Interaction between rhyolitic lava flow and unconsolidated sediments, the Membo volcano, Kozushima Island, Japan: an implication for silicic phreatomagmatism

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The rhyolitic lava flow of the 30-40 ka Membo volcano located at the southern Kozushima Island interacted with its subjacent unconsolidated deposit, leading to phreatomagmatic explosions. The lava flow, 150 m in thickness and 0.2 km3 in volume, is elliptically distributed on the slope inclined at 5-6 degrees southwestward. The lava whose base is not visible above sea level comprises basal breccia zone, massive lava zone and pumiceous breccia zone from the bottom. Basal breccia zone comprises lava blocks cut by a number of minor faults and welded, ash-sized matrix, which suggests that brittle fracturing of highly viscous melt was caused by accumulation of shear stress due to flowage of the lava. Massive lava zone accounting for the large fraction of the lava represents flow-banded, intact rhyolite. Pumiceous breccia zone comprises moderately to highly vesiculated lava blocks.

At Senryoike located at the southwestern edge of the lava, siltstone intrudes empty spaces of the basal breccia zone, forming the peperite zone. The siltstone comprises well-sorted crystal splinters, which are perhaps derived from the substrate. Some clastic dikes, 0.1-5 m in width, are almost vertically developed from the peperite zone and penetrate into massive lava zone. These dikes comprise lava blocks and ash-sized fragments of both lava and siltstone. Dip and strike of these dikes are concordant with that of minor faults developed in the basal breccia zone. Formation processes of the Senryoike outcrop are interpreted as follows. Brittle failure of basal part of the lava prompts fluidization of the substrate sediments due to the rapid heat transfer from lava to sediments and the decompression by roof rock failure, which results in coarse mingling of lava and sediments. The local equilibrium between steam and water is formed in the peperite zone. Further faulting of lava triggers destruction of the equilibrium condition, leading to sudden decompression and following explosive expansion of the water. Clastic dikes in the lava are the resultants.

This series of processes is plausible for the model of phreatomagmatic explosions due to interactions between degassed, highly viscous magma and unconsolidated sediments. Thus, auto-brecciation of magma not only facilitates mingling between silicic magma and unconsolidated sediments but also can trigger phreatomagmatic explosions.