Self-potential variation at Akita-Yakeyama volcano since 1983

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The SP (Self-potential) method is one of powerful tools for the geophysical exploration and has been actively used in geothermal areas in order to investigate the terrestrial fluid circulation. In this research, SP survey was carried out at Akita-Yakeyama and the relationship of SP anomalies and the cause of them inside the volcanic body was considered.

The Sengan geothermal area is on the Hachimantai volcanic zone across Akita Prefecture and Iwate Prefecture. At several districts in the Sengan area, surveys of geological features, earthquake, gravity, and electromagnetic property have been done. Consequently the understanding of the volcanic activities has been advanced.

SP was observed at Akita-Yakeyama volcano in the Sengan area in 2007. According to the SP contour map obtained from the observation result, positive and negative SP anomalies are recognized. Positive anomalies are at the vicinity of the summit crater, on the west side slope, and on the north side slope to the west of the Sumikawa geothermal power plant. Negative anomalies are located around the lateral cone of Kunimidai to the east of the summit, at the Sumikawa power plant, and at the hot springs of Tamagawa and Goshogake.

Based on the concept of streaming potential, the positive anomaly can be explained by fluid upflow from the depth to the ground surface. On the other hand, the candidates of the cause of negative anomalies are a) downflow of volcanic fluid and/or meteoric water, b) acidic alteration of ground surface, and c) the existence of ore deposit, and so on.

It is probable that the set of the positive anomaly at the summit and the negative one at Kunimidai lateral cone is caused by hot water circulation inside the volcanic body. The upflow of hot water causes the positive anomaly at the summit and in due course the hot water cooled near the ground surface infiltrates again down to the earth. The cause of the negative anomaly at Kunimidai can be regarded as the downward infiltrating of cooled water and meteoric water. It is possible that the old volcanic vent of Kunimidai or old acidic alteration zone around it is the water infiltrating passage.

It was reported that a wide-area SP observation was carried out by Kikuchi et al. (1987) in the Sengan geothermal area in 1983 and 1985. In addition, the SP surveys from 1993 to 1998 were performed in the vicinity of the Sumikawa power plant by Matsushima et al. (2000). The observation result in this study reproduced the almost same SP distribution of the result of 1983 around the summit area including summit crater and Kunimidai. On the contrary, large decrease of SP more than 650mV compared with 1983 was recognized in the vicinity of the Sumikawa power plant. It is the largest potential change found in this field. Comparing the result of this study with that of 1996, the decrease of SP about 300mV was also seen. It is clear that the decrease of SP is influenced by the Sumikawa power plant whose operation began in 1995. An explanation of the mechanism of the SP decrease at the power plant was considered by Matsushima et al. (2000). The pressure decline due to production causes expansion of two-phase (vapor and liquid) zone at the top of geothermal reservoir underground. Consequently one-phase liquid zone, which carries positive charge, is depressed to the depth and enforcing the downward counterflow of liquid in the two-phase zone.

Moreover, moderate SP decreases of 150mV or more at the surroundings of the Beko moor field and the Goshogake hot spring were recognized compared with 1983. The Beko moor field is next to the Sumikawa power plant to the south and the Goshogake hot spring is aligned to the south of it. It might be suggested the influence of the operation of the power plant extends to these surrounding areas.