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Extracting temporal variation at deep part of geothermal area resistivity using by Magnetotelluric Method

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Eruption damage by volcanic activity is a problem around the world. The eruption is repeated from 2000 to the present centering on Mt. Oyama several times in Miyake-jima Island, Japan. The eruption damage caused by volcanic gas, a pyroclastic flow, volcanic rocks, fallout, and a mud flow in Miyake-jima Island. For this reason, the provision to a volcanic disaster has been a globally important subject. Although a volcanic earthquake, movement of fluid in the depth, etc. take place besides an eruption in a volcano area, the relation between these phenomenon and volcanic activity is not known well. Then, if the relevance of volcanic activity and the phenomenon generated underground in volcanic area can be grasped, the contribution of volcanic disaster prevention is expectable. In this study, the relation between temporal change of deep resistivity value around geothermal reservoir using magnetotelluric survey and volcanic activity is considered. Geothermal reservoirs are generally composed of porous rocks covered by impermeable layers (cap rocks). Fractures in the reservoirs have important roles as paths and storage places for hydrothermal fluids.

The western side of Mt. Aso crater, southwest Japan, was chosen as the case study area. Mt. Aso has a has the large caldera which is 18 km of east and west, and 25 km of north and south, and is located in the center of central Kyushu volcanic line which consists of Tsurumi, Yufu, Kuju, Kinpou, and Unzen volcano. Three hot springs exist there. The reason for selecting this area is based on our previous results (Asaue et al., 2006) that detected existence of a geothermal reservoir in the depth range 2-4 km and its configuration by MT resistivity. To grasp the effect of temporal change in physical condition of geothermal reservoir on the resistivity, a periodic MT (magnetetelluric) method at a fixed point was applied in western side of Mt. Aso. MT method is an effective geophysical prospecting method for imaging regional geologic structures by measuring resistivity from shallow to deep parts. The measurement period was for six months when is from June 24 to December 23 in 2008. Data were obtained one or two times for a month. A remote reference point was set on 30 km away from measurement site in the Misato town. The apparent resistivity data by MT method were converted to true resistivity by an 1D inversion method based on simulated annealing. Resultant MT resistivity from the surface to the 5 km depth highlighted that relatively large changes of resistivity occurred at upper part and lower parts of the cap rocks. Resultant MT resistant from the surface to 5 km depth highlighted that relatively large changes of resistivity occurred at the surface and lower part of the cap rocks. the resistivity changes in the surface and deep parts may be caused by disturbance of the groundwater flow and volcano activity, respectively.

An interesting feature is a time delay phenomena of the resistivity in the deep parts, which changed one month after the swarm of A-type volcanic earthquakes: this type earthquakes were found to occur generally in the depth range at which the resistivity tend to change. Resistivity is sensitive to water content of rocks. It is plausible accordingly that the earthquakes affect paths of the geothermal fluid flows by generating new fractures. In addition, The changes of upper part has also relevance to B-type. As the result, temporal changes around geothermal reservoir by MT resistivity could be estimated and relevance are found out between its changes and volcanic earthquakes in geothermal area.