Why rootless cone is ubiquitous on the martian surface?

*Kei Kurita[1], Rina Noguchi[2], Aika K Kurokawa[3]

1. ERI,The University of Tokyo, 2. JAXA, 3. NIED

Rootless eruption is one type of magma-water interactions. They are quite rare in the terrestrial environment while water is a ubiquitous component on the surface. On the other hand enormous numbers of rootless cones are identified on the martian surface. What is the essential difference between terrestrial environments and the martian ones? This is a key question of our stating point of the research. As for the formation mechanism of rootless eruption there also exists another enigma. When hot lava flows into a wet region the lava heats up water to boiling which induces explosion. But different from other types of magma-water interactions explosion seems to continue for a while in a somehow controlled fashion to form cinder cones. The main controlling factor is still unknown. In Hawaii Island over hundreds lava flows enter the sea to meet water but only a few rootless cones were formed. Some unspecified conditions are necessary fo the formation.
Noguchi et al (2016) investigates the morphometry of rootless cones in comparison with that of scoria cone and maar. In the diagram of crater diameter vs ejecta volume rootless cones locate between scoria cones and maars. Based on this we can estimate the magnitude of explosivity but above mentioned enigmas still remain unanswered. To explore keys to the enigmas about rootless eruption we conducted a comparative study on the internal structure of vesiculated pyroclasts at between rootless cones and scoria cones.
The volatiles which control the explosive eruption is exsolved from magma under decompression in the case of scoria cone-forming eruption(intrinsic exsolution) , while in the case of rootless eruption the volatile(water) is supplied out side of magma(external supply). This difference of the origin should be reflected in the internal structure of explosive products. In the intrinsic exsolution vesiculation progressively develops via nucleation and growth stages. In the case of external supply mixing characteristics controls explosivity and vesiculation. To identify these processes microstructure should be a good reference. The pyroclastic samples investigated are form Myvatn Lake,Iceland for rootless eruption and fissure eruptions, Miyakejima for scoria cone eruptions. The microstructure images in micron scale are obtained by SEM-BSI (NIED Tsukuba) and micro focus X ray CT (Saitama Sangyougijyutu Center). Overall vesicle void structure seems surprisingly similar in both cases. Both in the section image of SEM-BSI and 3D image of CT well-preserved ellipsoidal voids are common and homogeneously distributed in entire sample. This means complete quenching of vesiculation occurs before settling on the ground in scoria eruption and rootless eruption. Apparent resemblance of microstructure of vesiculated pyroclast in rootless eruption is surprising. This suggests highly efficient mixing of water and magma occurs. This seems not plausible if water exists as a pure phase because intense vaporization starts from the interface and this vaporization disturbs water taken into the inside of magma. In Myvatn area rootless cones concentrates in the area of thick lake sediment where water and mud mixture exist. This should be the key for the cause of rootless eruption. On the martian surface thick dust layer exists uniformly. In several areas this dust layer contains water, known as lattitude-dependent dust-ice mantling layer(Mustard et al, 2001). We propose this layer contributes efficient mixing of water and magma in a controlled fashion to form rootless eruption.
One remarkable difference, however exists between scoria cone forming eruption and rootless eruption; the minimum size of void is different. In fissure and scoria cone eruptions the minimum size of void is less than 5 micron while in the rootless eruption the size is larger than 50 micron. This also suggests water are taken into the magma with mud grains.

Reference:
Mustard et al,Nature 412,411 (2001)
Noguchi et al, JVGR 318, 89 (2016)

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