

Did Timok Magmatic Complex (East Serbia, SE Europe) originate by subduction? A petrological and geochemical perspective

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The origin of the Timok Magmatic Complex (TMC) has been variously interpreted. Most authors suggest that the TMC originated by Late Cretaceous eastward subduction of the remnants of the Mesozoic Tethys under the southeastern European margin. This model was mainly based on the fact that most TMC rocks are calc-alkaline andesites and related rocks, which possess a 'subduction geochemical signature'. The latter is commonly described as the presence of LREE- and LILE-enriched patterns, as well as a variable Eu-anomaly and Nb-Ta-Ti negative spikes on chondrite- and primitive mantle-normalized diagrams, respectively. This signature was commonly interpreted as having resulted from subduction processes, although it is known that the rocks from settings unrelated to contemporaneous subduction can have similar geochemical affinities. Accordingly, the fact that any mixture of mantle and crustal material would produce a similar geochemical signature was used by most opponents of the subduction hypothesis.

In spite of their generally enriched trace element patterns, the TMC rocks display relatively unradiogenic initial strontium isotope composition ($^{87}\text{Sr}/^{86}\text{Sr}_{\text{initial}}$ range 0.7039-0.7049). A very similar range of Sr isotopes is reported for the analogous Late Cretaceous rocks in Romania and Bulgaria. Hence, the central question addressed here is: what processes were responsible for the combination of high LILE contents and LILE/HFSE ratios with relatively low initial strontium isotopes, observed in the TMC volcanic rocks.

A possible role of low-pressure differentiation processes was examined by geochemical modeling. The assimilation-fractional crystallization and pure fractional crystallization processes were modeled for Turonian-Campanian andesites and Senonian andesites and basaltic andesites, respectively. The results indicate a minor role of crustal material added by assimilation. Because such small amounts of crustal rocks could have not produced high LILE/HFSE ratios this geochemical signature must have come from the mantle component, i.e. it is the result of source mixing processes. This, in turn, raises the question: if this mixing event had happened long time before magmatism took place, or they occurred roughly concomitantly. The first model would imply that the mantle lithosphere was already hydrated and LILE-enriched when the TMC magmatism took place, whereas the second one favors a subduction model, i.e. introduction of metasomatic agents shortly before or during magmatism. In this context, we compared the geochemistry of the TMC rocks with neighboring magmatic rocks of relatively well-known source characteristics, such as the East Serbian Palaeogene mafic alkaline rocks (low LILE/HFSE and $^{87}\text{Sr}/^{86}\text{Sr}_{\text{initial}}$ – asthenosphere-like mantle) and Serbian Tertiary potassic/ultrapotassic rocks (high LILE/HFSE and $^{87}\text{Sr}/^{86}\text{Sr}_{\text{initial}}$ – metasomatized lithospheric mantle). The TMC rocks show similar Sr isotopic ratios as do the Palaeogene alkaline volcanics, but in terms of the trace element composition they are indistinguishable from the latter. The source modeling based on Sr/Nd and La/Yb ratios indicate that such geochemical pattern could have been produced by source mixing processes involving depleted mantle (asthenosphere?) material and subduction fluids. The presented geochemical evidence and the existing age pattern shown by the studied rocks, in combination with the characteristics of the mantle lithosphere underneath East Serbia, inferred from study of mantle xenoliths, support the subduction model for the origin and evolution of the TMC.