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Identifying Potential Porphyry Copper Deposits at the Zhunuo Ore-Cluster District in Western Gangdese, Tibet: Insights from SWIR Spectrometry and Geochemical Anomalies

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The Zhunuo ore-cluster district in the western Gangdese belt, southern Tibet, China, is characterized by a significant geochemical anomaly, where the Zhunuo super-large porphyry copper deposit has been discovered through geochemical methods. However, due to the extended coverage of Linzizong volcanic rocks, it is quite difficult to find concealed porphyry copper deposit only by geochemical methods. Thus, the application of new technical methods is urgently needed to guide exploration breakthroughs in the Zhunuo district. Recently, more studies have shown that the wavelength variation of diagnostic absorption peaks of white mica and chlorite measured by shortwave infrared (SWIR) spectrometry is closely related to the mineralization temperature, which can be footprints to trace the hydrothermal/mineralization (H/M) centers of porphyry ore systems. In this study, 3,666 surface rock samples from 20 km southwest of the Zhunuo deposit were systematically collected from an area of about 130 km^2, and 10,022 spectral data were obtained by SWIR. In general, fifteen kinds of alteration minerals, mainly consisting of white mica, chlorite, epidote, and kaolinite, have been identified. The white mica and chlorite were widely distributed in the study area, and the Al-OH wavelength of white mica and the Fe-OH wavelength of chlorite varied between 2,191-2,219 and 2,239-2,260 nm, respectively. Moreover, there is an increasing trend of Al-OH wavelength of white mica and Fe-OH wavelength of chlorite from porphyry centers to distal locations. When combined with geochemical anomalies of stream sediments and geological characteristics in the Zhunuo district, three potential M/H centers have been determined that are dominated by short wave anomalies (Al-OH, 2,191-2,206nm; Fe-OH, 2,243-2,250 nm), namely Cimabansuo, Rimujucuo, and Luobugangmu. Significantly, we found that a Dongshibu copper prospect previously identified by geochemical methods didn’t show any porphyry mineralization-associated alteration information as reflected by SWIR, consistent with the barren copper results of later verification through drilling exploration. This decoupling may be caused by the long-term migration and weathering of stream sediment samples, during which the obtained geochemical anomaly cannot represent their in situ information. Therefore, caution must be taken when using stream sediment data to delineate prospecting targets. Instead, SWIR is a potentially powerful vectoring tool to aid exploration for porphyry systems, especially in the western regions where the level of prospecting work is extremely low.