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SPECIAL COLLECTION: APATITE: A COMMON MINERAL, UNCOMMONLY VERSATILE

LA-Q-ICP-MS apatite U/Pb geochronology using common Pb in plagioclase: Examples from layered mafic intrusions

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Abstract

Apatite geochronology is a versatile method for providing medium temperature history constraints of magmatic and metamorphic rocks. The LA-ICP-MS technique is widely applied to U/Pb geochronology using various minerals. Apatite U/Pb geochronology, in contrast to e.g., zircon, is compromised by variable amounts of common Pb incorporated into the crystal during growth. Magmatic apatite often shows a sufficient spread in data to obtain a precise and accurate lower intercept age. If this is not the case, the initial Pb isotopic composition needs to be estimated to obtain accurate and precise age information from apatite. Two approaches are common, one being the estimation of common Pb from a Pb evolution model and the other being the measurement of a coexisting mineral phase that tends to incorporate Pb but not U, e.g., feldspar. Most recent studies applying LA-ICP-MS to the analysis of Pb isotopes in feldspar utilize either multicollector or magnetic sector mass spectrometers. In this study we first evaluate the application of quadrupole mass spectrometry for apatite U/Pb geochronology combined with Pb isotopic measurements in feldspar and compare the results with modeled initial Pb isotopic compositions. The resulting age information is accurate and precise despite using plagioclase rather than K-feldspar, as is normally used, to define initial Pb isotope compositions. We apply this method to apatite-bearing gabbroic rocks from layered intrusions (Bushveld, Bjerkreim-Sokndal, Hasvik, and Skaergaard) ranging in age from ca. 2 Ga to ca. 55 Ma and generate metamorphic/cooling ages generally consistent with the known geologic history of these intrusions.

Keywords: Apatite, feldspar, common Pb, quadrupole ICP-MS, laser ablation