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Lithogeochemical Investigation of the Big Bulk Cu-Au system, Northwestern British Columbia: Implications to Fertility in Island-Arc Settings

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The Big Bulk Cu–Au porphyry system is located in the Kitsault River area at the southern extent of the Stewart–Iskut mineral district, a highly mineralized belt extending more than 250 km along the western margin of the Stikine volcanic arc terrane in northwestern British Columbia. The district hosts numerous Late Triassic to Early Jurassic porphyry Cu–Au and epithermal Au deposits, including the Kerr–Sulphurets–Mitchell–Iron Cap (KSM) porphyry system associated with Early Jurassic intrusions of the Texas Creek plutonic suite. Although the KSM and Big Bulk systems were initially interpreted as calc-alkaline syn-subduction porphyry deposits, recent studies suggest emplacement in a post-subduction or back-arc setting controlled by localized pull-apart basin development.

Lithogeochemical analyses of the Big Bulk stock were conducted to assess its petrogenesis and fertility and to compare its geochemical signature with intrusive rocks associated with the KSM deposits. Similar to the Texas Creek plutonic suite intrusions associated with the KSM deposits, the Big Bulk stock is enriched in large-ion lithophile and light rare-earth elements relative to high-field-strength and heavy rare-earth elements, consistent with formation in a subduction-related volcanic-arc (I-type) setting. However, the Big Bulk stock exhibits a calc-alkaline-to-transitional affinity and diorite-to-gabbro compositions, indicating a more primitive stage of arc magmatism than the typical calc-alkaline, more evolved dioritic intrusions at KSM.

Big Bulk and KSM systems are classified as prospective using the recently proposed Cu- and Au-fertility indicators (Al_2O_3/TiO_2, Nb/Y, U/Yb, U/Y, Nb/Yb). However, commonly cited porphyry fertility indicators (e.g., Sr/Y and La/Yb) classify both systems as unprospective, despite displaying values comparable to those of mineralized island-arc systems (e.g., SW Pacific porphyry deposits). Collectively, these results are more consistent with the Big Bulk and KSM systems being related to fertile, subduction-related magmatism developed in the Early Jurassic Stikine island arc terrane than with post-subduction systems. This finding also highlights the need to better distinguish fertility indicators for island-arc and continent-arc environments.