Potential source of fracture calcite and associated sulfide mineralisation in a Surat Basin coal mine

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Pervasive calcite mineralisation occurs throughout parts of a Surat Basin coalmine. The calcite is present in fractures such as structural joints, cleats, and shears, as well as manifesting as layer parallel sheets, nodules, and permineralisation of the coal matrix. Fluid inclusion microthermometry of fracture calcites indicate both low and high temperature precipitation, with four distinct modes at <70, 130, 250 and 360°C. Coal inclusions within fracture calcite, as well as the coal immediately adjacent to fractures has only mildly elevated vitrinite reflectance relative to the mine average, indicative of short-lived fluid migration events.

The main population of fracture calcite $\delta^{13}C$ values (n = 36) are negatively correlated with $\delta^{18}O$ ($R^2 = 0.89$), with $\delta^{13}C$ ranging from -1.84 to 20.46 and $\delta^{18}O$ from 15.2 to 25.8 per mil. This may be related to fractionation effects between oxidized and reduced carbon species at temperatures greater than 200 ºC, coupled with mixing of different waters.

High precision ICP-MS analysis of the fault calcite found it to be more enriched in certain trace elements such as Cr, Rb, and Be relative to the other coal fractures, and most of the calcite samples have the signature of hydrothermal veins in a plot of Yb/Ca against Yb/La. All but one of the calcites are HREE-enriched, with the only LREE-enriched sample associated with multiple sulfide minerals within a fault.

Bornite and pyrite often occur intergrown with the fracture calcite either as spherules or in the case of shear fractures as syntectonic lineations. Fracture azimuths of the major orthogonal coal fracture networks (average joint spacing of 1.5 to 2.0 m) were diagonally aligned relative to north-trending faults. Given that both calcite and sulfide mineralisation was observed to have grown around corners of joint intersections, the mineralisation occurred whilst both joint orientations (NW-SE and NE-SW) were open for fluid flow, and possibly during fault activation. We are presently attempting to date the fracture calcite using techniques such as U-series, U/Pb, and Sm-Nd dating, to determine whether or not the mineralisation represents a geothermal anomaly related to a SW-trending line of recent volcanic activity.