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Orogenic Precious Metal Potential of a Variscan Shear Zone, Southern Hungary: The Role of Greenschist-Facies Metamorphosed Ultrabasic-Basic Bodies and Black Shales

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The Mecsekalja Shear Zone, formed during the Variscan orogeny, runs WSW–ENE across Southwest Hungary, spanning over 90 km in length and 1–1.5 km in width. It contains mylonitic, greenschist-facies metamorphosed rock bodies of highly various origin. Their juxtaposition resulted from the collision-related incorporation of subducted oceanic slab remnants into a collisional wedge and its subsequent postcollisional shearing. Precious metal prospecting began in the Eastern Mecsek Mts. (N–NW from the Mecsekalja zone), where native gold was found in metamorphic quartzite from Miocene detrital sediments and fluvial placers. The inclusion paragenesis of gold grains matches that of the quartzites, indicating a common genetic environment. Miocene fluvial transport pathways and gold-bearing quartzite pebbles suggest the metamorphic sequence of the Mecsekalja Shear Zone as the primary source. Mineralogical, petrographic and geochemical analyses of outcrops and drill cores indicate that hydrothermal alteration of sheared ultramafic–mafic rocks contributed to the orogenic gold mineralization. Ni–Co sulfide assemblages in nuggets, quartzites, and gneisses, along with pyrite trace elements, support this model. Key alteration processes include chloritization, albitization, carbonatization (dolomite, ankerite, minor calcite), silicification, and weak sericitization. In Miocene detrital quartzites, adularia–sericite occurs as an ore-associated mineral. Main ore minerals include native gold, gold-bearing pyrite, Bi–Te sulfides, chalcopyrite, galena, and arsenopyrite. Drill cores revealed ferrichromite-bearing dolomitic ores, with Ni-rich pyrite around ferrichromite grains. Cr-rich, hydrothermally altered dolomitic rocks and veins show elevated PGE (Pt, Pd) concentrations. Ferrichromite grains also exhibit significant gold content (LA-ICP-MS). The PGE-rich paragenesis is mainly Ni–Co sulfides (siegenite, vaesite, gersdorffite). SEM–EDS analyses show 1–20 µm low-silver gold inclusions in cataclastic pyrite with chalcopyrite and with siegenite. Gold may have also entered the tectonic zone during metamorphism of sheared, graphite-rich metasediments (originally black shales), representing a possible additional source alongside ultramafic–mafic rocks. Raman spectroscopy indicates graphitization at ~460 °C (+- 50 °C). Sheared Pd-telluride (kotulskite) with gersdorffite inclusions in the graphite schist suggests erosion of ultramafics–mafics into a pre-metamorphic, organic-rich sedimentary basin followed by diagenesis and greenschist-facies orogenic metamorphism.