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Geology and mineralization of the Mt Carbine Tungsten Deposit, Northern Queensland, Australia

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The Mt Carbine quartz-wolframite-scheelite sheeted vein deposit is located ~80 km NW of Cairns, Northern Queensland. It was the largest vein type W deposit in Australia and accounted for 43% of Australia's annual W production in 1986, prior to closure because of international Sn-W market crash. The hard rock resources at Mt Carbine include indicated resources of 18 Mt at 0.14% WO_3 and inferred resources of 29.3 Mt at 0.12% WO_3 (Carbine Tungsten Limited Annual Report 2014). The vein system in Mt Carbine is hosted in Ordovician to Devonian Hodgkinson Formation metasedimentary rocks, which include turbiditic metasediments composed mainly of greywacke, siltstone-shale, slate, basalt, conglomerates and chert.

There are four 30-40 m wide vein zones in the open pit with different orientations, with Zones 1 - 3 being ~300°/80° (strike/dip) with dip direction of 210°, 210° and 20°, respectively, and Zone 4 270°/65° with dip direction of 180° to 185°. Based on drill core logging and open pit observation, the paragenesis sequence has been established. Stage 0 is represented by deformed curvy and discontinuous quartz-dominant veins with minor to none W mineralization. Stage I continuous quartz-dominant veins have straight and continuous margin, and are composed of wolframite±scheelite±K-feldspar±biotite± tourmailine±apatite. Stage II veins are straight & continuous, quartz-dominant with sharp boundaries, and contain chlorite±scheelite± wolframite±cassiterite ± muscovite. Stage III is represented by undeformed straight and continuous quartz±chlorite±muscovite± molybdenite±arsenopyrite±chalcopyrite±pyrite±pyrrhotite±sphalerite veins, without W mineralization. Stage IV veins are featured by the undeformed straight and continuous shape and quartz ± calcite ± fluorite mineralogy without any W mineralization. The W mineralization is mostly in stage II quartz veins, with less economic W mineralization in the other 3 stages of veins. Ore minerals are wolframite and scheelite. Wolframite is typically euhedral and occurs in quartz veins, while the occurrences of scheelite are: (1) euhedral grains in quartz vein and, (2) pseudomorphing wolframite grains or cutting across wolframite grains as veinlets.

There are at least 3 felsic igneous rock types in the mining district, including porphyritic biotite granite, equigranular coarse-grained biotite granite and fine-grained felsic dykes that cuts across the ore body. There is no observable contact between granite and the W veins, thus their relationship is unclear. Mineralized quartz veins and chlorite alteration occur in the porphyritic biotite granite, whereas no quartz vein and alteration are present in the fine-grained felsic dyke, indicating that the porphyritic biotite granite was earlier than mineralization and the felsic dyke later than mineralization. This observation is consistent with the latest dating results: the LA-ICP-MS zircon U-Pb age of the porphyritic biotite granite is 298±3 Ma and the felsic dyke 261±7 Ma, whereas the molybdenite Re-Os age from the mineralized quartz vein is 28 ±1 Ma, and the muscovite ^{40}Ar-^{39}Ar ages are 282-277 (±1-2) Ma. There is no overlap between the 2 muscovite ^{40}Ar-^{39}Ar ages, probably indicates there was some post-mineralization tectono-thermal activities.

Preliminary fluid inclusion studies reveal that most of them are primary, with sizes up to 26 μm. The homogenization temperatures range from 210 to 290°C, final ice-melting temperatures are between 0 and −3.7°C. Laser Raman analysis identified CH_4 in the vapor bubble. The $\delta^{34}S$ values of sulphides range from -9.1 to -6.0‰, and O-H isotopes largely overlap with metamorphic water.