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SPECIAL COLLECTION: APATITE: A COMMON MINERAL, UNCOMMONLY VERSATILE

Cathodoluminescence images and trace element compositions of fluorapatite from the Hongge layered intrusion in SW China: A record of prolonged crystallization and overprinted fluid metasomatism

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Abstract

Cathodoluminescence (CL) and trace element analyses were performed for fluorapatite from the gabbro and Fe-Ti oxide ores in the upper zone of the Hongge Fe-Ti oxide-bearing, mafic-ultramafic layered intrusion in SW China. The fluorapatite is closely associated with Fe-Ti oxides and interstitial to plagioclase and clinopyroxene. The fluorapatite grains in one thin section vary from ~10 to 800 μm in width and ~50 to 1200 μm in length. Coarse-grained fluorapatite crystals (>200 in width) in the same thin section show both simple and complex CL images. The coarse-grained fluorapatite crystals with simple CL images show discontinuous, thin dark rims along grain boundaries, whereas those with complex images show clearly bright veinlets across the grains. On the other hand, fine-grained fluorapatite crystals (<200 μm in width) show complex CL images and can be divided into four types, i.e., concentric, chaotic, banded, and overall dark. The concentric type shows distinctly bright core surrounded by dark mantle that is irregularly zoned, whereas the chaotic type shows disordered bright and dark sectors in the interior with a thin dark rim. The banded type shows unevenly distributed bright and dark bands. The overall dark type shows a relatively dark and uneven image. Fluorapatite grains contain 1.84–2.74 wt% F, 0.07–0.19 wt% Cl, and 0.86–1.63 wt% OH. Coarse-grained fluorapatite grains have total rare earth elements (REE) concentrations ranging from 2278 to 3008 ppm and Sr/Y of 9 to 13. Fine-grained fluorapatite grains have relatively high REE (2242–4687 ppm) and low Sr/Y of 6 to 14 in the bright cores, sectors, and bands and relatively low REE (1881–2728 ppm) and high Sr/Y of 9 to 15 in the dark mantles, sectors, and rims under CL imaging. On the thin section scale, the bright sections under CL imaging for fine-grained fluorapatite have much higher REE contents than those for similar bright CL images for coarse-grained fluorapatite. The highly variable REE concentrations among fluorapatite grains and the sections within a single fluorapatite are attributed to a prolonged crystallization process and overprint by fluid metasomatism. The coarse-grained fluorapatite may have crystallized earlier than fine-grained fluorapatite. Then variable degrees of hydrothermal metasomatism released REE from the fine-grained fluorapatite so that diverse CL images developed in the crystals. This study reveals that magmatic apatite from a layered intrusion can be intensively modified by later-stage fluid-induced metasomatism in both trace element composition and CL image texture. Reconstruction of primary melt compositions using apatite from layered intrusions should therefore be treated with caution.

Keywords: Fluorapatite, cathodoluminescence image, trace element, fluid metasomatism, mafic-ultramafic layered intrusion