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Metallogeny of the Northwestern and Central Dinarides and Southern Tisia

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ABSTRACT

The Dinaridic metallogenic province is a part of the Alpine–Himalayan orogenic system, developed as a result of opening and closure of the Tethys Ocean by convergence of the African and Eurasian plates. The northern boundary of the Dinarides is related to the northern African margin (Adria–Apulia). The Tisia mega-unit, a small continental block, positioned between the Dinarides and the Carpathians, is genetically related to the South Eurasian edge.

The geology of the Dinarides is constrained by the Alpine Wilson cycle. The major stages of the cycle are: (a) Permian early intra-continental rifting; (b) Triassic advanced rifting; (c) Jurassic oceanization; (d) Cretaceous subduction; (e) Paleogene collision; and (f) Neogene post-collision and extension followed by orogenic collapse. Each stage creates characteristic ore deposits related to the specific geological environments. Stage (a) bears hydrothermal siderite–barite–polysulphide deposits, epigenetic sedimentary uranium deposits, red bed-type, sabkha-type copper and barite deposits and evaporites. Stage (b) favored SEDEX and hydrothermal iron–polysulphide–barite–mercury and MVT deposits. Stage (c) developed chromites, asbestos, talc and magnesite deposits. The spatial position of stage (d) remains poorly constrained. The Southern Tisia unit might be a possible candidate for the Tethyan active continental margin with the Cretaceous subduction zone positioned beneath. Absence of voluminous subduction-related magmatism and mineral deposits, however, favors subduction within the Vardar zone (the easternmost Dinarides), adjoined to the Serbomacedonian ensialic terrain with its large Cu-porphyry deposits. Stage (e) was a prelude to the prolific phase (f) with its numerous hydrothermal Pb, Zn and Sb deposits that mostly occur in the western Vardar zone. The geology and metallogeny of Southern Tisia, with medium/high grade metamorphics, I-type, S-type granites, resembles the Middle Austro-Alpine unit, formed during the main Carboniferous collisional stage.

This contribution provides a review of the metallogenic characteristics of the Northwestern and Central Dinarides and Southern Tisia mega-units, based on recently-gained knowledge on the regional geology, petrology and genesis of mineral deposits. Establishment of the plate tectonic model several decades ago greatly contributed to an integrated interpretation of ore deposit genesis. In turn, basic research in the field of ore genesis generated new data that can be used to improve the plate tectonic model.

1. Introduction

Mineral deposits in the southeastern part of Central Europe belong to the two prominent geological mega-units: Northwestern–Central Dinarides and Southern Tisia. The Dinarides, an orogenic belt positioned between the Adria microplate to the southwest and the Tisia ensialic block to the north, is part of a long suture of the Tethyan Ocean, squeezed between the Gondwana and Euroasian continents. Their common history, however, extends back to pre-Variscan time.

The Alpine–Carpathian–Dinaride (ACD) arcuate orocline comprises basement units composed of pre-Variscan continental fragments previously amalgamated between Baltica and Gondwana (Matte, 1991; Franke et al., 1995). There is, however, a wide range of interpretations in the nature, position, kinematics and chronology of rifting, drifting and collisions of the suspected terrains — with their inherited metallogenies, which were assembled before the final continent–continent collision in the Variscan orogen.

The ACD loop consists of external units, mainly medium-grade metamorphic terrains, namely the “Variscan peri-Mediterranean metamorphic belt”, and the internally-located, peri-Apulian, fossil-bearing, “Noric–Bosnian” terrain. The former incorporates Tisia, and the latter the basement and uncovered Paleozoic terrains of the Dinarides (Neubauer and Handler, 1999). The boundary between the two units suggests the presence of a Carboniferous suture, placed between the southern branch of the European Variscids and a Gondwana-derived paleo-Alpine indenter. The geodynamic evolution related to continental plate collision involves consumption of the intervening ocean basin with obduction of ophiolites, medium/high

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pressure metamorphism, intrusion of I-type granitoids, followed by S-type granitoids, and deformation of the Gondwana-derived Noric–Bosnian terrain in Late Devonian/Early Carboniferous time. The boundary was entirely reactivated during Alpine rifting.

Magmatism in the Eastern Alps and the Southern Tisia shows similar petrochemistry, timing and style of emplacement. South Tisia underwent Variscan orogenesis, as evidenced by its crystalline basement with medium/high- grade metamorphic rocks, I-type and S-type granitoids. The granitoids and metamorphic rocks in South Tisia have been dated by K/Ar, Ar/Ar and Rb/Sr methods. Barrovian-type metamorphic rocks in the Slavonian Mts. yielded 568 to 264 Ma, S-type granites and migmatites, 336 to 300 Ma, and I-type granites in the Slavonian Mts. 339 to 321 Ma (Lanphere et al., 1975; Pamić, 1988; Pamić and Lanphere, 1991; Lanphere and Pamić, 1992; Pamić et al., 1996).

