Comprehensive chemical analyses of a cordierite from Kiranur, South India, and of an ilvaite from Serifos, Greece: Two new microprobe reference samples

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ABSTRACT

A cordierite sample (42/IA) from Kiranur, South India, and an ilvaite sample (ISX1) from Serifos, Greece, have been characterized and prepared for use as potential electron microprobe reference samples. By combining different high-precision analytical methods, we determined the major-, minor-, and trace-element composition of these samples and demonstrated their near-stoichiometric composition and high homogeneity at the micrometer level. The chemical composition (working values) of ilvaite ISX1 is (in wt%): SiO₂ = 29.68%; Al₂O₃ = 0.67%; Fe₂O₃ = 34.72%; FeO = 18.67%; FeO₇ = 51.52%; MnO = 0.31%; MgO = 0.22%; CaO = 13.76%; H₂O = 2.21%; and of cordierite 42/IA is (in wt%): SiO₂ = 49.65; Al₂O₃ = 33.17%; FeO₇ = 2.34%; MnO = 0.03%; MgO = 12.44%; Na₂O = 0.33%; H₂O = 1.21%; CO₂ = 0.59%. Aliquots of these samples for use as primary or secondary electron microprobe reference sample can be obtained on request.

Keywords: Cordierite, ilvaite, EMPA, LA-ICP-MS, ICP-OES, microprobe reference sample

INTRODUCTION

The quality of electron microprobe analyses (EMPA) essentially depends on the quality of the reference material used. To reduce matrix and wavelength shift effects, it is desirable to use reference samples that are similar in composition and structure to the unknown samples. Important requirements for a good microprobe reference sample are homogeneity and stability under the electron beam. There is a lack of well-characterized reference materials with either constitutional water or channel volatiles.

Cordierite is a framework silicate with structural channels in which volatiles (H₂O, CO₂, ...) can be incorporated. It occurs as a rock-forming mineral in medium- and high-grade aluminous rocks of the amphibolite and granulite facies. The selected cordierite sample (42/IA) from Kiranur, South India, has been investigated and characterized previously by other workers (Lal et al. 1984; Geiger et al. 2000a, 2000b; Bertoldi et al. 2004). Sufficient quantity of this transparent gem-quality cordierite was available for detailed study.

The mineral ilvaite is a black, calcium-iron sorosilicate found in Ca-Fe-Si skarn deposits. It contains mixed valences of iron, in which Fe²⁺ occupies the A- and Fe³⁺ the B-position. A single crystal of ilvaite (ISX1) from Serifos, Greece (Dachs et al. 2003), weighing about 200 g, was available for chemical analysis.

SAMPLE PREPARATION

Cordierite (42/IA)

Contamination due to traces of mineral or fluid inclusions was minimized by careful mineral separation under a microscope. Between 50 and 100 mg of pure, gem-quality cordierite were hand-picked for H₂O and CO₂ determination, and about 50 mg for trace-element investigation by ICP-MS.

Ilvaite (ISX1)

A clean fragment was cut from the ilvaite sample and broken into pieces. The grains were examined under a microscope to avoid contamination by inclusions or intergrowths with other minerals. About 100 mg of virtually pure ilvaite were hand-picked for H₂O determination, and about 50 mg for investigation by ICP-MS and ICP-OES.

About twenty grains from the cordierite sample 42/IA and the ilvaite sample ISX1 were embedded into epoxy holders for EMPA and LA-ICP-MS analyses.

ANALYTICAL METHODS

Electron microprobe analysis

Major and minor elements were determined using a JEOL JXA-8900R microprobe at the University of Kiel, Institute for Geoscience. Analytical conditions were 15 keV accelerating voltage and 20 nA probe current. Natural mineral standards (Mg = forsterite, MAC; Fe = fayalite, USNM 85276; Si, Ca = wollastonite, MAC; Mn = spessartine, MAC; Na = anorthoclase, USNM 133868; K = microcline, USNM