

Petrogenesis of the Bissett Creek flake graphite deposit: Implications for regional graphite mineralization models in the southwestern Grenville Province

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Graphite is becoming more important as an ore mineral because of its uses in many “green” technologies, including electric vehicle manufacturing. The factors controlling graphite mineralization, however, are not well understood and there are currently no detailed genetic models for mineralization that can help prioritize exploration in the Grenville Province in Ontario. The Bissett Creek flake graphite deposit in the Central Gneiss Belt (CGB) of the Grenville Province is an ideal location to investigate mineralization and to develop a regional genetic model. The focus of this study is to assess whether graphite mineralization in the deposit is syngenetic or epigenetic and to determine the source of the carbon related to mineralization. In the Bissett Creek deposit, graphite is hosted in biotite-rich quartzofeldspathic gneiss, garnet-diopside-tremolite-biotite gneiss and garnet-biotite-sillimanite gneiss, which have all undergone polyphase folding. Mineralization is characterized by homogeneously-distributed, disseminated graphite flakes (1 to 5 mm in size) that make up 2–10% by volume of the gneiss hosts. Graphite flakes are intergrown with metamorphic minerals, primarily biotite, and mineralization occurs in stratabound layers. The $\delta^{13}\text{C}$ values of the graphite flakes (-17‰ to -29‰) are consistent with a biogenic source of carbon. The association of graphite within the Bissett Creek deposit, along with a biogenic source of carbon, suggests that mineralization formed syngenetic to the high-temperature metamorphism of organic-rich units. These factors can help define useful criteria that will target further exploration in the CGB. First, if carbon is biogenic in origin then carbonate units do not play an important role in graphite mineralization in the CGB, unlike in the Central Metasedimentary Belt of the Grenville Province. Subsequently, the stratabound nature of graphite mineralization can be used to unfold polyphase folding in the gneissic terranes to identify areas with mineralization potential. As well, the metamorphic mineral assemblage, consistent with a sedimentary protolith, suggests that only paragneiss units should be considered when exploring in the CGB for graphite mineralization like the Bissett Creek deposit.