

Sulfate Reduction and Sulfur Isotope Fractionation in Modern Evaporite Ponds

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The oldest evidence for sulfate reduction is found in ~3.5 billion year old barites from North Pole, Australia (Shen *et al.*, 2001). These rocks are thought to have first precipitated as gypsum in a marine evaporitic setting. Sulfides are fractionated compared to sulfate by 8 ‰ to 22 ‰, with a mean of 11.6 ‰. This is well within the range of fractionations observed for pure cultures of sulfate reducers, ~10-25 ‰ (Kaplan and Rittenburg, 1964).

A modern analogue to this ancient environment is found in the concentrating ponds of the Eilat Salt Company, Israel. Here, stratified populations of microbes exist in gypsum crust which house active sulfate reducers (Sørensen *et al.*, 2004). These communities are well adapted to the high salinities found in the evaporation ponds (Sørensen *et al.*, 2004)

Fractionation and sulfate reduction rate studies were carried out using a plug flow-through reactor (Roychoudhury *et al.*, 1998). The crusts were separated into two layers, the top 2 cm containing the colorful, phototrophic organisms and the bottom 2 cm, with the non-phototrophic communities.

Fractionations of 25 ‰ were found in both the top (oxic) and (anoxic) bottom layers. Sulfate reduction rates in the bottom 2 cm ranged from 0.02 to 2.65 nmol cm⁻¹ hr⁻¹. The sulfate reduction rates found in the upper 2 cm are higher, ranging from ~13 to ~20 nmol cm⁻¹ hr⁻¹.

The sulfur isotope fractionation found in modern gypsum crust microbial communities is of the same magnitude as found in Archean barites, lending support to the hypothesis that the sulfides here were produced by microbial activity.

References

- Kaplan I. and Rittenburg, S.C. (1964) *J. of Gen. Micro.* **34**, 195-212.
- Roychoudhury A. N., Viollier E., and Van Cappellen P. (1998) *Applied Geochemistry* **13**, 269-280.
- Shen Y. A., Buick R., and Canfield D. E. (2001) *Nature* **410**, 77-81.
- Sørensen K. B., Canfield D. E., and Oren A. (2004) *App.Env.Micro* **70**, 1608-1616.

Mobility of REE, Sr, Zr and other rare elements during late stage processes in peralkaline rocks: A mineralogical perspective

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Both over and undersaturated peralkaline syenites are notable for their enrichment in rare elements and complex mineralogy. In contrast to common plutonic aluminous granites and syenites, peralkaline syenites are typified by extended crystallization intervals (~1000-450°C) with a continuum from late-stage magmatic crystallization to alkaline hydrothermal residua. Interaction of the latter with previously-formed minerals can result in distinctive auto-metasomatic processes that result in the mobilization of many elements which are commonly considered as incompatible and/or immobile. Peralkaline complexes are characterized by distinctive styles of low temperature alteration and replacement depending upon whether the hydrothermal residua have either formed discrete pegmatites (e.g. Lovozero) or reacted in -situ (e.g. Pilansberg), with previously-formed mineral assemblages. In some instances, (e.g. Strange Lake) externally-derived fluids have had a significant influence on the style of alteration. Elements which can be redistributed during metasomatic transformations involving alkaline-Cl-F-bearing low temperature fluids include the rare earths, Zr, Hf, Nb, Ta, and Sr. This mobility has consequences for ore deposits associated with alkaline rocks, whole rock geochemical studies and for geochronology based on the Lu-Hf, Sm-Nd and Rb-Sr systems. Examples illustrating the mineralogy of metasomatic miassicitic, agpaitic and hyperagpaitic replacements are presented for eudialyte and other minerals from Ilimaussaq, Pilansberg, Pocos de Caldas, Gordon Butte, and Pajarito Mountain together with experimental data on the solubility of Nb and Ta in Ca-O-H-F fluids.