The Sept Iles mafic layered intrusion: An example of ferrobasaltic differentiation

O. NAMUR[1], B. CHARLIER[1], M.D. HIGGINS[2] AND J. VANDER AUWERA[1]

[1]Department of Geology, University of Liège, Belgium
[2]Earth Sciences, University of Chicoutimi, Canada (onamur@student.ulg.ac.be)

The Sept Iles Mafic Intrusion (SIMI) (Quebec, Canada), part of the Sept Iles Intrusive Suite (SIIS), is a 6 km-thick layered troctolite-gabbro intrusion with a funnel shape of 80 km in diameter. The SIIS has been dated at 564±4 Ma [1] and supposedly results from the activity of a mantle plume related to the formation of the St-Laurent rift system. Flood basalts may have erupted before its emplacement [2]. A detailed petrologic study of the SIMI has been undertaken with the aim of better constraining the differentiation of ferrobasaltic liquids [3]. We present here the first results of this study which focus on the possible composition of the SIMI parent magma and on the main structure of this magma chamber.

The exposed part of the SIIS is surrounded by a Border zone of variable thickness made of massive and locally fine grained gabbros. These fine-grained gabbros have high FeO_t (up to 15 wt. %) and TiO_2 (3 wt. %) contents, moderate P_2O_5 content (0.35 wt. %) and no Eu anomaly (Eu/Eu* = 0.95). They are typical ferrobasalts very similar to the estimated parent magmas of the Skaergaard [4] and Newark Island intrusions [5]. The composition of liquidus phases obtained with the MELTS algorithm (plagioclase An_{67}, olivine Fo_{75}) perfectly matches the most primitive compositions of plagioclase (An_{68}) and olivine (Fo_{75}) observed in the SIMI. Moreover, the sequence of crystallization experimentally obtained by [5, 6] on samples which are very similar to the ferrobasalts from Sept Iles is in agreement with the sequence of crystallization of the SIMI (plagioclase and olivine, + Ca-rich clinopyroxene, + magnetite and ilmenite - olivine, + olivine + apatite). The fine-grained gabbros from the Border Intrusion are thus plausible compositions for the parent magma of the SIMI.

From base to top, the plagioclase composition evolves continuously from An_{68} to An_{40}, then displays a significant reversal to An_{60} followed by a new decrease down to An_{53}. The magnetite Cr content displays a parallel evolution. This reversal is interpreted as a new magma influx which is marked by an intraplutonic quench horizon. Other small reversals are observed throughout the Series.

References:

[1] Higgins, M.D. and van Breemen, O. (1998) *J. Geol.* **106**, 421-431.
[2] Higgins, M.D. (2005) *Lithos.* **83**, 199-213.
[3] Thy, P. *et al.* (2006) *Lithos.* **92**, 154-180.
[4] Hoover, J.D. (1989) *J. Petrol.* **30**, 441-476.
[5] Snyder, D.A. *et al.* (1993) *Contrib. Mineral. Petrol.* **113**, 73-86.
[6] Toplis, M.J. and Carroll, M.R. (1996) *J. Petrol.* **37**, 837-858.

Zircon M257 – A new standard for SHRIMP U-Pb geochronology

L. NASDALA[1], W. HOFMEISTER[2], J. MATTINSON[3], W. DÖRR[4], F. CORFU[5], P.W. REINERS[6], A. KRONZ[7], N. NORBERG[1] AND A. KRÖNER[2]

[1]Institut für Mineralogie und Kristallographie, Universität Wien, Austria (lutz.nasdala@univie.ac.at; nicholas.norberg@gmx.at)
[2]Institut für Geowissenschaften, Johannes Gutenberg-Universität Mainz, Germany (hofmeister@uni-mainz.de; kroener@uni-mainz.de)
[3]Department of Earth Science, University of California, Santa Barbara, CA, U.S.A. (mattinson@geol.ucsb.edu)
[4]Institut für Geowissenschaften, Universität Giessen, Germany (wolfgang.doerr@geolo.uni-giessen.de)
[5]Department of Geosciences, University of Oslo, Norway (fernando.corfu@geo.uio.no)
[6]Department of Geosciences, University of Arizona, Tucson, AZ, U.S.A. (reiners@u.arizona.edu)
[7]Geowissenschaftliches Zentrum, Georg August-Universität Göttingen, Germany (akronz@gwdg.de)

The possibility to determine U-Pb ages from micron-sized areas within single zircon crystals using the SHRIMP technique has opened up new possibilities for detailed studies of the history of crustal rocks and constraining their ages. This technique, however, depends on the availability of well-characterized, natural reference materials (Kennedy, 2000). We propose a gem-quality zircon (Univ. Mainz sample no. M257) as a future SHRIMP U-Pb zircon standard.

Zircon M257 is a pale brown, clear stone with a weight of 25.7 ct [for comparison, SHRIMP standard CZ3 (Pidgeon, 1997), which has been used for more than ten years, had a weight of only 4.5 ct]. M257 is remarkably homogeneous; no internal zoning at all was found using CL imaging, transmitted light microscopy and Raman line-scanning. Its comparably high actinide concentrations (U, 810 ppm; Th, 224 ppm) will account for high U, Th and Pb count rates. Preliminary TIMS analyses (done in Giessen, Santa Barbara and Oslo) indicate a concordant U-Pb age of ~562 Ma. Unit cell dimensions (a_0, 6.626 Å; c_0, 6.030 Å) and Raman parameters {e.g., FWHM[$\nu_3(SiO_4)$], 11.8 cm^{-1}} correlate very well with the calculated time-integrated alpha dose of 1.66×10^{18} α/g (compare Nasdala *et al.*, 2004). This and the (U+Th)/He age (419 ± 9 Ma), which is consistent with previous helium ages for zircon from Sri Lanka, allow us to exclude any heat-treatment. Further characterization of the isotopic composition of sample M257 is in progress.

References

Kennedy A.K., (2000), In: Woodhead J.D., Hergt J.M. and Noble W.P. (Eds.), *Beyond 2000: New Frontiers in Isotope Geoscience, Lorne*, Abstr. & Proc., pp. 109–111.
Nasdala L., Reiners P.W., Garver J.I., Kennedy A.K., Stern R.A., Balan E. and Wirth R., (2004), *Am. Mineral.* **89**, 219–231.
Pidgeon R.T., (1997), *Z. Dt. Gemmol. Ges.* **46/1**, 21–28.