Southern Hemisphere orbital forcing and its effects on CO_2 and tropical Pacific climate

K. TACHIKAWA[1], A. TIMMERMANN[2], L. VIDAL[1], C. SONZOGNI[1] AND O. ELISON TIMM[2]

[1] Aix-Marseille Université, UMR7330, CNRS, IRD, CEREGE UM34,13545 Aix en Provence, France, kazuyo@cerege.fr
[2] IPRC, SOEST, University of Hawaii, Honolulu, HI 96822, USA

The western Pacific warm pool (WPWP) is an important heat source for the atmospheric circulation and influences climate conditions worldwide. Understanding its sensitivity to past radiative perturbations may help better contextualize the magnitudes and patterns of current and projected tropical climate change. Here we present a new Mg/Ca-based sea surface temperature (SST) reconstruction over the past 400 kyr from the Bismarck Sea, off Papua New Guinea, along with results from a transient earth system model simulation. Our results document the primary influence of CO_2 forcing on glacial/interglacial WPWP SSTs and secondary effects due to changes in wind-driven tropical boundary currents. In addition to the SST, deep ocean temperature reconstructions from this core are linked with Southern Ocean temperature and sea-ice variations on timescales of ~23 kyr. It is proposed that Southern Hemisphere insolation changes serve as pacemaker for sea-ice variations in the Southern Ocean, which in turn modulate windstress curl-driven upwelling of carbon-rich waters, hence controlling atmospheric CO_2 and tropical WPWP temperatures.

CO_3, OH, and halogen microanalysis in apatite group minerals

R. CHRIS TACKER[1]

[1]North Carolina Museum of Natural Sciences, 11 W. Jones St., Raleigh, NC, USA 27601-1029, christopher.tacker@naturalsciences.org

The last three years have seen a re-evaluation of microanalytical methods for apatite, including standards. This presentation presents new data and reviews recent results for analytical methodology for C, OH, and halogens for apatite minerals.

Initial documentation of anisotropic beam-driven halogen diffusion [1] in apatites, long ignored, has been confirmed and shown to be more complex for varying F and Cl concentrations [2]. Quantitative analysis requires constraints on crystal orientation for *both unknowns and standards*, as well as controlled history under the electron beam. Analytical methods presented here use accelerating voltages <10keV and short analytical durations to clearly define the rise and fall in count rates for zero-time regression. Data in hand show that F and Cl are rapidly lost from the apatite during analysis at 15 and 20 keV in all crystal orientations. Analyses are unlikely to be valid without regression-to-zero techniques for unknown and standard. Uncertainties in electron microprobe halogen analyses are magnified in OH caclulated by the difference method.

Problems with FTIR analysis of apatite (strongly polarized OH stretching, crystal size, sample thickness) have been overcome to allow analysis of unpolished mineral separates and experimental products. Polarized radiation is preferred for OH analysis, but unpolarized radiation can be used on (100) sections [3] and euhedral synthetic crystals. The A and B type carbonate substitutions are not strongly polarized, allowing use of unpolarized radiation.

Carbonate and OH standards for apatite are lacking. A large FTIR dataset for naturally occurring apatites shows homogeneities or complexities precluding their use as standards. For example, Durango fluorapatite shows trimodal OH distribution (n=5570). Synthetic standards are under development.

Previously published apatite studies should be carefully evaluated in the light of these results.

[1] Stormer *et al*. (1993) Am. Miner.**78**, 641-648. [2] Goldoff *et al*. (2012) Am. Miner. **97**, 1103–1115. [3] Tacker (2004) Am. Miner. **89**, 1411-1421.

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