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Shallow vent architecture of Puyehue Cordón-Caulle, as revealed by direct observation of explosive activity

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On June 4, 2011, an explosive eruption of rhyodacitic magma began at the Puyehue Cordón-Caulle volcanic complex (PCCVC), southern Chile. Initial Plinian phases of the eruption produced tephra plumes reaching > 14 km high, the ash from which quickly circumnavigated the globe to cause widespread disruption to air traffic in the Southern Hemisphere. Within two weeks, the continuing explosive eruption was joined by synchronous effusion of lava. We present observations of complex vent activity made 7 months after the eruption onset, on January 4th and 10th, 2012, when explosive activity from PCCVC continued at a lower level of intensity. Fortuitous climatic conditions permitted direct, ground-based observation and video recording of transient vent dynamics within the asymmetrical tephra cone around the main eruptive vent complex and site of lava effusion, as well as real-time collection of juvenile ash as it rained out directly from the active plume.

On Jan. 4, explosive activity was semi-continuous ash jetting punctuated by Vulcanian-like blasts. In the ∼50m-diameter sub-circular base of the ∼400 m-wide, asymmetrical tephra cone, near-continuous ash jetting was observed from two primary point sources. The northerly source was clearly visible, with time-averaged diameter of ∼10 m, and the apparently larger southerly source was mostly obscured from view by the ash plume. Activity was at all times somewhat erratic, but followed a rough cyclicity on 30-45 s timescales, consisting of: (1) restriction of the point source into a focused ash jet up to ∼50 m high, producing coarse ash dominated by tube pumice (with minor free pyroxene crystals); followed by (2) Vulcanian-like failure of the region around the point source, producing incandescent ballistic bombs thrown up to 100-200 m from the vent. Jetting from the two main point sources combined in the crater to produce a low gas-thrust region and sustained buoyant plume. Directed ash plumes that climbed and breached the inner wall of the tephra cone were entrained upward into the main vertical portion of the plume.

On Jan. 10, explosive activity was manifested as semi-continuous ash jetting from multiple point sources, as accommodated by a 10-20 m high incipient dome that had formed in the tephra cone. At any given time, up to 10 discrete point and linear sources of gas and ash discharge could be seen. These had variable directionality and produced plumes with spatially and temporally variable ash contents. Cycles of overpressure buildup and vent failure were still observed, but rarely produced significant bombs. Instead, failure was characterized by the simultaneous or staggered opening of many additional point discharge sources, often defining a dish-like structure around - but not disturbing - the incipient dome. During this lower-intensity activity, no defined gas-thrust region was maintained and the plume would often collapse to fill the tephra cone. Directed plumes that breached the cone continued to descend its outer slopes.

Ongoing analysis of juvenile pyroclasts and video footage permits an assessment of overpressure buildup and release in the shallow conduit of the PCCVC, and an assessment of the complex shallow vent architecture. We address the ideas: (1) that to describe explosive ash jetting from a single "vent" is a gross oversimplification of what is actually a highly transient, multiple point-source vent complex subject to variations in permeability and rate/type of discharge; and (2) that gas and ash jetting and Vulcanian blasts play an important if not necessary role in generating degassed magma that erupts effusively (see Castro et al., this session).