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Stratabound tungsten deposits in the Alps revisited in the light of new age data

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Correct genetic models are vital for successful exploration of mineral deposits. Key information for deciding on the validity of a genetic model proposed for an ore deposit comes from geochronology. In this presentation we will demonstrate how absoute age determination of ore minerals and associated host rocks with conventional and in-situ dating techniques using the U-Pb, Sm-Nd and Re-Os systems have changed our understanding about the formation of stratiform/stratabound scheelite deposits, a rather unique class of tungsten deposits. This will be demonstrated for tungsten deposits in the Alpine orogen, with focus on the Felbertal scheelite deposit in the Eastern Alps, which is the type locality for this class of tungsten deposits. Genetic models, first propagated in the 1970-ties, postulated a syngenetic/syndiagenetic formation of this and similar deposits by exhalative-hydrothermal processes related to Early Palaeozoic mafic volcanism with subsequent magmatic as well as metamorphic reworking and mobilisation during the Variscan and Alpine orogeny. Discovery of Felbertal has boosted world-wide exploration for this type of W deposit, however without success. No second economic deposit of this type was ever discovered, likely because of inadequate exploration models that were based on a wrong genetic concept.
Some essential aspects controlling formation of tungsten deposits in the Eastern Alps are: (1) They are restricted to some Early Palaeozoic terranes now incorporated in the Alpine orogen (pre-Alpine Penninic units, Celtic terrane within the Austroalpine units); this could indicate a selective geochemical pre-concentration of W in some parts of the pre-Alpine crust. (2) Collision-related Variscan magmatism with emplacement of a geochemically highly anomalous metagranitoid at c. 340 Ma ("K1 orthogneiss") proved to be crucial for the Felbertal deposit. (3) A new in-situ U-Pb age of c. 340 Ma for „Scheelite 1“ (previously thought to be c. 520 Ma) confirms that at Felbertal all three main scheelite types formed between c. 360-320 Ma. (4) Emplacement of this granitoid overlaps (within the uncertainties of the ages) with Variscan regional metamorphism and deformation. Formation of W deposits in the Penninic is not related to the late to post-orogenic Variscan magmatism (c. 320-290 Ma). (5) Ore formation is coeval with development of a fluid system which is characterised by enrichment in LIL (K, Rb, Cs) and especially in F. These fluids are thought to be of magmatic-hydrothermal origin and affected the host rocks including the K1 orthogneiss and formed scheelite ores in quartz stockwork veins, shear zones and of disseminated type. (6) Foliated ores, previously regarded as syngenetic ore textures (e.g. metaexhalites), are best interpreted as tectonites; e.g., mylonites with older scheelite porphyroclasts plus recrystallised scheelite that formed in high strain zones.
Where the direct link with specialised granitoids is lacking – what is the common case for scheelite showings in the Austroalpine units – only sub-economic tungsten mineralisation is developped. Hence: „No economic tungsten deposit without the right granite“.