**Methods and analytical procedures**

Mineral compositions were determined by wavelength-dispersive spectrometry (WDS) with a JEOL JXA-8230 electron microprobe equipped with three crystal spectrometers at Electron Microscopy Laboratory and X-ray Analyses unit of Cordoba National University (http://www.famaf.unc.edu.ar/lamarx/lamerx1sem.html). Operating conditions were: acceleration voltage of 15 kV, probe current of 10 nA, with a beam diameter ranging from 5 to 8 μm. The analyses were corrected using Phi-Rho-Z method. Representative mineral analyses are listed in Table S2.

Zircon grains from samples TAB-24 and TAB-40 were separated following the classic method at the Geochronological Research Center, São Paulo University (GRC-SPU), Brazil. As starting material 3 kg of rock were crushed and sieved. The <140 mesh fraction was separated using hydraulic processes to obtain heavy mineral pre-concentrates, which were further separated in bromoform and then methylene iodide to obtain a fraction enriched in zircons. This was followed by an electromagnetic separation with Frantz Isodynamic equipment when necessary. Zircons were hand-picked under a binocular microscope and subsequently mounted in 2 cm diameter epoxy resin and polished. The grains were photographed in reflected and transmitted light, and cathodoluminescence (CL) images were produced in order to investigate the internal structures of the zircon crystals as well as to characterize different populations.

SHRIMP U–Pb analysis of separated zircons were carried out at the Institute of Geosciences of the University of São Paulo. SHRIMP software was LabVIEW 8.5 and SHRIMP SW, version 2.1. Data were reduced using SQUID software (Ludwig, 2009). Common lead corrections were carried out using 204Pb according to Stacey and Kramer (1975). More detail about the analytical methodology are extensively reported by Sato et al. (2014). Results are reported in Table 1.

Whole-rock major and trace element analyses using ICP and ICP-MS were carried out at AcmeLab Bureau Veritas Mineral Laboratories, Vancouver, Canada (following the procedure LF-200 lithogeochemistry code; <http://acmelab.com/wp-content/uploads/2009/03/BVM_2018-Fee-Schedule_USD_v2_20Sep2018.pdf>). Results are listed in Table 6. The detection limits, reference materials and duplicates are found in Table S1.

Sr and Nd isotopic analyses were carried out at the Geochronology and Isotope Geochemistry Center of the Complutense University (Madrid, Spain) using an automated multicollector TIMS-Phoenix®. Results are shown in Table 2. Errors are quoted throughout as two standard deviations from measured or calculated values. Analytical uncertainties are estimated to be 0.01% for 87Sr/86Sr, 0.006% for 143Nd/144Nd, 1% for 87Rb/86Sr, and 0.1% 147Sm/144Nd. Replicate analyses of the NBS-987 Sr-isotope standard yielded an average 87Sr/86Sr ratio of 0.710243±0.000012 (n = 6) and JNdi-1 Nd-isotope standard yielded an average 143Nd/144Nd ratio of 0.512106 ± 0.000006 (n = 10). 87Sr/86Sr and 143Nd/144Nd were normalised to 86Sr/88Sr = 0.1194 and 146Nd/144Nd = 0.7219, respectively. Sr were separated using cation-exchange columns filled with DOWEX AG-50\*8 (200-400 mesh) and Nd was concentrated using Ln-Spec resin.

**References:**

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