
Targeting the Biggest Discoveries along the Biggest Faults: How Hard Can it Be?

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Large ore deposits have a more ordered distribution than smaller ones, which implies that their locations should be more predictable. Examples of ordered spatial patterns include the proximity of giant deposits to translithospheric fault zones (TLFs) and the spatial and temporal periodicity of many camp-scale large deposit clusters. Using more than 120 global case studies of district-scale structural controls on large magmatic Ni-Cu and porphyry Cu-(Au) deposits, we show that TLF intersections provide more predictable controls on giant ore deposit locations than other commonly proposed structural targets (e.g., fault jogs). Large magmatic Ni camps preferentially form proximal (less than 25 km) and aligned parallel to primary TLFs marking paleocraton margins. Large porphyry Cu-(Au) deposits/camps also form near primary arc-parallel TLFs at lithospheric domain boundaries, in contrast to Ni, which frequently form closer (within 5 km) and aligned parallel to cryptic secondary transverse TLFs. We hypothesize that differences in camp-scale structural controls are related to the dynamic permeability of TLF intersections in predominantly transtensional (Ni) versus predominantly transpressional (Cu) settings. Many large porphyry Cu-(Au) deposits in well-explored metallogenic belts show along-strike semi-regular spatial periodicity, which appears to be inherited from the spacing of intersections with a (commonly older) transverse TLF set. In contrast, evidence for spatial periodicity among large magmatic Ni-Cu deposits appears lacking due to either exploration immaturity and/or non-regular spacing of cross faults. The challenge of applying the TLF framework to exploration lies in the fact that, while primary strike-parallel TLF corridors are usually well-defined, intersecting secondary transverse TLFs tend to be cryptic. Moreover, distinguishing prospective translithospheric faults from more common transcrustal faults is challenging, given that seismic reflection profiling does not directly detect steep TLFs. Here we propose leading practices, highlighting a multidisciplinary approach to optimize lithospheric structural targeting at corridor to camp scales for undercover giant discoveries.