# Dynamical regime and advance rate of lava flows using its deposit characteristics: 2 cases from the Lonquimay and Villarrica volcanoes, Southern Andes of Chile

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The advance of lava flows is controlled by the effusion rate, rheology, topography and cooling effects. Consequently, the deposits of lava flows would reflect the interplay between these factors. We tested a methodology to estimate the variations of flow rate and velocity of ancient lava flows using its deposit dimensions, textural characteristics and petrography. We studied the deposits of two lava flows with contrasting styles generated during historical times in the Southern Andes of Chile: the 1971 eruption of Villarrica volcano and the 1988-89 eruption of Lonquimay volcano. Both eruptions have a record of its duration and advance rate, so we can test different dynamical models in order to fit better the available data.

The Villarrica eruption lasted a couple of days and the resulting lava flow reached a length of 16.5 km, with thicknesses of 3-15 m, depending mainly on the channelling of the flow. The morphology is transitional between Pahoe-hoe and Aa. Clasts morphologies are mainly rubbly and slabby, ranging from a few cm to a couple of meters in diameter. The lava has a basaltic andesitic composition, with a porphiric texture and a vitric groundmass.

The Lonquimay eruption, on the other hand, lasted a year and the lava flow reached a length of 10.2 km, with increasing thicknesses from 10 m near the vent to more than 40 m at the front. The morphology is transitional between Aa and blocky. Major structures include levees, crease structures, compressional ridges and spines more than 5 m height towards the front. Surface blocks could be rubbly or fragments with angular and planar surfaces. The lava has an andesitic composition, with an aphanitic texture but with a very crystalline groundmass.

We used 3 simplified, 2-D models, assuming different dynamical regimes in each case, to estimate the advance of the flows: a viscous regime, a crustal yield strength or an internal yield strength. The rheology of the flows is modelled as a Herschel-Bulkley fluid and was estimated with samples taken at different locations through the flows, using glass composition (to calculate the liquid viscosity) and crystal content.

The modelling of the advance of these flows, together with field observations, suggests that the Villarrica flow was controlled by the internal viscosity of the lava with a viscosity of $10^4$-$10^5$ Pa s, while the Lonquimay flow was controlled by the crustal yield strength, with a value of $2x10^5$ Pa.

Our results show that it is possible to estimate the dynamical regime, velocity and flow rate variations of ancient lava flows, and not only the mean effusion rate, combining the dimensions, morphology and petrography of the deposits.