

Characterisation of ore fluid(s) at the Wallaby Gold Deposit using scheelite.

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The source of mineralising fluid(s) and solutes that formed Archaean low grade gold deposits is controversial. There are two possibilities, a metamorphic fluid and magmatic fluid. One line of evidence that is often used to distinguish between these hypotheses is the oxidation state of the ore fluid(s), because fluids derived from magmatic sources are generally oxidised, whereas fluids derived from metamorphic sources are reduced. Scheelite (CaWO_4), a common accessory mineral associated with Archaean gold deposits, can be used to characterise the oxidation-state, trace element composition, and isotopic ratio of source region of the ore fluid, making it a useful mineral in the study of Archaean gold systems.

Wallaby is a plus 10 million ounce gold deposit located in the Eastern Goldfields Province of the Archaean Yilgarn Craton, Western Australia. It is hosted in conglomerate of dominantly metabasaltic composition. The ore mineral assemblage is albite + Fe-carbonate + pyrite + gold + minor quartz \pm fuchsite \pm scheelite \pm galena. A suite of monzonite-syenite-carbonatite dikes are spatially and temporally associated with the deposit, providing an excellent location to test the magmatic hypothesis for the origin of Archaean gold deposits.

The scheelites were analysed by laser ICP-MS, using its Ca concentration, which was assumed to be stoichiometric (19.47%), as the internal standard. The chondrite normalised REE spidergrams typically have a hump shaped pattern (figure 1). These patterns in scheelite have been explained by previous workers as due to size controlled substitution of REE for Ca in the scheelite crystal structure. The REE patterns show little evidence of Eu anomalies (Fig. 2), which indicates (i) that there was no Eu anomaly in the ore fluid and (ii) that all of the Eu in the fluid was behaving like trivalent Sm and Gd. The oxidation-state of the fluid was therefore high enough to ionise all Eu to its trivalent form. A second indicator of the oxidation-state of the fluid is the substitution of Mo^{6+} for W^{6+} . For Mo^{6+} to be present in the fluid it needs to be relatively oxidised. Molybdenum concentrations of up to 110.4ppm were found with an average of 11.71ppm. The identification of oxidised mineralising fluid(s) is important as it is consistent with a magmatic origin for the fluid.

