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Editorial

Quaternary Highlights (September–December 2018)

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Editorial summaries of selected papers relevant to Quaternary science published in high-impact multidisciplinary journals between 12 September and 10 December 2018. Other relevant papers are also listed.

1. Climate Change and Neanderthal Decline in Europe

According to available evidence, the replacement of Neanderthals by modern humans in Europe took place in a diachronic manner between about 48 and 36 cal kyr BP. The potential influence of climate on this transition has been suggested but existing paleoclimatic information is still insufficient for a definite assessment. Staubwasser et al. [1] use stable isotope analysis of speleothems from the Romanian Carpatians (Central Europe) to reconstruct Middle Pleniglacial paleoclimatic trends from around 50 to 30 cal kyr BP. These records document the occurrence of two prominent cold-dry stadials—G12 (44.3–43.3 cal kyr B) and G10 (40.8–40.2 cal kyr BP)—coinciding with the disappearance of Neanderthals in the study region. The authors suggest that Neanderthals failed to adapt to the expansion of steppes during these cold-dry reversals and were replaced by modern humans, who were more adapted to steppic environments. The same pattern of climatic stress and Neanderthal decline, associated with stadials G10, G11 and G12, is observed for other European regions, suggesting that climate change was influential in the replacement of Neanderthals by modern humans across the whole continent.

2. Interglacial Ice Losses and Sea Levels

Antarctic ice sheet (AIS) dynamics have been fundamental in global sea-level (GSL) shifts through history, at least since the Pliocene. Current simulations estimate that AIS melting significantly contributed to an increase in GSLs during the late Pleistocene interglacials but empirical data supporting these model estimates are still lacking. Wilson et al. [2] use sedimentological and geochemical analyses of marine cores to study the dynamics of the Eastern AIS, which is a potentially significant contributor to GSL variations. The authors use the isotopic composition of neodymium (Nd) to infer sediment supply and provenance, which is a proxy for glacier erosion and, hence, for continental ice dynamics. The results indicate relevant continental margin retreats and ice losses during the late-Pleistocene interglacials, especially during marine isotope stages (MIS) 5, 9, and 11, when Antarctic temperatures were up to 2 °C above Holocene (preindustrial) ones. This is consistent with modelling outputs indicating, for example, GSLs 6 to 9 m higher than today during MIS 5, likely with a significant contribution of Antarctic ice loss. The authors warn that even moderate future increases in temperature may lead to a significant reduction of the Antarctic ice sheet and higher than expected GSL increases.

3. The First Human Drawings

Henshillwood et al. [3] report the oldest drawing attributed to *Homo sapiens* known to date. The discovery was made at Blombos Cave, South Africa, and consists of a small (38.6 × 12.8 × 15.4 mm)

73,000-year-old flake made of silcrete (indurated soil duricrust) containing a cross-hatched pattern drawn with an ochre crayon. The drawing predates by ~30,000 years the oldest human artworks known to date from several European, African and Asian localities (the oldest figurative artwork known to date is ~40,000 years old and has recently been found in Borneo [4]). The engraved flake (labelled as L13) was excavated in 2011, in already dated horizons, but remained unprocessed until now. More recently, the piece has been washed and carefully analyzed using macrophotography and SEM techniques. These observations have been compared, using the same photographic and microscopic methods, with experimental drawings made with ochre pieces on other silcrete flakes from the same site to demonstrate that the L13 drawing was intentional and thus constitutes a human-made drawing. Other engraved objects and evidence for the production and storage of pigmented compounds were also found. According to the authors, this " ... adds a further dimension to our understanding of the processes that shaped the behavior and cognition of early *H. sapiens*".

4. Anthropogenic Influence on Global Nitrogen Cycle

Humans have significantly altered the global nitrogen cycle since the Industrial Revolution, mainly through fossil fuel burning and increasing the use of fertilizers. Human influence is manifest in the atmosphere and also in terrestrial and coastal ecosystems, which have been significantly N-enriched over the past few decades. Current models suggest that oceans, especially the North Atlantic and the North Pacific, have also been affected but little empirical evidence is available to verify these predictions. To test this hypothesis, Wang et al. [5] reconstruct the annual trends in N isotopic composition ($^{15}N/^{14}N$ or $\delta^{15}N$) of a ~130-year-old coral record from Bermuda, as a proxy for anthropogenic atmospheric nitrogen (AAN). Contrary to expectations (model simulations have predicted a significant $\delta^{15}N$ decline as a result of AAN enrichment) the $\delta^{15}N$ record showed striking stability over time, suggesting that AAN has not been a relevant N source in the North Atlantic during the 20th century. The most conspicuous variations in the Bermuda record were decadal oscillations that were associated with the North Atlantic oscillation (NAO) effect. The authors predict that the situation will remain unchanged during the coming decades.

