Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

SVC47-P14 Room:Convention Hall Time:May 26 18:15-19:30

The sequence of caldera-forming eruption of Shikotsu caldera inferred from component analysis

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Shikotsu caldera, located at southeastern Hokkaido, was formed ca. 42ka. The caldera forming eruption has been studied in detail. The eruption started with phreatomagmatic eruption, followed by plinian eruption to deposit. In final, pyroclastic flows (Spfl) were produced to form the Shikotsu caldera (Katsui, 1959). Yamagata (1992) revealed the detail sequence of the caldera-forming eruption and emphasized the presence of lag-breccia in the upper part of Spfl to discuss the formation of the caldera. In addition, Nakagawa et al. (2006) revealed temporal variation of magma type during the caldera-forming eruption to discuss the relationship between caldera formation and magmatic processes. However, the relationship between eruption sequence and temporal variations of eruptive materials has not been well revealed. Recently, good outcrops have occurred at the southern area of Shikotsu caldera, where the whole sequence of the caldera-forming eruption can be observed. We describe these deposits and carry out component analysis of representative samples. Based on these data, we discuss the eruptionsequence and caldera formation processes. In newly formed outcrops, we can observe tephra layers for 60 ky. The tephra of the caldera- forming eruption of Shikotsu caldera can be divided into 5 eruptive phases, based on the mode of eruption and emplacement. Phase1 is defined as phreatomagmatic deposits. After that, a seriesof plinian eruptions occurred(Phase 2). After possible erosional gap, large scale and high energy pyroclastic flow erupted (Phase3). The lowermost flow sometimes include the block of deposits of the Phase 2, suggesting that the flow was energetic to erode the surface. Following pyroclastic flows of Phase 4 are characterized by the presence of thick lithic concentration layer. After that, the scale of eruption had decresed to depost thin surge deposits and pumice fall deposits (Phase5).

We collected sampls for the component analysis from 40 horizons. Lithic fragments of each unit composed of sedimentary rocks (shale and sandstone), volcanic rocks (two pyroxene andesite), and altered rocks. And rarely contain fragments of plutonic rocks and minerals. The weight ratio of lithic in these layers is usually less than 30%. Not only the weight ratio of lithic breccia but also the ratio of lithic types temporally change. The weight ratio of lithic breccia becomes quite high in the upper layer of Phase 2. These suggest the vent widening and/or migration during early stage of the caldera-forming eruption. In Phase 3, the types of lithic breccia had not changed. The lithic concentration layer in the deposts of Phase 4 is most voluminous among all deposits. We will investigate the temporal variation of juvenile materials based on our newly revealed stratigraphy.

Phase1 is characterized by high content of volcanic rocks but, in early plinian eruption, that generally as high as 50 wt.%. And, in the plinian eruption medium phase, volcanic rock on behalf of the sedimentary rocks content increases. This suggest vent is moved from phase1 through phase2, after that column became unstable by vent expansion. And when phase2 late dropped to about 20 wt.%, became higher of content of volcanic rocks and altered rocks , and there is also unit reaches 70%. Therefore, in phase2 later, expansion and movement of the vent is suggested on a large scale. Lithic fragments type in phase2 later feature is followed by phase 3. That suggests a large scale vent movement and expansion was not over the pyroclastic flow eruption in Phase 3. Lithic breccia layer containing more than 70% of the lithic fragments in phase 5 is the most large scale in this outcrop, also is observed new volcanic rock type. This shows activities from a new vent and the vent expansion on a large scale. Thus, this phase was a mature stage of caldera-forming. In the future, in addition to the process of caldera-forming eruption to attempt to elucidate the detailed magma transition.

Keywords: caldera-forming eruption, tephrastratigraphy, component analysis, eruption sequence