The arrested HP antigorite dehydration front from Cerro del Almirez (SE Spain)

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Dehydration fronts in metamorphic terrains are mechanically distinct zones where fluids and grain-scale porosity are generatated. Their temporal evolution is a complex interelationship between metamorphic and compactation timescales leading to several mechanisms of fluid expulsion and kinetic fluctuations [1]. An exceptionally well preserved dehydration front, corresponding to the high-pressure (680-710°C and 1.6-1.9 GPa) antigorite breakdown reaction (Atg-out), crops out in Cerro del Almirez (Betic Cordillera, Spain), which displays a complete sequence of metamorphic reactions and allied textures [2, 3]. Detailed mapping of the Atg-out front shows that, between Atg-serpentinite and prograde Chl-harzburgite, a narrow band (up to 8 m thick) occurs of transitional lithologies consisting of chlorite-antigorite-olivine-serpentinite (Chl-serpentinite), grading through antigorite-chlorite-orthopyroxene-olivine (Atg-Chl-Opx-Ol) rocks to Chl-harzburgite (Ol-Opx-Chl). Mass balance calculations and phase diagram considerations indicate that HP Atg breakdown occurred by the sequential formation of: Chl-serpentinite through the reaction,

Atg (Al-rich) + Ol = Atg (Al-poor) + Chl + fluid (1)

and Atg-Chl-Opx-Ol assemblage through the reaction,

Atg = Ol + Opx + Chl + fluid (2)

Observed continuous chemical changes and progresive grain coarsening suggest that these reactions took place at near equilibrium conditions. These observations are important to unravel the kinetics and fluid expulsion mechanisms of this natural dehydrating system.

[1] Connolly (2010) *Elements* **6**, 165–172. [2] Padrón-Navarta *et al.* (2008) *Contrib Mineral Petr* **156**, 679–688. [3] Padrón-Navarta *et al.* (2010) *Contrib Mineral Petr* **159**, 25–42.

Methane and the PETM: All good things must come to an end?

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Global warming during the Paleocene Eocene Thermal Maximum is often explained by a massive release of methane hydrates. However, modeled methane hydrate abundances during warm climates are lower than required to explain the carbon isotope shift that characterizes the PETM. Even if ancient hydrate abundances were greater than model predictions, a very high climate sensitivity to CO_2 would be required to explain the magnitude of warming during the event. While some portion of this high apparent climate sensitivity could be related to an assumed pre-warming that triggered hydrate instability, evidence for that warming is weak at best, and why this warming occurred repeatedly to trigger successive hyperthermals has never been adequately addressed.

In contrast to the methane paradigm, an emerging supposition involving the storage and orbitally controlled release of terrestrial carbon from the arguably vast permafrost reservoirs of Antarctica and the high Arctic region readily explains the warming characteristics of the early Cenozoic hyperthermals. Modeled permafrost carbon estimates and simulations accounting for rising background greenhouse gas concentrations and orbital variability demonstrate terrestrial permafrost thawed during high eccentricity and obliquity orbital nodes once a long-term warming threshold was reached. This new supposition allows for the massive amount of carbon necessary to explain the magnitude of carbon isotope shifts, a reasonable climate sensitivity to CO_2, and the mechanistic basis for repeated warming events during an ever-warming planet.