Fluid Evolution and Carbon-Gold Systematics at the Fairview Mine, Barberton Greenstone Belt, South Africa

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The Paleoarchaean Barberton Greenstone Belt (BGB) plays host to a number of gold deposits, with over 350 tons of Au being extracted since its discovery in 1882. Gold has a wide variety of applications, with its most prominent role being how it serves as a safe haven for investors, which was exemplified during the recent Covid-19 pandemic. Of the many deposits within the BGB, one of the most economically significant is the Fairview gold mine in the northwest portion of the belt. Recent work has focussed on the structural aspects controlling mineralisation; however, the chemical controls on mineralisation are still poorly understood. This research focuses on understanding the evolution of ore fluids and characterising graphite found in and around high-grade shear zones.

Underground samples were characterised using scanning electron microscopy and laser ablation-inductively coupled plasma-mass spectrometry and document how variation in carbonate species and sulphide trace element distribution can be used to track temporally separate fluid flow events. Carbon isotope analyses provide insights into the potential source of ore fluids, with black shales of the Fig Tree Group appearing as a likely candidate. Graphite Raman spectroscopy reveals that graphite within shear networks is of nanocrystalline size and has a high degree of structural disorder. Geothermometry calculations based off of Raman spectra of graphite suggest that shear zones were subjected to maximum temperatures of around 400°C. A better understanding of how carbon contributes to gold deposition at Fairview will help geologists discern whether or not graphite is a useful parameter to consider during exploration. Graphite is strongly conductive and is therefore useful during geophysical surveys, which are cheaper and more environmentally friendly than conventional drilling programs. The findings of this research also have significant implications for ore-forming models pertaining to Archaean greenstone belts.