

Ultra high grade Au: links to alkaline, Cl-rich, low aH₂O fluids

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Gold ± ullmannite veins (mm to cm thick) from the Wattle Dam deposit, eastern Yilgarn, Western Australia occur in actinolite - biotite - calcite altered komatiites. There are no macro- alteration assemblages adjacent to the gold veins that appear undeformed both at the macro-scale and from detailed micro-structural EBSD studies. Micro-selvage assemblages (<300 μm thick) to the gold veins of (1) aegirine-riebeckite and (2) chloro-sodicgedrite±talca± anthophyllite were revealed by synchrotron x-ray fluorescence microprobe (XFM) and SEM-EDX mapping. The distribution of sodicgedrite, using Sr as a proxy, revealed a micro-stockwork across gold bearing samples. Traces of barite, vlasovite, zircon and allanite-(Ce) were identified along sodicgedrite±anthrophyllite filled fractures in actinolite. Subtle mineralogy and mineral chemical changes suggest significant chemical gradients adjacent to the gold veins at the time of gold deposition. Selvages to Au veins show an internal zoning from sodicgedrite±anthrophyllite±talca on gold margins to aegirine ± riebeckite on contacts with actinolite. A sharp decrease in the Cl content of sodicgedrite (4890 to 360 ppm) occurs in the transition from micro-selvages of major gold veins (3 to 10mm thick) through to selvages of minor veins (<100 μm) that branch from major veins. Within 3mm of major veins bladed ilmenite is replaced by rutile on the margins of thin gold veins (<100 μm). More distant from major veins ilmenite is stable where cut by thin gold veins. Vlasovite with zircon cores occurs with sodicgedrite close to major veins. Elsewhere zoned xenocrystic zircon grains have recrystallized along fractures with gold. Thermodynamic calculations at 400 °C and 2kb show the micro-selvage assemblages represent a unique micro-chemical environment associated with Au transport and deposition. The fluids were alkaline (pH ~ 8 - 9) with high Na, Mg and Cl activity relative to near-neutral ambient fluids with higher Ca, Fe and CO₂ activity and lower pH (4-6). The absence of a significant alteration selvage with the gold veins is consistent with fluids of low aH₂O. Alkaline conditions mobilized Zr and vlasovite was stable relative to zircon.