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Superposed orogenic collision and core-complex formation at the present contact between the Dinarides and the Pannonian basin: The Bukulja and Cer Mountains in central and western Serbia

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Formation of large extensional detachments during orogenic collapse can follow inherited weakness zones such as major asymmetries given by pre-existing subduction zones active during mountain building processes. This is valid in particular in low-topography foreland coupling orogens of Mediterranean type where large amounts of deformation is concentrated in their lower plates, favoring weakness zones activated during a subsequent phase of extensional collapse.

One good place to study the orogenic collapse post-dating major collision is the NE margin of the Dinarides in central and western Serbia, where Cretaceous-Eocene shortening and collision was recorded in the Alpine Tethys Sava zone between the European-derived Dacia and Tisza mega-units and the lower Adriatic plate. This is the same place where the Pannonian basin formed as a Miocene back-arc basin in response to a different subduction and roll-back taking place along the external Carpathians. A lineament of Paleogene and Miocene plutons is observed at the northern and eastern margin of the Dinarides, interpreted to be the product of both syn- to post-orogenic subduction magmatism and of decompressional melting during the Pannonian extension. Two of these plutons, Cer and Bukulja, located in western and respectively central Serbia, are intruded in the Jadar-Kopaonik composite thrust sheet, part of the lower Adriatic plate, near the contact with the main suture formed during the Cretaceous-Eocene subduction of the Sava zone.

The Lower Miocene age (19-17Ma) Bukulja intrusion is a S-type granite with rare aplitic veins (Cvetkovic et al., 2007). The Cer intrusive complex is a S type two mica granite of around 16Ma in age with an older I-type quartz monzonite component (Koroneos et al. in press). Both granitoids are intruded into the Jadar-Kopaonik metamorphic series, which are in direct contact along the northern, eastern and southern flank with non-metamorphosed, mainly clastic sediments of Cretaceous-Miocene in age and, in the case of Bukulja, with serpentinized ophiolites. The metamorphic sequences are generally characterized by a Paleozoic age meta-sedimentary basement and a meta-sedimentary and meta-volcanic sequence. In the case of Bukulja, a succession of contrasting metamorphosed lithologies has been observed such as sandstones, black limestones, shallow water white limestones, basic volcanic sequences, deep nodular limestones and turbiditic sequences. The lower part of the sequence represents a metamorphosed Triassic sequence similar to what has been defined as the Kopaonik and Studenica series in southern Serbia. This part of the sequence is characterized by at least 3 successive stages of folding, asymmetric folds with WSW-ward vergence and NNE-SSW upright folds being affected by vertical flattening folds associated with extension (see also Marovic et al., 2007). The upper part of the sequence, which is the only part outcropping along the eastern flank of the Cer granitoid, is made up by metamorphosed distal turbidites which have been palinologically dated in Bukulja as Upper Cretaceous in age. This is the metamorphosed equivalent of the Upper Cretaceous – Eocene "flysch"-type of deposits commonly observed elsewhere in the main Sava subduction zone. These rocks are overprinted with a pervasive and strong extensional milonitic foliation indicating top-100 movement of the hanging-wall and are in direct contact with non-metamorphosed, but similar Upper Cretaceous distal turbidites. This suggests a large-scale tectonic omission along the eastern flanks of the Bukulja and Cer detachment. In the case of Bukulja, the extension was associated

with the formation of the Early Miocene Morava basin in the detachment hanging-wall, which is an endemic lacustrine precursor of the much larger Middle-Late Miocene Pannonian basin.

These finding points towards a bi-modal evolution of the internal Dinarides in central and western Serbia near the present-day contact with the Pannonian basin. An Upper Cretaceous-Eocene phase of top-WSW shortening and metamorphism in the Sava zone and its subducting lower Adriatic plate was subsequently followed by massive core-complex exhumation and top-E directed extension during initiation of the Carpathians back-arc extension. Interestingly, the newly defined extensional detachments accompanying the Pannonian extension closely follow the pre-existing subduction zone and its associated duplications in the lower orogenic plate. This conclusion is compatible with observations in other areas of the Dinarides, such as the Prosara-Motajica in Bosnia/Croatia or Kopaonik-Studenica in southern Serbia (Schefer et al., 2008; Ustaszewski et al., 2009).