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Au-porphyry systems in Western Carpathians – mineralisation, alteration patterns and outstanding fluid properties

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Au porphyry systems are a recently discovered type of ore mineralization in Western Carpathians on several localities in the Central Slovakian Neogene Volcanic Field. Three major systems have been discovered in the central zone of the Javorie stratovolcano (Biely Vrch, Kráľová, Slatinské Lazy) and 2 systems in the mantle of the Štiavnica stratovolcano (Beluj, Župkov - Píla) in addition to several other smaller or weakly mineralized systems. Only the Biely Vrch deposit, hosted by the Javorie stratovolcano reaches economic accumulation of Au (34 t Au @ 0.8 g/t Au).

All systems are centered on small px and amph-px diorite to andesite porphyry stocks up to 1 – 1.5 km in diameter, some with rare biotite and garnet phenocrysts (Kráľová, Beluj), emplaced into earlier andesitic rocks, rarely also basement rocks (Píla). Quartz stockwork typically marks the areas of Au-mineralization, however, gold is hosted by altered rock (K-silicate, intermediate argillic, Fe-Ti oxides) usually in the vicinity of veinlets. Average grades are 0.2 to 0.4 g/t Au, but 0.8 g/t at Biely Vrch. Cu/Au ratio (ppm/wt%) ranges from 0.023 (B. Vrch) to 0.09 (Kráľová, Beluj). Alteration is dominated by intermediate argillic type that variably overprints earlier K-silicate at shallow and Ca-Na silicate alteration at deeper levels. Propylitisation represents outer zone of the systems. Some localities also contain phyllic alteration on their margins. Ledges of advanced argillic alteration are the youngest with remobilizing effect on gold. Preservation (B. Vrch, S. Lazy, Beluj) or absence (Kráľová, Píla) of this alteration type probably indicates relative erosion level of the systems. Quartz stockwork consists of several generations of quartz veinlets, including early A-type with biotite and later banded type. All systems are enriched in magnetite, but depleted in sulphides and are thought to represent very shallow porphyry systems (<1 km).

Fluid properties were studied in detail only from the Biely Vrch deposit. In all generations of vein quartz, vapor inclusions dominate, accompanied by inclusions of hydrous salt melt with vapor. LA ICPMS microanalysis showed that vapor as well as salt melts contain Fe-K-Na-Cl in relatively stable but unusual proportions (FeCl2>KCl>NaCl). Low density vapor, accompanied by extreme “brines”, resulted from fluid heterogenisation at very low pressures. Shallow emplacement is also suggested by rapid supersaturation of SiO_2 inferred from botryoidal textures in banded veinlets. Fluid heterogenisation occurred at high temperature (∼670°C) as shown by δ18O data from vein quartz and magnetite, which were in equilibrium with purely magmatic fluid. Most of the inclusion assemblages had similar Cu/Au ratio to the average ratio of the deposit. Gold is preferentially concentrated in vapor (in respect to total salinity of inclusions) and precipitated due to the effective stripping of the stabilising hydration sphere of gold complexes in a high-T but low-P subvolcanic fumarole environment. Several generations of gold point to significant remobilisation by later aqueous fluids in the clay mineral stability field, composed of mixture of magmatic and meteoric fluids (∼0-5 wt% NaCl eq., Th 230-260°C).

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