5. The Causes of Dansgaard-Oeschger (DO) Cycles

DO events consist of rapid stadial to interstadial transitions followed by slower relaxations to stadial conditions, and occurred repeatedly during the last glaciation with a periodicity of ca. 1500 years. These events have been recorded in both poles (Greenland and Antarctica) with a delay of ca. 200 years, which has been called the seesaw effect. The occurrence of DO cycles has been related to regime shifts in the Atlantic meridional overturning circulation (AMOC) but the causes of these shifts are still unclear. Boers et al. [6] develop a dynamic model that successfully reproduces the DO cycles observed in the isotopic records from Greenland and Antarctic ice cores, including the seesaw effect, as a result of changes in Greenland ice shelves and sea ice cover. The authors conclude that thermodynamic interactions between Greenland ice shelves, sea ice and the AMOC would be enough to explain DO cycles, without the need for invoking salinity feedback as formerly proposed by other models.

6. Aridification and Hominin Evolution

Several hypotheses exist about the potential relationship between environmental change and human evolution, but their testing has been hindered by a lack of continuous and close enough paleoecological and archaeological records. Lake Magadi (Kenya), whose sediments cover the last million years, is near to some of the most important archaeological and paleontological sites documenting hominin evolution and megafaunal turnover since the Middle Pleistocene. Owen et al. [7] analyze Lake Magadi sediments using geochemical, mineralogical and biological (diatoms and pollen) proxies to reconstruct the climatic and environmental history of the region. They find an overall trend towards aridity since 575 kyr BP, with an intensification between 525 and 400 kyr BP, followed by a sequence of wetter-drier cycles. The 525 to 400 kyr aridity intensification coincides with a major shift in stone technologies (Acheulean to Middle Stone Age) and closely overlaps with a major overturn in mammalian fauna, with the extinction of large grazers. Owen et al. [7] suggest that aridity would have enhanced hominin mobility and interaction with other groups, which would have facilitated technological change and its dissemination. Climatic variability has increased since 350 kyr BP, coinciding with the appearance of modern humans (*Homo sapiens*) and the onset of the Late Stone Age. The authors conclude that environmental shifts could have acted as strong selective agents for hominin evolution.

7. Iron Bioavailability and Atmospheric CO_2 Concentration

Glacial-interglacial changes in atmospheric CO_2 concentration are thought to be linked to shifts in iron-rich dust inputs to the Southern Ocean (SO). During the last glaciation, it is believed that glacial physical weathering substantially increased dust-borne Fe and that its deposition fertilized SO phytoplankton, thus increasing CO_2 fixation and decreasing its atmospheric concentration. Shoenfelt et al. [8], demonstrate that Fe fertilization is not only dependent on total amounts of Fe captured by the ocean but also on the bioavailability of such Fe, which is higher in its reduced Fe(II) form than in the oxidized Fe(III) form. These authors use X-ray absorption spectroscopy (XAS) to study Fe speciation in SO sediments from the last glacial and the current interglacial. They find that although total Fe flux increased by a factor of 3–5 during the last glaciation, the highly bioavailable Fe(II) flux was 15–20 times higher. The authors conclude that glacial weathering increases the amount of dust-borne Fe(II) available for phytoplankton growth due to positive feedback between glacial activity and low temperatures.

8. Biomass Burning and Climate

Biomass burning is known to affect atmospheric chemistry and climate by releasing reactive aerosols and greenhouse gases. However, the magnitude and timing of changes in global biomass burning over the last millennium are controversial, which has prevented a comparison between preindustrial and present levels and, hence, an estimation of the contribution of this burning process to anthropogenic climate change. Approximately two-thirds of ethane emissions are due to fossil fuel burning and the remainder derives from biomass burning and seep outgassing. Nicewonger et al. [9] use the ethane trapped in Greenland and Antarctica ice cores as a proxy for biomass burning changes from 1000 CE to the present. Maximum levels of biomass burning (significantly higher than today) were recorded during the Medieval Period (1000–1500 CE) and minimum values occurred during the Little Ice Age (1600–1800 CE), when ethane emissions due to biomass burning decreased by 30–45%. According to the authors, this supports the idea that biomass burning was sensitive to climate during the preindustrial era. The potential effects of anthropogenic deforestation during the industrial era could not be resolved. The authors conclude that feedback between biomass burning and climate could compromise the achievement of societal climate goals for the present century.

9. Other Relevant Papers

For further relevant readings, see Freeman et al. [10], González-Guarda et al. [11], Marshall et al. [12], Hu et al. [13], Tan et al. [14], Trinkaus [15], Tushingham et al. [16], Pickering et al. [17], Beier et al. [18], Gebregiorgis et al. [19], Tzedakis et al. [20], McKillop and Aoyama [21], Hoogakker et al. [22], Park et al. [23], Magill et al. [24], Moreno-Mayar et al. [25], Lamnidis et al. [26], Jeong et al. [27], Zhang et al. [28], McGee et al. [29], Buizert et al. [30], Manning et al. [31], and Wang et al. [32].

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