Is tephra stratigraphy in seasonal snow likely to be preserved? Observations from proximal deposits at Fimmvorduhals (2010) and Tolbachinsky Dol (2012-13)

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Recent and ongoing eruptions have provided new opportunities for observing interactions between basaltic lava flows and snow: the 2010 eruption at Fimmvorduhals, Iceland, and the ongoing (as of 13 Feb) eruption at Tolbachinsky Dol, Kamchatka, Russia. Fieldbased observations highlight many similarities but also differences, which result in part from variations in pre eruptive snow conditions.

The 2010 Eyjafjallajokull eruption began on 20 March with the opening of a small fissure at the northern end of Fimmvorduhals, a pass separating Eyjafjallajokull to the west and Myrdalsjokull to the east. Eruption initiation produced local bomb and tephra deposits surrounding the vents and extending to the south, west and northwest of the vents. Two months after the end of the eruption we observed raised mounds in tephra immediately south of Magni cone at Fimmvorduhals. A small subset of the estimated more than 1000 observed mounds were measured and dissected in 2010 and 2011. The mounds vary in diameter from 0.5 to 1 m, and in height from 5 to 25 cm. We have tentative identified three developmental stages including: 1) incipient, 2) fractured, and 3) burst. The mound cores either contain a volcanic bomb at their core, or have formed over large boulders that were part of the pre-eruption landscape. Both types of cores are covered in turn by course basaltic tephra and fine trachyandesite tephra. We believe that, unlike typical dirt cones found on bare ice surfaces of glaciations, the bomb/boulder-cored tephra mounds (BCTMs) form by melting of snow deposited syn-eruption. Snow melting causes compaction of the overlying tephra, which accentuates tephra draping over the core stones. Likely critical for the formation of the mounds is the covering layer of finer-grained, more cohesive trachyandesite tephra, which was deposited in mid-April after the eruption shifted from Fimmvorduhals to the summit of Eyjafjallajokull. It is unlikely that this unique sequence of events is common, and the mounds likely have a low preservation potential. However, they preserve a record of eruption during winter months when snow can accumulate during less vigorous periods of eruption, and something closely akin to BCTMs might form on planets like Mars when lava domes are emplaced into permafrost that is later covered by fine-grained dust.

Tephra pits dug in snow during January 2013 show a complex tephra-snow stratigraphy within 2 km of the active vents at Tolbachinsky Dol. The main pit, 2.5 m in depth, exposed four main layers of coarse ash and lapilli separated by variable thicknesses of snow. The pit shows that some snow was present before the start of the eruption, and tracks the interaction between environment (snow accumulation and/or wind direction) and eruption dynamics (changes in intensity of eruption). We will be revisiting this site during summer 2013 to determine what happens to the tephra-snow stratigraphy during summer snowmelt.