The facies architecture of felsic subaqueous volcanoes in “Green Tuff” Formation in the Katakai field, Niigata, Japan

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Interpretation of the mechanism of subaqueous volcanic activity related to “Green Tuff” is important since it greatly contributes to clarifying the formation process of the island arc and active subaqueous volcanoes all over the world. Also, “Green Tuff” is necessary from the viewpoint of energy resources because it is bearing and producing a large amount of gas especially in the Northeast part of Japan. In this study, we constructed a facies model of the subaqueous basin in which a variety of volcanic facies are intercalated with sedimentary facies to clarify a series of volcanic activity styles in the unrevealed “Green Tuff” field located in the Niigata Chuetsu district.

The Katakai field is located 10km southwest of Nagaoka-city and consists of an anticline 5km long and 1.5km wide extending in the NNE - SSW direction. “Green Tuff” was produced by subaqueous volcanic activity during back-arc rifting in early to middle Miocene. After the activity, Nanatani and Teradomari Mudstone as source rock overly the “Green Tuff” formation in late Miocene. Finally, the compressive tectonic movement created the current anticline in the field. The top of “Green Tuff” Formation is deeper than 4,000m, its thickness is more than 1,000m and its lower limit is unidentified.

We observed cuttings and core samples from more than a dozen wells in the field analyzed major elements in the cutting samples and trace elements of the core samples with the information of electricity well logging and FMI image data.

The Formation is the succession of volcanic materials which consist mainly of felsic rocks (from rhyolite to dacite) and accompanied with mafic rocks (from basalt to basaltic andesite). The stratigraphic classification characterized by rock types, textures, occurrences, and distribution is below:

The lower part of the formation at least several tens meters thick is distributed only in the south of the field. It is dominated by pumice clasts and glassy rhyolite lava. They are considered as carapace pumice breccia which surrounds lava dome. The middle part several hundred meters thick is distributed over the whole area in the field. It has a wide variety of rhyolite, including massive lava, breccia, tuff breccia, tuff, and perlite. They are considered as the complexes of lava domes which consist of coherent lava facies, block lava facies and resediment facies one to several hundred meters thick and several hundred to one thousand meters wide. The complex in the north of the field is dominated by glassy rhyolite lava with flow band and breccia. The upper part about several hundred meters thick is distributed over the whole area of the field. It consists of dacite pumice, tuff breccia, and tuff. The uppermost part is distributed from the central area to the south area of the field and consists of massive lava, breccia, and tuff breccia.
From the bottom to upper part, massive basalt lavas several tens to a hundred meters thick bearing intersertal textures are observed. They are considered to the succession of sheet flows during the bimodal volcanic activity.

From their distribution, the transition of the eruption style throughout the subaqueous volcanic activity is

indicated. The formation was composed of the successions of felsic the lava domes and mafic sheet flows by the bimodal volcanic activity. In the early stage, the lava domes associated with carapace pumice breccia formed under the deep marine environment. As the increment of the supply rate of magma, large-scale volcanic complexes were created from south to central part of the field. On the other hand, the north of the field had the source of lava which formed the complex(es) of relatively glassy lava domes. In the late stage, after the dacite pyroclastic material was provided over the whole area under the shallow marine environment, the magma changed its composition to rhyolite and provided a volcanic complex.

Keywords: Green Tuff, back-arc rifting, Miocene, volcanic facies, lava dome

