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Mineral resource potential of the Kingdom of Bhutan

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Significant efforts in the last two decades have provided a better understanding about the regional geological and structural setting of the Kingdom of Bhutan. Structurally, Main Frontal Thrust marks the Subhimalayan zone, further to the north, structural units are, Main Boundary Thrust, Lesser Himalayan zone, Main Central Thrust, Greater Himalayan zone, South Tibetan detachment, and the Tethyan Himalayan zone. However, little is known about the mineral resource potential of the country. Based on the available geological, geophysical and geochemical data, we divided the country into potential tectono-metallogenic provinces from north to south. Currently, Bhutan is known for its mineral potential with respect to coal, dolomite, ferrosilicon, limestone, marble, talc and slat, graphite (sedimentary) and gypsum (evaporites). The mineral resources of Bhutan also include beryl, copper, iron, lead, mica, precious stones, pyrite, silver, tin, tungsten and zinc. So far, a stratabound Cu-sulphide deposit is discovered in the Tethyan Paleozoic sediments (Maneting Formation) of the Black Mountain region of central Bhutan. Sporadic occurrences are reported for carbonate-hosted Pb-Zn deposits. Recently, anomalous REE concentrations have been observed in the laterites samples in the foothill region. Many epithermal Ag-Au-Cu-Mo and Porphyry Cu-Au-Ag-Mo despites are hosted by the Alpine-Himalyan orogenic system. Bhutan lies in the eastern part of the Alpine-Himalayan orogenic system, also known as the Tethyan metallogenic belt. Numerous epithermal and porphyry deposits have been discovered in the adjacent Yulong Porphyry Cu belt and Gangdese porphyry Cu belt, Tibet. Nickel-laterite deposits in the adjacent Indian Territory suggest potential of nickel deposits in the Bhutanese laterites. In the present work, we demarcated the Tethyan affinity rocks for potential Cu-Ag-Au porphyry and epithermal-type resources. For carbonate-hosted Pb-Zn mineralization, potential areas of interests are marked in the thick limestone-dolomite belt. Also, altered and lateritized zones are indicated for future detailed investigations and sampling to delineate their potential for REE resources. Further to the south in the Subhimalayan zone, thick fluvial sandstones of Miocene-Pliocene of Siwalik group are highlighted to host epigenetic sandstone-hosted uranium deposits. River deltas and fluvial sands along the river banks and at the nick points in the northwestern Himalayas reportedly enriched in the heavy minerals including rutile, ilmenite, zircon and uraninite along with placer gold occurrences. Therefore, for placer Au and heavy minerals (e.g., zircon, rutile and ilmenite, uraninite), potential areas are identified for detailed investigations. Given to the geological and tectonic setting, Bhutan has potential to host many important mineral resources. Fewer studies have been carried out to reveal the soil geochemistry on the southern slopes of the eastern Himalayas with the main objectives to understand the provenance and genesis of soils in the foreland regions. Therefore, we propose to conduct detailed and systematic stream sediment sampling to better understand the metallogeny in the region. In addition, airborne radiometric and magnetic surveys should also be undertaken.