The Multi Layered Chert Sourcing Approach (MLA) using LA-ICP-MS and CODA

Authors:
Michael Brandl (corresponding author)
Austrian Academy of Sciences, Inst. OREA, Fleischmarkt 22, 1010 Vienna, Austria
michael.brandl@assoc.oeaw.ac.at

Christoph Hauzenberger
University of Graz, Dept. of Earth Sciences, Universitätsplatz 2, 8010 Graz, Austria

Maria M. Martinez
University of Texas at Austin, Department for Anthropology

Peter Filzmoser
Vienna University of Technology, Department of Statistics and Probability Theory

Key words
Chert sourcing – MLA – LA-ICP-MS – Compositional Data Analysis

Abstract
Provenance studies of chert and flint raw materials (silicites) are an important component of archaeological research. The identification of the sources of rocks used for the production of chipped stone tools is the gateway to any further investigations concerning prehistoric resource management strategies. Chert source provenance studies thus play a significant role in the interpretation of lithic assemblages concerning the procurement, processing and distribution of lithic raw materials, e.g., revealing routes of migration, intercultural exchange and circulation networks.
A transdisciplinary concept (the Multi Layered Chert Sourcing Approach, short MLA) presents a clear possibility for successfully sourcing chert and flint. The proposed method consists of a tripartite analytical system: Visual (macroscopic), microscopic and petrological/geochemical. For geochemical analysis, Laser Ablation-Inductively Coupled-Mass Spectrometry (LA-ICP-MS) is applied. LA-ICP-MS allows for the detection of main-, trace- and ultra-trace element concentrations (-0,1 ppm) in rock materials and has been well established in lithic raw material research. The multivariate geochemical datasets are subsequently evaluated by applying Compositional Data Analysis (CODA). Since CODA is concerned with the ratios between values, raw composition data (i.e. the absolute measured values) need to be transformed into the Euclidean geometry system where statistical methods can operate. After transformation, discriminant analysis (DA) is applied for classification. We demonstrate the potential of the MLA in case studies which illustrate that it is not sufficient to rely on a single analysis method for chert sourcing. A combination of the proposed techniques produces the most robust data base for a secure characterisation and source separation, including the possibility to lay weight on the performed method(s) that produced the best results.