

## Stratigraphy of pyroclastic flow deposits in the Onoda Formation distributes on Iwagasaki region in the north of Miyagi

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### Introduction

The Onoda Formation, formed in the Late Pliocene to the Pleistocene, distributes on Iwagasaki region on the east of Onikobe and Naruko calderas (Tsuchiya et al. 1997). It is mainly recognized at Mozume area in Osaki City and Uguisuzawa area in Kurihara City. Pyroclastic flow deposits on Quaternary period over lie on the Onoda Formation, and some similar pyroclastic flow deposits are also in Onoda Formation. Soda (1993) and Kuzumaki and Oba (2009) counted five and four pyroclastic flow deposits in Onoda Formation at Mozume area, respectively, and three of them are considered to be identical. Kuzumaki and Oba (2011) also studied Uguisuzawa area and found that two pyroclastic flow deposits are identical with those at Mozume area, although they did not reveal their source.

It is important to reveal the source of the pyroclastic flow layers in Onoda formation and to investigate their relations with the eruption products of Onikobe and Naruko calderas. To re-examine the stratigraphy of pyroclastic flow deposits in Onoda formation we observed the outcrops at Uguisuzawa area.

### Stratigraphy of pyroclastic flow deposits in the Onoda Formation

The stratigraphy was studied based on the distributions of each deposit, inferred topography at deposition, heavy mineral assemblages and bulk chemical compositions of pumice clast.

These analyses revealed that the Onoda Formation at Uguisuzawa area contains at least seven discrete pyroclastic flow deposits, named Flow 1 to Flow 7 from bottom to top. Heavy minerals in pumice are: opx and cpx in Flow 1; opx in Flow 2; opx (minor) in Flow 3; opx in Flow 4; opx and cpx in Flow 5; opx in Flow 6; opx and hb in Flow 7 (opx=orthopyroxene, cpx=clinopyroxene, hb=hornblende).

Among the seven flows five of them are identical to those at Mozume area reported by Soda (1993).

### Characteristics of chemical composition

SiO<sub>2</sub> content in bulk pumice ranges 70-74 wt% on Flow 1 and 2, 74-77 wt% on Flow 3 and 4, and 72-75 wt% on Flow 5, 6 and 7.

SiO<sub>2</sub>-K<sub>2</sub>O plot shows that K<sub>2</sub>O content of Flow 5-7 pumices are higher than those of Flow 1-4. Compared with these, and with Onikobe pumice, Naruko pumice is poor in K<sub>2</sub>O. Flow 1-4 pumices are on the same SiO<sub>2</sub>-K<sub>2</sub>O trend with the pumices from Onikobe caldera, but Flow 5-7 pumices, which are rich in K<sub>2</sub>O, deviate from it.

### Discussion

Since five pyroclastic flow deposits in Mozume area (Soda, 1993) are identical with those found in Uguisuzawa area, the distribution area of each flow in Onoda Formation is over 200 km<sup>2</sup>, all of which are categorized as large pyroclastic flow.

SiO<sub>2</sub>-K<sub>2</sub>O plot indicates Flow 1-4 were from the same eruption source and the source magma had become felsic with age. They might be from Onikobe caldera because Flow 1-4 pumices are on the same chemical composition trend with the pumice from Onikobe caldera.

K<sub>2</sub>O content of Flow 5-7 are so high that they should not be from Onikobe and Naruko caldera. There are calderas, formed in the Late Miocene to the Pleistocene, around the Iwagasaki region (Ito et al. 1989). Among them Innai, Sanzugawa, Genbi, and Ginzan calderas are not the origins of Flow 5-7 because they are too old and topographic barriers on their activity periods should hinder to distribute the Onoda formation pyroclastic flow deposits on Iwagasaki region. To the contrary Akakura caldera and Mukaimachi caldera, locate on the west of Mozume area and back arc side of Onikobe and Naruko calderas, formed between 3-1.4 Ma (Otake, 2000) and between 1.0-0.6 Ma (Koike et al. 2005), respectively, which agrees with the period when Onoda formation was deposited (3.3-0.6 Ma; Tsuchiya et al. 1997). In addition, there was no obstacle between these calderas and Iwagasaki region. For these reasons we propose Akakura and Mukaimachi calderas are the source of Flow 5-7. Our proposal is in harmony with the fact that K<sub>2</sub>O content of Flow 5-7 are higher than that of Onikobe and Naruko, because K<sub>2</sub>O content tends to be higher from fore to back arc.