

Distinguishing basalt magma types and their magmatic evolution in the field with portable XRF

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Portable X-ray fluorescence (pXRF) technology has progressed considerably. When taking care of proper calibration, it can be used to acquire high-precision geochemical data in the field. During an Antarctic expedition (FINNARP 2022), the authors analyzed major and trace element composition of lava units of Jurassic continental flood basalt successions at Vestfjella (Fig. 1a), western Dronning Maud Land, Antarctica. The device (Olympus Vanta VMR-CCC-G3) was calibrated with basalt samples for which laboratory XRF data existed (in-house standards).

For the analysis, fine-grained basalt samples were cut with a rock saw at the research station (Fig. 1b). The cut surfaces were then polished and analyzed with the pXRF on-site (Fig. 1c). The final analysis consisted of average of several individual analyses. Porphyritic and more coarse-grained samples were analyzed more thoroughly. Within-sample variation of individual spots was usually < 10 % for most of the elements. We succeeded to analyze major and minor elements Si, Ti, Al, Fe, Mn, Mg, Ca, and P (no Na), and trace elements V, Ni, Cu, Zn, Sr, Zr, and Y. Data for K, Cr, Co, Rb, and Ba showed more variation. Titanium, P, Zr, and Y are crucial in distinguishing the different flood basalt types and linking them to different magmatic sources and extinct volcanic centers in the area (Fig. 1d).

The on-site use of pXRF facilitated rapid geochemical analysis of over 300 individual lava units. In addition to geochemical grouping, the data can be used to preliminarily investigate differentiation of the lava successions and guide the selection of samples for further research. pXRF has considerable potential to assist in petrological studies of volcanic (and other geological) environments for which large-scale sample collection for laboratory analysis is not possible.

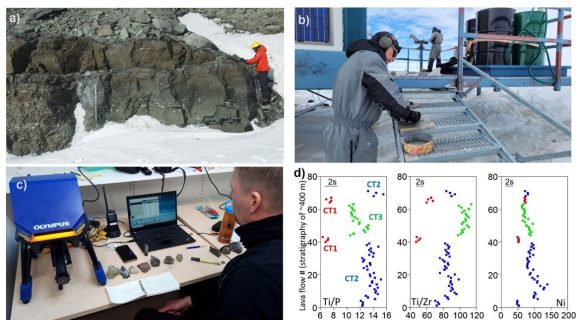


Figure 1. a) Sampling flood basalts at Vestfjella. b) Sawing and polishing the samples at the Aboa research station. c) pXRF in action at Aboa. d) Geochemical stratigraphy of flood basalts analyzed with pXRF. The different colors refer to different magma types (CTX). Photos: a) by AVL, b) by Antero Kukko, c) by JSH (FINNARP 2022).