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Middle Jurassic to Cenozoic evolution of arc magmatism during Neotethys subduction and arc-continent collision in the Kapan Zone, southern Armenia

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ABSTRACT

The Kapan Zone in southern Armenia is a Middle Jurassic to Upper Cretaceous island-arc domain at the southern margin of Eurasia that collided with the Gondwana-derived South-Armenian Block in the Upper Cretaceous–Paleocene. Igneous rocks of Middle Jurassic to Quaternary age record the geodynamic evolution of the Kapan Zone, whose tectonic setting changed from an active arc environment, related to the northeastwards subduction of the Neotethys, to a post-collisional setting. U–Pb zircon ages of intrusive rocks from the Kapan Zone confirm the division of the stratigraphic column into the Middle Jurassic, Upper Jurassic–Lower Cretaceous and Paleogene magmatic complexes. Middle Jurassic tonalite was sampled from pebble dykes and dated at 165.6 ± 1.4 Ma, voluminous plutons intruded in the Kapan Zone between 137.7 ± 1.6 Ma and 131.5 ± 2.1 Ma within a time span of less than 10 Ma and Paleogene gabbro was dated at 50.82 ± 0.51 Ma. Volcanic rocks in the Kapan Zone range from basaltic to rhyolitic composition with andesite being the most common rock type. Intrusive and volcanic rocks from the three magmatic complexes and Quaternary basanite have subduction-related signatures. They are enriched in fluid-mobile LILE such as K, Rb and Ba and are depleted in HFSE such as Zr, Nb and Ta, which suggest their derivation from a metasomatized mantle source as old crustal material is virtually absent in the Kapan Zone. The subduction-related signature is conserved in post-collisional rocks from the Paleogene magmatic complex and the Quaternary basanite, indicating their origin from a mantle source which was metasomatized during preceding subduction. REE patterns from igneous rocks of the Kapan Zone are characterized by increased slope in younger rocks. Flat patterns in Middle Jurassic rocks indicate melting from a depleted mantle reservoir whereas REE patterns with increased slope in rocks from the Upper Jurassic–Lower Cretaceous magmatic complex, the Paleogene magmatic complex and the Quaternary basanite suggest either smaller amounts of partial melting and/or input of less depleted mantle material in the source region. The initial isotopic signature of rocks from the Kapan Zone supports melting of a primitive mantle source with limited contribution of assimilated crustal material. The more crustal isotopic signature of rocks from the Middle Jurassic and Paleogene magmatic complexes relative to rocks from the Upper Jurassic–Lower Cretaceous magmatic complex indicates subduction of continent-derived sedimentary material and interaction with old basement units at depth. Reported coeval subduction-related Middle Jurassic to Cretaceous intrusive and volcanic rocks from the Sanandaj–Sirjan Zone in Iran are in good agreement with our results from the Kapan Zone in southern Armenia. This suggests a continuation of the magmatic arc of the Lesser Caucasus to the southwest of the Kapan Zone, indicating continuous arc magmatic activity along the Eastern Pontides, the Lesser Caucasus and the Sanandaj–Sirjan Zone.

1. Introduction

The Lesser Caucasus is part of the Tethyan orogenic belt which developed as result of geodynamic processes in the Mesozoic and Cenozoic, that include several phases of subduction, obduction, micro-plate accretion, continent–continent collision and exhumation (e.g., Dercourt et al., 1986; Hafkenscheid et al., 2006; Knipper et al., 1986). The magmatic arc of the Lesser Caucasus formed during northeastwards subduction of the Neotethys below the Eurasian margin (Fig. 1) and can be divided into the Somkheto–Karabakh Island Arc and the Kapan Zone (Gevorkyan and Aslanyan, 1997; Kazmin et al., 1986). It is now generally accepted that the island-arc domain of the Lesser Caucasus and the ophiolites of the Sevan–Akera suture zone find their continuation in the Eastern Pontides and the Izmir–Ankara–Erzincan suture zone in northeastern and northern Turkey, respectively (e.g., Danelian et al., 2012; Yilmaz et al., 2000). The