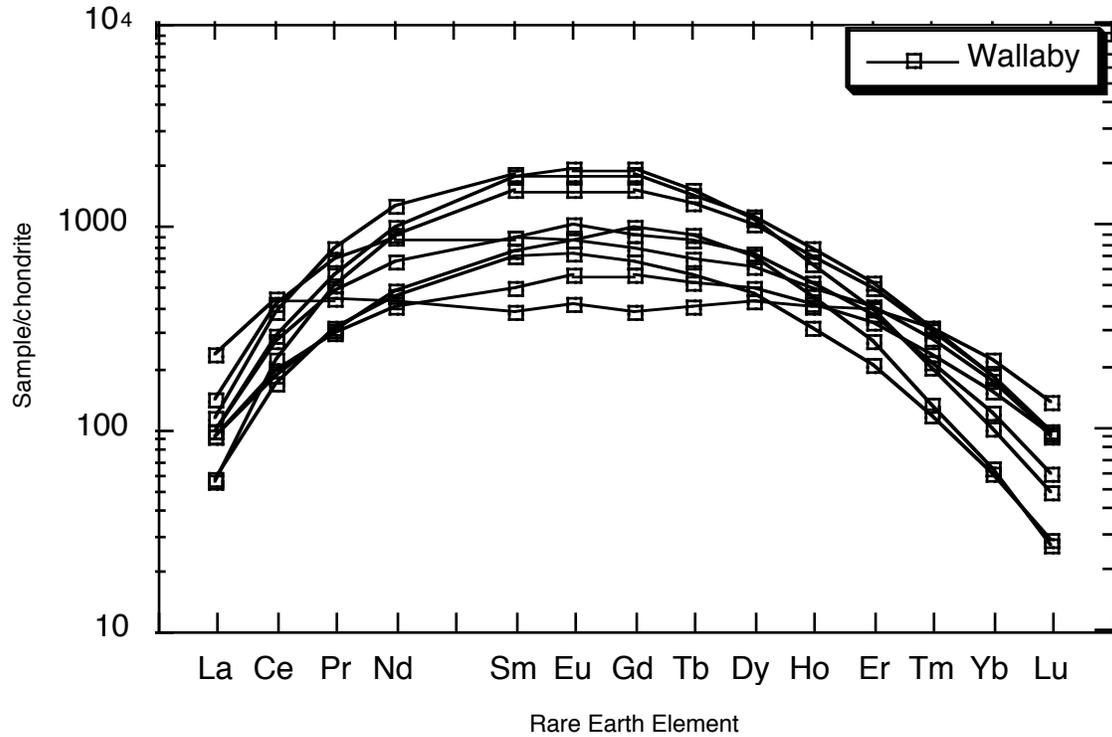


Figure 1. Rare earth composition of scheelite, chondrite normalised. Displaying the typical hump shaped pattern. With one sample deviating from this pattern in the MREE.

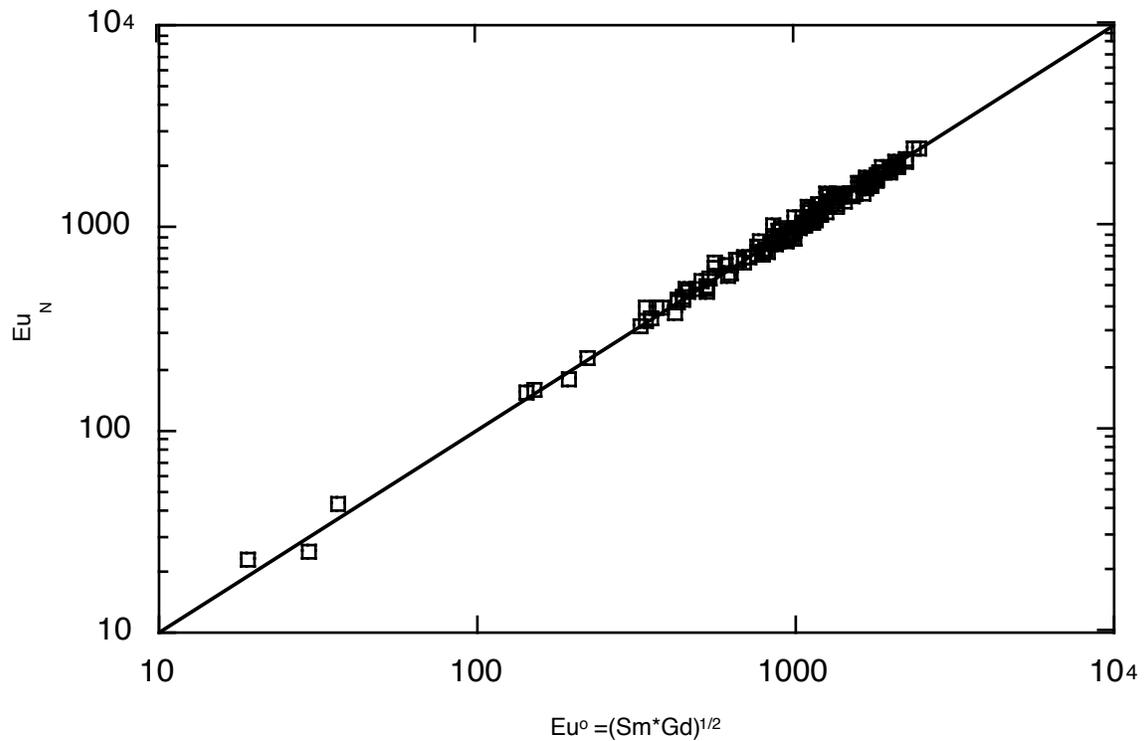
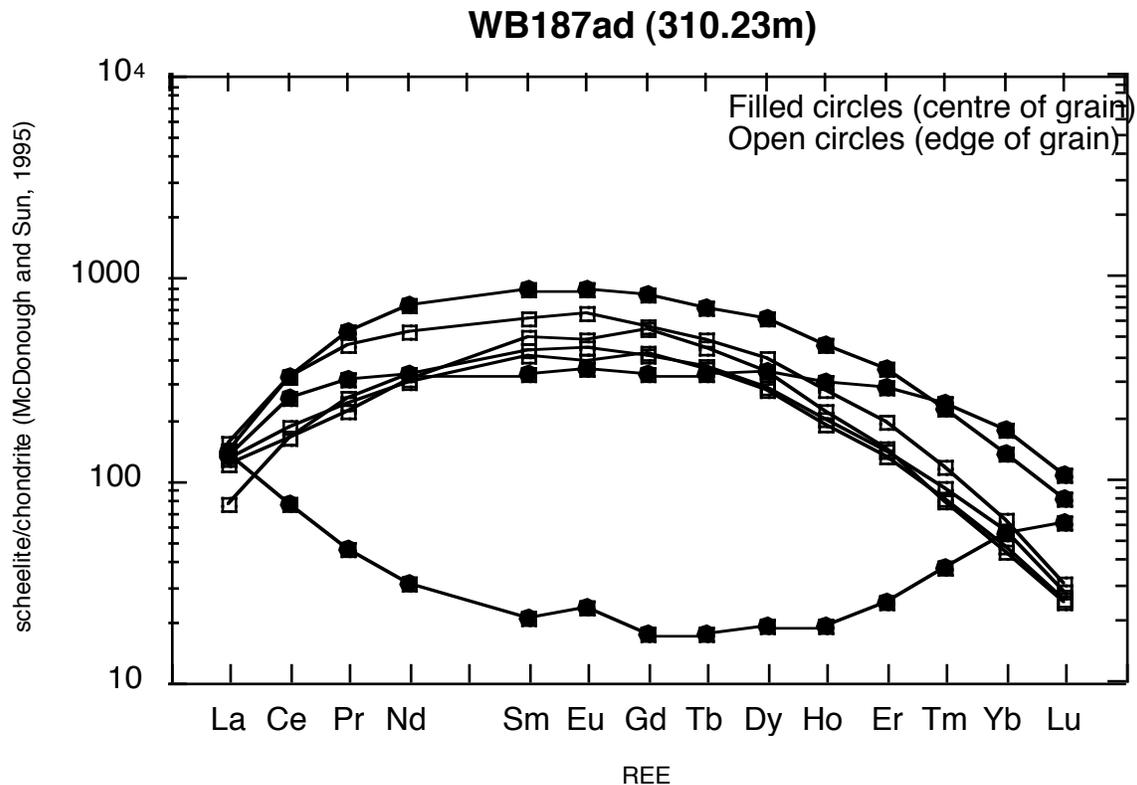


