

The Tethyan Tectonic and Metallogenic History of Iran and Neighboring Areas

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Iran is a resource-rich country, with large deposits of iron, copper, zinc, and gold, as well as industrial minerals and oil and gas. Most of these resources were formed in response to complex and protracted contractional deformation events related to the subduction and eventual closure of the Neotethys ocean in the late Mesozoic and Cenozoic. Here we focus on porphyry Cu \pm Mo \pm Au and related epithermal Au deposits, which were once thought to be synonymous with subduction, but are now recognized to also form during collisional and other post-subduction tectonic processes. Recent advances in tectonic and paleogeographic reconstructions and new geochronological and geochemical data reveal that, in fact, most of Iran's major porphyry and epithermal deposits fall into this post-subduction category (e.g., Sungun, Sari Gunay, Meiduk, Sar Cheshmeh). The same applies to several major deposits in neighboring Turkey (e.g., Kişladağ, Çöpler), whereas continued subduction beneath the Makran in western Pakistan accounts for some of the only "normal" subduction-related porphyry deposits in the region (e.g., Saindak, Reko Diq). Few igneous rocks or mineral deposits associated with the Paleotethys ocean occur in Iran, although several Paleozoic ophiolite belts are preserved, and Early Cambrian Kiruna-type iron oxide-apatite deposits are found in the Bafq district of eastern central Iran. Arc magmatism associated with Mesozoic subduction of the Neotethys ocean is widespread in the Sanandaj-Sirjan zone, but no porphyry or epithermal deposits of this age have been discovered to date, likely due to erosion down to batholithic levels. Arc magmatism shifted to the Urumieh-Dokhtar belt and Lut block in the late Paleogene-early Neogene, and the first significant porphyry deposits formed in the Eocene and Oligocene. However, the main period of porphyry formation occurred later in the early to mid-Miocene, synchronous with terminal collision between the Afro-Arabian and Eurasian plates. Several large porphyry Cu deposits (Sungun, Meiduk, and Sar Cheshmeh), as well as the porphyry-related Sari Gunay epithermal Au deposit, were formed at this time (~20–11 Ma) along the length of the orogen. Active subduction continues only beneath the Makran of southeastern Iran and western Pakistan, where the large Saindak (~22 Ma) and Reko Diq (13–10 Ma) porphyry deposits occur.

Mineral exploration in Iran to date has been largely restricted to areas of outcrop, but the potential for extensions of known deposits or "blind" discoveries below widespread Quaternary cover is considered to be high.