

K-Ar and $40\text{Ar}/39\text{Ar}$ age determinations of USDP cores in Unzen Scientific Drilling Project

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In order to clarify the internal structure, growth history and magma ascending mechanism of Unzen volcano, the USDP-1 and -2 (752 and 1,463 m in total length) were drilled into the northeastern and eastern flanks. The USDP-3 (352 m) was also drilled into the northern flank as a pilot hole for conduit drilling, and the USDP-4 (1,996 m) were drilled as a main hole for conduit drilling. We propose systematic K-Ar and $40\text{Ar}/39\text{Ar}$ age determinations on the four USDP cores, together with the ages of products exposing on the surface of Unzen Volcano.

In the USDP-1 core, the bottom of Unzen Volcano appears at 684 m depth. The pyroxene andesites between 694 and 751 m depth gave ages of around 500 ka (UNIT 1; Pre-Unzen). These ages are consistent with those of similar Pre-Unzen products exposing on the surface around the southern flank. The ages between 626 and 681 m depth, which are classified into the UNIT 2 (Older Unzen), were within the range 400-500 ka. These mean that the activity of Unzen Volcano would start at about 500 ka without an evident time interval after the last eruption of Pre-Unzen Volcano. The ages between 104 and 557 m depth, which are classified into the UNIT 3 (Middle Unzen), were accumulated relatively short periods between about 170 and 230 ka. Similar deposits of around 200 ka are found along the 200 m-high steep cliff of the Tarukidaichi Plateau, a tilted faulted block immediately south from the USDP-1 site. In contrast, between 230 and 400 ka, very small amount of products reached the drill site. These suggest that extensive volcanism and subsidence of Unzen Graben occurred contemporaneously at around 200 ka. Relative uplift of the Tarukidaichi Plateau prevented the supply of volcanic materials to the drill site until 200 ka.

In the USDP-2 core, the bottom of Unzen Volcano appears at 1,198 m depth. The lava, pyroclastic and debris flow deposits between 1,210 and 1,455 m depth, which were classified into the UNIT 1, gave ages in the range 500-800 ka. Large amounts of phreatomagmatic explosion deposits continue from 567 to 829 m depth (UNIT 3A). These deposits gave ages of around 300 ka, and continuously overlie pyroclastic, debris and pumice flow deposits of the UNIT 2 (300-450 ka). Such phreatomagmatic explosion deposits have never been found on the surface of Unzen Volcano nor in the USDP-1 core. This finding suggests that rapid subsidence rate of Unzen Graben on the eastern flank at around 200-300 ka exceeded the production rate of volcanic materials and led strong interactions between magma and groundwater or seawater. There are, however, no submarine sediments that could indicate the invasion of seawater into the graben, at least to the USDP-2 site. Several pyroclastic and debris flow deposits, and lava between 325-545 m depth overlie phreatomagmatic explosion deposits, and gave ages in the range 180-280 ka. They are classified into the UNIT 3B. The lava flows between 245 and 287 m depth, which are classified into the UNIT 4 (Younger Unzen), gave ages in the range 120-130 ka.

In the USDP-3 core, the six samples gave ages in the range 100-210 ka. However, the ages of lavas at 305 and 349 m in length are stratigraphically inconsistent with each other. Because the USDP-3 was drilled obliquely, it would cross a concealed fault between the sampling depths. The ages of about 150 ka, which were given by the samples at 74 and 99 m in length, have been never found in the products on the surface of Unzen Volcano. This result suggests that the dormancy between Middle and Younger Unzen would be at most less than 30,000 years or not exist between the two active periods.

In the USDP-4 core, the five cuttings from lavas and pyroclastic or debris flow deposits between 76 and 936 m in length gave ages in the range 200-300 ka. These ages correspond to those of Middle Unzen (UNIT 3: 150-300 ka). Such Middle Unzen products are widely distributed around the first half of USDP-4 hole.