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3D gravity inversion and thermodynamic modelling reveal properties of shallow silicic magma reservoir beneath Laguna del Maule, Chile

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Active, large volume, silicic magma systems are potentially the most hazardous form of volcanism on Earth. Knowledge of the location, size, and physical properties of silicic magma reservoirs, is therefore important for providing context in which to accurately interpret monitoring data and make informed hazard assessments. Accordingly, we present the firrst geophysical image of the Laguna del Maule volcanic field magmatic system, using a novel 3D inversion of gravity data constrained by thermodynamic modelling. We image a 30 km^3, low density, volatile rich magma reservoir, at around 2 km depth, containing at least 85 % melt, hosted within a broader 115 km^3 body interpreted as wholly or partially crystallised cumulate mush. Our model suggests a magmatic system with shallow, crystal poor magma, overlying deeper, crystal rich magma. Even though a large density contrast (-600 kg/m^3) with the surrounding crust exists, the lithostatic load is 50 % greater than the magma buoyancy force, suggesting buoyancy alone is insufficient to trigger an eruption. The reservoir is adjacent to the inferred extension of the Troncoso fault and overlies the location of an intruding sill, driving present day deformation. The reservoir is in close proximity to the 2.0 km^3 rln eruption at 2-3 ka, which we calculate tapped approximately 6 % of the magma reservoir. However, we suggest that the present day magma system is not large enough to have fed all post-glacial eruptions, and that the location, or size of the system may have migrated or varied over time, with each eruption tapping only a small aliquot of the available magma. The presence of a shallow reservoir of volatile rich, near liquidus magma, in close proximity to regional scale faulting, has important implications for volcano monitoring and hazard mitigation.