

Supplementary material

Geochemical analyses were performed at ISTERre, Grenoble (France) using a Perkin Elmer Optima 3000 DV ICP-AES for the measurement of major element compositions, and an Agilent 7500ce ICP-MS for trace elements. Samples were primarily crushed into powder using agate grinders to prevent contamination, and the following analytical procedure was adapted from [1]. Accuracy and precision of the data were evaluated using international rock reference materials BHVO₂ and RGM1 as part of the sample set.

- **Major element analyses.** A portion of the powder was precisely weighed (50 mg) and mixed in closed Savillex beakers with 2 mL of nitric acid ($[\text{HNO}_3] = 14\text{mol.L}^{-1}$) and 15 drops of hydrofluoric acid ($[\text{HF}] = 24\text{mol.L}^{-1}$). Samples are entirely dissolved after 7 days onto a hotplate at 90°C. After cooling, 20 mL of boric acid ($[\text{H}_3\text{BO}_3] = 20\text{g.L}^{-1}$) was added to neutralize the excess HF and the solution was further diluted by the addition of 250 mL of Milli-Q water. The complete neutralization of HF by H_3BO_3 was further guaranteed by two days of storage in refrigerators for the solutions, and analyses are performed within the following week. The calibration of the signal was obtained using a blank and mixed solutions containing pure elements: the solutions are prepared using five different dilutions to mimic and calibrate the major element composition of the samples. The volatile content, expressed as the loss on ignition (LOI), was estimated by heating samples at 1000°C for 1h. The concentrations of the analyzed reference materials are generally within 5% of the published values, except for manganese and magnesium oxides in reference material RGM1, and the uncertainties on the measurement (1σ) varies from 0.01% to 1.35%, showing the very good reproducibility of our data.
- **Trace element analyses.** A portion of the powder was precisely weighed (100 mg) and mixed with perchloric acid (HClO_4) and high purity hydrofluoric acid ($[\text{HF}] = 24\text{mol.L}^{-1}$). Samples are cooked in steel Paar bombs over 7 days to allow for the complete dissolution of heavy minerals, such as zircons, and the use of HClO_4 was justified by the common presence of organic matter in our samples. The solution was then evaporated using hotplates to obtain a dry residue. The residue was diluted in concentrated HNO_3 for one day before being evaporated again, then diluted in about 40 mL of 7 mol.L⁻¹ HNO_3 . A weighed aliquot of this mother solution was sampled and diluted in 2% v/v HNO_3 with HF traces to produce a daughter solution with variable dilution factors according to sample specificities. For the detritus-rich samples and reference materials, the best results were obtained for a 2500 dilution. With such values, we minimized the matrix effects while maintaining a sufficient signal for all the measured elements. The daughter solution was finally mixed with a spike containing five elements (Be, Ge, In, Tm and Bi) before being analyzed within the day of preparation. The international standard BHVO₂, diluted at 5000, was used for the calibration of the ICP-MS signal and was combined to the reference material RGM1 to estimate the accuracy and precision of our measurement. BHVO₂ composition was within <0.6% of theoretical values, except for As (10.4%), whereas RGM1 more significantly deviated from its theoretical composition. However, uncertainties on the

measurement (1σ) of both standards were sufficient to sustain a high reproducibility of the data.

REFERENCES

1. Chauvel C, Bureau C and Poggi C (2011) Comprehensive Chemical and Isotopic Analyses of Basalt and Sediment Reference Materials. *Geostandards and Geoanalytical Research*, 35(1) : 125–143.