Development and optimization of non-invasive and portable techniques (pMS, pXRF, IA, pRaman) for granite discrimination in geoarchaeological survey

A. Triantafyllou1,[2,3*], N. Mattielli[4], S. Clerbois[5,9], M. Vlieghe[4], A-C. Da Silva[1], G. Brkojewitsch[6,7]

1 Department of Geology, University of Liège, Sart Tilman, Liège, Belgium
2 Department of Geosciences, University of Arizona, Tucson, AZ 85721, USA
3 Laboratoire de Géologie de Lyon : Terre, Planètes, Environnement, Université de Lyon, France
4 Laboratoire G-Time, Université libre de Bruxelles, CP 160/02, Brussels, Belgium.
5 Centre de recherche en archéologie et patrimoine, Université Libre de Bruxelles, Brussels, Belgium
6 Pôle archéologie préventive de Metz Métropole, Metz, France
7 Centre Camille Jullian, UMR 7299, Aix-en-Provence, France

2One of the major challenges in archaeometry and geoarchaeology is to precisely characterize rocks of archaeological monuments and identify their provenance, linking them to their quarrying sites. Combining multiple analytical methods and diversifying discriminant proxies is the key to improve the distinction of sourcing regions with a higher spatial resolution. Numerous handheld analytical tools exist and have been used in geoarchaeological studies, i.e. portable X-ray fluorescence spectrometer (pXRF), portable Magnetic Susceptibilimeter (pMS), pLIBS, spectrophotography, but mainly for the characterization of fine-grained rocks (e.g., obsidian, flints, sandstones). Our study aims to apply and optimize these tools on medium to coarse-grained granitic rocks. Those were indeed highly valued materials under imperial Rome, particularly for the production of monumental monolithic columns, used in both public and private architecture.
We present a workflow to conduct a full characterization of medium to coarse-grained granitic rocks, using portable, non-invasive and reproductible approaches. It includes: (i) Image Analysis to quantify mineral phases proportions, grainsize distribution using Weka trainable machine learning algorithm, (ii) pXRF (Bruker Tracer IV) to quantify the chemical composition. We developed a dedicated calibration method for several key elements (Si, Al, K, Ti, Ca, Fe, Mg, Mn, Cu, Sr, Ga, Ba, Rb, Zn, Nb, Zr, Y and Cr) by analyzing certified SRMs of igneous rocks and pure mineral phases, using the open-source CloudCal app. (iii) pMS (Bartington MS2K susceptibility system) to constrain the mineralogical content of the samples and complement the image analysis approach. These three methods were tested, and their operational conditions optimized, on six igneous rocks from in-house collection with variable grainsizes, mineral contents, diverse surface conditions and geochemical compositions. Ultimately, this workflow was applied on granitic and granodioritic rocks of onshore Roman monuments (southern Corsica). Our results allow us to link them to their quarrying sites in the Lavezzi islands with a high spatial resolution.

Mots-Clés : Geoarchaeology, Granite discrimination, pXRF, magnetic susceptibility, pRaman, ML-image analysis, Roman quarry, Corsica

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