A Trace Element and C-O Isotope Study of Sb-Au Vein-Hosting Carbonate-Talc Schists of the Murchison Greenstone Belt, South Africa

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The Archaean greenstone belts of the Kaapvaal Craton of South Africa host numerous Au and Au-Sb lode deposits. The Murchison Greenstone Belt is composed of a ca. 3 Ga volcano-sedimentary succession metamorphosed to greenschist-amphibolite facies. Across the succession, the rocks are variably carbonatised as a result of sea-floor metasomatism. In the central part of the belt is a zone of sheared carbonate-talc rocks known as the Sb-Line that hosts Sb-Au deposits occurring as quartz-carbonate veins.

We analysed bulk rocks and carbonate minerals from mineralised veins and host-rock, in addition to C-O isotopes, to estimate the source of CO_2-bearing fluids and trace the origin of mineralisation. By comparing data of mineralised rocks from drill core and open pit, and regionally occurring unmineralised rocks, we test the hypotheses whether 1) carbonate of the Sb-Line was mobilised from the carbonatised volcanic rocks of the greenstone belt during deformation and metamorphism (internal derivation), or 2) carbonate formed from CO_2 originated outside the greenstone belt, either in magmas or the mantle (external origin).

Whole-rock analyses of talc-carbonate mineralised rocks and regionally distributed meta-mafic and meta-ultramafic rocks have similar, overall unfractionated chondrite-normalised trace element patterns. In situ analyses of carbonate-talc schist samples indicate coexisting magnesite and dolomite-ankerite with distinct trace element compositions. In particular, fine-grained dolomite-ankerite has overall relatively high REE contents compared with coarse-grained magnesite. In PAAS-normalised plots, dolomite-ankerite displays patterns with depleted light REEs over mid- and heavy REEs, near-flat mid-heavy REE trends, and positive Eu anomalies. The REE compositions of dolomite-ankerite are overall similar to whole-rock analyses. The $\delta^{13}C$ values of mineralised schists range between -6.0 and -3.1‰ and peak at -5‰, contrasting with regional carbonatised rocks with a range of -4.7 to 1.3‰ and a $\delta^{13}C$ peak at -2‰, suggesting contrasting sources of C and implying an external, deep derivation of CO_2.