東北日本弧、後期新生代カルデラ群の特徴

The characteristics of the Late Cenozoic calderas in the northeastern Japan arc

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The uplift of the present Ou Backbone Range began in the island-arc period at 10 Ma, and was associated with an increase of horizontal compression. Between 8 and 1.7 Ma, active felsic volcanism created more than 80 calderas associated with subordinate andesites to basalts in the northeastern Japan arc (Ito et al., 1989; Yamamoto, 1992; Sato and Yoshida, 1993; Sato, 1994; Yoshida et al., 1999; Prima et al., 2012). There are two peaks in caldera formation interrupted by a short period of dormancy at 5-4 Ma, which is related to a short transgression, and the number and size of collapse calderas decreased from the late Miocene to the Pliocene.
These late Cenozoic calderas have an average diameter of about 10 km and an average aspect ratio of 1.24 in diameter. They are divided into three groups related to their diameter size (about 5, 10 and over 14 km), and are mainly classified into piston-cylinder type with subordinate funnel type. The spatial and size distributions of calderas are comparable with those of the Cretaceous granitic plutons from the Kitakami Mountainland in northeast Honshu. The collapse of such calderas would bave formed in a neutral to weakly compressive stress field (Sato and Yoshida, 1993; Sato, 1994), and this would have resulted in the rise of felsic magmas into the crust where large intra-crustal magma chambers were formed (Yoshida et al., 1993; Aizawa and Yoshida, 2000; Aizawa et al., 2006). It has been argued that the regional stress field controlled the volcanic activity in the northeast Japan arc (Sato and Yoshida, 1993; Yoshida et al., 1993, 1997, 1999, 2014; Acocella et al., 2008), and that basaltic magmas derived from the mantle wedge, underplated and stagnated near the Moho, which acts as a density barrier (e.g. Ryan, 1987; Takada, 1989). These magmas would then have fractionated, re-mobilized or re-melted from solidified mafic precursors or the pre-existing arc crust, to form the felsic magmas in the inland area of the northeast Japan arc, with a thick crust (Sato and Yoshida, 1993). Such an event is confirmed by the existence of large felsic effusives in the eastern margin of the back-arc basin rift system (Yamada et al., 2012). During the neutral stress condition between 13.5 and 10 Ma, the felsic magmas would have risen diapirically through the ductile lower crust owing to their buoyancy (Aizawa and Yoshida, 2000; Aizawa et al., 2006), and the mode of ascent would have changed in the brittle upper crust to dyke or sheet. An increase in the compressional stress field occurred between 10 and 8 Ma, and it is likely that this increase led to the formation of sills and laccolithic shallow reservoirs in the upper crust (Sato and Yoshida, 1993; Aizawa and Yoshida, 2000). The regional change in the stress field was, therefore, the major control of caldera-dominated volcanism with laccolithic shallow reservoirs that occurred in the earlier half of the island-arc period. Felsic magma at this level could then have intruded along subsurface low-angle thrust sheets, and it is possible that magma migration along the thrust sheets caused the uplift of the Ou Backbone Range (Sato and Yoshida, 1993; Sato, 1994; Yoshida et al., 1993, 2014).
The clockwise rotation of SW Honshu (Otofuji and Matsuda, 1983) and the collision with the Kuril forearc sliver (Kimura, 1986) caused an oblique (NE-SW trending) compression of the northeast Japan arc during the Miocene to Pliocene, and triggered felsic magmatism along the areas of localized

extension (Acocella et al., 2008). After about 5 Ma, the Pacific plate accelerated (Pollitz, 1986). Pollitz(1986) suggested that the change in Pacific plate motion introduced a large component of compression normal to the Japan trench. This strong ENE-WSW compression closed the caldera-feeding systems and favoured the development of stratovolcanoes with deeper magma plumbing systems directly connected to the basaltic mantle source region.

キーワード：後期新生代カルデラ群、東北日本弧、珪長質火山活動
Keywords: Late Cenozoic calderas, northeastern Japan arc, felsic volcanism

