A long-term record of continental lithosphere exhumation via U-Pb thermochronology of the lower crust

TERRENCE BLACKBURN[1]*, SAMUEL BOWRING[1], TAYLOR PERRON[1], KEVIN MAHAN[2] AND FRANCIS DUDAS[1]

[1]EAPS, MIT, Cambridge, MA, USA (*correspondance: terrence@mit.edu)
[2]Dept of Geol. Sci., Univ. of CU Boulder, CO, USA

Exposures of cratonic lithosphere (shields) are generally characterized by low long-term erosion and sediment accumulation. Seismic tomography and mantle xenolith studies of cratons reveal keels of seismically fast and relatively buoyant and viscous mantle; physical properties intimately linked with their long-term stability and topographic expression. Missing from these observations is a long-term record (>1000 Ma) of continental exhumation/burial that can be used to quantity the forces operating within these ancient regions. The exhumation or burial of the continent surface has a direct effect on the rate of heat loss within the lithosphere. By reconstructing the thermal history for the lithosphere using thermochronologic techniques, the magnitude of burial and exhumation through time can be estimated. Here we demonstrate how a long-term record of lithosphere exhumation or burial can be reconstructed using U-Pb thermochronology on lower crustal xenoliths. The U-Pb system is sensitive to cooling at temperatures of ~400-650 °C, corresponding to lower crustal depths of 20-50 km. Integration of this thermochronologic record with thermal models for the stable lithosphere allows one to reconstruct the magnitude of surface exhumation/burial during long-term cooling of the continents. In Montana, USA, lower crustal samples record extreme slow cooling consistent with low exhumation rates (<0.01 km/Ma) over time scales billions of years. Constraining the magnitude and variation of lithosphere exhumation over a billion years or more provides the opportunity to understand the degree of thermal and mechanical coupling between continental lithosphere and the underlying convecting mantle in the deep geologic past.

Are noble gases in the sediment pore water of Lake Van promising proxies for paleoclimate conditions?

R. BLÄTTLER[1], Y. TOMONAGA[1]*, M.S. BRENNWALD[1], O. KWIECIEN[1], R. KIPFER[1,2], AND THE PALEOVAN SCIENTIFIC PARTY

[1]Eawag, Swiss Federal Institute of Aquatic Science and Technology, CH-8600 Dübendorf, Switzerland (*correspondence: tomonaga@eawag.ch)
[2]Institute of Geochemistry and Petrology, Swiss Federal Institute of Technology (ETH), CH-8092 Zurich, Switzerland

As noble gases are chemically inert, they are ideal tracers to study physical processes in water bodies. The noble-gas partitioning between the atmosphere and the respective water body occurs according to Henry's Law, which is mainly controlled by the temperature and salinity of the exchanging water phase. Therefore, atmospheric noble gases (He, Ne, Ar, Kr, and Xe) have been successfully used in the past to reconstruct the physical conditions in aquatic systems such as groundwater, lakes, and oceans.

Several decades ago, noble gases in the pore water of unconsolidated sediments have been proposed as proxies for the reconstruction of environmental conditions in lakes and oceans. During sedimentation, a certain volume of the water overlying the sediment/water interface is trapped in the pore space of the growing sediment column. If the noble-gas diffusion within the pore water is sufficiently attenuated, the sediment column can conserve noble-gas concentrations over long time scales. However, only recently analytical methods allowing robust and reliable determination of noble-gas concentrations in the sediment pore water have been developed and improved. In Lake Issyk-Kul, a large closed-basin lake in central Asia, atmospheric noble gases in sediment pore water have been successfully applied for the first time as proxies for paleoclimate conditions.

In this study we present concentration profiles measured in the sediment column of Lake Van (Turkey). Lake Van is one of the largest terminal lakes and the largest soda lake on Earth. The lake is known to react very sensitively to changes in the local climate conditions.

We interpret the measured noble-gas concentrations in terms of possible changes in the physical conditions of the water body of the lake (i.e., changes in temperature and salinity). In particular we discuss the potential of noble gases as proxies for paleoclimate reconstruction considering the ongoing ICDP deep drilling project PALEOVAN (http://www.icdp-online.org).