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Role of magma mixing in the genesis of W-Mo porphyry mineralization: example of the Ochtiná-Rochovce granite (Western Carpathians, Slovakia)

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W-Mo porphyry mineralizations of economic interest are rare, partly because the two metals display contrasting geochemical behavior during melt-crystal partitioning under given redox conditions. Consequently, the processes responsible for their enrichment, and the evolution of their parental granitic systems, remain poorly understood. We studied the Late Cretaceous Ochtiná-Rochovce granites, occurring as concealed occurrences in the Western Carpathians, Slovakia. The granitic system is linked to an economic W-Mo porphyry mineralization where W is mainly hosted by wolframite and scheelite, while Mo is hosted by molybdenite [1]. The granitic intrusion comprises two phases: (i) an early, strongly oxidized (magmatic magnetite, allanite-(Ce), anhydrite) coarse-grained porphyritic biotite monzogranite containing mafic microgranular and surmicaceous enclaves; and (ii) a late, more differentiated and ore-productive leucosyenogranite. Both phases are subaluminous and magnesian, showing calc-alkaline, high-K affinities, with dominant I-type and minor A-type characteristics (F-rich chemistry). Petrographic, mineralogical, geochemical, and isotopic evidence reveals magma mixing between two end-members, i.e., a highly fractionated felsic magma of igneous lower-crustal source, and a more mafic magma of metasomatized mantle source. The latter likely supplied the Mo, whereas W was preferentially contributed by the evolved felsic magma. Further concentration of the metals was driven by strong differentiation. Continued solubility of W and Mo during the magmatic evolution was allowed by the formation of (oxy)fluoride complexes in the melt due to the F-rich character of the fractionated felsic magma. The magmatic-hydrothermal evolution finally led to fluid exsolution and the genesis of the porphyry system, associated with significant metasomatism and F-driven mobilization of HFSE and REE in the granite. Overall, we propose that distinct sources for the enrichment of W and Mo, alongside an enrichment in F, are necessary for the continuous enrichment of granitic magmas in these metals and subsequent genesis of economic W-Mo porphyry deposits.

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[1] Koděra, Yáñez, Brčeková, Vojtko, Majzlan, Uher, Nemec, Bakos (2025), Ore Geology Reviews 185, 106786.