Geophysical Research Abstracts
Vol. 14, EGU2012-11451-2, 2012
EGU General Assembly 2012

Observations of obsidian lava flow emplacement at Puyehue-Cordón Caulle, Chile

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The dynamics of obsidian lava flow emplacement remain poorly understood as active obsidian lavas are seldom seen. In contrast with well-documented basaltic lavas, we lack observational data on obsidian flow advance and temporal evolution. The ongoing silicic eruption at Puyehue-Cordón Caulle volcanic complex (PCCVC), southern Chile provides an unprecedented opportunity to witness and study obsidian lava on the move. The eruption, which started explosively on June 4th 2011, has since June 20 generated an active obsidian flow field that remains active at the time of writing (January 2012), with an area of ∼6 km2, and estimated volume of ∼0.18 km3. We report on observations, imaging and sampling of the north-western lava flow field on January 4th and 10th 2012, when vent activity was characterised by near-continuous ash venting and Vulcanian explosions (Schipper et al, this session) and was simultaneously feeding the advancing obsidian flow (Castro et al, this session).

On January 4th the north-western lava flow front was characterised by two dominant facies: predominant rubbly lava approximately 30-40 m thick and mantled by unstable talus aprons, and smoother, thinner lobes of more continuous lava ∼50 m in length that extended roughly perpendicular to the overall flow direction, forming lobes that protrude from the flow margin, and lacked talus aprons. The latter lava facies closely resembled squeeze-up structures in basaltic lava flows[1] and appeared to originate from and overlie the talus apron of the rubbly lava. Its upper surface consisted of smooth, gently folded lava domains cut by crevasse-like tension gashes. During ∼2 hours of observation the squeeze-up lava lobe was the most frequent location of small-volume rockfalls, which occurred at ∼1-10 minute intervals from the flow front and indicated a locus of lava advance. On January 10th the squeeze-up lava lobes had evolved significantly, with disruption and breakage of smooth continuous lava surfaces to form blocky lava domains. Gravitational collapse of lobe toes had created an incipient talus apron that had markedly advanced. In contrast, the rubbly lava had undergone only modest evolution, reflecting continued rockfall and subtle advance of its well-developed talus apron.

Visualisation of the lava morphology and evolution was assisted by 3D models of the lava flow front, produced by an automated photo-reconstruction technique (SfM-MVS, a combination of structure from motion and multi-view stereo algorithms), and >1000 digital images taken at the scene. Additionally samples were collected from the rubbly lava and squeeze-up lava lobe facies. Sample textures, geochemistry and volatile concentrations will provide further insight into the evolving physical and chemical state of the lava. Our observations indicate that endogenous growth plays a major role in obsidian lava flow advance, with effective thermal insulation of lava that emerges from squeeze-ups close to the flow margin. This has important implications for the longevity, mobility and hazard potential of obsidian flows and indicates striking similarities with the dynamics of basaltic lava flow emplacement.

[1]Applegarth L.J. et al. 2010 Bull. Volcanol. 72, 641–656.