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Test of borehole observation of temperature and SP in Matsukawa at the foot of Mt. Iwate: Toward seafloor seismo-EM observation

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Water is believed to play an important role in generation of earthquakes as well as magma. Therefore, it is necessary to clarify the distribution, movement and state of the water in the crust. Recent studies of resistivity of the crust show that electromagnetic methods are powerful tools for investigating the water. Furthermore, observation and analysis of time series of the electric and magnetic fields have been in steady progress, and they are providing a new view for electromagnetic phenomena prior to earthquakes. However, these researches have been mostly done on land. For the further development, the electromagnetic observation on and in the seafloor will be one of the most important challenges, because large earthquakes have more frequently occurred in the sea area than the land area. From such a standpoint, we are developing a borehole instrument for long-term temperature and self-potential observations.

The instrument consists of a main unit on the seafloor, sensors in the borehole, and two cables that connect the sensors with the main unit. The sensors are 18 thermistors, 6 Ag-AgCl non-polarizing electrodes, and 4 Cu electrodes. The details were presented in the last meeting (Sayanagi et al., 2002). As reported in that meeting, the instrument has been tested in a well in the Matsukawa geothermal field at the foot of Mt. Iwate in the northern part of Japan since December 7, 2001. Ten thermistors and 4 Ag-AgCl and 4 Cu electrodes are used in this test. The deepest sensor was installed at a depth of 270 m.

The main features of the retrieved data until December 1, 2002 (359 days) are as follows. The temperature was stable within a range of less than 0.5 ℃ The highest temperature (80.840 ℃) was recorded at a depth of 270 m. The electric potential of the Cu electrodes became stable in 20 to 40 days. On the other hand, two of the three Ag-AgCl electrode pairs (Sp6 and Sp7) took 155 days to stabilize, and the third pair (Sp5) took 205 days. After the initial instability, an unusual change of potential difference was observed in February and March, 2002. The changes, lasting for 3 to 4 days, showed a sudden increase and gentle decrease. There were no corresponding changes of temperature. From around the end of September, the Sp6 and Sp7 fell into unstable state again. The Sp6 rapidly increased from 45 mV/25m to 547 mV/25m over 58 days (October 5 to December 1). After the Sp7 rapidly increase from 35 mV/25m to 118 mV/25m over 11 days (September 29 to October 9), it decreased to -71 mV/25m over 24 days (to November 1). Then it increased back to about 55 mV/25m over two weeks (to November 14), followed by relatively stable value (41 mV/25m).

The measurement is still continuing. This test has been providing basic and useful data for evaluating the sensitivity, stability and reliability of the instrument in high temperature environment that is expected a few kilometers below the seafloor. It may also provide some information about the effect of casing pipe and wire rope on self-potential. Furthermore, as a byproduct of the test, we may detect some signals related to geothermal fluid flows.