

## $^{14}\text{C}$ dating for the Holocene tephra deposits at the Esan volcanic complex, northern Japan

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Phreatic explosion is a smaller-sized eruption that is randomly generated from the pressurized steam chamber above a heat source. Thereby, the phreatic explosion may become hazardous, in the case where the social facilities or residential areas or people are very close to the active craters. Indeed, such a phreatic hazards has come arisen at the 2014 Ontake eruption, and then, it has widely become recognized as one of critical issues in volcanic hazards of Japan.

GSJ/AIST has a geological map project of "Esan Volcanic Complex (EVC)" since FY 2014. In the EVC, a large number of residential areas with tourist accommodations are located at the aprons where the distance to active fumarole craters is only 1-2 km. This spatial relationship implies a high risk of volcanic hazard even by a small phreatic explosion. Substantial information on the risk of phreatic explosions at EVC should be unraveled accurately. Yet, the spatial and temporal relationships of Holocene tephra deposits have been uncertain. We have therefore performed twelve measurements of  $^{14}\text{C}$  datings into the soils between Holocene tephra units.

The stratigraphic sequence of Holocene tephra units has been determined by the geological and geochronological studies, based on those originally established from Arai (1998 MS) (Okuno et al., 1999; CDPCEV, 2001; Miura et al., 2013). The sequence from the oldest to the youngest is EsMP, Es-1, Es-2, Es-3, Es-4, Es-5 and Es-6. EsMP is the episode of Esan lavadome (Ed) and block-and-ash flow (PDC) deposit, and is the largest in the Holocene eruption units. A charcoal in the PDC deposit has revealed the reliable  $^{14}\text{C}$  age of 8,648-8,594 cal yBP (1 sigma) for the EsMP. Es-1, 2, 3, 4, 5 and 6 are the unit originated from phreatic explosions at the Ed lavadome, and are constituted by phreatic ash-fall, pyroclastic surge (PDC) and/or lahar deposits. Previously obtained  $^{14}\text{C}$  ages (cal yBP) for these phreatic units are the followings. Es-1: 5,909-5,680 (bottom soil, 2 sigma), Es-3: 2,435-2,344 (a charcoal soil in PDC, 1 sigma), Es-4: 1,894-1,829 and 636-551 (bottom and cover soils, 1 sigma). Eruption ages of Es-5 (AD1846) and Es-6 (AD1874) have been determined by certain reliable documents.

Our new measurements of 12 samples (bottom and cover soils) for  $^{14}\text{C}$  dating have revealed a certain constraints into the eruptive ages of Holocene tephra units (cal yBP, 2 sigma). Es-1: 5,595-3,984, Es-2: 4,150-3,477, Es-3: 3,341-1,822 and Es-4: 681-536. These constrained ranges of eruption ages are consistent to the previously obtained  $^{14}\text{C}$  age results. The further constraint by all of available measurements implies that the Es-4 unit might have erupted at 681-551 cal yBP.

Keywords:  $^{14}\text{C}$  dating, phreatic explosion, Holocene, Esan volcanic complex