

Analytical methods

Representative polished thin sections were prepared for petrographic and mineralogical studies. Chemical compositions of variable minerals (Supplementary Tables S1-S8) were determined by CAMECA SX100 electron microprobe operated in wavelength-dispersive mode at the Department of Lithospheric Research, University of Vienna, Austria. Accelerating voltage and beam currents were 15 kV and 20 or 40 nA, respectively, with a beam diameter ranging from 1 to 5 μm . The raw data were corrected using the PAP matrix corrections.

Thirteen representative rock samples were selected for bulk-rock major and trace elements geochemical analyses (Table 1). Several steps and operations have applied to the samples before analyses. These steps include cleaning, grinding of the specimen in electric agate mill. Samples powder is then homogenized and dried at 110 °C and finally ignited at 950 °C. Fused pellets were then prepared to measure the major elements concentrations, while the powder pellets were used to get the trace elements concentrations. All analyses were measured using the sequential X-ray spectrometer Phillips PW 2400 and standard techniques at the University of Vienna, Austria. Replicate analyses of geo-standards (TDB-1_FA, BHVO-2_FA, JH-1_FA) gave an overall procedural error better than 2 % for major oxides and 5 % for trace elements. Eight samples were chosen to measure the concentration of rare-earth elements (REEs). HF/HClO₄-digested samples were re-dissolved in nitric acid (10 % v/v) and the REEs concentrations were measured using Agilent 7500ce Inductively Coupled Plasma Mass Spectrometer (ICPMS) at Institute of Analytical Chemistry, University of Graz, Austria. The instrument was operated in the helium mode using 5 mL/min. External calibration curves were established with a Lanthanides/REEs standard Spec-pure® from Alfa Aesar (Johnson Matthey GmbH, Karlsruhe, Germany) in the concentration range from 0.050 to 100 $\mu\text{g/l}$.