Magma chamber processes beneath Icelandic central volcanoes: Evidence from gabbros of the Austurhorn intrusive complex, SE Iceland

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The ~6 Ma Austurhorn (15 km^2) intrusive complex was emplaced at approx. 2 km depth into Neogene basalts of Southeast Iceland. The exposed gabbros, granophyres and acid-basic complexes are among the largest in Iceland and represent the exhumed roots of a late Neogene central volcano.

The 2,3 km^2 layered gabbro sequence at Hvalnesfjall makes up the central part of the intrusion. Our results demonstrate that the cumulate stratigraphy exceeds 800 m, making it the largest known gabbro outcrop in Iceland. The gabbro is dominated by leucocratic, plagioclase – clinopyroxene – Fe-Ti oxide cumulates. However, seven 2-10 m thick olivine-bearing melanocratic layers define the bases of macrorhythmic units. Cumulus minerals have a limited compositional range (An85-56 in plag; Mg#84-72 in cpx) compared with closed-system layered intrusions and show no overall evolution from bottom to top of the sequence. Cryptic variation shows a zigzag pattern with increases in Cr_2O_3 in magnetite and Mg# in clinopyroxene occuring across boundaries of macrorhythmic units. This is interpreted to reflect crystallisation in a periodically replenished, tapped and fractionated magma chamber.

The emplacement sequence of the intrusive rocks at Austurhorn is debated. An approx. 100 m thick gabbroic body at Hvashjalli east of the Hvalnesfjall gabbro was mapped by Furman *et al*. (1992) as gabbro cross-cut by granophyre. Our mapping, however, demonstrates that this gabbroic body is a monster pillow that grades from lobate dolerite at the margins to gabbro at the centre. We therefore suggest that all gabbroic bodies at Austurhorn were formed by intrusion of basaltic magma into pre-exisitng rhyolitic magma chambers.

Reference

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Excess ^{176}Hf in early crystallised meteorites

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The ^{176}Lu decay constant (λ^{176}Lu) has been determined to be 1.87 x $10^{-11}yr^{-1}$ using terrestial samples of known U-Pb ages (Scherer *et al*. 2001, Söderlund *et al*. 2004), a value recently verified by an internal isochron from phosphate minerals from a 4557 m.y. old meteorite (Amelin 2005). However, previous Lu-Hf analyses from meteorites older than 4.56 Ga have ^{176}Hf excesses that are correlated with their Lu/Hf elemental ratios (Blichert-Toft *et al*. 2002, Bizzarro *et al*. 2003). To evaluate this issue, we derived an internal Lu-Hf isochron from the basaltic angrite SAH99555 yielding a Pb-Pb age of 4564.5 Ma (Amelin *et al.* 2007).

Similar to the earlier results on pre-4.56 Ga meteorites, our Lu-Hf results show an ^{176}Hf excess corresponding to ~6% increase in the slope of the isochron. Due to the correlation with Lu, we infer this excess be generated by an accelerated decay of Lu most likely related to the formation of the $^{176}Lu^m$ isomer with a half-life of 3.7 hours. Alberede *et al*. (2006) proposed that ^{176}Lu was excited due to solar and/or supernova generated gamma radiation. However, the shallow penetration of gamma radiation precludes this model explaining the ^{176}Hf excess in SAH99555. We considered supernova generated neutrinos as an alternative means to excite ^{176}Lu but this process is precluded by the very small neutrino cross section. A third energy source also related to supernova shocks is cosmis rays. Cosmic rays can excite nuclei and penetrate accreted material as deep as 100-200 meters. As such, they could account for the excess ^{176}Hf in material crystallised before the supernova explosion. This model is consistent with Fe-Ni isotope data that indicate that a supernova(e) occurred after accretion of the angrite parent body (Bizzarro *et al*. in press).

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