The 290 Ma jackpot: hot LIPs and giant deposits due to magmatic and metallogenic peak activity across Eurasia

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The Central Asian Orogenic Belt (CAOB, synonymously used to describe the Altaids orogenic collage) was a very busy place in the late Carboniferous to early Permian. An extraordinary number of significant mineral deposits formed at ~290 Ma, including the Muruntau and Bakyrchik gold deposits, the Dhezkazgan copper deposit, and the Kalatongke-Maksut copper-nickel deposits, among many others.

The widespread, bimodal Early Permian magmatism of the CAOB, characterised by numerous A-type granites and mafic-ultramafic intrusions located in fault zones and suture shear zones, often of trans-lithospheric nature and commonly found also in the Permian rift basins, is considered to be essentially "post-collisional", but it occurs during a time when magmatism should be shutting down at the termination of a Wilson cycle. The collisional phase was northward underthrusting of the continental Tarim Block beneath the Tien Shan region of the CAOB, as evident from structural studies and deep seismic data. However, the tectonic regime is demonstrably extensional or transtensional. Tectonic models have varied from ridge subduction to mantle "superplume" activity, but it is suggested that the magmatism was related to rapid retreat of the same long-term, W-dipping slab associated with accretionary development of the CAOB throughout the Paleozoic. As the Tarim and North China craton continental blocks approached the Siberian craton from the south in the Late Paleozoic, the CAOB was trapped between these two blocks, and it folded to produce the characteristic E-W trending oroclines of the orogen. Synchronously, the underlying oceanic slab retreated eastward as the intervening cratons juxtaposed, producing a transtensional stress regime that induced melting of asthenospheric depleted mantle and refractory lower crust in a distal backarc setting, to produce the Permian A-type granites and coeval mafic rocks. This combined tectono-magmatic scenario set the stage for the mineralization peak taking place at around 290 Ma.

As one example, nickel-copper mineralization associated with small often funnel-shaped mafic-ultramafic intrusions is localized along major fault structures in Central Asia. Many have an age that demonstrates a link with the 290 Ma Tarim Large Igneous Province (LIP). Two of the more significant ca. 290 Ma Ni-Cu bearing intrusive groups are the Maksut complex of Eastern Kazakhstan and the Kalatongke complex of northern Xinjiang region, north-western China, both of which are located along the Irtysh shear fault system. Key features of these Ni-Cu mineralized small intrusions are the association with crustal scale shear zones and the age match with the 290 Ma Tarim LIP. It is inferred that at 290 Ma a mantle plume arrived and spread out beneath the Tarim craton and Junggar block (supposedly spreading out as far as beneath Kurama and Kyzylkum), and that its melts opportunistically ascended along trans-lithospheric shear zones. Further verification of this concept will improve an exploration model of continued focus along these shear zones.