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Linking igneous zircon texture to magmatic thermal history in the Torres del Paine intrusive complex

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The interpretive link between zircon texture and geochronology has been enormously successful in its application to diverse geological problems. The recognition of features such as metamorphic rims and inherited cores using cathodoluminescence (CL) imaging has allowed for the rigorous interpretation of zircon U-Pb geochronological data in the context of regional geological studies. However, it remains a challenge to link specific textures and zoning patterns in magmatic zircon grains to the thermal and chemical processes that occur within individual magmatic systems.

Here we use the Torres del Paine intrusive complex in Patagonia, Chile to investigate how magmatic zircon textures are related to the processes operating during the assembly of magmatic systems. Extensive prior fieldwork and textural, geochemical, and geochronological characterizations of both the magmatic system and the country rock provide an exceptionally well-constrained context for investigating the textures of magmatic zircon grains.

Detailed CL study shows that apparently oscillatory zoned zircons from the ~800m thick laccolithic Catedral granite, which was constructed incrementally by the intrusion of m-dm scale sills, are characterised by numerous micron-scale concentric resorption interfaces truncating oscillatory concentric zones. Meanwhile, late granitic rocks within the mafic laccolith that intrudes the base of the Catedral granite contain a distinct population of zircons that are characterised by uninterrupted oscillatory zoning, with only rare resorption interfaces. These late granites are the youngest magmatic component of the Torres del Paine intrusive complex based on field relationships. High precision CA-ID-TIMS U-Pb geochronology of this zircon population anchors its position within the timeline of the assembly of the intrusive complex and confirms the field observations regarding timing. We contrast the thermal histories of the magmas to explain the differences in the zircon textures. The resorption interfaces in Cathedral granite zircon are produced during thermal pulsing by the injection of sills, while the uninterrupted oscillatory zoning is associated with the simple cooling of the late granite that is required by field and temporal constraints. We propose that repetitive resorption and growth interfaces in zircon record thermal oscillations of magmatic systems related to replenishment and cooling.