Geometry, petrology and growth of a shallow crustal laccolith: the Torres del Paine Mafi c Complex (Patagonia)

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1. ABSTRACTS - RÉSUMÉS

SCIENTIFIC ABSTRACT - ENGLISH VERSION

Geometry, petrology and growth of a shallow crustal laccolith: the Torres del Paine Mafi c Complex (Patagonia)

The Torres del Paine intrusive complex (TPIC) is a composite mafi c-granitic intrusion, ~70km$_2$, belonging to a chain of isolated Miocene plutons in southern Patagonia. Their position is intermediate between the Mesozoic-Cenozoic calc-alkaline subduction related Patagonian batholith in the West and the late Cenozoic alkaline basaltic back-arc related plateau lavas in the East. The Torres del Paine complex formed during an important reconfiguration of the Patagonian geodynamic setting, with a migration of magmatism from the arc to the back-arc, possibly related to the Chile ridge subduction. The complex intruded the flysch of the Cretaceous Cerro Toro and Punta Barrosa Formations during the Miocene, creating a well-defi ned narrow contact aureole of 200–400 m width.

In its eastern part, the Torres del Paine intrusive complex is a laccolith, composed of a succession of hornblende-gabbro to diorite sills at its base, with a total thickness of ~250m, showing brittle contacts with the overlying granitic sills, that form spectacular cliffs of more than 1000m. This laccolith is connected, in the western part, to its feeding system, with vertical alternating sheets of layered gabbronorite and Hbl-gabbro, surrounded and percolated by diorites. ID-TIMS U-Pb on zircons on feeder zone (FZ) gabbros yield 12.593±0.009Ma and 12.587±0.009Ma, which is identifcal within error to the oldest granite dated so far by Michel et al. (2008). In contrast, the laccolith mafi c complex is younger than than the youngest granite (12.50±0.02Ma), and has been emplaced from 12.472±0.009Ma to 12.431±0.006Ma, by under accretion beneath the youngest granite at the interface with previously emplaced mafi c sills. The gabbronorite crystallization sequence in the feeder zone is dominated by olivine, plagioclase, clinopyroxene and orthopyroxene, while amphibole forms late interstitial crystals. The crystallization sequence is identical in Hornblende-gabbro from the feeder zone, with higher modal hornblende. Gabbronorite and Hornblende-

gabbro both display distinct Eu and Sr positive anomalies. In the laccolith, a lower Hornblende-gabbro crystallized in sills and evolved to a high alkali shoshonitic series. The Al_2O_3, TiO_2, Na_2O, K_2O, Ba and Sr composition of these gabbros is highly variable and increases up to ~50wt% SiO_2. The lower hornblende-gabbro is characterized by kaersutite anhedral cores with inclusions of olivine, clino- and orthopyroxene and rare apatite and An70 plagioclase.

Trace element modelling indicates that hornblende and clinopyroxene are in equilibrium with a liquid whose composition is similar to late basaltic trachyandesitic dikes that cut the complex. The matrix in the lower hornblende gabbro is composed of normally zoned

oligoclase, Magnesio-hornblende, biotite, ilmenite and rare quartz and potassium feldspar.

This assemblage crystallized in-situ from a Ba and Sr-depleted melts. In contrast, the upper Hbl-gabbro is high-K calc-alkaline. Poikilitic pargasite cores have inclusions of euhedral An70 plagioclase inclusions, and contain occasionally clinopyroxene, olivine and orthopyroxene. The matrix composition is identical to the lower hornblende-gabbro and similar to the diorite. Diorite bulk rock compositions show the same mineralogy but different modal proportions relative to hornblende-gabbros

The Torres del Paine Intrusive Complex isotopic composition is $^{87}Sr/^{86}Sr=0.704$, $^{143}Nd/^{144}Nd=0.5127$, $^{206}Pb/^{204}Pb=18.70$ and $^{207}Pb/^{204}Pb=15.65$. Differentiated dioritic and granitic units may be linked to the gabbroic cumulates series, with 20-50% trapped interstitial melt, through fractionation of olivine-bearing gabbronorite or hornblende-gabbro fractionation The relative homogeneity of the isotopic compositions indicate that only small amounts of assimilation occurred. Two-pyroxenes thermometry, clinopyroxene barometry and amphibole-plagioclase thermometry was used to estimate pressure and temperature conditions. The early fractionation of ultramafi c cumulates occurs at mid to lower crustal conditions, at temperatures exceeding 900°C. In contrast, the TPIC emplacement conditions have been estimated to ~0.7±0.5kbar and 790±60°C.

Based on fi eld and microtextural observations and geochemical modelling, fractionation of basaltic-trachyandesitic liquids at intermediate to lower crustal levels, has led to the formation of the Torres del Paine granites. Repetitive replenishment of

basaltic trachyandesitic liquid in crustal reservoirs led to mixed magmas that will ascend via the feeder zone, and crystallize into a laccolith, in the form of successive dioritic and gabbroic sills. Dynamic fractionation during emplacement concentrated hornblende rich cumulates in the center of individual sills. Variable degrees of post-emplacement compaction led to the expulsion of felsic liquids that preferentially concentrated at the top of the sills. Incremental sills amalgamation of the entire Torres del Paine Intrusive Complex has lasted for
~160ka.