Underground geological structure and groundwater geochemistry around mud volcanoes in the Tokamachi City, Niigata Prefecture

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Introduction

The Kamou mud volcano is erupting NaCl type groundwater originated in deep underground brought by abnormal pore water pressure (Shinya and Tanaka, 2005). As a result of geological survey, geophysical exploration and morphological investigation, depression structure and geologic basin structure are recognized around the mud volcanoes. Furthermore, mud chamber with a diameter of 800 m is distributed in a depth of 600 m under the Kamou mud volcanoes (Tokuyasu et al., 2007). Inside of the depression, it is assumed that groundwater circulates in the shallow underground and a formation water is rising up from deep underground by abnormal pore water pressure and these are balanced each other near the ground surface (Ishihara and Tanaka, 2006). We excavated a bore hole to investigate the underground geologic structure and the geochemical properties of groundwater.

Geological setting

Neogene to Quaternary sedimentary rocks are distributed in the study area and characterized by anticline and basin structure around mud volcanoes (Ishihara and Tanaka, 2006).

Results and discussion

Geology and geological structure:

HQ-wire line core drilling with a depth of 120m was carried out inside of the depression in the Kamou area. Humus soil is distributed from ground to a depth of 2.1 m. Scaly network clay composed of mudstone breccia and clay is distributed to a depth of 5.8 m. Non-fractrued mudstone is distributed to a depth of 45 m. Mud breccia composed of mudstone breccia and scaly clay is distributed to the bottom of borehole.

As a result of XRD analysis of clay mineral, (Ca, Mg) type smectite is dominant from the ground surface to a depth of 50 m and (Na, K) type smectite and mica/smectite mixed layer are dominant deeper than 60 m.

Groundwater geochemistry:

Groundwater distributed in shallow underground 20m to 30m in depth is characterized by low electric conductivity (EC) of 0.03 to 0.2 S/m and Cl- content of 33.3 to 328.9 mg/l. On the other hand, that in a depth of deeper than 50 m is characterized by high EC of 0.8 S/m and Cl- content of 1725.2 to 4188.3 mg/l. As a result of oxygen hydrogen isotopic analysis, pore water distributed in a depth of deeper than 50 m is plotted on the mixing line between meteoric water and formation water.

Geological structure, ion content of groundwater, EC and isotope ratio is remarkably changed at a depth of about 50 m. This means that meteoric water penetrates to a depth of about 50 m and formation water originated in deep underground is rising up to a depth of about 50 m through fractures that are generated by hydro-fracturing caused by the high pressure gradient from outside to inside of mud volcano conduit (Deville et al.,2003).

References:

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