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Cu-rich Orogenic Mineralization in Metasedimentary Terranes: Kansanshi and Its Global Analogues

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Kansanshi is a world class Cu–Au deposit (26 Blbs Cu, 7 Moz Au) that does not fit an established class of ore deposits. However, it shares key features with deposits such as Telfer, Winu, Onganja, and Bidjovagge, systems variably classified as Orogenic Au, Intrusion related Au, or IOCG. We characterize these structurally controlled Cu–Au systems in metamorphic terranes and propose they represent a Cu-rich variant of orogenic mineralization. They are distinguished by elevated Cu, negligible As–Sb–Hg, high salinity fluid inclusions, and reduced metasedimentary host rocks. Fluid chemistry is more oxidized and saline than in typical orogenic Au systems, consistent with metamorphism of sedimentary rocks in intracratonic basins containing evaporitic brines. As with Orogenic-Au deposits, syn-tectonic intrusions may be present, but their relationship to mineralization remains ambiguous.

Unifying characteristics include:

- Mineralization: large quartz–carbonate veins with chalcopyrite, pyrite, and pyrrhotite
- Alteration: Fe-carbonate and albite common, with biotite, muscovite, K-spar, chlorite, and actinolite locally; possible thermal zoning
- Host rocks: reduced, polydeformed metasediments near the upper-greenschist to lower-amphibolite transition
- Timing: syn- to late-metamorphic during brittle–ductile transition; multiple mineralizing events
- Structure: notable association with domes, anticlinal crests, boudins, and folds
- Geochemistry: felsic signature (Cu, Au, Te, In, Ag, W, Bi ± Ni, Se, Sn, Mo, Co, U, REEs); Au commonly with Bi–Te in pyrite but separate from Cu
- Cu/Au systematics: variable ratios and poor correlation, suggesting multiple events and potential continuum with orogenic Au
- Accessory minerals: apatite, green V/Cr mica, rutile, monazite, uraninite, brannerite, Ni sulfides, anhydrite
- Fluids: oxidized, high salinity, Na–K–Mg–Ca–CO₂ rich metamorphic brines (fluid inclusions >20 wt% NaCl eq., commonly >40 wt%)