Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.11079

THE SOURCE AND STORAGE OF NITROGEN IN EARTHS FELSIC PLUTONIC CRUST: A CASE STUDY OF THE DEVONIAN LOCH DOON PLUTON, SCOTLAND

TOBY J. BOOCOCK[1], EVA E. STÜEKEN[1], JULIE PRYTULAK[2], ADRIAN BOYCE[3], GRANT M. BYBEE[4], RAMONA KOENIG[1] AND SAMI MIKHAIL[1]

[1]University of St Andrews

[2]Durham University

[3]Scottish Universities Environmental Research Centre

[4]University of the Witwatersrand

Presenting Author: tjb7@st-andrews.ac.uk

The igneous portion of Earths continental crust is a major long-term sink of nitrogen on Earth, but the sources and storage mechanisms of nitrogen in this reservoir remain poorly constrained. We have developed a facility capable of accurately quantifying trace abundances of nitrogen in igneous rocks and minerals and will present results which speak to the behaviour of nitrogen during magmatic differentiation. We have undertaken a detailed petrological and mineral-specific isotopic study of nitrogen geochemistry in a zoned felsic pluton, Loch Doon, SW Scotland (outer diorite through to inner granite). The pluton is formed by nested incremental growth and accompanying fractional crystallisation in a calc-alkaline system (plagioclase-biotite-pyroxene). We focus on the partitioning and associated isotopic fractionation of nitrogen between biotite, orthoclase, plagioclase and the bulk rock. Our novel nitrogen data are benchmarked with the well constrained oxygen isotope system. Oxygen isotope data reveal that the major mineral phases are at disequilibrium in samples nearest the pluton contact and in the late-stage central granites; however, the central granodiorites appear to preserve mineral-melt isotopic equilibrium between biotite and feldspar(s). The observed isotopic disequilibrium likely reflects a mixture of alteration, crustal anatexis and late-stage fluid exsolution processes. However, within the central granodiorites we also find systematic N-isotopic offsets between mineral phases consistent with equilibrium fractionations between melt and mineral. The overall bulk rock value of these granodiorites is unusually heavy ($\delta^{15}N$ ca. +8 to +10‰), which likely indicates that the source of nitrogen in this system is (meta)sedimentary and linked to the generation of partial melts associated with the slab breakoff of the Iapetus subduction zone. Overall, our new data reveal previously underappreciated complexity of nitrogen isotopes in igneous processes. However, when samples are well constrained, plutonic systems may offer important insights into the storage of nitrogen over giga-year timescales.