

## Zircon age gaps in the Great Proterozoic Accretionary Orogen: a possible connection between the 1.5-1.3 Ga granite-rhyolite province and subduction erosion

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Collisional zircon ages record the assembly of Nuna between 2100-1900 Ma (early phase) and 1900-1800 Ma (main phase). During this time collisional convergent margins shifted to the perimeter of Nuna forming the possibly contiguous Great Proterozoic Accretionary Orogen (GPAO) in Laurentia-Baltica-Azonania (1900-1300 Ma). Accompanying this shift is an increase in the proportion of juvenile crust as reflected by eHf values in detrital zircons. Major gaps in both *in situ* and detrital zircon age spectra occur at 1750-1700 (Baltica, Amazonia), 1600-1500 (Laurentia), and 1300-1200 (all three cratons). The two oldest age gaps in the GPAO may be due to subduction erosion related to initial rifting of Siberia from Baltica and of Amazonia from West Africa (1750-1700 Ma) and Laurentia from Siberia (1600-1500 Ma). The 1300-1200-Ma gap may record major breakup and limited dispersal of the supercontinent. Depending on how much Paleoproterozoic crust is buried beneath the margin of the Grenville orogen, as much as 30% of the original crustal volume of the GPAO may have been lost by subduction erosion. Subduction of 1600-1500-Ma continental crust along the coast of Laurentia may have resulted in enrichment of the mantle wedge above a low-dip subduction zone between 1500 and 1300 Ma as the convergent margin migrated inwards towards the center of the supercontinent. This may have given rise through multi-stage melting of the mantle wedge and its mafic melting products to the extensive 1500-1300 Ma granite-rhyolite province in south-central and southwestern Laurentia.

## Integrated Sr-Pb-S-O-Cu Isotopes of Sulfide and Mn-oxide Mineralization of the Boléo Cu-Co-Zn-Mn District, Baja California Sur, Mexico

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### Introduction

Stable and radiogenic isotope composition of stratiform Cu-Co-Zn-Mn mineralization from the Boléo district of the Miocene Santa Rosalía basin, Baja California Sur, are used to constrain the source and evolution of fluids and the mechanisms responsible for sulphide and oxide deposition. Mineralization consists of finely disseminated sulfides and Mn-Fe-Cu-oxides within claystones and tectonically triggered debris flows that occur near the base of five cyclical fan-delta sequences of the Boléo Formation, which developed in response to development of the Proto-Gulf of California.

### Results

Newly acquired isotope data and data compiled from [1,2] are provide in Table 1. Results from this study are comparable to those recently reported by [3].

**Table 1:** Range in radiogenic isotope compositions of Boléo manto Mn oxides and sulphides.

Phase	<sup>87</sup> Sr/ <sup>86</sup> Sr	<sup>208</sup> Pb/ <sup>204</sup> Pb	<sup>207</sup> Pb/ <sup>204</sup> Pb	<sup>206</sup> Pb/ <sup>204</sup> Pb
Mn-ox	0.70750 to 0.70584	38.70 to 38.40	15.67 to 15.57	18.80 to 18.70
Sulfide	n/a	38.49 to 38.41	15.60 to 15.57	18.80 to 18.72
	$\delta^{18}\text{O}$ (‰)	$\delta^{34}\text{S}$ (‰)	$\delta^{65}\text{Cu}$ (‰)	
Mn-ox	12.5 to -2.9	n/a	1.86 to 0.50	
Sulfide	n/a	1.8 to -13.7	-0.39 to -2.72	

### Discussion and Conclusions

Strontium and Pb isotopes indicate that the ore-forming brines originated as basin seawater that interacted with basement volcanic and plutonic rocks and the evaporite sequence that underlies the Boléo Formation.  $\delta^{34}\text{S}$  values of pyrite-Cu-sulfide-bearing mineralization show that sulfur originated from bacterial sulfate reduction, with more enriched  $\delta^{34}\text{S}$  values indicating sulfate reduction at higher temperatures during the infiltration of the metal-bearing brines. The  $\delta^{65}\text{Cu}$  composition of sulfides is consistent with reaction of Cu-rich fluids ( $\delta^{65}\text{Cu} \approx 0\%$ ) with a framboidal pyrite reductant [e.g., 4]. Higher  $\delta^{65}\text{Cu}$  values for Mn oxides are the product of abiotic oxidative leaching of chalcocite-covellite mineralization [e.g. 5], during the waning stages of discrete hydrothermal episodes.

[1] Conly et al. (2006), *Miner. Dep.* **41**, p. 127-151. [2] Conly et al. (2011), *Econ Geol.* **106**, p. 1173-1196. [3] Del Rio Salas (2011), PhD Thesis Univ. Arizona, 259p. [4] Asael et al. (2006), *Geochim Cosmochim Acta* **70**, A23-A23. [5] Mathur et al. (2005), *Geochim Cosmochim Acta* **69**, p. 5233-5246.