Isotopic reservoir mixing in the early solar system: Hints from 21st century sample return missions

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Oxygen is isotopically heterogeneous on size scales ranging from microscopic to planetary. Analyses of high temperature condensate minerals in primitive meteorites demonstrate the co-existence of ^{16}O-enriched and ^{16}O-depleted gaseous reservoirs in spatially distinct locales in the solar nebula, with some materials rapidly transferred between these environments. In other cases, high temperature processing accompanied by partial oxygen isotopic exchange appears to have taken place several $\times 10^5$ years after the initial formation of calcium-aluminum-rich inclusions (CAIs). The oxygen isotopic evolution of at least the inner solar nebula may have continued for up to several million years, according to estimates of the temporal gap between CAI and chondrule formation. Leading hypotheses for the driving force of oxygen isotope evolution invoke self-shielding during photochemical processing of CO into H_2O, although other chemical mechanisms have also been postulated. When and where such fractionation mechanisms operated, and the processes transporting gas, ices, and dust between the various astrophysical environments remain poorly constrained.

The GENESIS and STARDUST Discovery misisons have recently returned matter from the inner and outer solar system, respectively. Combined with detailed examination of early chronology based on short-lived radioactivity in meteoritic samples, the oxygen isotopic compositions of these spatially distinct components carry information about the timescales and processes of reservoir mixing in the solar accretion disk. Analyses of the GENESIS solar wind concentrator sample imply an ^{16}O-rich starting composition of the solar nebula and thus require a very effective mechanism for isotopic evolution of materials in the terrestrial planet-forming region and asteroid belt. STARDUST mineralogical and O-isotopic data suggest radial transport of high-T material from the inner nebula. Although the X-wind provides a mechanism for ballistic launch of micro-CAIs to Kuiper belt distances, the existence of chondrule-like fragments in the comet may require other explanations. The planetary-like O isotopic compositions of some interplanetary dust particles appear to present additional problems for understanding the origin and distribution of oxygen isotopic reservoirs in the solar system.

The age and peterogenesis of Palaeogene flood basalt volcanism in NE Ireland

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A major part of the Palaeogene North Atlantic Igneous Province (NAIP), the British Palaeogene Igneous Province (BPIP) has been extensively studied in the past, with work on the Hebridean islands (e.g. Skye, Mull etc.) making major contributions to research that underpinned much of modern igneous petrology through the 20th century. The Antrim Lava Group (ALG) in NE Ireland is one of the lesser studied parts of the BPIP, yet it covers an area in excess of 4000 km^2, with thicknesses >700m reported in some drillholes.

The aim of this research project is to carry out a modern, stratigraphically and geophysically (field–based and using the GSNI's TELLUS database) constrained, geochemical and geochronological investigation of this lava suite and associated intrusions.

The Antrim Lava Group (ALG) consists of mainly basaltic rocks that cover a large portion of NE Ireland. It is split into two main groups – the Lower Basalts and the Upper Basalts, the eruption of which occurred in two cycles. These cycles are believed to coincide with two province-wide phases of magmatism, separated by distinctive laterised red bole horizons and intermediate to felsic lava flows of the Interbasaltic Formation.

New $^{40}Ar/^{39}Ar$ ages for lava flows from the ALG, give statisically meaningful age plateaus for lava flows from each of the three main formations. The ages record a northward time progression across the ALG. New XRF and ICP-MS wholerock data also record geographic trends.

It is hoped that further investigation of the geochemical and geographical heterogeneity in the ALG will provide a better understanding of the emplacement of the BPIP in relation to the rest of the NAIP in Palaeogene times.