# The Mallnock tungsten mineralization – Trace element evolution and geochronology (Gurktal Alps, Carinthia/Austria)

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During the late 1980s, systematic alluvial prospecting and field exploration led to discovery of a peculiar type of tungsten mineralization at Mallnock in the Gurktal Alps in Carinthia. The unique feature, which sets Mallnock apart from any other type of tungsten mineralization in the Eastern Alps, is the paragenesis of wolframite (95 mol.-% ferberite) with scheelite. The tungsten occurrence at Mallnock was re-evaluated as a part of the “W Alps” project, which examines the tungsten potential in the Eastern Alps. Scheelite and wolframite were analyzed regarding micro-textures and trace element concentrations using a combination of electron probe microanalysis (EPMA) coupled with cathodoluminescence (CL) and laser ablation-inductively coupled plasma mass spectrometry (LA-ICP-MS). Tungsten mineralization is restricted to deformed layers of Fe-rich magnesite-dolomite marble within phyllite belonging to the Paleozoic Kaser Complex within the Stolzalpe Nappe of the Drauzug-Gurktal Nappe System. Two different styles of mineralization can be distinguished. At Mallnock-North (MN), ferberite occurs together with scheelite as network fissure fillings in coarse-grained Fe-rich magnesite (15 mol.-% $FeCO_3$, avg. 0.9 wt.-% $WO_3$). In contrast, at Mallnock-West (MW) scheelite-quartz veinlets are hosted by fine-grained dolomite marbles (avg. 0.5 wt.-% $WO_3$); i.e., ferberite and ferroan magnesite are missing. Under shortwave UV-light all scheelites show bluish fluorescence, but significant differences in scheelite micro-texture are observed. At MN scheelite clearly replaces ferberite (pseudomorphs) and shows homogeneous CL textures, while at MW scheelite is mostly finely crystallized and occasionally relict cores with primary growth zoning are preserved. Scheelite and ferberite from MN are characterized by a distinct trace element chemistry and rare earth element (REE) patterns. The replacement of ferberite by scheelite is also documented in the trace element composition; e.g., the REE patterns of the two W minerals are comparable. Scheelite from Mallnock has high concentrations of Na, Sr, and U compared to other scheelites from the Eastern Alps, while Mo, Nb, Ta and REEs are rather depleted. The main difference between MN and MW is, that most of the trace elements have a higher concentration at MW where only scheelite is found. Scheelite from Mallnock is particularly rich in U with concentrations of up to 180 µg/g. In situ U-Pb dating of scheelite by LA-ICP-MS yielded Lower Permian and Middle Triassic ages for scheelite from MW and MN, respectively. These scheelite ages are supported by a new Permian U-Pb apatite age of a basaltic trachyandesite dyke farther ENE. The scheelite and apatite ages show that formation of magnesite and tungsten minerals at Mallnock should be interpreted in the context ofthe Permian/Triassic geodynamic evolution of the Alps. Previously, Variscan and/or Eo-Alpine orogenic events were hold responsible for the formation of the wolframite-scheelite mineralization with syn(dia)genetic scheelite as primary metal source.