Highly Siderophile Elements and Planetary Accretion

J.H. JONES[1], C.R. NEAL[2], AND J.C. ELY[2]

[1]SR, NASA/JSC, Houston, TX 77058
(jjones2@ems.jsc.nasa.gov)
[2]Dept. Civil Engineering and Geological Sciences University of Notre Dame, Notre Dame, IN 46556
(Clive.R.Neal.1@nd.edu; ely.1@nd.edu)

Analyses of highly siderophile elements (HSE) in martian (SNC) meteorites indicate that Pt behaves indifferently during basalt genesis [1]. The SNC suite is a mixture of diverse lithologies: a dunite, augite cumulates, basalts, evolved basalts, and partial cumulates. But despite this diversity, the Pt in the SNC suite is remarkably constant (6.2 ± 3.1 ppb), and we therefore infer that D^{Pt} ~1 during basalt genesis/fractionation. This is in sharp contrast to Os and Ir, whose abundances in SNC's vary by ~10^4 X.

We attribute this Pt partitioning behaviour to its valence and ionic radius. Both quantum arguments and experiments [2] indicate that Pt in silicate systems exists as Pt^{2+}. Therefore, Pt can substitute into mafic silicates without requiring charge balance. Secondly, the ionic radius of Pt^{2+} is 0.80 Å , which compares to 0.72 Å and 0.61 Å for Mg^{2+} and Fe^{2+}, respectively [3]. Therefore, Δr for Pt-Mg is about the same as that of Fe-Mg. Since Fe^{2+} behaves rather indifferently during basalt fractionation and petrogenesis, we should expect similar behaviour from Pt.

If D^{Pt} is truly ~1, we may use the SNC Pt abundances to estimate the Pt content of the martian mantle, which would also be ~6 ppb. We compare this concentration to the Pt content of the Earth's upper mantle, 6.5 ± 0.8 ppb, and find these values are indistinguishable. The Pt concentration of the Earth's depleted mantle is also in this range [4], further supporting the indifferent nature of Pt during basalt genesis. Further, analyses of low-Ti mare basalts indicate that Pt in the Moon (7.7 ± 1.6 ppb) is very similar to the Pt concentrations of the Earth and Mars [5].

This similarity of HSE concentrations among the terrestrial planets is not expected from the late veneer (LV) hypothesis. Planets at different heliocentric distances are expected to have seen different fluxes of LV material. For the Earth and Mars, this difference is estimated to be 2 X [6]. And if the LV was well mixed into planetary mantles, geometry considerations dictate that smaller bodies will have proportionally higher HSE concentrations than larger bodies. The net effect of these considerations is that we expect the Moon and Mars to have ~4 X higher HSE concentrations than the Earth. Such is not observed, so it may be that we must find alternatives to the LV hypothesis.

References

[1] Jones J.H., et al. (2002) *Chem. Geol.* Submitted. [2] Borisov A., et al. (1994) *Geochim. Cosmochim. Acta* 58, 705-716. [3] Shannon R.D. (1976) *Acta Cryst.* A32, 751-767. [4] Brandon A.D. et al. (2000) *E.P.S.L.* 177, 319-335. [5] Jones J.H., et al. (2002) *Lunar Planet. Sci. XXXIII*, #1194. [6] Ivanov B.A. (2001) In *Chronology and Evolution of Mars*. pp. 87-104, ISSI, Bern.

Modelling an in situ test of PCE oxidation using permanganate

S. JORDANA[1], J. GUIMERÀ[1], L. DURO[1], J. A. DOMÈNEC[2] AND J.M. SUBIRANA[2]

1 ENVIROS, PTV, Cerdanyola del Vallès 08290, Spain
(sjordana@quantisci.es) (jguimera@) (lduro@)
2 Junta de Residus, Dr. Roux 80, 08017 Barcelona, Spain
(subirana@junres.es) (domenec@)

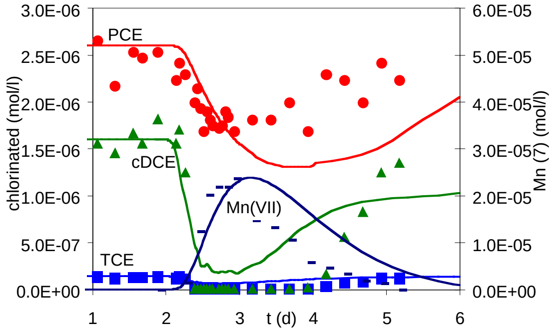
In situ experiment

We conducted a pilot test in an aquifer polluted by organic chlorinated solvents (PCE, TCE, DCE, see table) consisting of a concentrated injection of $KMnO_4$ and a long term pumping from a borehole 13 m downstream. The reactant slug was 10 kg of commercially available $KMnO_4$ injected during 3.2 h along with 680 l of water. Extraction rate was maintained constant for 10 d at a 4.75 l/s.

Modelling results

The experiment was modelled with PHAST (Parkhurst et al., 2000), the domain being a grid of 10m×10m×20m. The hydrodynamic parameters were calibrated using the results of a tracer test. The chemical processes considered were the oxidation of the chlorinated ethylenes by Mn (VII) as described in Yan and Schwartz (1999). 2nd order kinetics reaction was used for PCE, while the rest followed a 1st order reaction. No other electron donors such as OM were considered and the injected Mn was adjusted for the modelling. The "best fit" parameters used in the model are listed below. The computed (line) vs. measured (dots) concentrations are shown in the plot below.

Parameter	PCE	TCE	cDCE
Mn_{max}/Mn_{min} (mol/l)	$10^{-5}/10^{-6}$	10^{-6}	10^{-6}
$k_{1\,(sec^{-1})}$	10^{-5}	10^{-3}	$5.0 \cdot 10^{-3}$
k_2 (mol^{-1}l/sec)	0.66	-	-
d.t. (mol/l)	10^{-8}	10^{-8}	10^{-8}
C_0 and C_{bc} (mol/l)	$2.6 \cdot 10^{-6}$	$1.4 \cdot 10^{-7}$	$1.6 \cdot 10^{-6}$
Mn_{injec} (mol/l)	$3.73 \cdot 10^{-2}$ (≈_ of the actual)		



Conclusions

The model reproduces the drop down of the chlorinated but the recovery is poorly described. The kinetic reaction constants used have been calibrated to reproduce the data.

References

Parkhurst, D.L., Kipp, K.L. and Engesgaard P. (2000), PHAST User's guide. USGS.

Yan, Y. E. and Schwartz, F. W. (1999), J. Cont. Hydrol. 37, 343-365.