

**Paragenesis, Re-Os Systematics, and *in situ* Sulfur Isotopic Composition of the Anarraaq Zn-Pb-Ag-Ba Deposit, Red Dog District, Northwestern Alaska, USA**

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The Anarraaq Zn-Pb-Ag-Ba deposit is located in the Red Dog District in northwestern Alaska. The Anarraaq sulfide ore body is hosted by carbonaceous mudstones and calcareous debrites of the Mississippian Kuna Formation. Also in the Kuna, approximately 60 m above the sulfide body, is a massive barite deposit. An organic-rich mudstone from approximately 20 m above the massive sulfide ore body yields a Re-Os isochron age of  $339.2 \pm 8.6$  Ma with an unradiogenic initial  $^{187}\text{Os}/^{188}\text{Os}$  value of  $0.375 \pm 0.019$ . This age is within uncertainty of ore-stage pyrite dated elsewhere in the Red Dog District.

A detailed paragenesis for the Anarraaq sulfide deposit has been constructed from observations from hand specimen and thin-section petrography and back-scattered electron imaging. Pyrite ( $\pm$  marcasite) occurs in a variety of textures including 1) framboids, 2) euhedral overgrowths, 3) massive pyrite, 4) ore-stage pyrite / marcasite in which concentric growth zoning is common, 5) coarse-crystalline veins, and 6) cubic pyrite. Pyrite phases 1-3 pre-date zinc mineralization and are interpreted to have formed during early diagenesis. Textural evidence, as well as rare remnant barite inclusions in pyrite and sphalerite, indicate barite was also part of the earliest diagenetic assemblage and was replaced by the ore minerals. Phase 4 pyrite / marcasite both crosscut and are crosscut by sphalerite and electron probe microanalysis shows this generation of pyrite contains zones enriched in lead (up to 3.5 wt. % in pyrite), arsenic (up to 1.2 wt. % in pyrite), and / or antimony (up to 0.44 wt. % in pyrite). Iron-rich sphalerite is interpreted to be the earliest phase of zinc mineralization. Later iron-poor sphalerite is most commonly precipitated with a euhedral to microcrystalline quartz phase that is widespread and volumetrically important. Galena is late in the ore sequence, is locally associated with dolomite crystals, and displays textures indicating it is far from equilibrium with earlier sulfide phases. Phase 5 pyrite crosscuts sphalerite but contains local minor element enrichments similar to those of phase 4 pyrite. Phase 6 cubic pyrite occurs in quartz-calcite veins interpreted to have been formed during the Cretaceous Brookian orogeny. Secondary ion mass spectrometry (SIMS) of sulfur isotopes in pyrite and barite will be used to interpret source of sulfur and reduction processes in the Anarraaq deposit over time.