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Laguna del Maule magma feeding system and construction of a shallow silicic magma reservoir

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Laguna del Maule Volcanic Field is composed by at least 130 basaltic-to-rhyolitic eruptive vents that erupted more than 350 km^3 of lavas and pyroclasts since Pleistocene in the Chilean Andes. It has captivated attention because of its current high accelerated uplift suggested to be formed by a growing shallow rhyolitic magma reservoir beneath the zone of deformation. Studying six Holocene post-glacial andesitic-to-rhyolitic lavas and one dome that partially overlap the ground-inflation zone, we determined the architecture and steps of construction of the magma feeding system that generated its post-glacial effusive volcanism. Further we suggest a possible origin for the rhyolitic magma that generated the ring of rhyolites encircling the lake and remain active causing the uplift.

Mineral chemistry and textures suggest the same provenance of magma for the studied units, as well as complex magmatic history before eruptions. Similar temperatures, pressures, H_2O and fO_2 conditions for amphibole crystallisation in first stages indicate a common ~17 km deep original reservoir that differentiated via in-situ crystallisation. The chemistry of the amphiboles present in all not-rhyolitic units shows trends that indicate a temperature domain on their crystallisation over other thermodynamic parameters such as pressure, water activity or chemistry of co-crystallising phases. All this supports a mush-like reservoir differentiating interstitial magma while crystallisation occurs.

P-T conditions for amphibole crystallisation indicate that only amphiboles from rhyodacites show a non-adiabatic decompression that give rise to a polybaric and polythermal evolution trend from ~450-200 MPa and ~1030-900 °C. In addition, unbuffered fO_2 conditions were calculated for rhyodacite amphibole crystallisation upon cooling from melts with rather constant H_2O contents. We propose that a large part of these rhyodacite amphiboles were formed during a non-adiabatic magma ascent similar to that expected for within-reservoir convective plumes that interact with surrounding cooler and more differentiated melts. Rhyolites appear to be unrelated to the evolution of rhyodacitic magma because they crystallised under buffered and less oxidizing conditions. This along with plagioclase patterns is in agreement with inputs of slightly hotter rhyolitic magma with no significant chemical difference that formed a zone of rhyolitic magma accumulation. This is consistent with the absence of mafic enclaves in the studied rhyolites.

However, eruptions of andesitic-to-rhyodacitic lavas were triggered by injections of different more primitive magma batches into a mush-like reservoir stalled at different depths. Likewise, ascent of magma from a deeper to a shallower level would also be conducted by a more primitive magma recharge as it is suggested by the presence of mafic enclaves and complex zonation and textures of plagioclases in these lavas. Here constant input of hotter and more primitive magmas enables the system to remain active in time. In the case of the rhyolitic units, the silicic reservoir receives constant input of the extracted interstitial rhyolitic magma from a deeper level of the mush-like reservoir.