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Tectonics and Metallogeny of Mainland Southeast Asia – Exploration and Discovery Opportunities

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Compared to adjacent South China, the mineral industry in mainland Southeast Asia is underdeveloped while its mineral potential remains largely unrealised and generally not well understood. All Southeast Asian countries have been fundamentally underexplored in the period since European colonisation ended, and extensive tracts have had no effective modern exploration. This is mainly the result of historical geopolitical factors that also resulted in limited advanced geological research and incomplete understanding of this geologically complex region. Understanding of geology and tectonics has advanced dramatically in the last 20 years; this can underpin effective targeting and discovery. The operating environment remains challenging in many jurisdictions, but political risk can be countered by minimising exploration risk through optimised understanding of metallogeny at a belt and mineral-system scale.

SE Asia and South China comprise a collage of crustal blocks including the South China, Indochina-Simao, Sibumasu-Baoshan, and West Burma-Lhasa terranes, all derived from Gondwana in the Palaeozoic and amalgamated in the Mesozoic during Asian accretion, separated by accretionary arc belts and suture zones. Metallogeny is intimately related to this complex accretionary history, including mineral belts and systems related to volcanic arcs and basin evolution.

In the Early Palaeozoic, all of the crustal blocks resided on the northern margin of Gondwana. Cambro-Ordovican volcanism and back-arc extension on the Sibumasu part of this margin is associated with the large lead-zinc-silver deposit at Bawdwin and the Irish-type zinc-lead silver-barite deposits of Thailand and Myanmar. Following a collision event on the Indochina margin in the Silurian, rift and drift of South China and Indochina from Gondwana occurred from the Late Silurian through the Devonian, with collision between the blocks in the Early Carboniferous. The Ni-PGM deposits of the Emeishan-Song Da LIP are associated with a Permian plume impinging on the South China block north of the Song Ma suture. Rifting of Sibumasu commenced in the Carboniferous and is associated with formation of SHMS zinc-lead deposits in rift-sag basins.

Arc volcanism initiated on the western Indochina margin in the Late Carboniferous to Early Permian when porphyry-skarn Cu-Au deposits in the Truong Son belt were formed in a distal back-arc setting. Back-arc VHMS deposits of Permian to Triassic age occur in Yunnan and Sichuan. Late Permian to Early Triassic epithermal and porphyry-skarn Cu-Au deposits formed in the Loei-Phetchabun-Pak Lay arc belt, in the Sukothai arc to the west and in its extension in peninsular Malaysia.

The Indosinian orogeny commenced with arc collision in the Early Triassic and culminated in closure of Palaeotethys between Sibumasu and Indochina in the Late Triassic. Orogenic gold deposits were formed especially in the Raub-Bentong belt in Malaysia. Major deposits of the Southeast Asian tin-tungsten belt are associated with S-type late orogenic granites.

Following SE Asia amalgamation, subduction recommenced along the western Sibumasu margin from Sumatra to Burma and Tibet in the Late Triassic and along the eastern Indochina-South China margin in the Jurassic. On the western Sibumasu margin, tin-tungsten mineralisation is associated with A-type magmatism in a Late Cretaceous back-arc setting. Porphyry copper-gold and epithermal systems developed in this arc belt in the Oligocene to Miocene with sediment-hosted gold systems in the back-arc in the Mio-Pliocene.

In South China and Indochina, Jurassic-Cretaceous continental arc magmatism was associated with an evolving range of mineral systems from epithermal gold to

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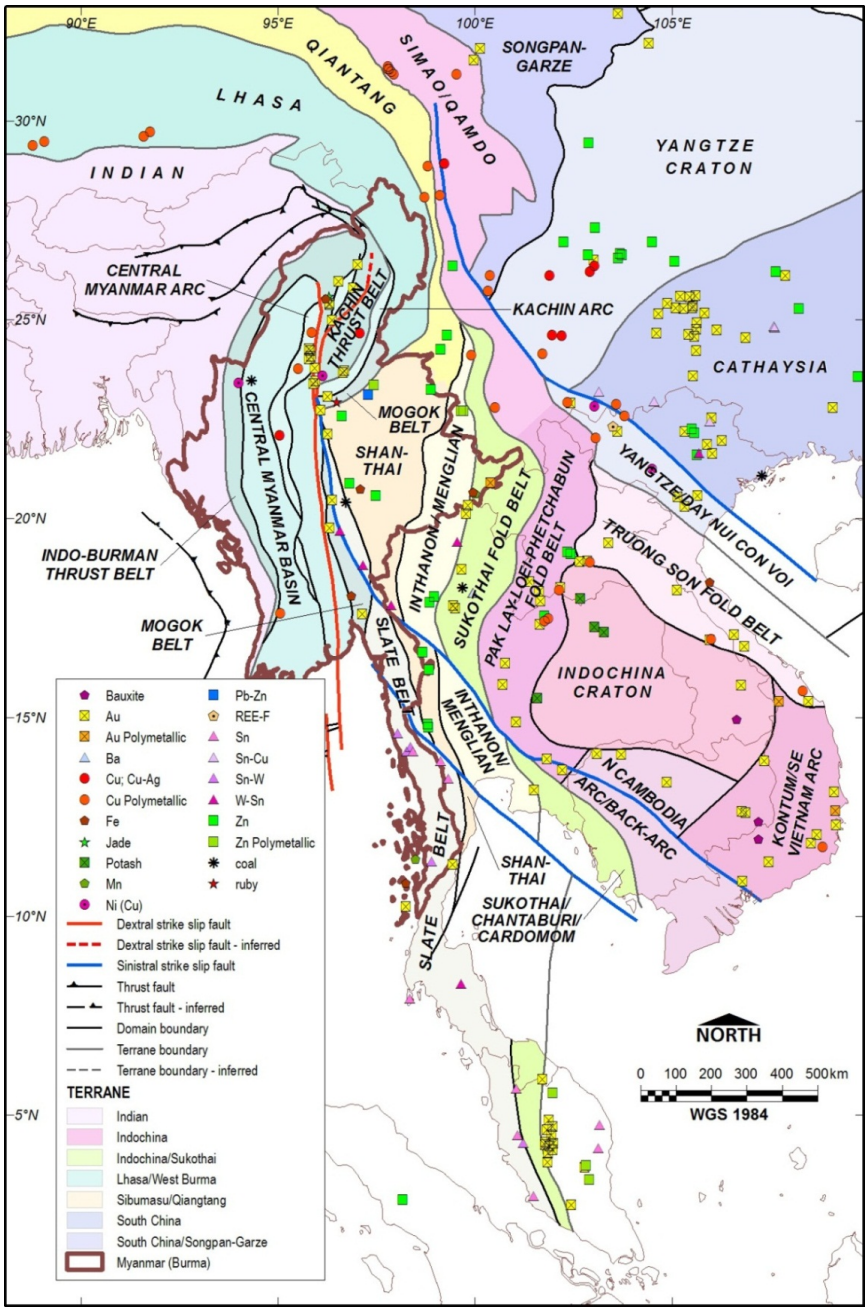

Summary terrane map of mainland Southeast Asia showing location of significant mineral deposits

tin- and tungsten-polymetallic deposits.

Reactivation of old subduction zones in response to Indian collision saw development of Eocene to Miocene porphyry copper and epithermal mineral systems, especially in a belt from western Yunnan into Vietnam.

Despite the favourable settings and known potential for economically attractive deposits of a variety of styles in a range of settings, there are only four large metal mines in active production in mainland Southeast Asia. The more-developed mining industry in contiguous belts in neighbouring southwest and south China provides a good indication of the remaining potential for discovery in Southeast Asia.