Geology of the Hakkoda-San District

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The Hakkodasan district is situated in northern Honshu. In ascending order, geology of the district is composed of (1) the Miocene Series almost entirely deposited under marine environment, (2) the Pliocene Series deposited under marine regression stage, and (3) the Quaternary System deposited under on-land environment although there still remains lacustrine environment. Characteristics of the district are the Quaternary volcanoes. Part of Okiura caldera of Early Pleistocene occupies the west of the district, part of Hakkoda caldera of Middle Pleistocene occupies the north of the district and part of Towada caldera of Late Pleistocene occupies the south of the district. The younger volcanic units tend to cover the wider area.

The Miocene exposes in a very limited area at the surface, but extends to the almost entire area at depth. The Miocene is composed of the Itadome Formation, Nuruyu Formation and Miocene Intrusive Rocks. The Pliocene is composed of the Obirakiyama Tuff, Nijikai Tuff , Fujisawamori Lava, Kuromori Lava, and intrusive Rocks.

The Quaternary is mainly divided into calderas-forming pyroclastic flow deposits and their pre-caldera and post-caldera volcanic units of the three calderas: the Early Pleistocene Okiura caldera, Middle Pleistocene Hakkoda caldera, and Late Pleistocene Towada caldera. Okiura caldera lies in the west of the district and is semi-circular caldera with 15 km in diameter. The Aoni Tuff was several times produced from Okiura caldera and ranges in age from 1.7 to 1.1 Ma. Afterward, the Okiura Dacite of ca. 0.9-0.7 Ma was erupted in Okiura caldera as the post-caldera cones. The intracaldera Aoni Tuff is almost entirely composed of lacustrine deposits and includes dacite pumice tuff, fine-grained tuff, basalt lava, lithic tuff, and debris flow deposits. The intracaldera Aoni Tuff abuts on the caldera basement units and is thinning out in the Ou backbone range of the northern Honshu at its eastern edge of distribution. This shows that the Ou backbone range has already existed prior to the collapse of Okiura caldera, and therefore, it is obvious that Okiura caldera initially has a semi-circular structure.

Afterward, volcanic center shifted to the northeast, and Minami-Hakkoda Volcanoes were formed in the center of the district. The Osegawa Pyroclastic Flow Deposits with a middle-class volume was erupted in part of Minami-Hakkoda Volcanoes during 0.9-0.8 Ma and deposited in and around the Osegawa River. After Minami-Hakkoda Volcanoes were relatively grown up, the Hakkoda 1st-stage and 2nd-stage Pyroclastic Flow Deposits were erupted in the northeast of the district during 0.7-0.30 Ma, and then, Hakkoda caldera was formed. After the collapse of Hakkoda caldera, Kita-Hakkoda Volcanoes commenced their eruptions in the north of the district, and Hinadake, Takadaotake, Tamoyachidake, Maedake, Narusawadaichi, Sennintai, Iodake, Kodake, Idodake, Akakuradake and Odake Volcanoes were formed as post-caldera volcanoes of Hakkoda caldera. At the same time, pre-caldera volcanism of Towada caldera occurred in the south of the district, and Ohanabeyama Lava and Aobunayama Pyroclastic Rocks were erupted. Three caldera-forming pyroclastic flows with middle-class and large-class volumes, Towada-Okuse Pyroclastic Flow, Towada-Ofudo Pyroclastic Flow and Towada-Hachinohe Pyroclastic Flow occurred in the southern Towadako district during 55-13 ka, and then, Towada caldera was formed. Large-scale Plinean-type eruption occurred in the Towada caldera at ca. 5.4 ka, forming the Chuseri Pyroclastic Fall Deposits. At least, five events of Vulcanian and phreatic eruptions occurred at the summit of the Kita-Hakkoda Volcanoes during the last 6000 years. At A.D. 915, Kemanai Pyroclastic Flow occurred in Towada caldera. At the present Jigokunuma crater in the southwestern foot of Kita-Hakkoda Volcanoes, three events of phreatic eruptions occurred during A.D. 1300-1650.