Widespread evidence for heterogeneous accretion of the terrestrial planets and planetisimals

Conference or Workshop Item

A Late Triassic major negative $\delta^{13}C$ spike linked to Wrangellia LIP: The Carnian Pluvial Event revealed

J. DAL CORSO[1]*, P. MIETTO[1], R.J. NEWTON[2], R.D. PANCOST[3], N. PRETO[1], G. ROGHI[4] AND P.B. WIGNALL[2]

[1]Dipartimento di Geoscienze, Università degli Studi di Padova, via Gradenigo 6, 35131, Padova, Italy (*correspondence: jacopo.dalcorso@unipd.it).
[2]School of Earth and Environments, University of Leeds, Woodhouse Lane, LS2 1JT, Leeds, UK.
[3]Organic Geochemistry Unit, School of Chemistry, University of Bristol, BS8 1TS, Bristol, UK.
[4]Istituto di Geoscienze e Georisorse, CNR, via Gradenigo 6, 35131, Padova, Italy.

During the Carnian (Late Triassic) a major climatic and biotic change is known, namely the Carnian Pluvial Event (CPE) [1]. This event is characterized by more humid conditions testified by hygrophytic palynological assemblages and palaeosols typical of humid climates; the crisis of rimmed carbonate platforms, a rise of the CCD and the increase of siliciclastic input across the western Tethyan realm; high extinction rates among ammonoids, crinoids, bryozoans and conodonts [2] and the first occurrences of dinosaurs and calcareous nannoplankton [3]. The CPE is similar in age to the eruption of Wrangellia large igneous province (LIP) [3], an oceanic plateau outcropping in western North America. Here we report an abrupt negative $\delta^{13}C$ shift at the onset of the CPE: high and low molecular weight n-alkanes, isoprenoid lipids and total organic carbon (TOC) show a sharp 2‰ - 4‰ negative carbon isotope excursion (CIE) that testify for a rapid injection of ^{12}C into the atmosphere-ocean system. This CIE occurs at the end of a ~3‰ long term Ladinian-Carnian positive CIE previously explained with organic carbon sequestration by coal swamps after the end-Permian mass extinction [4]. We propose that this CIE was caused by an injection of light C by the Wrangellia volcanism into the reservoirs of the exogenic C-cycle with strong consequences for climate and biota.

[1] Simms & Ruffel (1989) *Geology* **17,** 265-268. [2] Rigo *et al.* (2007) *Palaeogeogr. Palaeocl. Palaeoecol.* **246,** 188-205. [3] Furin *et al.* (2006) *Geology* **34,** 1009-1012. [4] Korte *et al.* (2005) *Palaeogeogr. Palaeocl. Palaeoecol.* **226,** 287-306.

Widespread evidence for heterogeneous accretion of the terrestrial planets and planetisimals

C.W. DALE[1]*, K.W. BURTON[2], D.G. PEARSON[1,3], AND R. GREENWOOD[4]

[1]Dept. of Earth Sciences, Durham University, DH1 3LE, UK (correspondence: christopher.dale@durham.ac.uk)
[2]Dept. of Earth Sciences, Oxford University, OX1 3PR, UK
[3]Dept. for Earth & Atmos Sci, University of Alberta, Edmonton, Canada
[4]PSSRI, Open University, Milton Keynes, UK

The abundance and relative proportion of highly siderophile elements (HSEs) in Earth's mantle deviate from those predicted by low-pressure equilibrium partitioning between metal and silicate during formation of the core. For many elements, high-pressure equilibration in a deep molten silicate layer (or 'magma ocean') may account for this discrepancy [1], but some highly siderophile element abundances demand the late addition, a 'late veneer', of extraterrestrial material (i.e. heterogeneous accretion) after core formation was complete [2]. Siderophile elements in smaller asteroidal bodies will not be affected by high-pressure metal-silicate equilibration and so, with highly efficient core formation [3] and if a 'late veneer' is absent, significant differences in the proportions of HSEs can be anticipated.

Here we present new HSE abundance and $^{187}Os/^{188}Os$ isotope data for basaltic meteorites, the HEDs (howardites, eucrites and diogenites thought to sample the asteroid 4 Vesta), anomalous eucrites (considered to be from distinct Vesta-like parent bodies) angrites and aubrites (from unidentified parent bodies) and SNCs (thought to be from Mars). Our data, taken with those for lunar rocks [4], demonstrate that these igneous meteorites all formed from mantle sources that possessed chondritic (i.e. primitive solar system) elemental and isotope compositions, indicating that late accretion is not unique to Earth, but is a common feature of differentiated planets and asteroidal bodies. Variations in the total HSE abundance suggest that the proportion of 'late veneer' added is a simple consequence of the size of each body (cross-section and/or gravitational-attraction), and may account for the volatile element budget, and the oxidation-state of Earth, Mars, the Moon and Vesta.

[1] Righter *et al.* (2008) *Nature Geosci.* **1**, 321-323. [2] Brenan & McDonough (2009), *Nature Geosci.* **2**, 798-801. [3] Greenwood *et al.* (2005) *Nature* **435**, 916-918. [4] Day *et al.* (2007) *Science* **315**, 217-219