Redox state of the South Mountain Batholith, Nova Scotia, Canada: a reconnaissance study

JUAN CHAVEZ AND JAMES BRENAN
Department of Earth Sciences, Dalhousie University, Halifax, Nova Scotia B3H 4R2

The late Devonian South Mountain Batholith (SMB) of southwestern Nova Scotia is the largest plutonic igneous body emplaced in the Appalachian orogen, with a current surface expression of 73 000 km^2. The batholith is composed of 13 distinct plutons that are broadly peraluminous in composition, ranging from tonalite to syenogranite. A parameter that has been particularly difficult to quantify for the SMB is the redox state, as measured by the oxygen fugacity (fO_2), which exerts a profound control on magmatic phase stability, element partitioning, and importantly, the potential for economic mineral deposits. Here we present a redox state survey of mineralised and unmineralised units of the SMB using the newly calibrated Ce-in-zircon oxygen barometer. This method combines bulk rock and zircon compositions to calculate apparent zircon/melt partition coefficients for Ce, a parameter which varies with the Ce^{4+}/Ce^{3+} in the melt, and hence oxygen fugacity.

A total of 23 samples were collected and 13 were selected for whole-rock major and trace element analysis and zircon separation based on spatial distribution, mineralogy, and preliminary geochemical data acquired by X-ray fluorescence spectroscopy. We obtained 13 samples from the spatially zoned Halifax pluton. From these, 2 samples were taken near the contact with the metasedimentary country rock (Halifax Group of the Meguma terrane) to assess how assimilation might influence fO_2. The remaining 11 samples were taken from a contact-to-contact traverse, yielding information on fO_2 evolution during increasing differentiation from contact to core. An additional 7 samples were taken from the adjacent Sandy Lake pluton from a traverse along Highway 103. The remaining 3 samples were obtained from the New Ross pluton, which hosts uranium, molybdenum, and copper mineralization, and will provide information on the relationship between ore formation and magma redox state. Individual zircon crystals will be selected for trace element analysis by laser ablation ICPMS, following detailed textural characterization. Preliminary results for the New Ross pluton indicate an abundance of euhedral zircons, exhibiting well-developed igneous zonation, but also clear evidence for multiple growth events and the likelihood of inherited cores from older zircon-forming episodes.

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