resolution magnetometer system.

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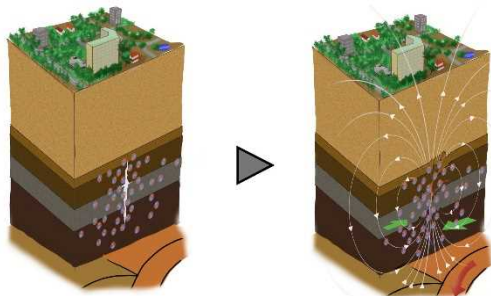


Fig. Aspect of Earthquake (EQ)-piezomagnetic effect: Earth’s magnetic field variation due to piezomagnetic effects caused by earthquake rupturing

Keywords: magnetometer, HTS-SQUID, earthquake-piezomagnetic effects, observation