Mo scavenging by manganese oxyhydroxides and the seawater Mo isotope record in oxic sediments

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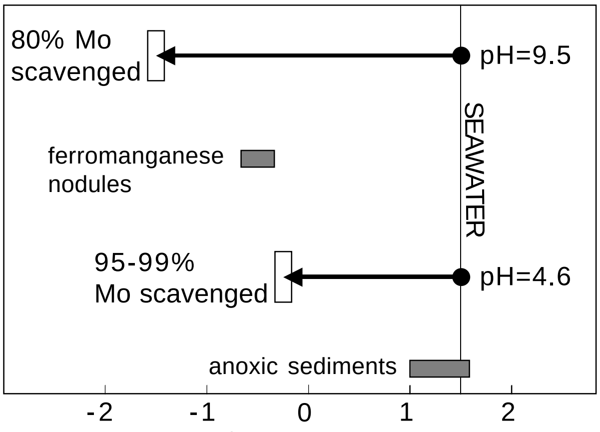
Our studies of the Mo isotopic composition in anoxic sediments, in oxic marine FeMn nodules, in seawater, and in laboratory experiments, have led us to infer that the largest effective fractionation of Mo isotopes in the oceans occurs during the scavenging of Mo onto Mn oxyhydroxide (Barling *et al.*, 2001). We therefore hypothesize that the balance between Mo removal to anoxic and oxic sediments controls the isotopic composition of Mo in seawater (Mo_{SW}) and that the isotopic record of Mo_{SW} could in turn be used as a monitor of the degree of global oceanic anoxia through time. While anoxic sediments broadly record Mo_{SW}, it is not clear whether oxic sediments could also be used to track Mo_{SW}.

For such a record to be useful, $\Delta^{97/95}Mo_{MnOx\text{-}SW}$ (i.e. $\delta^{97/95}Mo_{MnOx}$-$\delta^{97/95}Mo_{SW}$) needs to be ~ constant. Thus, the adsorption of Mo onto Mn oxyhydroxides needs to be investigated to determine whether natural variables are likely to have a significant effect on $\Delta^{97/95}Mo_{MnOx\text{-}SW}$.

Experimental results indicate that the degree of fractionation between Mo scavenged by Mn oxyhydroxide precipitates and residual Mo in solution is on the order of $\Delta^{97/95}Mo_{MnOx\text{-}SW}$ (Figure). Assuming a Rayleigh fractionation model for these experiments, there is a slight pH dependence on the characteristic fractionation factor ($\alpha = 1.00038 \pm 0.00024$) of the scavenging process.



Use of Mo_{MnOx} as a monitor of Mo_{SW} through time will also depend on whether or not scavenged Mo is readily exchangeable with Mo in ambient solutions. The experimental investigation of this is our current goal.

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Simulating primary phase equilibria for the parental magma and early cumulates of the Kiglapait intrusion

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Physical constraints evidence for magma emplacement process should not be treated as a filling magma chambers with a homogeneous liquid. In fact, intrusive magmas come to the reservoirs with some amount of primary crystals controlling convective styles at early to middle stages of solidification. With the purpose to estimate the initial temperature, crystal-melt proportions, and compositions of the parental suspensions we have developed a special technique, called *geochemical thermometry* (*Ariskin,* 1999), including phase equilibria calculations for the most primitive cumulates and average weighted compositions obtained by summation over the whole section (*AWC*). Using the COMAGMAT-3.65 model, simulations of crystallization at P=2.2 kbar and *WM* buffer conditions have been carried out for six primitive rocks and the *AWC* of the Kiglapait intrusion. The results of the modeling define the most probable range of the initial temperatures (1220-1240°C) at which the primary troctolitic cumulates could be formed: the average value of 1230°C was considered to correspond to the “emplacement temperature”. Combining the temperature with the modeled *AWC T-X* trajectory both primary phase proportions and compositions have been determined (table).

Phases	Primitive troctolites	Modeling *AWC*
	Primary mineral compositions, wt.%	
Pl	$An_{66.7\pm1.6}$	$An_{66.6}$
Ol	$Fo_{78.8\pm1.0}$	$Fo_{79.0}$
	Primary phase proportions, wt.%	
Melt	30-56	75.2
Pl	36-56	20.0
Ol	2-26	4.8

The results evidence for the early troctolites contained of 30-40% (as an extreme case, 56%) intercumulus liquid, whereas the parental magma brought to the camera ~20% *Pl* and 5% *Ol* crystals. The modeled composition of the liquid fraction of the initial suspension is shown to represent a high-Al silica-depleted and iron-enriched melt that strongly endorses the conclusion on the occurrence of the Al-Fe troctolitic magmas associated with Proterozoic anorthosites (*Olson and Morse*, 1990). A discrepancy between the calculated and observed ($Fo_{67\text{-}68}$) olivine compositions is interpreted to be resulted from the post-cumulus re-equilibration of the primary *Ol* crystals with the iron-enriched intercumulus liquid.

References

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Olson K.E. and Morse S.A. (1990) Nature. **344**, 760-762.