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Technology Metals and Metamorphism: Linking Geologic Environments, Processes, Tools, and Techniques

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Technology metals are used in products such as computers, batteries, and magnets critical to the green technology needed to help decarbonise our societies. As global demand for these metals increases, new thinking is required to improve our understanding of where and how deposits containing these metals can form. The study of metamorphic geology covers a range of geologic environments and processes, many of which are integral to the study of deposits host to technology metals. Titanium and graphite are examples of technology metals hosted in or sourced from metamorphic rocks by processes such as prograde metamorphism.

Metamorphic rocks grow new minerals in response to new physical or chemical conditions such as heating, burial, deformatio, and fluid infiltration. As such, metamorphic rocks provide a record of changing crustal conditions in different geologic environments through time. The scope of the discipline of metamorphic geology is therefore extremely broad, overlapping with other disciplines in terms of lithologies, geological environments, tools, and techniques. A key example of this overlap is hydrothermal metamorphism, where growth of new minerals occurs in response to introduction of fluids, dissolved species, and heat, influencing metamorphic reaction progress at a range of conditions. For example, the contentious genesis of the Broken Hill deposit in New South Wales, Australia, provides a window into the ways that sedimentary, exhalative, metamorphic, and/or hydrothermal processes may have been important factors in concentrating or diluting metals.

When it comes to technology metals, the majority of our current data sets focus on ore minerals host to high concentrations of targeted elements. To better understand these ore systems, and perhaps imagine new undiscovered types of deposits, we need a broader understanding of the natural processes that enrich and deplete these metals. Data required includes measuring subeconomic concentrations in minerals from a range of geological environments, as well as developing a much fuller understanding of the effect that different processes have on elements concentrations. Just as we are understanding that the fertility of copper porphyries may reside in the history and composition of portions of the mantle and crust associated with and individual subduction zone, we should also consider the environment of deep crustal melting that may lead to derivation of Sn- and W-rich melts but may also leave behind other elements in the partially melted residuum that are concentrated by other physiochemical means. More research defining the life cycle of elements, including the technology elements in rock masses subjected to prograde metamorphism and melting is required to help us perceive currently poorly understood means of elemental concentration.