Abrupt shift in mid-Holocene climate in the Western Pacific Warm Pool

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Carbonate palaeoenvironmental archives are important for reconstructing changes in tropical climate systems and for understanding the processes controlling climate change. This study uses coral climate reconstructions from the Western Pacific Warm Pool (WPWP), a key player in the El Niño-Southern Oscillation (ENSO) system, to investigate WPWP-ENSO-monsoon interactions during the mid-Holocene.

Modern and fossil *Porites sp.* corals were drilled from Koil and Muschu Islands, Papua New Guinea in the WPWP core region. Here, reductions in rainfall and sea surface temperature (SST) characterise El Niño events. Changes in these parameters are reflected in coral skeletal oxygen isotope ($\delta^{18}O$) and Sr/Ca ratios, allowing reconstruction of mean conditions and variability in the annual cycle.

Fossil coral Sr/Ca ratios from 7.7 to 5.8 ka indicate a general warming trend throughout the period, culminating in a SST peak ~1°C higher than present at ~5.8ka. At the same time, coral $\delta^{18}O$ values are higher, suggesting drier conditions relative to present. Measurements of near-weekly samples from this period show greater amplitude of the annual SST cycles compared to present and increased salinity, particularly during the dry season. Between 5.8 and 5.4 ka Sr/Ca ratios and $\delta^{18}O$ values suggest a rapid transition to cooler and less saline conditions, with a distinct, extended monsoon season. By 2 ka, present conditions prevail. All periods, from 7.7 to 2 ka show evidence for El Niño events.

The results for 7.7 to 5.8 ka suggesting more saline and/or drier conditions in the WPWP region, in contrast to the present situation. This change could be due to stronger windfields in the Western Pacific, reducing atmospheric convergence in the region and/or increasing ocean mixing across the thermocline. The sudden shift to cooler and wetter conditions between 5.8 and 5.4 ka may signal a rapid initiation of moisture convergence at the WPWP, marking the establishment of a modern-like Warm Pool. The timing and nature of the rapid climate shift identified here coincides with mid-Holocene changes in the Asian-African monsoon and could represent a reorganisation of the ocean-atmosphere-land system in the tropics. High resolution coral records are currently being used to explore the implications of this abrupt mid-Holocene climate change for ENSO dynamics.

Melt generation beneath NE Iceland: melting of a seamount from the Iapetus Ocean

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Detailed geochemical studies of 40 samples of basalt erupted from a single ridge segment, Theistareykir, in NE Iceland during the last 10,000 years show that the variations in Sr, Nd, Hf and Pb isotopic ratios correlate excellently with each other and with the concentrations of moderately and very incompatible trace elements (Stracke et al 2002). Such variations allow the nature of the source enrichment to be analysed in some detail. If the elemental concentrations in each sample are plotted as a function of the weighted average of the isotopic anomalies, obtained using principal component analysis, the slope of the best fitting lines correlate with 1/D, where D is the estimated partition coefficient of the element concerned for a garnet peridotite residue. This result shows that the enrichment in the source is caused by the addition of melt generated in the stability field of garnet peridotite. Detailed analysis of the nature of the correlation shows that it results from the addition of an OIB magma to the source whose composition is similar to that of Suiko Seamount in the NE Pacific, and allows the thickness of the lithosphere, the extent of melting and the potential temperature of the plume involved to be estimated. Model ages, of between 375 Ma and 486 Ma, provide an estimate of the time at which the seamount was formed. These ages are upper limits, because they assume that the seamount initially had the same isotopic ratios as MORB. These results suggest that detailed geochemical studies of basalts from plumes and oceanic ridges can be used to reconstruct the structure of the oceanic lithosphere whose age is at least twice that of any that now exists in the ocean basins.

Reference

Stracke A., Zindler A., Salters V.J.M., McKenzie, D., Blichert-Toft J., Albarede F., & Gronvold K. Theistareykir revisited. G^3 (in press)