The Tisian Variscan basement is overlain by a non-metamorphic Mesozoic cover, and the thick Tertiary fill of the Pannonian basin. By contrast, the Dinarides, underlain by low/medium-grade metamorphic rocks of the pre-Alpine African crust, with a Cadomian signature, experienced the complete Alpine Wilson cycle from rifting to collision in the Mesozoic.

Alpine metallogeny of the Dinarides was primarily created by opening and closure of Vardar and Dinaridic branches of the Tethyan ocean. The Dinarides contain well-developed and preserved tectonostratigraphic units of the Alpine Wilson cycle, in contrast with the neighbouring Alps where the indentation of Adria obliterated or

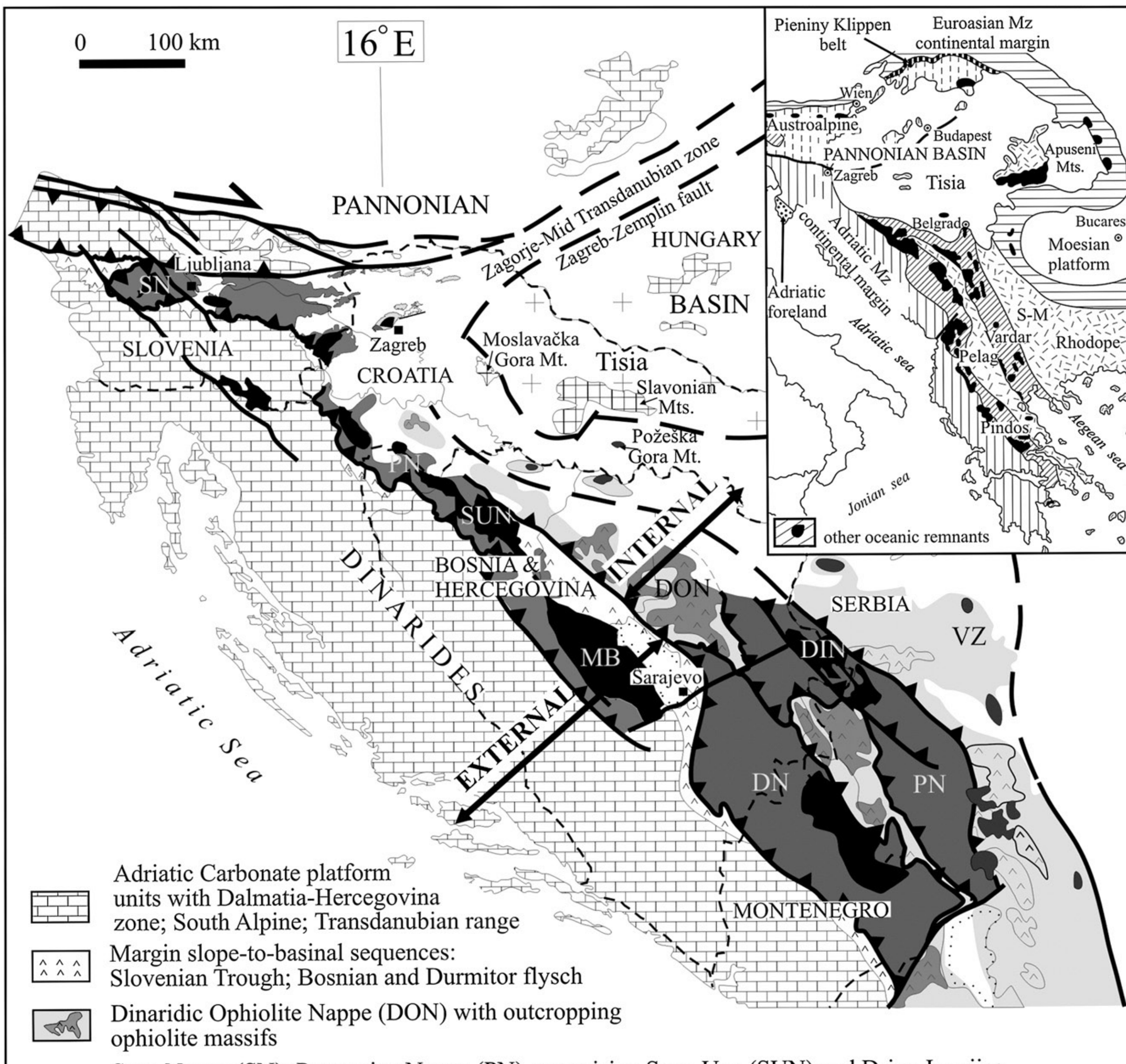

Fig. 1. Geological structural scheme of the Dinarides and surrounding area with index-map (modified after Channell and Kozur, 1997; Tomljenović, 2002).