Tennant Creek Style Au-Bi-Cu Mineralization: Integrated Geologic Model and Constraints on the Timing of the Tennant Creek Supersuite, Northern Territory, Australia

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The Tennant Creek mineral field (TCMF) is a well-endowed metallogenic province that has produced approximately 157 t of gold, 345000 t of copper, 14000 t of bismuth, 220 t of selenium and 56 t of silver from 130 mines; the majority of production was derived from 12 deposits between 1932 and 2005.

The geology of the TCMF comprises three principal units: the Warramunga Formation meta-sediments, which hosts the Au-Bi-Cu mineralization; the Tennant Creek Supersuite (TCS) granitoids and related high-level porphyries and coeval intermediate-mafic intrusives; and the younger Ooradidgee Group metasediments and felsic extrusives (1843 ± 4 and 1841 ± 8 Ma). Detrital zircon dating of the Warramunga Formation indicates that this unit was deposited from 1866 to 1854 Ma. The Tennant Event (1850–1840 Ma) intrusive magmatism was assigned to the TCS. Granitic rocks of the TCS include the Red Bluff Granite (1854 ± 7 Ma), the Tennant Creek Granite (1850 ± 4 Ma) and the Hill of Leaders Granite (1846 ± 3 Ma). SHRIMP U-Pb geochronology of the intermediate-mafic intrusive rocks shows a narrow age range of 1852 to 1849 Ma, slightly older than the 1847 Ma age of the quartz-feldspar porphyries reported by others, but within the analytical uncertainty of the Red Bluff Granite. Consequently, based on crosscutting relationships, it is interpreted that the intermediate-mafic intrusive rocks are coeval with and probably represent a more primitive variant of the TCS.

The majority of the Tennant Creek Au-Bi-Cu mineralization is commonly hosted by iron oxides (known locally as ironstones) and associated alteration. Two styles of Au-Bi-Cu mineralization have been identified: a predominantly ironstone-hosted and a shear-hosted ironstone mineralization. Alteration and vein assemblages have been grouped into pre-main, early, main, and late stages. Pre-main alteration is characterized by quartz-chlorite-sericite, magnetite assemblages with chlorite alteration typically occurring as envelopes around the magnetite bodies. Early stage quartz-sericite-albite-chlorite-actinolite alteration and veins are temporally and spatially related to the TCS. Most of the gold and copper mineralization was introduced during the main stage. This alteration is characterized by hematite-chlorite-sericite assemblages and is interpreted to be associated with shearing within the Tennant Event immediately after emplacement of the TCS. Locally, dolomite-talc ± calcite alteration developed during the late stage and occurs as discrete envelopes and often defines a cap above and partly adjacent to many ironstone bodies.

It has proven difficult to directly date the age of Au-Bi-Cu mineralization event within the TCMF. Previous geochronological control consists of a porphyry dike (1846 ± 4 Ma) at the White Devil Mine that crosscuts ironstone, indicating that ironstone formation occurred during the early stages of the Tennant Event. Au-Bi-Cu mineralization overprints the White Devil porphyry while at the Gecko mine Au-Bi-Cu mineralization is crosscut by barren dolerite (1844 ± 5 Ma). The recalculation of ^{40}Ar-^{39}Ar (hydrothermal muscovite samples) yielded an age range of 1851 to 1847 Ma. The ^{40}Ar-^{39}Ar age of muscovite associated with mineralization is in close agreement with the ages of magmatic zircon supporting the hypothesis of a close temporal link between intrusive activity and mineralization during the Tennant Event.