Orbital scale alkenone based CO_2 records across the Pliocene intensification of Northern hemisphere glaciation

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The most informative analogues for future anthropgenic climate change are likely to be those with boundary conditions similar to today. The late Pliocene is the most recent time in earth history with elevated global temperatures and CO_2 estimated to be similar to that anticipated by the end of this century [1, 2, 3]. Furthermore, Pliocene continental positions and vegetation distributions are thought to be broadly similar to today. Consequently the IPCC fourth assessment report highlighted the Pliocene as an important time period for further study. Recently our understanding of Pliocene CO_2 and temperature has improved, with publication of multiple records from alkenone and boron isotope reconstructions for CO_2 [2, 3], and Mg/Ca, $U^{K'}_{37}$ and TEX_{86} reconstructions for sea surface temperature. However, none of the published CO_2 records have sufficient temporal resolution to resolve orbital scale variations in CO_2, or to determine the relationship between the apparent reduction in atmospheric CO_2 and the intensification of northern hemisphere glaciation. Here we present new high resolution records of CO_2 and temperature from ODP Site 999 over the critical interval from 3.3 to 2.6 Ma using alkenone palaeobarometry and the $U^{K'}_{37}$ and TEX_{86} palaeothermometers. By combining these with a full analysis of the biotic response to changing conditions and reconstructing haptophyte cell sizes [4], critical for the alkenone palaeobarometer, we present well constrained, coupled records of the response of the climate system to changing CO_2.

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A multidisciplinary study of core composition

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Planetary cores form as a results of the major chemical differentiation even on a terrestrial planet; the melting of accretionary building blocks (dust, meteorites, planetesimals, protoplanets) leads to a separation of the metal from the silicate, ensued by a gravitationally-driven segregation of a dense metal-rich core at the centre of the planet, with the lighter buoyant silicates remaining on top. The process of core formation determines the composition of this deep reservoir, and leaves an imprint on the residual bulk silicate Earth.

Matching geophysical observables (seismically determined radial density and velocity profiles) and geochemical observables (siderophile trace-element concentration in the upper mantle, and through modelling in the bulk silicate Earth) with experimental and theoretical data provides a robust way to estimate both the present day composition of the core as well as the conditions under which it formed. Adding observational constraints, both from geophysics (gradients, anisotropy) and geochemistry (isotopic and trace-element fractionation) will help to continually improve the models and beyond that, define and refine the paradigm of core formation.

We will present the results obtained through (i) the study of phase equilibrium under extreme conditions in the laser-heated diamond anvil cell, (ii) the study of outer-core density and seismic velocity from first principles calculations, and (iii) the study of inner-core elasticity from experimental mineral physics. We will interpret these results in order to devise compositional models consistent with the observations, and to formulate scenarios for core formation.