

Boring survey of mud volcano in Tokamachi City, Niigata Prefecture

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Introduction and borehole design:

Boring drilling and core logging were carried out in the center of topographic depression in the Kamou area, Tokamachi City, Niigata Prefecture. Wire-line boring method was applied for the excavation of a vertical borehole with a depth of 120 m. Casing with a diameter of 8 inch is installed to a depth of 5m. Then, that of a diameter of 6 inch was installed to a depth of 60 m.

To obtain all the cores, water-free drilling method was applied from the surface to the top of the basement rock and cores were preserved in an acryl pipe. As a result, almost 100 % of cores were obtained.

Core description:

0m - 2.1 m: Cultivated soil and humus soil.

2.1m-5.8 m: Erupted mud and fragments intercalated with a charcoal that is characterized by the horizontal bedding plane.

5.8m-45m: Non-fractured massive mudstone intercalated with tuff layers with a thickness of 10 cm belonging to the Tertiary Sugawa Formation. By correlating them with the horizon of the tuff in this area, the depression area is thought to be subsided about 100 m. Mudstone is hard and the converted uni-axial strength obtained by penetration test is up to 4 MPa.

45m-120m: mudstone and mud breccia belonging to the Sugawa Formation

Mud breccia is composed of brecciated mudstone and scaly unconsolidated clay with a uni-axial strength of 0- 1 MPa. Calcareous concretions are appeared in several horizons. Breccia of andesite and granite are contained in the clay matrix that is possibly injected from deep underground with gas and groundwater.

Mud breccia is classified into several types as follows,

Size of fragments: (1) rare or very small (less than 1 mm in diameter), (2) small (1-3mm in diameter), (3) large (10-20mm in diameter)

Orientation of fragments: (A) foliated arrangement, (B) network arrangement,

Also, the relationship between basement rock and injected mud breccia is classified as follows,

(i) sharp boundary, (ii) concordant to bedding plane, (iii) irregular boundary

Mud breccia with large blocks shows the irregular boundary to the basement rock and it is assumed that the fragmentation is occurred in-situ. However, that with small blocks injects into fractures and shows the sharp boundary to the basement rock and it is estimated that blocks fractured in deep underground rises upward and injects to the fractures in the shallow underground. As a result, some of the small fragments are rounded.

Degassing :

When cores were taken off from the core tube, small gas bubbles were erupted from surface of cores due to degassing of methane and core was swelled about 10 cm in length. Particularly, degassing is appeared dominantly in the interval of clay matrix along fractures. It is expected that the swelling cores observed in the bore hole possibly corresponds to the swelling rock in the Nabetachiyama Tunnel. Groundwater table observed in the bore hole is thought to be affected by the gas drift.

Hydro-fracturing:

Mud breccia is characterized by a brittle deformation. Some of them were possibly fractured in-situ and others were injected through fractures from deep underground. Mud chamber is thought to be distributed in a depth of 400 m under the depression (Tokuyasu et al., 2007). Hence, it is assumed that the pressurized groundwater, mud and gas stay in the mud chamber formed under impermeable cap rock for a time and rise upward by hydro-fracturing due to the high pressure gradient from inside to outside of mud volcano conduit (Deville et al., 2003).

References:

Tokuyasu et al., 2007, this meeting

Deville et al., 2003, Subsurface Sediment Mobilization, Geological Society, 475-490.