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Magma mixing and partial hybridization during the 1993 subplinian eruption of Lascar volcano, northern Chile

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Lascar volcano is considered one of the fourteen volcanoes with the highest risk in Chile. Its last major eruption in April 1993 generated an eruptive column >21 km high and a series of compositionally heterogeneous pyroclastic flows and fallout deposits. The tephra fall, dispersed towards the southeast, is mainly composed of green pumice (SiO_2 57.14%wt) and, to a lesser extent, dense lithics of the dome (SiO_2 58.69%wt) and the 1 cm-isopach reached up to 16 km from the vent. However, the flow deposits in the same direction, are mostly composed of white pumice (SiO_2 59.52%wt) which reached up to 4.5 km from the vent. Meanwhile, the northwest flow deposits, are mainly composed of scoria (SiO_2 56.59%wt), white and banded pumice (SiO_2 57.14wt%) and reached up to 10 km from the vent. The glass components (matrix glass and melt inclusions) of all different lithologies are more differentiated with SiO_2 contents between 57.39-71.70%wt. Thermobarometric calculations using Opx-Cpx, Plg-L and Opx-L equilibria (L: glass and whole-rock) suggest that the identified lithologies record consistently distinct P-T conditions: 233-259MPa/974-981°C (white pumice), 375-407MPa/965-1066°C (green pumice), 100-350MPa/859°C (light band, banded pumice), 300-650MPa/968°C (dark band, banded pumice) and 551-584MPa/~1000°C (scoria). Based on these data, we propose a multi-stage petrological model for Lascar volcano magmatic system, which consists of a deep reservoir located at least at 20-24 km (~551-650 MPa and ~1000°C), that would host the less differentiated magmas and a shallower reservoir located at 4-15 km depth (~100-407 MPa and ~859-1066°C). It's in the latter where the mixing of the 1993 eruption would have originated, caused by the input of mafic magma from the deepest reservoir to this more differentiated shallow reservoir, generating both a complete (green pumice) and incomplete (banded pumice) hybridization of its components in a dynamic and out-of-equilibrium interaction process of magma mixing - evidenced by the more significant amount of melt inclusions and sieve texture in green pumice compared to white pumice and scoria - and erupting before a fully effective hybridization of the interacting magmas was achieved.