Figure 2. When Eu_N is plotted against Eu^o_N (where $Eu^o_N = (Sm_N^o * Gd_N^o)^{1/2}$) a direct correlation is observed. This indicates that Eu has been substituted into scheelite by the same mechanism as Sm and Gd, and that the mineralised fluid did not have a pronounced Eu anomaly.

Some scheelite show chondrite normalised REE patterns that deviate from the general hump shaped pattern. They are lower in the Middle REE elements while containing light REE and heavy REE consistent with other grains (Figure 3). A single grain of scheelite, which was analysed 7 times across the grain, shows areas of the hump shaped pattern and areas with flat middle earth values. The lower middle REE analyses were generally from the center of the grain with edges of the grain more commonly displaying hump shaped patterns. This indicates that an addition of middle REE to the fluid occurred during mineral growth, either by a) influx of a new or replenished fluid that contains higher REE



content or b) movement of REE from wall rock to the fluid.

Figure 3. Single scheelite grain with multiple analysis, showing variable MREE content.

The host rock of the mineralisation is very high in LREE (1000 * chondrite) and MREE and therefore is a possible source of the REE. To confirm or refute the addition of elements to the mineralising fluid by wall rock interaction, a bulk whole rock sample will be analysed for Sm-Nd, Rb-Sr and Pb isotopes and compared to the values obtained for scheelite. Identifying any wall rock component to the fluid will be important for the interpretation of scheelite isotopic data that is generally assumed to represent the fluid source. The occurrence of Eu and Mo in their most oxidised forms indicates that the mineralising fluid was oxidised even if addition of wall rock elements to the fluid occurred supporting a magmatic source for the fluids.