Exploring a Sleeping Giant: Chlorite Chemistry as a Vectoring Tool in the World-Class Tennant Creek Au-Bi-Cu Province

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The Tennant Creek mineral field in the Northern Territory is one of Australia's largest historical mining provinces, with significant past production of gold, copper and bismuth. Tennant Creek deposits are tentatively classified as iron-oxide copper-gold (IOCG) type and are typically hosted in iron oxide-chlorite-quartz bodies known locally as ironstones. Unlike many other IOCG systems, these deposits are characterized by spatially restricted chlorite-rich hydrothermal alteration haloes, making exploration challenging, especially undercover. This study investigates the potential of chlorite chemistry as a vectoring tool to mineralization in the province. Using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS), chlorite grains were analyzed from mineralized, proximal and distal barren zones across several high-grade deposits.

Results show systematic variations in key trace elements (such as, Fe, Co, V, Ba) with proximity to mineralization. These patterns extend well beyond visible alteration, delimiting the geochemical fingerprint of mineralized ironstones and effectively distinguishing barren from mineralized zones. Elemental gradients are observed at the deposit scale and provide insights into fluid flow pathways around the deposits. Chlorite chemistry also reflects differences in metal endowment between deposits, potentially delineating cobalt-, uranium-, and bismuth-rich mineralization. Additionally, multivariate statistical analyses show compositional similarities between Tennant Creek chlorite and that from other IOCG systems, confirming the classification of Tennant Creek deposits in the IOCG class.

Our findings highlight the usefulness of chlorite chemistry as a powerful mineral exploration tool in the Tennant Creek province. Further application in greenfield or undercover terrains could help in the search for the next generation of world-class discoveries at Tennant Creek.