SYNG 2: Applied Noble Gas Physics Part 2

Time: Thursday 14:30–16:30 Location: C/gHS

Invited Talk SYNG 2.1 Thu 14:30 C/gHS

Using Noble Gases to Understand the History of Terrestrial Volatiles — •Don Porcelli — Oxford University, Dept Earth Sciences, Oxford, UK

Noble gas isotopes provide essential information on the origin and distribution of terrestrial volatiles. The 3He/4He ratios measured in mantle-derived volcanics indicate that the noble gases initially incorporated into the Earth remains heterogeneously distributed, although it is not yet clear how this relates to mantle structure. Xe isotopes indicate that separate noble gas reservoirs were established during Earth formation, with variations that must have been created before complete decay of short-lived 129I and 244Pu. Further, Ne isotopes suggest that there have been several different solar system sources of noble gases. Also, Xe isotopes indicate that substantial quantities of noble gases were incorporated into the Earth and lost soon after. A number of key questions remain, as data are limited due to the subtle variations and low concentrations involved, and the presence of atmospheric contamination. More precise measurements of all noble gases, and with greater sensitivity, are essential to better identify how many sources of noble gases there have been; the extent of isotope variability within the Earth and so the history of early losses and subsequent reservoir isolation; the role of the core in storing noble gases; and the relationship between variations of the different noble gases and so the history of each separate reservoir. With such data, the history of terrestrial volatiles can be understood within the context of evolving theories of planetary accretion.

Invited Talk SYNG 2.2 Thu 15:00 C/gHS

Noble gas analysis in water: from temperature reconstruction over excess formation to oxygen turnover on environmentally relevant time scales — •Rolf Kipfer and Matthias Brennwald — Eawag, Swiss Federal Institute of Aquatic Science and Technology, 8600 Dübendorf, Switzerland

Noble gases (and other quasi-conservative transient trace gases) in aquatic systems have commonly been used to determine water residence times and to reconstruct past environmental and climatic conditions.

However, these analyses were hampered by the occurrence of a surplus of atmospheric gases in natural ground water, e.g. the presence of excess air (EA) which in former days was only considered as contamination.

Recent developments in understanding the physics of air (gas) / water partitioning in porous media as well as revisiting noble gas diffusion in water now allows EA formation to be understood in mechanistic terms and facilitates the robust interpretation of EA as a proxy for the hydraulic conditions during groundwater recharge.

Furthermore, portable membrane-inlet mass spectrometers enable continuous and real-time analysis of dissolved (noble) gases directly in the field, allowing, for instance, quantification of O2 turnover rates on time scales as small as minutes.

This presentation will touch some of these recent achievements with the intention of stimulating a broader discussion on the future applications of gases in conventional and unconventional aquatic systems.

Invited Talk SYNG 2.3 Thu 15:30 C/gHS

Applications of Noble Gases in Oceanography — •Peter Schlosser[1,2,3], Robert Newton[3], Gisela Winckler[3], and Angelica Pasqualini[2,3] — [1]Dept of Earth and environmental Sciences, Columbia Universiy — [2]Dept of Earth and Environmental Engineering, Columbia University — [3]Lamont-Doherty Earth Observatory, Columbia University

Over the past decades, methods for detection and routine measurement of noble gases and their isotopes at ultra-low levels have been developed. They enabled application of these trace substances to many problems of ocean circulation, dynamics, and air/sea exchange. In principle, noble gases are used in studies such as (1) radioactive clocks (Tritium/He-3; Ar-39), (2) natural or anthropogenic injections into specific water masses (He isotopes), and (3) global dyes (Kr-85 or the quasi noble gas sulfurhexafluoride). To illustrate these applications three oceanographic noble gas studies are presented and discussed. Determination of the major circulation pathways and man residence times of the waters in the Arctic Ocean (tritium/He-3; Ar-39): knowledge of the Arctic Ocean circulation pattern is needed to understand the implications of rapid Arctic Environmental Change. Large-scale mixing at mid-depth in the Pacific Ocean: the turbulent mixing coefficients derived from these studies are used to quantify redistribution of water and dissolved substances (He-3). Air/sea exchange, especially in the high-wind regimes of the Southern Ocean: air/sea gas exchange rates, together with measurements of the partial pressure of carbon dioxide, are applied to calculate the uptake of carbon by the oceans.

SYNG 2.4 Thu 16:00 C/gHS

Basal ice-shelf melting in the Weddell Sea inferred from oceanic noble-gas observations — •Oliver Huhn[1], Monika Rhein[1], and Michael Schröder[2] — [1]Institute of Environmental Physics, University of Bremen, Germany — [2]Alfred-Wegener-Institute, Bremerhaven, Germany

We use oceanic noble-gas observations from the Weddell Sea from the period 1990 to 2013 to infer basal ice-shelf melting and the spatial distribution and temporal variability of the melt water input into the ocean. Helium and neon data were used to compute the glacial melt water contributing to the formation of Antarctic Bottom Water, a substantial water mass in the global ocean and important driver of the Meridional Overturning Circulation.

Oceanic measurement of low-solubility and stable noble-gases helium and neon provide a useful tool to quantify glacial melt water. Atmospheric air with a constant composition of these noble gases is trapped in the ice matrix during formation of the meteoric ice. Due to the enhanced hydrostatic pressure at the base of the floating ice, these gases are completely dissolved, when the ice is melting from below. This leads to an substantial excess of helium and neon in pure glacial melt water.

We find an increasing trend in helium, neon, and, hence, in the glacial melt water content in the deep Weddell Sea. Melt water fractions along a repeated section in the north-western Weddell Sea are almost doubling from 1990 to 2013, indicating increasing melting in the Weddell Sea.

SYNG 2.5 Thu 16:15 C/gHS

Environmental Tracer and helium measurements in the context of Coal Seam Gas exploration. — •Axel Suckow and Stanley D. Smith — CSIRO Land and Water Flagship, Gate 5, Waite Road, Urrbrae, SA 5064, Australia

The Surat Basin in Northeast Queensland, Australia is subject to massive exploration and development for coal-seam gas extraction. To extract the gases, reduction of hydrostatic pressure in the Walloon Coal Measures by up to 70bar is necessary. The impact of this groundwater de-pressurization on adjacent aquifers is unknown. Also the flow regime of the underlying Hutton Sandstone and Precipice Sandstone aquifers is not well understood. Environmental tracers (SF_6, CFCs, tritium, helium, $^{87}Sr/^{86}Sr$, ^{14}C, ^{36}Cl) were measured along two north-south transects in the Hutton Sandstone aquifer. Also helium pore water profiles were obtained in vertical profiles through two aquitards isolating the Walloon Coal measures from the underlying Hutton Sandstone and this from the underlying Precipice Sandstone. Results indicate that groundwater in the Hutton has very low flow velocities and ^{36}Cl decreases to background values along a flow distance of less than 150km. Vertical profiles of terrigenic helium through the aquitard formations indicate very low vertical flow in these formations and the aquifer system seems to be dominated by diffusion processes. However, it remains an open question to what extent the $^{36}Cl/Cl$ decrease can be attributed to aging or is dominated by diffusive inflow of dead Cl from adjacent aquitards. To further elucidate this flow system, samples for ^{81}Kr are planned along these transects.