

## Numerical modeling based on gravity and hydro-geochemical data, - A case study of Obama geothermal field, southwestern Japan -

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The Obama geothermal field is located in the western side of Kyushu Island, southwestern Japan and exactly on the western foot of Unzen volcano and in front of Chijiwa bay. This area is characterized by high potential geothermal resources. The Obama spa is historically noted for the abundance and high temperature of its spring waters. The Obama geothermal field is a dynamic system, and its coastal location allows the incorporation of seawater into the underground circulating waters. It was suggested that Obama geothermal field is originated from magmatic emanations derived from a magmatic reservoir, at about 15km depth beneath Chijiwa bay. For the detailed understanding of the Obama geothermal field, a numerical simulation technique has been carried out at the Obama geothermal field after combining gravity and hydrogeochemical results. First, we studied the structure of Obama geothermal field using integrated gravity interpretation techniques such as: 3-D inversion, analytic signal, Euler deconvolution, transformations and 2-D modeling of the gravity data. These analyses indicate that the dominant subsurface faults trend E-W, but N-S trending faults also exist. The substratum of the Obama geothermal field is characterized by many grabens and horsts separated by normal faults. Also, a micro-gravity monitoring was conducted at Obama geothermal field from 2003 to 2004 and showed an increase by about 95 microgal, which is attributed to groundwater level change and increasing of reservoir pressure. The calculated anomalous mass is 15Mt. The recovery of reservoir pressure is caused by the recent limitation in withdrawal of hot water. Secondly, a hydrogeochemical study of Obama hot spring waters was carried out. Some chemical/isotope geothermometers, fluid/mineral equilibrium modeling and mixing models were analyzed. All hot spring waters are of Na-Cl in type. The reservoir temperature is estimated to be 210°C. The Obama geothermal reservoir is recharged by deep-chloride waters and secondarily by meteoric/surface and seawater, with a sea water mixing ratio of 24%. In general, the Obama geothermal field is in recovering process with the recovering of the water quality, increasing in the number of boiling well, rising in the water temperature, and decreasing in the salinity. Finally, a comprehensive hydrothermal model of the Obama geothermal field was constructed. Building the Obama geothermal field, two heat sources were necessary. The first one (Source I) is located in the eastern part of Obama geothermal field. The second one (Source II) is located beneath the Obama geothermal field. The physical properties of the Source I and the Source II are enthalpy of 3200 kJ/kg, 400 kJ/kg and a mass flow of 300 kg/s, 30 kg/s, respectively. The characteristics of the first source agree with the previous geochemical studies. The second source seems to be cooled by the infiltrating low temperature waters. An estimation of heat supply was calculated. 1000 MWt was supplied from the first source and just 12 MWt from the second source. We must note that the major part of the heat supplied from the first source was discharged into the sea. From the above results, the Obama geothermal field can be used much more for various kinds of geothermal energy utilization.