

The Goshogake mud volcano field, Tohoku, Japan: an acidic, high-temperature system related to magmatic volcanism

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Mud volcanoes occur everywhere in various geological settings on the Earth and, possibly, on other planetary bodies, such as Mars and Enceladus ocean floor. Their surface terrains are formed by mud ascending and erupting, together with water and gas, from depths. Therefore, mud volcano is one of the most suitable landforms for exploring the subsurface geology and microbiology (i.e., extremophile) because mud volcanoes allow us to access easily to deep underground materials. Recognizing the importance of astrobiological potential of mud volcanoes, we have conducted field works, laboratory chemical and microbial analyses on terrestrial mud volcano fields as an analog for future exploration missions to the planetary bodies.

In this study, we focus on the Goshogake mud volcano field in Tohoku, Japan. The field has hot springs fed with high-temperature fluids emerging on the eastern flank of the Quaternary Akita Yakeyama volcano. Its uniqueness is highlighted by the following reasons: (i) The geomorphological features observed in the Goshogake (salsa, gryphon, and mud pod) are similar to those commonly observed in conventional sedimentary mud volcanoes. (ii) On the other hand, the physico-chemical environment in the Goshogake mud volcano field is an acidic and high-temperature system in association with magmatic volcanism, which is totally different from conventional sedimentary mud volcanoes characterized by relatively low temperatures. In-depth understanding of this unique example will tell us about the environmental and biological diversities and formation conditions of mud volcanoes on the Earth and beyond.

We present in this study documentation of the Goshogake mud volcano features, and the results of in-situ measurements and laboratory analyses of gas and water at the Goshogake mud volcano field to discuss the nature of its mud fluids and their origins, which are essential for understanding habitability and ecology of such systems, and biological analysis of the Goshogake mud volcano field.

Keywords: Goshogake onsen, gas chemistry, microorganism