Archean andesites as products of plume/crust interaction?

STEPHEN J. BARNES[1], CARISSA ISAAC[2] AND MARCO L. FIORENTINI[2]

[1]CSIRO, Perth, Western Australia, (steve.barnes@csiro.au)
[2]University of Western Australia, Perth, WA, (20685898@student.uwa.edu.au)

A key line of evidence for Archean plate tectonics rests on the presence of andesites, the signature rock type of modern subduction zones. This study considers the petrogenesis of andesites from the 2.7 Ga East Yilgarn Craton (EYC) in Western Australia, a richly mineral-endowed terrane that has been a prime focus of debate between proponents of a uniformitarian, plate-tectonic driven interpretation, and advocates of an alternative plume-driven model. While EYC andesites have incompatible trace element characteristics similar to those of modern island arc andesites, they have unusually high Ni, Cr and MgO contents. This suggests the possibility that they contain a substantial mantle plume component. To test this hypothesis, we consider the major and trace element compositions of these rocks in relation to the entire assemblage of EYC volcanic rocks with ages between 2690 and 2710 Ma, including komatiites, plume-derived basalts and dominantly dacitic felsic rocks. The dacite component occurs as part of a bimodal association with simultaneously erupted komatiites, has characteristic TTG-like trace element chemistry, and chondritic to slightly depleted Nd and Hf isotopic characteritics. This component is interpreted as the partial melting product of underplated juvenile or near-juvenile mantle-derived mafic material. Numerical modelling of fractionation of plume-related tholeiitic basalts coupled with contamination by the TTG-like dacite component provides a good fit to all of the essential major and trace element characteristics of the EYC andesites, and is also consistent with the chondritic to slightly depleted Nd and Hf isotopic characteristics of the andesites[1]. Thus, a rock type previously taken as a key line of evidence for plate tectonic processes can be explained just as well by an alternative plume-driven mechanism, consistent with the overwhelmingly plume-derived character of basalts and komatiites across the entire craton[2]. This explains a paradox, noted in a number of Archean volcanic rock sequences, that apparently subduction-related rocks are interleaved with voluminous basaltic magmatism derived from 1000 km-scale plume-head arrival events. The problem is moot if Archean andesites are products of plume, not subduction zone, magmatism.

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[2] Barnes SJ *et al*., (2012), *Aust J Earth Sci* **59**, 707-735.

Isotopic tracing of ancient metal production using geological and mining archaeological research – Gaul mining from Limousin and Morvan (France). A case study

S. BARON*[1], B. CAUUET[1] AND C.G. TAMAS[2]

[1]TRACES-CNRS, 5, allées A. Machado, 31058 Toulouse Cedex 09, France.
(*correspondence: sbaron@univ-tlse2.fr)
[2]University Babes-Bolyai, 1, M. Kogalniceanu str., 400084 Cluj-Napoca, Romania

The isotopic tracing from mines/ore bodies to archaeological materials (slags, metals, objects) constitutes a powerful tool in metal provenance studies. The progress of high resolution mass spectrometers (MC-ICP-MS) during the last decade currently facilitates accurate analyses of traditional and non-traditional isotopes, allowing thus precise and consequently more accurate interpretation [1]. Nevertheless, these high precision isotope analyses on ores are often carried out in an elusive way ignoring the geological approach as well as the mining archaeology background. The currently used lead isotope ores database is not completly relevant for the tracing of the ancient metals for several reasons: i) the isotopic composition of the analysed ores is usually not linked with their mineral paragenesis, and ii) the analysed ores are not those really exploited by the ancient miners. Futhermore, the ancient *chaîne opératoire* from ores to metal(s)/objects is not systematically considered [2].

Through an example of metal production in Gaul (France) during Protohistoric times, we demonstrate the importance of establishing a geochemical tracing based on geological and chronological/archaeological samples.

Our aim is to characterize the mining activity and the metal production at regional scale (Limousin and Morvan) and in a second stage to acquire the isotopic and trace element signature of the exploited ores and the produced metals (Au, Ag and Sn). This approach based on geological, mining archaeological and geochemical studies will refine the tracing of the metals at least for Limousin (5^{th} to 1^{st} centuries BC) and Morvan (2^{nd} to 1^{st} centuries BC) and will allow to obtain isotopic data bases needed for relevant metal provenance studies.

Acknowledgments: Research carried out in the frame of ANR MINEMET project (France).

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DOI:10.1180/minmag.2013.077.5.2
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