Reassembling a volcanic conduit using bombs at Cordón Caulle, Chile

Jonathan M Castro[1], C. Ian Schipper[3], Hugh Tuffen[2], Mike James[2], Annemarie Militzer[1]

[1]University of Mainz, Germany, [2]University of Lancaster, UK, [3]Victoria University Wellington, NZ

E-mail: castroj@uni-mainz.de

Active volcanic conduits are not directly observable, however, snapshots of the state of magma feeding varied eruption styles can be reconstructed from pyroclasts. During the opening weeks of the June, 2011 Cordón Caulle eruption, hundreds of large (cm's to m's) bombs were ejected and deposited up to 2.5 km from the vent. At this time, activity changed from being explosive to hybrid, involving effusion of obsidian lava along side a pyroclastic fountain. The bombs at El Caulle provide an unprecedented view into an active conduit that fostered simultaneous explosive and effusive volcanism.

We examined the physical characteristics of >70 bombs from the flanks of Cordón Caulle, and based on these observations group them into two general categories. Type I bombs were erupted as dense magma and quenched to form either obsidian or breadcrusted blocks. The dense, flow banded blocks have incipient surface cracks and etched outer surfaces. Type I breadcrusted bombs occur as many separate fragments that individually vesiculated after the bomb impacted and broke. Both dense and breadcrusted bombs have white, ash- and pumice-laden tuffisite veins (mm to cm's) adjoined to their surfaces, indicating that some of the Type I bombs were actually composites of dense obsidian and juxtaposed ash and pumice domains at the time of their eruption.

Type II bombs are pumiceous with <5 vol% obsidian clasts. These bombs may be partly or wholly brecciated, comprising angular pumice clasts (cm to dm's) suspended in fine to coarse ash and pumice lapilli. Some Type II bombs are homogenous pumice blocks that also contain red tuffisite veins cutting through them. Pumice breccia bombs often have large (dm's) coalesced vesicles at their centers that cracked the outer bomb surface due to their expansion after the bomb erupted. These features indicate that despite the bomb's clastic and porous nature, brecciated conduit magma must weld to the point of having low permeability—this may, in turn, impede outgassing to the point of explosive release in the conduit.

The glassy and pumiceous bombs found at Cordón Caulle represent juxtaposed regimes of magma movement and degassing. Type I facies develops during coherent magma flow through the conduit, while Type II records multiple fragmentation events and gas-driven flow of clastic bubbly magma. That overlap exists between these facies—this evidenced by the mixing (inclusion) of pyroclastic and dense elements in Type I and II bombs—suggests that the bombs are sourced from a boundary zone/layer that separates effusively and explosively erupting magma. This boundary zone must allow not only physical exchange of pyroclastic and coherent elements, but also chemical transfer of exsolved gases between the different magma domains.