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A-type granites in the Internal Hellenides (Macedonia, Greece): rift-related or post-orogenic? A reappraisal.

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The Serbo-Macedonian Massif belongs to the Internal Hellenides, and is subdivided into two units: the Kerdyllia and Vertiskos Unit in the eastern and central and northwest Chalkidiki Peninsula (Macedonia, Greece), respectively. The Vertiskos Unit mostly comprises various types of gneisses, associated with amphibolites and metasediments, and it is intruded mainly by Mesozoic leucocratic granites and dykes. The largest granitic bodies are those of the Arnea and Kerkini complexes, which were studied using new and literature U-Pb geochronological zircon data as well as new whole rock geochemical data, aiming at investigating the origin and evolution of the two complexes as well as providing constraints on their geodynamic environment. Arnea complex shows differences in ages between the rocks cropping out at South and North of Volvi Lake, with 254 Ma and 244 Ma, respectively, whereas Kerkini has an age of 247 Ma. Arnea and Kerkini complexes are two-mica syenogranite and alkali-feldspar granites containing quartz, K-feldspar, plagioclase, and biotite, and allanite, titanite, zircon, and fluorite as typical main and accessory minerals, respectively. They are variably peraluminous with molar Al2O3/CaO+Na2O+K2O values of 0.96 - 1.34. Both complexes evolved mainly by Fractional Crystallization, separating assemblages consisting of feldspars, biotite, allanite and zircon. Parental magmas are crustal melts derived by partial melting of TTG sources. The smaller bodies and the dykes intruding the Vertiskos Unit were studied using geochemical literature data. They are mainly white mica granites, rich in quartz and albitic feldspar with molar Al2O3/CaO+Na2O+K2O values invariably higher than 1.1. They are considered as the product of partial melting of crust-dominated sources.
All the granitic magmatism in the Vertiskos Unit has been considered as A-type, linked to the rift, which led to the formation of a branch of Neotethys (Vardar–Meliata Ocean). This was based mainly on the previously considered Middle Triassic age, and on single petrotectonic diagrams. Our new U-Pb geochronological data, obtained on zircon oscillatory rims and having an excellent concordance, indicate that the obtained ages can be considered as the crystallization ages, at the boundary between Permian and Triassic. Employing a statistical approach, using all the main features able to discriminate A-type granite igneous suites, all the rocks belonging to the magmatism intruding the Vertiskos Unit show variable behaviour: some parameters indicate a clear A-type affinity for both the complexes, but conversely other parameters indicate a clear differentiated I-type affinity. This contrasting behaviour is common in the A-type granites because of their variable petrogenetic processes. In addition, all the rocks plot in the A2 subtype, indicating that the magmatism is connected with a post-collisional rather than an intra-plate rifting environment.
Some fundamental constraints on the geodynamic evolution of the region can be gained by the time distribution, the geochemical and petrological features of the plutonic rocks intruding the Vertiskos Unit. We suggest that, at the boundary between Permian and Triassic, the area was in an incipient rift environment, and as such oceanization had not still occurred. Continental crust accreted during previous continental collision, is present at the rift floor. Such a crust could melt partially to produce batches of magma similar to the studied magmatism. It is worth noting that a submarine rhyolitic magmatism of similar age and geochemistry to the granitoid magmatism, exists, outcropping on the floor of the epicontinental sea, indicating that granitic melts, produced by partial melting of the crust, either remained at depth, generating the granitic complexes, or extruded as rhyolitic lavas.
Magmatism intruding the Vertiskos Unit emplaced, hence, in the post-orogenic environment that follows the subduction of Godwana under Eurasia, at the beginning of the rifting leading to the opening of the Vardar-Meliata Ocean.