CHARACTERIZATION AND GAS ANALYSIS OF FLUID INCLUSIONS IN ARCHEAN BARITES FROM THE WARRAWOONA GROUP, NORTHWESTERN AUSTRALIA.

1. NRC-Research Associate, SN-4/NASA-JSC, Houston, TX.
2. SN-4/Experimental Planetology, NASA-JSC, Houston, TX.
3. LEMSCO/JSC, 1830 NASA Rd. 1, Houston, TX 77058.

Our examination of the fluid inclusions in 3.4-b.y.-old barites from the North Pole deposit have shown that four coexisting inclusion types are present: (1) large (20-40 micron) irregular, morphologically distinct inclusions which may contain one, two, or three phases, commonly they contain only an aqueous and a vapor phase, but may also contain an aqueous phase plus liquid and vapor CO₂, or only a single phase; (2) smaller (10-30 micron) roughly equant three-phase inclusions having liquid and vapor CO₂, and commonly an additional pale yellow daughter mineral; (3) much smaller (1-10 micron) two phase secondary inclusions aligned along planes in the barites, and (4) intermediate sized (5-15 micron) one-phase inclusions of pale yellow or brown color. The occurrence of this variety of inclusion types indicates that the barites have not been thoroughly recrystallized during a later (2.95-b.y.-old) lower-greenschist facies metamorphic event, as evidenced by the presence of the assemblage calcite+chlorite+actinolite+phrenite in the surrounding metavolcanic host rocks (Hickman, 1981).

The type (1) inclusions most likely represent primary fluid inclusions in the barite. Textural relationships show no obvious alignment of the inclusions along healed fractures. The variety of liquid/vapor ratios can be explained by leakage of fluids into or out of the inclusions during later tectonism. Although it cannot be assumed with certainty that they formed from the original mineralizing fluid, it is clear that they are older than type (2) and type (3) inclusions.

The high-density type (2) inclusions, which contain both liquid and vapor CO₂, have phase relations consistent with their having formed from fluids generated by the decarbonation/dehydration reactions during the lower greenschist facies metamorphic event. A likely reaction involving observed metamorphic minerals in the vicinity of the deposit which could generate the observed fluids in the type (2) inclusions is:

\[ 4 \text{calcite} + \text{chlorite} + 8 \text{quartz} = \text{phrenite} + \text{actinolite} + \text{CO}_2 + \text{H}_2\text{O} \]

Textural relations indicate that the type (3) inclusions post-date all the other inclusion types and were likely formed during the waning stages of the metamorphic event. Because the last tectonic event affecting the Pilbara Block, which hosts the barite deposits, is dated at 2.7-b.y.-old (Marston and Groves, 1981), all the inclusion types are at least this old. These observations also imply that although barite is a notoriously 'leaky' mineral for fluid inclusion studies, the North Pole barites have been able to contain CO₂-H₂O fluids at internal
pressures of greater than 60 bars (because they contain coexisting liquid+vapor CO₂) for at least 2.7-b.y.

Apparently, replacement of the gypsum by barite took place in a 3.4-b.y.-old hydrothermal event, which coprecipitated galena and sphalerite, a common mineral assemblage in Phanerozoic volcanogenic sulfide deposits. Other workers have shown that the barites formed by replacement of pre-existing gypsum, and that H₂S is present in some (as yet unidentified) types of inclusions (Lambert et al., 1978, Rankin and Shepherd, 1978). The presence of H₂S in the inclusions indicates that the fluid inclusion contents have not undergone significant oxidation due to hydrogen gas diffusion out of, or oxygen diffusion into the inclusions, as H₂S is known to readily oxidize to SO₄²⁻ or native sulfur. Common lead dating of galenas intergrown with the barites gives an age of formation of 3.4-b.y., which implies a similar age for the barites.

To further characterize the inclusion types and determine whether or not representative samples of the 3.4-b.y.-old mineralizing fluids are contained in the type (1) inclusions, we are using a laser microprobe-gas chromatograph (Gibson et al. 1982) to identify and measure the gas contents of individual inclusions or groups of inclusions of a common type. Using the microanalyser, CO₂ has been positively identified in the type (2) inclusions, in which the presence of CO₂ was predicted from heating/freezing phase relations. We are examining the various inclusion types for other gases including hydrocarbons, particularly in the type (4) inclusions. Positive identification and quantification of the gas contents is being accomplished both by coinjection of known gas amounts and by analysis of synthetic minerals containing fluid inclusions of known gas contents. If samples of the primary mineralizing fluids can be identified, comparison of the gas contents of more recent analogous hydrothermal fluids with the fluids contained within the barites may help to identify whether or not the redox state of fluids in the upper crust has undergone significant changes since the early Archean.

References:


