Basalt weathering rates on Earth and the duration of water on Mars

E.M. HAUSRATH[1], A.K. NAVARRE-SITCHLER [1], P.B. SAK[2], C. STEEFEL[3] AND S.L. BRANTLEY[1]

[1]Department of Geosciences, Penn State University, University Park, PA 16802 (emh191@psu.edu)
[2]Department of Geology, Dickinson College, Carlisle, PA 17013
[3]Earth Sciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA 94720

Understanding the duration of time that Martian rocks were exposed to liquid water is of great interest because it influences the interpretation of the climate history and the potential for life on that planet. The presence or absence of primary minerals may provide constraints for the presence, duration and characteristics of liquid surface water on Mars.

Weathering rates are very sensitive to the pH of the reacting fluid. If pH values of terrestrial and Martian weathering solutions were similar, then mineral persistence ages on Mars are likely to be $\geq$ those on Earth. We present a compilation of field terrestrial persistence ages for 8 common rock-forming phases (plagioclase, volcanic glass, quartz, feldspar, micas, pyroxene, amphibole, and olivine) collected from dated chronosequences representing a wide climatic spectrum ranging from -10°C to 30°C mean annual temperature and 400 mm to 4500 mm mean annual precipitation. The extent to which these minerals persist may help constrain the rates at which primary phases weather under field conditions on Earth, and likely represent minimum mineral persistence times on Mars if pH values were similar.

However, Mars weathering solutions may have been more acidic than on Earth. Relative mineral dissolution rates at different pH values can be predicted from laboratory dissolution experiments. Here we compare relative mineral weathering rates observed in the field with laboratory predicted trends. Relative mineral weathering rates observed for basalt in Svalbard (Norway), Pennsylvania,and Costa Rica are explainable by pH. These results suggest that the pH-dependence of laboratory rates can be used to interpret relative mineral persistence on Mars to yield information about the pH of the reacting fluid.

We also interpret both terrestrial and Martian weathering profiles using reactive transport modeling, which can yield insights into the duration of weathering. The interpretation of weathering profiles on Mars is a promising approach to study that planet's aqueous history, and highlights the need for additional depth profiles.

The generation and evolution of the continental crust

CHRIS HAWKESWORTH[1] AND TONY KEMP[2]

[1]Department of Earth Sciences, University of Bristol, Bristol, BS8 1RJ UK (c.j.hawkesworth@bristol.ac.uk)
[2]School of Earth Sciences, James Cook University, Townsville QLD, 4811 Australia (tony.kemp@jcu.edu.au)

Detrital and inherited zircons encapsulate a more representative record of igneous events than the rock record, and their hafnium isotope ratios reflect the time since the source of the parental magmas separated from the mantle. O and Hf isotope ratios on well-dated zircons are used (i) to distinguish crust formation ages that reflect involvement in the sedimentary cycle, and those that do not, and (ii) to reconcile the crust formation ages of material whose isotope ratios reflect evolution in the igneous and sedimentary reservoirs.

Global peaks in juvenile igneous activity have been identified at 2.7, 1.9 and 1.2 Ga from the geological record. An initial study on samples from the Lachlan Fold belt revealed sharp peaks in Hf model ages in zircons with $\delta^{18}O$ of < 6.5 per mil at 1.9 Ga and 3.3 Ga. It is rare to find zircons with similar crystallization and Hf model ages. At issue are the links between such peaks in the geological and zircon records, and the time periods between initial crust formation and the generation of high silica magmas that might crystallize zircon in different tectonic settings.

The sedimentary record shows no evidence for major pulses of crust generation, and one interpretation is that it can take up to one billion years for new crust to dominate the sedimentary record. The residence times of material in the lower crust appears to be much lower than in the upper crust. Finally, the development of granulite facies rocks, and their effects on the deformation history of the continental crust, will be briefly explored.