$^{238}U/^{235}U$ ratios of angrites: Adjusting absolute ages of anchors

G.A. BRENNECKA* AND M. WADHWA

School of Earth & Space Exploration, Arizona State Uni., Tempe, AZ (*correspondence: brennecka@asu.edu)

The use of short-lived chronometers is critical to our understanding of the high-resolution time sequence of events in the early Solar System. To map relative ages from short-lived systems onto the absolute time scale, they are "anchored" to the Pb-Pb ages of appropriate meteoritic materials. Previously reported high precision Pb-Pb dates of the basaltic angrite meteorites, some of which have been used extensively as anchors [1-2], have assumed a $^{238}U/^{235}U$ ratio (=137.88). However, the $^{238}U/^{235}U$ ratio has recently been shown to be variable in Solar System materials [3-6], requiring the reevaluation of these previously reported Pb-Pb ages. An adjustment to the Pb-Pb age of an anchor would consequently require a corresponding correction to the calculated "model" ages for any other meteoritic materials dated using that anchor and an extinct chronometer, such as the ^{26}Al-^{26}Mg, ^{53}Mn-^{53}Cr, or ^{182}Hf-^{182}W chronometers.

Here we report U isotope compositions of several angrites. Specifically, $^{238}U/^{235}U$ ratios were measured in whole-rock (WR) samples of the D'Orbigny, NWA 4801, NWA 4590, and NWA 6291 angrites. Additionally, phosphate separates from Angra dos Reis, pyroxene separates from D'Orbigny, and the leachate and residue from a separate acid-washed WR fraction of NWA 6291 were also measured. For D'Orbigny, two WR fractions and the pyroxene mineral separate yield identical (within 2SD errors) U isotope compositions. From these measurements, a $^{238}U/^{235}U$ ratio of 137.776±0.026 is determined, corresponding to a corrected Pb-Pb age of 4563.34±0.30 Ma (using the age previously reported by [2]). Furthermore, the $^{238}U/^{235}U$ ratios determined for WR samples of the angrites NWA 4590 (137.757±0.026), NWA 4801 (137.763±0.026), NWA 6291 (137.754±0.026), as well as for the phosphate separates of Angra dos Reis (137.791±0.042) are also identical (within 2SD errors) to those determined for D'Orbigny. Therefore, there is no detectable variation in the $^{238}U/^{235}U$ ratios measured in the angrite WR samples and mineral separates. This indicates that the angrite parent body was homogenous (at our current level of precision) in terms of its $^{238}U/^{235}U$ composition.

[1] Amelin & Irving (2007) *Work. on Chron. of Met.* #4061. [2] Amelin (2008) *GCA* **72**, 221-232 [3] Brennecka *et al.* (2010) *Science* **327**, 449-451 [4] Brennecka *et al.* (2010) LPSC #2117 [5] Amelin *et al.* (2010) *EPSL* **300**, 343-350 [6] Amelin *et al* (2011) LPSC #1682

Simultaneous analysis of dissolved noble gases, SF_6 and CFCs in water

M.S. BRENNWALD[1]*, M. HOFER[1], AND R. KIPFER[1,2]

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

Dissolved atmospheric noble gases, sulfur hexafluoride (SF_6) and chlorofluorocarbons (CFCs) are widely used as (transient) environmental tracers in water bodies. The concentrations of these trace gases in the water are determined by their partial pressure in the air, the gas equilibration at the water surface, the (partial) dissolution of air bubbles entrapped in the water ("excess air"), and the mixing within the water body.

In contrast to the noble gases, the partial pressures of SF_6 and CFCs in the atmosphere have increased strongly during the recent decades, e.g. due to release from industrial appliances. The SF_6 and CFC concentrations therefore contain direct information on the time when the water was last in contact with the atmosphere (water age), which is highly useful to study the mixing and deep-water formation in surface waters, the transport and mixing dynamics in groundwaters, and the geochemical origin and fate of other solutes and gases in aquatic environments (e.g. oxygen, methane, nutrients or contaminants).

For reliable water dating with SF_6 and CFCs, the relative gas contributions from air/water equilibration at the water surface and the formation of excess air to the total SF_6 and CFC concentrations in the water need to be quantified. However, the information required to disentangle these two components from each other is usually poorly constrained from the data available from the conventional analytical techniques.

A way forward to address this issue is to derive the required information from the noble-gas concentrations in the water. However, the analysis of SF_6, CFCs and noble gases in water usually involves the use of separate instruments and techniques in different and highly specialized laboratories. We therefore developed a new method and apparatus for the simultaneous analysis of He, Ne, Ar, Kr, Xe, SF_6, CFC-11, CFC-12, CFC-113, N_2 and O_2 in a single water sample. The apparatus is constructed using only standard and commercially available components. The method is based on vacuum extraction of the dissolved gases from the water. The sample gases are then separated into three fractions. He and Ne is quantified by static mass spectrometry, the remaining gases are quantified by gas chromatography.