Application of Network Analysis in Exploring Continent-Scale Mineral Datasets

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Indicator minerals are minerals that, when appearing as transported grains in sediments, may indicate the presence of mineralisation, hydrothermal alteration or a particular lithology within basinal watersheds[1]. Traditionally the application of indicator minerals in hard rock exploration has involved the use of a shovel, gold pan and hand lens. However, recent technological advancements in automated mineralogy and improvements in microanalytical workflows allow for the rapid identification and characterisation of a large number of indicator minerals across extensive sample suites[2,3].

Mineral network analysis techniques provide a visually intuitive approach to facilitate the rapid interrogation of automated mineralogy datasets[4]. Network analysis is a subfield of graph theory used to visualise complex systems. Mineral datasets and their associated geological systems can be visualised as network graphs comprising nodes (vertices) and edges (lines), where nodes and edges represent geological entities and their relationships, respectively. Visualisation of mineral relationships as 2-D or 3-D networks allows for rapid identification and interpretation of co-occurring mineral assemblages potentially indicative of mineralisation within large mineral datasets.

We have developed an online Mineral Network Analysis (MNA) application that provides geoscientists with a toolkit to visualise and explore large mineral datasets, such as the Heavy Mineral Map of Australia project, which uses automated mineralogy techniques to analyse over 1,300 heavy mineral samples from across the continent[5]. We demonstrate the effectiveness of MNA techniques in domain analysis of a smaller dataset (150 samples; >5,710,000 unique mineral particles) generated from the Geological Survey of Western Australia's geochronology collection. By using the application to rapidly filter samples in which the zinc-bearing minerals gahnite ($ZnAl_2O_4$) and faustite ($(Zn, Cu)Al_6(PO_4)_4(OH)_8.4.5(H_2O)$) co-occur, we are able to highlight a sample from the Fraser Zone in Western Australia; an area prospective for base metal mineralisation[6]. In doing so, we highlight the potential utilisation of the MNA tool in modern mineral exploration.

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