Rice can be cultivated in a range of arable systems, including upland rain fed, lowland irrigated and deep water. Our current NERC-funded project aims to reconstruct early rice cultivation systems, and to better establish how ancient arable rice systems be seen using archaeobotanical data. One method is by building modern analogues using associated crop weeds, and phytolith morphotypes found within each type of cultivation regime. Different cultivation systems produce different flora assemblages. Rice weeds and sediment samples have been recorded and collected from a variety of arable systems in India, China, Thailand and Laos. The seeds added to a reference collection, and husks, leaves and culms processed for phytolith references, the sediment samples processed for phytoliths in order to establish patterns identifiable to specific systems. We are using these models on archaeological samples from the Lower Yangtze from between 5000 and 1800 BC to track the evolution of weed flora from Pre-Domestication cultivation (for example at Tianluoshan) to later intensive systems.

COASTAL VEGETATIONS OF THE THE EXPOSED CONTINENTAL SHELVES OF SE CHINA DURING THE LGM?

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During the glacial times, the sea-level was much lower than that of today, and a large area of the continental shelves near SE China were exposed above the sealevel, and were covered with some types of vegetation. However, most direct evidence from the continental shelves is not preserved after the sea-level rose again. Little is known about the vegetation in the coastal regions and the then exposed shelves. The pollen assemblages preserved in the deep marine sediments may provide important information about the coastal vegetation.
Most marine pollen records available from South China Sea and East China Sea indicate that the pollen assemblages during the Last Glacial were dominated by pollen of Artemisia, Chenopodiaceae, Poaceae and some other herbal taxa. It seems that the coastal regions and the exposed continental shelves in SE China were dominated by grasslands or some other grass-dominated vegetation types. This conclusion was also partially supported by some terrestrial pollen records, and is consistent with the simulated climate conditions that the region was drier during the Last Glacial. However, knowing the pollen source areas and the transportation of the marine pollen is crutial for understanding the pollen records. A new analysis of pollen collected from the air and the seawaters from the Western Pacific Ocean indicates that a large portion of pollen, especially Artemisia and Chenopodiaceae, deposited in this region may be transported from the arid regions of north China, over a thousand kilometers to the deposition sites, by the winter monsoon. The dominance of these taxa in the sediments of the Last Glacial was probably resulted from the intensified winter monsoon and the southward expansion of the grasslands and the arid and semi-arid vegetation at that time. Although the climatic conditions in the coastal regions may be drier during the Last Glacial, its vegetation was probably not altered as dramatically as suggested by earlier studies.

VARIABILITY OF HOLOCENE ATLANTIC WATER ADVECTION – A MULTIPROXY PERSPECTIVE FROM THE WEST SPITSBERGEN CONTINENTAL MARGIN

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Northward advection of relatively warm and saline Atlantic Water masses keeps the eastern part of the Fram Strait ice-free all year while the western part - occupied by cold and fresh Arctic water - is perennially ice-covered. The Fram Strait, often referred to as the Arctic Gateway, is the only deep-water passage for Atlantic-derived water masses to enter the Arctic Ocean. It therefore plays a crucial role for the heat budget of the Arctic Ocean. High-resolution sediment sequences from the Western Svalbard margin covering the last ca 10.000 years have been studied in order to reconstruct variations of Atlantic Water advection to the Arctic, the sea ice extent, and the structure of the water column. For this purpose we established a multiproxy data set including geochemical, micropaleontological, and sedimentological parameters with centennial to multidecadal time resolution. Records of foraminiferal oxygen and carbon isotopes, planktic foraminifer assemblages, and the amount of ice rafted debris clearly display distinct variations between climatically warmer and colder intervals throughout this period. Planktic foraminifer assemblages reveal warmest conditions for the early Holocene period. A second warming pulse is detected between 5 to 6 ka. Overall, increased IRD amount displays a significant cooling trend after 5 ka most likely attributed to decreasing insolation, culminating in the so-called 'neoglaciation' trend during the late Holocene. Planktic foraminiferal assemblages suggest a return of slightly strengthened Atlantic Water advection around 3 to 2 ka. However, Eastern Fram Strait never experienced the high temperatures of the early Holocene ever since, including a strong warming event of the present, anthropogenically influenced period.

NANODIAMONDS AS EVIDENCE FOR A YOUNGER DRYAS COSMIC IMPACT EVENT

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Nanodiamonds (NDs), either cubic or hexagonal diamonds (lonsdaleite), have been reported by others in sediment samples from Tunguska, Russia, and the Cretaceous-Tertiary (K-T) boundary, which are from known cosmic impacts. Similarly, for the Younger Dryas boundary layer (YDB) that dates to 12.9 ka, NDs have been found at widespread locations across North America and Europe, and the NDs also are proposed to result from cosmic impact. For all three sites (Tunguska, the K-T, and the YD), we have investigated acid-resistant residues using eight analytical techniques (High-res TEM, STEM, SAED, FFT, EDX, XRD, EELS, and Raman), and all confirm that the residues contain abundant NDs, while layers above and below the boundary contain none or few NDs. These tests refute recent speculation that the YDB residues do not contain NDs, but rather display only copper particles and other non-diamond minerals. Laboratory research to duplicate the diamond-forming process demonstrates that natural NDs form only under extreme physical conditions generated during an ET impact, but do not otherwise occur on Earth's surface. These conditions include high temperatures, hypoxic conditions, and rapid quenching, thus excluding volcanoes and regular wildfires, where oxidizing temperatures of more than 500 degree C would destroy the NDs. The collective evidence supports formation of YDB NDs by cosmic impact at 12.9 ka and argues against wildfires or volcanism as causes, for the following reasons: (A) lonsdaleite has never been found associated with any volcanic or igneous rocks or with mantle-derived terrestrial diamonds; (B) NDs have never been found in association with non-impact wildfires; (C) lonsdaleite has been found only inside fallen meteorites or associated with known impacts; and (D) NDs are extraordinarily rare in the geologic record, where there are only two known continental layers containing both NDs and impact-related proxies – the K-T boundary and the YD boundary.

DID RAINFOREST EXPANSION ENTICE MODERN HUMANS INTO SOUTHEAST ASIA EARLIER THAN IS SUGGESTED BY THE AVAILABLE EVIDENCE?

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As the timing of modern human arrival in Southeast Asia (~ 48 ka e.g., Niah Cave, Tabon cave, Jerimalai) is generally younger than the surrounding continents of Asia (~ 68 ka or 111-139 ka) and Australia (60-50 ka) it is argued that large gaps exist in the Southeast Asian evidence. These gaps relate to the subsidence, reworking and bioturbation of unconsolidated cave sediments, and a lack of suitable dating techniques applied to key sites. Clearly a new approach is vital for developing the SEA record. Palaeoenvironmental changes in this region caused by variable climatic conditions were responsible for the expansion and contraction of rainforest environments. Open environments, in the form of savannah corridors, prevailed in the drier glacials, but the warm humid conditions of the interglacials brought about the expansion of rainforest corridors through SEA into Indonesia. This caused faunal turnovers, extinctions and created new faunal assemblages. The presence of rainforest diagnostic fauna such as orangutan, gibbon and sunbear in Punung, East Java suggests that this