PETROLOGY AND GEOCHEMISTRY OF THE ALMOPIA PLIOCENE VOLCANICS

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ABSTRACT

An extensive volcanic field (~450 km²) of Pliocene age is found in the central part of Voras Mountain and the adjacent plain areas, in the confine between Greece and F.Y.R.O.M. The Hellenic sector of that volcanic field, which covers about the half area of the whole field, is called Almopia Volcanic field, and was the target of this study.

The Almopia volcanic edifices are monogenetic. They are endogenous, high aspect ratio domes or dome complexes, and related lateral lava flows. Feeding dykes and sills outcrop in the deeply eroded sectors of the volcanic field or in the areas with considerable tectonic displacement.

The age of the volcanic activity in the studied area spans through the whole Pliocene. The older volcanic products are found in the Miocene-Pliocene boundary. The last volcanic events have been manifested in the Pliocene-Quaternary boundary.

Published radiometric ages from samples of the Hellenic sector of the volcanic field, are found between 5.2 and 1.8 Ma. In the F.Y.R.O.M. sector, an older age of 6.5 Ma has been published. The new radiometric ages obtained by the Ar-Ar method, expand the lower limit of the activity in the Hellenic sector, to 5.6 Ma. Two large explosive events have been dated also: Xiromera Tephra formation (4.2 Ma) and Papa Tephra formation (2.6 Ma).

Volcanic activity was manifested in three distinct magmatic and age periods:
The first period was manifested between 6.5/5.6 and 5 Ma. It was restricted to the east and central sector of the volcanic field, and was fed by high-K andesitic and dacitic magmas.
The second period was manifested in the central and west sector of the volcanic field, between 4.9 and 4.2 Ma. This activity was fed by latitic to trachytic magmas.
The third, and last eruptive period, was manifested between 4 and 1.8 Ma. It was restricted to the SW sector of the field and was fed firstly by trachytic magmas (up to 3 Ma) and later exclusively by latitic magmas.

The total volume of the volcanic products in the Voras Mountain volcanic field, including both the Almopia field and the F.Y.R.O.M. sector, has been calculated to ~350 km³ ORE. The volume of the magma that intruded the broader area can be estimated to ~3500 km³. Magmas that fed the volcanic activity in the Almopia area belong to the high-K calc-alkaline and the shoshonitic series. The major and trace element content, as well as the REE and Sr isotopes composition of the volcanic rocks are very similar to that of volcanic rocks found in active continental margins related to subduction processes or/and orogene collapse geotectonic environments. They are extremely similar to the high-K volcanic products of the Rome magmatic province, in Italy.

Six groups of products can be distinguished on petrographical and geochemical basis: High-K andesites dacites, trachydacites, trachytes, latites, rhyolites and shoshonites. The last group is
found only as enclaves in the other groups. The relationship between enclaves and host rock, their rock phenocrysts indicate that enclaves are products of magma mingling processes between a young mafic magma that intrudes in a differentiated magma chamber.

The study of the main trace element distribution as well as the isotopic ratios and the quantitative modeling of the magma differentiation processes, lead to the subsequent conclusions:

The shoshonitic enclaves can be considered as the most representative samples of the most primitive Almopias magmas. It is possible then that differentiation of these magmas could lead to the trachytic group by a process of mixing with the latic magma (r=0.5) and parallel crystal fractionation. It is also possible that the shoshonitic magma could produce the trachydacitic group from which rhyolites can be derived instead of crystal fractionation from the trachydacitic group. Shoshonitic group by any combination of magma differentiation processes. All these three groups

The study of the main petrographic characteristics of these three groups lead to the following conclusions:

a) Only shoshonitic melts could be considered as relatively primitive magmas.

b) The Almopias magma source region is a heterogeneous mantle variably metasomatized from place to place. Metasomatism is the result of the mantle enrichment-contamination from fluids and sediments.

c) The different primitive melts (from shoshonite to calc-alkaline) derived through partial melting processes of various metasomatized mantle portions. Subsequently, they differentiate through mixing, fractional crystallization and low-grade assimilation of continental crust giving rise to the whole range of the existing volcanic rocks.

d) Besides the different initial magma sources, the variable degrees of partial melting and the depth of magma genesis and differentiation should have played some role as well (eg. higher melting percentage and lower depths for the calc-alkaline magmas).

e) The primitive melts seemed to be in equilibrium with a garnet-bearing ferro-gabbro mantle composition. This limits the minimum depth of melt genesis to 60-75 km located in the lowest part of the continental lithosphere that has an estimated thickness of about 110 km in the area.

Based on the geotectonic regime of the area and the genesis and ascent rate of magma the depth of the magma chambers is estimated for the mafic magmas at the mantle-crust transition zone between lower and upper crust (15-20 km) as well as in the transition zone between the plastic and brittle deformation behavior of the upper crust (10-15 km).

Regarding the evolution in time and space of the volcanic activity it is clear that the Early Pliocene activity (>4.2 Ma) covers the whole area with the older products (>5 Ma) located mainly in the central and western sector. The Late Pliocene volcanic activity focused exclusively on the western half of the area which is not linear and well defined in space and time, especially for the second eruptive period (4.9-4.2 Ma).

Taking into account the above considerations and the tectonic regime during Pliocene the generation of the magmatic melts and the manifestation of the volcanic activity in the Almopias area can be explained by the following processes: The adiabatic decompression of the lower part of a lithospheric mantle tectonic regime. The adiabatic decompression of the lithosphere could be induced through spreading tectonic lineament as left-lateral strike-slip fault with concomitant extension in W-NW direction. This tectonic regime could also favor such conditions in the upper crust of the Almopias area that permit the volcanic centers to be developed in such a shape and position that are found today.