Multiple alkaline tephra layers from Ulleung Island detected by INAA in the southern Japan Sea

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The occurrence of Ulleung Oki (U-Oki) tephra, distributed across the southwestern Japan, originated in an explosive eruption of alkali magma from the caldera in Ulleung island ca. 9,300 14C yr BP (Machida and Arai, 2003). The U-Oki tephra is regarded as an important time-marker during the Last Deglaciation to study paleo-sea level and paleo-oceanographic environments in the Japan Sea (Machida et al., 1984). However, it is suggested that some unknown alkaline ash fall events, which are probably from the Ulleung island, had happened besides U-Oki tephra between AT and K-Ah (e.g., Domitsu et al., 2002). Machida et al. (1984) reported seven depositions events of pumice layers (U1-U7) on Ulleung island in the late Quaternary eruptive history. Recently, AMS 14C aging of the pumice layers demonstrated that the deposition ages of U4, U3, and U2 are ca. 9,800˜12,100 14C yr BP, ca. 7,500˜8,000 14C yr BP, and ca. 4,900 14C yr BP, respectively (Nakamura et al., 2004). Thus, the distribution of U-Oki is presently considered to be contemporary with the deposit of U4 pumice on the Ulleung Island. The alkaline tephra from continental volcano has significantly different characteristics with the general tephra erupted by island arc volcanism. Fukuoka (1988) reported that Ta/Sc elemental ratio of glass shard is about 15, whereas the average Ta/Sc value in typical sediments is below 0.1.

Toyoda et al. (2006) firstly demonstrated that instrumental neutron activation analysis (INAA) is the supersensitive and effective detection of alkaline cryptotephras. Cryptotephra are tephra horizons that are invisible to the naked eye. Toyoda et al. (2006) detect unknown alkaline cryptotephras from down-core profiles of the Ta/Sc ratio in a piston core from Lake Biwa and the eruption age is considered to be 583 years before the fallout of U-Oki.

In this study, we are performing INAA determination of 12 trace elements in about 1200 samples taken from five cores in the southwest Japan Sea, obtained by the research cruises of National Institute of advanced Industrial Science and Technology (AIST). The analysis of a core (GH 872-308) has revealed some peaks in the vertical distribution of Ta / Sc ratio in the upper and lower parts of U-Oki layer, as well as the strong peak at U-Oki layer. The lowest peak of Ta/Sc, which is discriminated from U-Oki layer, indicates the contribution by alkaline tephra component and it is correlated with the reported alkaline cryptotephra layer 10cm below U-Oki in the Lake Biwa core (Toyota et al, 2006). Few peaks in the upper layer of U-Oki tephra in this core are probably due to re-deposition of U-Oki by turbid current.

In another core (GH87-2-KT), a strong peak of Ta/Sc was detected about 20cm above the U-Oki layer. EPMA analysis reveals that the tephra glasses separated from the anomalous layer sediment have different sizes from that of U-Oki and alkaline composition similar to that of U-Oki. We consider that the unknown alkaline tephra is probably originated from the eruption of Ulleung island which also makes the pumice layer of U3 on the land.

All the Ta/Sc anomalous samples in this study are rich in thorium, hafnium, REEs, etc. These element ratios also suggest the contribution of alkaline tephra at these anomalous layers in two cores. We will show the distribution and stratigraphy of alkaline tephra deposited in the southwest Japan Sea during the late-glacial/Holocene with the results of the three remaining other cores (GH86-2-D, GH86-4-510, GH 88-2-303) under running analysis.