

SPECIAL COLLECTION: APATITE: A COMMON MINERAL, UNCOMMONLY VERSATILE

U-Pb LA-ICP-MS dating of apatite in mafic rocks: Evidence for a major magmatic event at the Devonian-Carboniferous boundary in the Armorican Massif (France)

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ABSTRACT

Apatite is a ubiquitous accessory mineral found in most magmatic rocks and is often the only U-bearing mineral available to date mafic rocks because primary zircon and/or baddeleyite are not present. In this paper, U-Pb LA-ICP-MS dating of apatite was applied to seven different dike and sill samples of dolerite from the Variscan belt of Brittany (Armorican Massif, western France). These dolerites, which are characterized by a within-plate tholeiite geochemical signature, are organized in several dense swarms across the belt. Their geochemical compositions are homogeneous although they intrude a large geographical area subdivided into several domains each characterized by different tectonic-metamorphic settings. Their emplacement ages were so far poorly constrained due to the difficulty to date these mafic rocks using either the ⁴⁰Ar/³⁹Ar or the U-Pb methods on classical minerals like mica, plagioclase, or zircon. Although the closure temperature of apatite is lower than the emplacement temperature of the magma, physical models show that the time needed to solidify and cool these mafic dikes and sills below the apatite closure temperature is basically of the order of 100 years or less. Consequently, the U-Pb dates obtained on apatite can be interpreted as the emplacement ages for these mafic intrusions. Our results demonstrate that, in all cases, the apatite grains do carry enough radiogenic Pb to be dated by in situ U-Pb analyses and yield a ²⁰⁷Pb-corrected mean age of 363.4 ± 5.8 Ma. These results reveal the existence of a major and short-lived magmatic event in the Variscan belt of Brittany during the Devonian-Carboniferous transition, a feature further highlighted by field evidence. Beyond the geological implications of these results, U-Pb LA-ICP-MS dating of apatite appears to represent an ideal tool to date small size mafic intrusions.

Keywords: Apatite, LA-ICP-MS, U-Pb dating, mafic rocks, French Variscan belt