Potassic and ultrapotassic rocks from the Roman Magmatic Province: crustal and mantle processes involved in terrains' Au (in)fertility

Palozza F.*[1], Braga R.[1], Moroni M.[3], Fiorentini M.[2], Loucks R.[2] & Nogueira Mafra C.[2]

[1] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Bologna. [2] School of Earth Sciences, University of Western Australia, Crawley (Australia). [3] Dipartimento di Scienze della Terra "A. Desio", Università di Milano.

Corresponding author e-mail: francesco.palozza96@gmail.com

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The Central-Western Mediterranean is one of the most important and studied regions worldwide to investigate the occurrence and genesis of potassic and ultrapotassic rocks and analyze the complex interactions between crust and mantle at convergent plate margins.

The spatial association between potassic magmatic rocks and porphyry Au and Cu-Au deposits and precious-metals epithermal deposits is long recognized, raising interest in evaluating the prospectivity of the terrains where they intruded. Furthermore, K-rich alkaline rocks host significant rare earth element deposits worldwide, and some may even be intrinsically enriched in platinum-group elements.

However, it is still unclear why some major potassic-alkalic igneous provinces are barren. In this context, the Pleistocene-Quaternary, barren K-rich igneous rocks of the Roman Magmatic Province represent an excellent Au-devoid reference province to refine geochemical tools to discriminate between fertile and infertile arc magmas and identify the crucial factors that led to such sterility.

The present study analyzed 13 potassic and ultrapotassic lavas from the Vulsini Volcanic District, Sabatini Volcanic District and Alban Hills Volcanic District and one lava-hosted ultramafic xenolith in lavas from the Alban Hills Volcanic District. Petrographic microscopy, whole-rock and mineral geochemistry were used to investigate the features of these lavas and provide additional data for constraining the conditions for formation of the Roman Magmatic Province.

The resulting mineralogy of the 13 lava samples is almost identical, consisting mainly in an assemblage of clinopyroxene, olivine, leucite, nepheline and spinel (Ti-rich magnetite- hercynite), with rare fluorapatite and F-rich phlogopite.

Trace element patterns indicate subduction-related geochemical signatures (low Ta–Nb, high Rb–Cs–LREE) and suggest sourcing of these magmas from a peridotitic sub-continental lithospheric mantle intensely metasomatized by reaction with melted metapelites.

Mineral chemistry results highlight the influence of carbonatic wall-rock assimilation in shifting the composition of the magmas towards more undersaturated compositions.

The ultramafic xenolith consists of coarse-grained, cumulus-textured clinopyroxenite rich in F- bearing phlogopite and fluorapatite. Clinopyroxene hosts mono- to polyphase Fe-rich sulfide blebs and droplets absent from the lava in all districts considered. Hence, this xenolith has been further investigated to detect Au anomalies by evaluating the micron-sized sulfide blebs' composition and Au signals (pyrrhotite, pentlandite, chalcopyrite) through electron EMPA chemical maps and scanning electron microscopy (SEM).

A geological model is proposed to account for Au-bearing Fe-Cu-Ni sulfide blebs in the xenolith and contextualize the results to illustrate the processes likely involved in the Au- infertility of the Roman Magmatic Province.