

Geopressured Hydrothermal System in the Niigata Sedimentary Basin, Central Japan

Naoki Watanabe[1]; Yuki Mori[2]

[1] Rsrch. Center Nat. Hazards, Niigata Univ.; [2] Dept. Geol., Fac. Sci., Niigata Univ.

In the Niigata sedimentary basin, high-salinity geothermal waters typically occur in and around epicentral areas of destructive earthquakes, in the landslide areas and in active fault zones. In addition, abnormal-pore-fluid-pressure strata have often been found in the Niigata sedimentary basin at the depth of more than 1000 meters, according to published data of drill-hole logs for petroleum exploitation. The hydraulic pressure gradients in the strata are much higher than the hydrostatic pressure gradient (10.5 kPa/m) and approach the lithostatic pressure gradient (22.6 kPa/m) with increasing depth. The geothermal waters in the Matsunoyama area, Tokamachi City, show the highest orifice temperature in Niigata Prefecture. Eight geothermal water wells in this area were drilled along the anticlinal axis nearby hilltop or higher breast of the Matsunoyama dome and ranges from 170 to 1200 meters at depth and from 35 to 95 degree C in temperature. For example, the Takanoyu geothermal water well has only 170 meters at depth but 90 degree C in temperature. These waters show geyser action associated with methane gas and are typically very high in salinity with considerable amount of chloride. The hydrogen and oxygen isotope values and chloride concentration of approximately 9,000 mg/l suggest that the origin of waters is altered fossil seawater trapped in the organic-matter-bearing sedimentary rocks. The temperature and depth of primary reservoir are estimated to be approximately 140 degree C and 4000 meters by using Li-Mg geothermometer and the mean geothermal gradient of 30 degree C /km in the Niigata sedimentary basin. Above characteristics are extremely similar to the geopressured hydrothermal system in the Gulf of Mexico, USA. In the Matsunoyama area, Na-Cl type ground waters have been found limitedly in landslides and are formed by mixing the deep Na-Cl type geothermal waters into the meteoric ground waters. The geothermal water injection into shallow aquifers in landslide mass makes partially high pore water pressure and causes occurrences of landslides in this area. The Muro no mud volcano is located in the neighborhood of the Matsunoyama area and associated with saline water and methane gas. The Shibatoge geothermal water near the mud volcano was found at the drilling depth of 1200 meters and its geochemical characteristic is slightly different from the Matsunoyama geothermal waters. The saline groundwater from the mud volcano is also formed by mixing the deep Na-Cl type geothermal waters into the meteoric ground waters. The hydrogen and oxygen isotope values and boron/chloride ratio suggest that the groundwater is similar to the Shibatoge geothermal water rather than the Matsunoyama geothermal water. Both Na-Cl type ground waters in landslides and the Muro no mud volcano are influenced by the geopressured hydrothermal system developed in the Niigata sedimentary basin. The geopressured hydrothermal system might play important role to solve the causes of large-scale landslides, mud diapirs, swarm earthquakes and difficulties at abnormal-pore-fluid-pressure strata in petroleum exploitation.