Peat bog Records of Atmospheric Dust fluxes - Holocene palaeoenvironmental and paleoclimatic implications for South America

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Abstract

Few attention has been given to pre-anthropogenic signals recorded in peat bogs, especially in the Southern Hemisphere. Yet they are important to 1/ better understand the different particle sources during the Holocene and 2/ to tackle the linkage between atmospheric dust loads and climate change and 3/ to better understand the impact of dust on Holocene palaeoclimate and palaeoenvironments in a critical area for ocean productivity.

In this poster, we will present the preliminary results and the main objectives of the PARAD project, which are: 1) to provide high-resolution continuous records of natural atmospheric dust using the elemental and isotopic signature of peat cores from Tierra del Fuego, and 2) to assess the linkage between dust inputs and climate.In this project, we will explore the use of a broad range of trace elements as dust proxies (soil particles, volcanism, cosmogenic dusts, marine aerosols). Radiogenic isotopes (Pb, Nd, Hf) will be used as tracers for fingerprinting predominant sources. Coupling these findings with biological proxies (plant macrofossils, pollen) and detailed age-depth modeling, we expect not only to identify and interpret new links between atmospheric dust chemistry and climate change but also to significantly improve our understanding of peat bogs as archives of climate change, and the role of dust in both palaeoenvironmental and palaeoclimatic changes.

Non-classical pathways of mineralization: Pre-nucleation clusters and oriented attachment

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Introduction

Recent investigations of crystallization in the calcium carbonate and phosphate systems have conclusded that classical concepts of crystal growth fail to predict observed pathways of nucleation. These pathways appear to start with pre-nucleation clusters and depend upon particle mediated growth processes that involve amorphous precursors. These conclusions follow upon a body of research documenting aggregation-based growth mechanisms in which primary crystalline particles are found to be co-aligned in the final crystal structure. However, little is known about the formation, structure and energetics of pre-nucleation clusters, and the mechanism by which co-alignment of primary particles occurs has not been established. Here we report results of novel simulations and experiments exploring these phenomena.

Results and Conclusion

Using replica-exchange molecular dynamics techniques previously applied to protein folding, we investigate initial formation and onset of order within hydrated calcium carbonate clusters. The clusters initiate as short linear chains that rapidly evolve into 2D and 3D structures with continued growth. Establishment of order is hindered by incomplete ion desolvation. However, in ~1 nm diameter particles, ordered motifs emerge that resemble the local order within crystalline carbonate phases. The free energy along the simulated growth pathways is currently being calculated to determine whether the clusters are thermodynamically stable or metastable with respect to ions in solution and to predict the free energy barrier that separates the cluster species from supercritical nuclei.

We investigated mechanism of oriented attachment (OA) of iron oxyhydroxide nanoparticles using high-resolution fluid cell TEM. The particles undergo continuous rotation and interaction until they find a perfect lattice match. A sudden "jump to contact" then occurs over < 1nm, followed by lateral atom-by-atom addition at the contact point. Interface elimination proceeds at a rate consistent with the curvature-dependence of the chemical potential. Translational and rotational accelerations show that strong, highly-