Deglacial climate dynamics in the western Pacific Ocean measured in a stalagmite from Guam

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We have measured stable isotopes ($\delta^{18}O$ and $\delta^{13}C$) and trace elements (Mg/Ca and Sr/Ca) in a stalagmite from Guam in the western tropical Pacific Ocean. A chronology was assigned from 12 high-precision TIMS U/Th dates. The geochemical record spans 22,000 years providing a time-series of changing hydrology and climate in the equatorial Pacific through the deglaciation. This region of the world's ocean plays an important, but still poorly understood, role in global climate dynamics during glacial/interglacial cycles.

Magnesium and Sr are positively correlated in the Guam speleothem. The slope matches a correlation found between several other Pacific speleothems that we have analysed (from Vanuatu and the Solomon Islands) suggesting a general hydrological control on these elements. Both elements show a broad peak centered on 5-6 kybp, which may indicate a dry period in the western Pacific during the mid Holocene.

Oxygen isotopes show no trend from 22 to 10 kybp but decrease rapidly between 10 and 5 kybp before present – a time when sea level and polar temperatures were relatively stable. Similar decreases during this interval are present in several other Pacific speleothem records, but are not reflected in reconstructions of surface ocean $\delta^{18}O$ from planktonic foraminifera in western tropical Pacific sediment cores. This discrepancy suggests a regional decoupling between isotopes in precipitation and the surface Pacific Ocean during the early to mid Holocene.

The cause is unknown at present, but may reflect a trend from dry conditions in the early Holocene to wetter conditions today as the strength of the Asian Monsoon changed with precessional forcing.

$^{40}Ar/^{39}Ar$, ^{238}U-^{230}Th, and K-Ar age of the Laschamp Excursion

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The Laschamp geomagnetic excursion is expressed magnetically as a paleointensity minimum or short-lived directional swing in several marine sediment cores and as an abrupt increase in cosmogenic nuclide flux in polar ice. It is therefore a critical tie-point common to several independent proxy records for past climate reconstruction that extend beyond the limits of precise ^{14}C dating. The excursion was discovered when 3 basaltic lava flows in the Chaîne des Puys, France—the Laschamp, Olby, and Louchadiere flows—yielded paleomagnetic directions nearly reversed from today's field. Until recently, attempts to date these lavas were too imprecise to realize the potential of the Laschamp excursion as a global chronostratigraphic marker. A new ^{238}U-^{230}Th mineral isochron from the Olby flow, new $^{40}Ar/^{39}Ar$ and unspiked K-Ar ages from the Louchadiere flow, combined with our previously published $^{40}Ar/^{39}Ar$ and K-Ar ages from the Laschamp and Olby flows, yields a weighted mean age for the Laschamp excursion of 40.6 ± 0.8 ka (2σ analytical uncertainty). The $\delta^{18}O$ variation in marine sediments used to create the NAPIS-75 paleomagnetic intensity record, and Greenland ice cores in which cosmogenic ^{36}Cl and ^{10}Be spikes are found, indicate that the Laschamp excursion is contemporaneous with the Dansgaard/Oeschger (D/O) cycle 10 interstadial. Moreover, counting of annual varves in the GISP2 ice core indicates that the D/O 10 interstadial occurred at 40.9 ka; recent revision of the NorthGRIP age model confirms this. ^{238}U-^{230}Th dating of speleothems in France and China further constrains the timing of D/O 10 to between 41 and 40 ka. At ODP sites 1233 and 1234 near Chile the Laschamp excursion is dated via bracketing AMS ^{14}C ages between 42.0 and 40.5 ka. We propose that an age of 40.6 ± 0.8 ka—based on 3 independent radioisotopic chronometers applied to lava flows in the type locality—be adopted for the Laschamp excursion as a global tie-point. Claims that the Laschamp excursion lasted much longer than 1 ka, or that it may be confused with the younger Mono Lake excursion at 34-33 ka, are unfounded.