

The preservation of sulfur isotope signals in low sulfate systems: How low is low?

M. GOMES^{1*} AND M.T. HURTGEN¹

¹Department of Earth and Planetary Sciences, Northwestern University, Evanston, IL, USA (*correspondence: maya@earth.northwestern.edu)

The sulfur (S) isotope difference between sulfates and sulfides preserved in sedimentary rocks ($\Delta^{34}\text{S}$) has been utilized to reconstruct ancient marine sulfate levels and oxygenation of the early Earth. Many modern lake systems have low sulfate levels (<1mM) and thus serve as useful analogs to low sulfate oceans of the early Earth. In these low sulfate systems, the preserved $\Delta^{34}\text{S}$ is typically lower than the magnitude of S isotope fractionation due to microbial S cycling (ϵ_{SR}) because $\Delta^{34}\text{S}$ is quantified as the S isotope difference between S phases (sulfate and pyrite) formed in different portions of the water column/sediment. This is a result of the reservoir effect where, at low sulfate levels, the S isotope composition of the sulfate reservoir becomes enriched in the heavy isotope of S (^{34}S) as microbial sulfate reduction occurs in anoxic portions of the water column/sediment. In turn, dissolved sulfide becomes enriched in ^{34}S with depth as it is formed from a ^{34}S -enriched sulfate reservoir. The result of this effect, which follows Rayleigh distillation theory, is that the S isotope composition of pyrite formed from ^{34}S -enriched sulfide is close to the surface water sulfate S isotope composition and $\Delta^{34}\text{S}$ is low. The reservoir effect is particularly important at low sulfate levels because the sulfate reservoir becomes enriched in ^{34}S more rapidly when the sulfate reservoir is small. However, it is not clear how low sulfate levels must be for the reservoir effect to place constraints on $\Delta^{34}\text{S}$ values. We use a combined reactive transport and Rayleigh distillation model to assess when the size of the sulfate reservoir affects $\Delta^{34}\text{S}$ values. We then compare this model to modern euxinic systems in order to better constrain how $\Delta^{34}\text{S}$ values can be used to interpret marine sulfate levels in the past.

Testing of Ce and Eu anomalies in natural zircon as a sensor of oxygen fugacity for Archean magmas

A. GONCHAROV^{1,2} AND N. KOROLEV²

¹St. Petersburg State University, Faculty of Geology, Russia (a.goncharov@spbu.ru)

²Institute of Precambrian Geology and Geochronology RAS, St. Petersburg, Russia

The recent experimental calibrations of cerium and europium partitioning between melts and zircons [1, 2] allow calculating Ce and Eu anomalies in magmatic zircons as a function of oxygen fugacity. We ran testing on current database of natural zircons from Precambrian complexes (~3500 - 2000 Ma) of the Voronezh Crystalline Massif (Eastern-European platform) to estimate redox conditions in parental magma sources.

The initial limitation was that CHUR normalized Ce and Eu anomalies in studied zircon cores show a wide variation in complex as well as in the sample, apparently due to the different origin. To separate zircon material in basic and silicic rocks produced by metamorphic or other endogenic process and identify captured or inherited zircons from ones with magmatic genesis has been used recently developed Hf-Nd isotopic systematics [3].

A study of Ce and Eu in selected zircon minerals has allowed an assessment of the redox conditions in magma source that prevailed in the upper mantle during the formation of ancient basement on Eastern-European platform. The obtained oxygen fugacity value varies from -1 to +2 ΔFMQ for most of basic complexes at temperature range: 800-1000°C and from 0 to +4 ΔFMQ at 700-900°C. Unfortunately, we did not find any correlations between ages and oxygen fugacity values in same complex, the only correlation observed is evolution of redox condition through time due to the different geodynamic settings of magma source.

[1] Trail *et al.* (2012) *Geochimica et Cosmochimica Acta* **97**, 70-87. [2] Burnham & Berry (2012) *Geochimica et Cosmochimica Acta* **95**, 196-212. [3] Lokhov *et al.* (2009) *Regional geology* (in Russian), **38**, 43-53.