

Analytical Methods

1. Electron microprobe mineral analyses

Twenty refined polished thin sections were prepared for mineralogical and petrographic studies using an optical polarizing microscope at the Geology Department, Minia University (Egypt). A subset of these sections was selected and coated with carbon for the analysis of major minerals (K-feldspar, plagioclase, amphibole, muscovite and biotite) and some accessory phases using a CAMECA SX5 electron microprobe equipped with four WDS and one EDS spectrometers at the Department of Lithospheric Research, University of Vienna (Austria). The analyses were conducted with an acceleration voltage of 15 kV, a beam current of 20 nA, and a beam diameter ranging from 1 to 5 μm . Major elements had a peak count-time of 20 s and a background time of 10 s, while trace elements had a peak count-time of 40–60 s and a background time of 20–30 s. The raw data was corrected using the PAP correction method, and calibration was performed using natural and synthetic standards.

2. Whole-rock geochemical analysis

A total of 20 representative samples were selected for whole-rock major, trace, and REE analyses. Before analysis, the samples were cleaned, ground in an electric agate mill, homogenized, dried at 110 °C, and fired at 850 °C. Whole-rock major oxides and trace elements were analyzed with a sequential Phillips PW 2400 X-ray spectrometer using fused pellets at the Department of Lithospheric Research, University of. Replicate analyses of geo-standard GSR-3 provided an overall procedural error better than 2% for both major and trace elements. REEs were analyzed at ACME Analytical Laboratories, Vancouver, Canada, by inductively coupled plasma mass spectrometry (ICP-MS), following a lithium metaborate/tetraborate fusion and nitric acid digestion of 0.2-g samples. Duplicate measurements provided a precision generally better than 2% (standard deviation), except for Er and Lu (<4%). The accuracy of the analyses was monitored by a series of international reference materials. Based on the rock standard, accuracy was usually better than 5%, except for La, Er (<10%), and Pr (<30%). The analytical precision and detection limits for ACME analyses are listed on the laboratory website (<http://acmelab.com/services/method-descriptions>).