Geochemical behaviour of Mo and porphyry Mo mineralization

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Molybdenum is very rare in the silicate Earth, with abundances of 50 ppb in the primitive mantle, and 0.8 ppm in the continental crust, yet it forms "pure" Mo porphyry deposits. Given that Mo is moderated incompatible, it requires pre-enrichment to form porphyry Mo deposits, e.g., through the oxidation-reduction cycle. Oceanic Anoxic Events are the most efficient and important process that enriches Mo. Large amounts of Mo-enriched sediments formed on the Pacific Ocean floor during at least 9 major OAEs since the Late Jurassic. The Eastern Pacific plate has been mostly subducted, with only Cenozoic crust left. During plate subduction, Mo-rich sediments may be taken down to the mantle wedge through subduction erosion, which were metamorphosed and then transferred to porphyry deposits through partial melting.

Molybdenum deposits can be classified into three types: porphyry-Cu-Mo, high-F porphyry and low-F porphyry-Mo deposits. Porphyry-Cu-Mo deposits are usually formed through partial melting of subducted oceanic crust and metamorphosed Mo-rich sedimentary material due to subduction erosion. The high-F porphyry-Mo deposits were likely formed by partial melting of metamorphosed Mo-enriched sediments during slab rollback. Low-F porphyry-Mo deposits were formed through direct partial melting of metamorphosed Mo-enriched sediments entrained into the mantle wedge through subduction erosion (usually associated with arc granite). Porphyry-Cu (Au) deposits in the southwest Pacific margin are all associated with subduction of backarc basins younger than the last Oceanic Anoxic Event. Therefore, porphyry Cu (Au) deposits in the southwest Pacific margin have no economic levels of Mo. The oxygen fugacity of northwest Pacific is lower than ΔFMQ +2, which inhibits the formation of porphyry deposits.

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