

## Studies on underground structure of mud volcano in Toukamachi City, Niigata Prefecture

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Mud volcanoes (MVs) are defined as the conical geometric high mounts which are formed by erupted mud and water. It is pointed out that swelling mudstone which cause a serious problem in tunnel construction work is possibly related to the activity of MVs. Therefore, in determination of tunnel route, it is important to find MVs, and to clarify the underground structure of MV.

Two active and a passive MV are reported in the Kamou area and Muro no area, Tokamachi City, Niigata Prefecture, locating in the area where Tertiary Shiiya Formation is disturbed. The Nabetachiyama tunnel was excavated in the underground of the Kamou area. Topographic collapse was identified near the MVs and relationships between them were discussed. And it took long time to complete the excavation due to the swelling mudstone zone distributed at a depth of 180m under the MVs.

In this study, I carried out geological and geometric survey and electromagnetic survey by controlled Source Audio Frequency Magnet Telluric Method (CSAMT) to clarify the underground structure of the MVs and what relationships between the geological and geographical features on land.

The major results obtained are summarize as follows,

In the Kamou area, it is concluded that geological structure around the topographic collapse is intensely disturbed, and the rim of the collapsed has been eroded and steep valleys have been formed. Hence, it suggests that this area was tectonically active in the past due to the uplift and eruption of groundwater. Also, a 500m diameter zone with low resistivity at 400m in depth was identified by CSAMT exploration 400m and it may corresponds to a mud chamber filled with saline groundwater and mobilized mud. And a concentric low resistivity zone was identified and it continues to the MVs of the earth surface and the peripheral boundary of the geologically disturbed zone. Geological and topographic features around MVs shows that there may exist a large caldera structure like a volcanic caldera and that saline groundwater, mud and natural gas may be ascending through the concentric path to the MVs.

The underground structure of the MV is classified into 3 types on the basis of the previous studies as follows,

Diapir type: Mobilized mud and groundwater rise with pushing up the overlying formation and form a mud chamber.

Christmas tree type: Mobilized mud and groundwater rise and spread into a permeable aquifer and form a mud chamber.

Caldera type: Mobilized mud and groundwater rise like a swarm and form a collapsed caldera due to the intense eruption of mud and groundwater.

The underground structure of the Kamou MV can be classified as the combination of the Christmas tree and Caldera type.

As a result of geological and topographic investigations, it is concluded that the swelling zone in the Nabetachiyama a railway tunnel is corresponded to the fracture swelling mudstone that was formed at the time of collapse caldera formation. Furthermore, the troubled zone is thought to have been caused by the compression due to the overburden of destructed caldera block and the abnormal pore water pressure introduced from the deep underground.