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Tethyan Tectonomagmatic Processes and Metallogeny

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The Paleotethyan ocean existed between Gondwana and Eurasia in the Paleozoic, but little record of its existence is preserved, and few ore deposits are known to be related to its formation and destruction. In contrast, the record of the Neotethyan ocean, which opened in the Permian-Early Triassic behind the Cimmerian continental fragments (parts of present-day Turkey, Iran, Tibet, and Indochina that rifted from the northern margin of Gondwana), is much better preserved, and numerous mineral deposits are found along its sutured margins. Most of these deposits relate to progressive closure of this ocean basin in the Mesozoic and Cenozoic and, in particular, to its final elimination by collision of India and Africa-Arabia with Eurasia in the Eocene and Miocene, respectively.

A high degree of complexity is preserved in the Neotethyan orogen because the northern margin of the ocean featured numerous small back-arc ocean basins that opened and closed between the Cimmerian continental fragments and Eurasia throughout the late Mesozoic-Paleogene. In this respect, the precollisional region more closely resembled the present-day Southwest Pacific than a simple Andean-type convergent margin. The lack of sustained periods of subduction in any single arc along the belt may explain the relative scarcity of "normal" subduction-related porphyry and epithermal deposits, although a few such Cretaceous-aged systems occur in the Balkans (e.g., Majdanpek, Bor, Elatsite), and rare Triassic (Yangla, Pulang), Jurassic (Xietongmen), and Cretaceous (Duolong) deposits occur in Tibet and southwest China. The mid-Miocene Saindak and Reko Diq porphyry Cu-Mo-Au deposits in the Chagai arc of western Pakistan are more recent examples of subduction-related porphyry formation (above the still-active Makran subduction zone), and formed after a long period of arc maturation (beginning in the Late Cretaceous). The rarity of older (Mesozoic) deposits could be purely a function of preservation, or it could reflect the relatively low volume of upper crustal arc plutonism and volcanism preserved in the rock record due to the brevity of individual subduction events.

The majority of the ore deposits found in the Neotethyan orogen are of late Oligocene to mid-Miocene age, and correspond either to the onset of terminal collision or post-collisional tectonic adjustments. Oligo-Miocene porphyry and epithermal deposits in Iran formed close to or very shortly after initial contact between Arabia and the collided Cimmerian continental fragments, and include the large Sungun and Sar Cheshmeh porphyry Cu-Mo deposits and the Sari Gunay epithermal Au deposit. They are interpreted to have formed by remobilization of previously subduction modified lithospheric material during orogenic crustal thickening. Mid-Miocene porphyry Cu-Mo deposits in the Gangdese belt of Tibet formed ~30 m.y. after the initial collision between the Indian continental margin and Asia (at ~50 Ma). These deposits are similarly thought to have formed by remelting of subduction-modified lithosphere, with upper crustal magmatic emplacement delayed until the onset of orogen-parallel extension in the Miocene.

The Neotethyan orogen thus hosts a remarkable range of mineral deposit types related to various stages of subduction and continental collision, and provides an opportunity to study the metallogeny of complex convergent margin settings.