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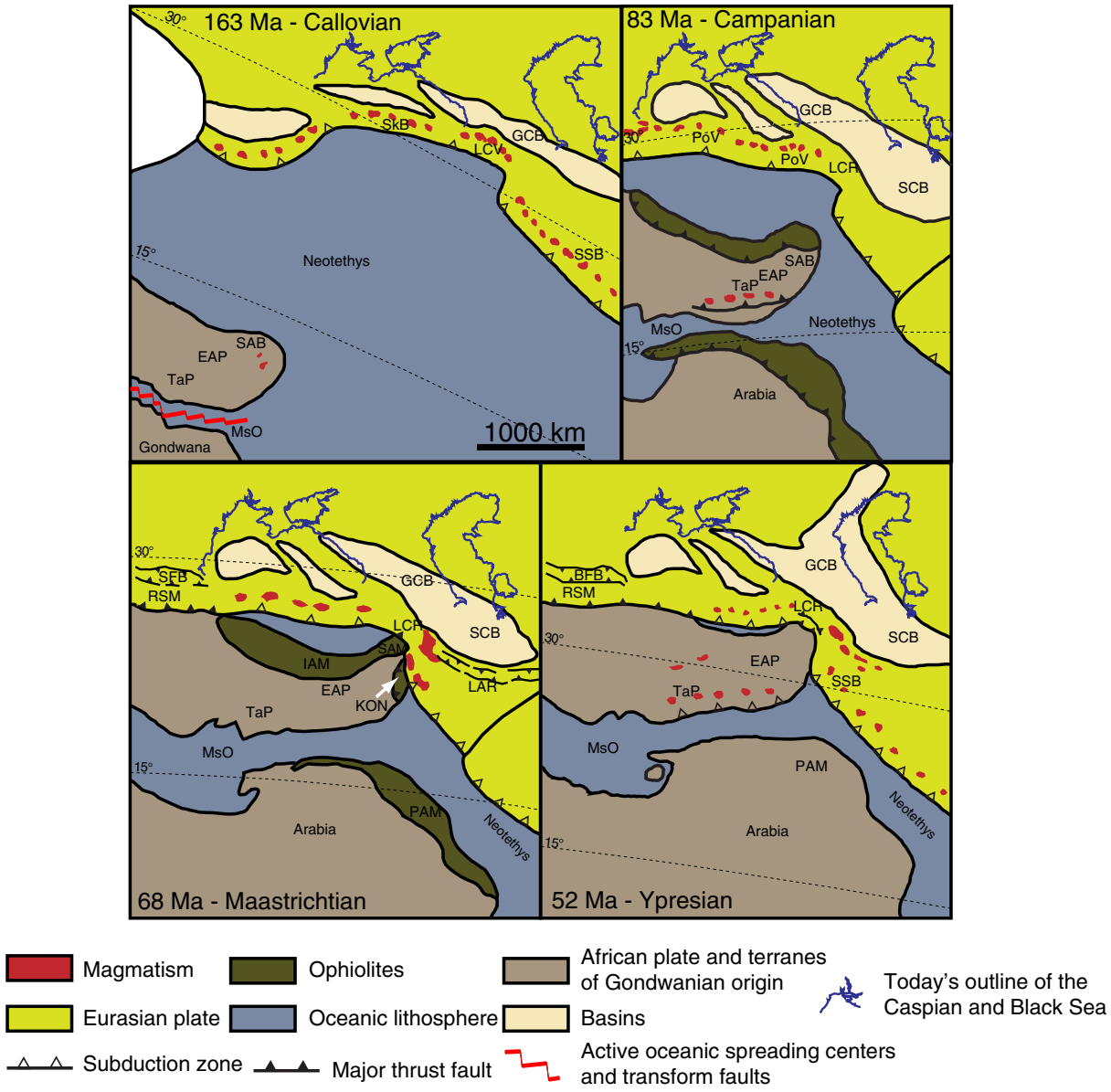

Fig. 1. Geodynamic reconstruction of the Lesser Caucasus region and its adjacent areas for Callovian, Campanian, Maastrichtian and Ypresian times (modified from Barrier and Vrielynck, 2008). BFB—Balkan fold belt; EAP—East Anatolian platform; GCB—Greater Caucasus basin; IAM—Izmir–Ankara–Erzinkan massif; KON—Khoy ophiolitic nappe; LAR—Laramian Alborz range; LCR—Lesser Caucasus ridge and study area; LCV—Lesser Caucasus volcanics, MsO—Mesogea ocean; PAM—Peri-Arabian massif; PoV—Pontide volcanic arc; RSM—Rhodopes–Standja massif; SAB—South Armenian block; SAM—Sevan–Akera ophiolitic massif; SCB—South Caspian basin; SFB—Srednogorie fold belt; SkB—Sakarya block; SSB—Sanandaj–Sirjan block; TaP—Taurus platform.

continuation of the magmatic arc towards the south, however, is still a matter of debate.

Recent studies in the area focused on the well-preserved ophiolitic complexes from Vedi, Stepanavan and the Sevan–Akera suture zone, which separate the magmatic arc of the Lesser Caucasus from the Gondwana-derived South-Armenian Block (Galoyan et al., 2009; Rolland et al., 2009b; Sosson et al., 2010). Trace-and rare earth element geochemical data of Cenozoic magmatism in Azerbaijan was published by Dilek et al. (2010), however no such data is available for the Mesozoic to Cenozoic igneous rocks of the Somkheto–Karabakh Island Arc and the Kapan Zone in Armenia.

In this study, we present new geochemical data and U–Pb zircon ages of igneous rocks from the Kapan Zone in southern Armenia. The stratigraphic column of this tectonic unit allows the investigation of Middle Jurassic to Quaternary volcanic and intrusive rocks, which document varying geodynamic conditions during the Mesozoic and Cenozoic. The geodynamic setting of the Kapan Zone changed from a subduction-related pre-collisional to a post-collisional setting with respect to the accretion of the South Armenian Block to the Eurasian margin, which took place in Upper Cretaceous to Paleocene time (Rolland et al., 2009a; Sosson et al., 2010).

As in many other places in the Tethyan metallogenic belt (e.g., Richards et al., 2012; Yigit, 2009), magmatic–hydrothermal base-and precious metal ore deposits in southern Armenia are also associated with subduction-related magmatism (Mederer et al., 2012; Moritz et al., 2012). Our results show the evolution of magmatism in the Kapan Zone and may help from a practical point of view in the exploration for base-and precious metal mineralization in this poorly explored region. Our data link the Kapan Zone and the magmatic arc of the Lesser Caucasus as a whole with the better known Turkish and Iranian parts of the Tethyan belt and thus contribute to a better understanding of the complex plate geometry of the region.