Technical Box VII: Ötzi – the ice man

Found by mountaineers in 1991 melting out of the Schnalstal glacier on the border between Austria and Italy, Ötzi is Europe’s oldest natural human mummy, dated by \(^{14}\text{C}\) to 5.2 ka BP (Spindler, 1994). It is a very rare case in which mummification took place by dehydration before the body became embedded in glacier ice. Equally unusually, his body was not carried down valley and deformed by the glacier but instead preserved in the ice at the place where he died (Plate 6.2). In addition to his extensively tattooed body, Ötzi’s clothes and possessions were also preserved in situ, and they give us an insight into many aspects of daily life in Neolithic times, including people’s use of natural resources. For example, he wore a cloak made of woven grass, a bearskin cap, and a vest, a belt, leggings, loincloth and shoes all made of leather (Bortenschlager and Oeggl, 2000; Acs et al., 2005). Other possessions included a copper axe with a yew handle, a flint knife with an ash handle, along with a quiver of 14 bone-tipped arrows with viburnum and dogwood shafts and flint heads. Analysis of Ötzi’s intestinal contents showed that his last meals included chamois and red deer meat, processed einkorn wheat bran (possibly in the form of bread) and sloes, a small plum-like fruit of the blackthorn tree. Equally remarkably, pollen analysis from his gut has been used to demonstrate his final journeys (Oeggl et al., 2007). During the last 33 hours of his life Ötzi walked from high up near the timber line (at about 2500 m), to low down in the zone of warmth-loving trees (about 1200 m or less), and finally very high in the zone of perennial ice above 3000 m. Perhaps inevitably, Ötzi has become a subject of controversy, including the question of which country should ‘own’ him; (the answer turned out to be Italy, since he lay 90 m inside their frontier…and he now

Plate 6.2 Ötzi, the Neolithic ice man; (left) the body as found protruding from an Alpine glacier in 1991 (reproduced with permission of the Austrian Police); (right) reconstruction (South Tyrol Museum of Archaeology – www.iceman.it).
resides in the South Tyrol Museum of Archaeology in Bolzano). Equally controversial was the cause of Ötzi’s death, an argument now effectively resolved by the discovery via forensic radiological investigation of an arrowhead inside an unhealed wound under his left shoulder (Gostner and Egarter-Vigl, 2002). In short, Ötzi was shot and eventually killed by an arrow.

Well-preserved ancient human bodies have been discovered in a wide variety of other circumstances around the planet. Mummified bodies have been found in desert environments, such as the Atacama desert of Peru and northern Chile, and in central Asia, the latter including the ‘Siberian Ice Maiden’. Dating to around 2400 years ago, she was found with along with six decorated horses, and her body covered with vivid blue tattoos of mythical animal figures. Very different conditions have led to the preservation of bog bodies found in peat deposits from Britain, Denmark and elsewhere in northern Europe; they include Tollund Man and Lindow Man, both of whom had been ritually executed.
technical box viii: ruddiman’s early anthropogenic greenhouse hypothesis

forest clearance and its conversion to farming and grazing land had local effects upon biodiversity, soil erosion, river flooding, and so forth. but did it—cumulatively—also have consequences for the global environment and climate? bill ruddiman (2003, 2005) has proposed that prehistoric and early historic land-use conversion led to an increase in the methane and carbon dioxide contents of the atmosphere thousands of years before the industrial revolution started. the ‘ruddiman hypothesis’ began as a sherlock holmes-like detective enquiry, prompted by a piece of evidence that didn’t quite fit. whereas atmospheric methane preserved in antarctic ice cores peaked near the start of previous interglacials and then declined in concentration (see chapter 3); during the holocene it has steadily risen during the last 5000 years (figure 6.4). it is not hard to find natural explanations for the holocene trend, such as boreal peatland emissions, but why would they have operated differently during the present interglacial compared to previous ones? the one thing that makes the holocene distinctive is human transformation of the natural world, in particular by farming and the associated change in land cover. ruddiman proposed that the natural downward trajectories of key greenhouse gases has been reversed over the last five to eight millennia, primarily due to agricultural forest clearance for co₂ and due to wet rice cultivation for ch₄ (figure 6.4). these, he argues, may already have increased temperatures during the pre-industrial era by up to 1 °c (and double that at high latitudes), and could even have prevented the onset of the next glaciation in northern canada. during the late holocene, the antarctic ice core record includes a series of minor dips in co₂ concentration, and ruddiman argues that these relate to major pandemics, such as the sixth-century ad justinian plague, which may have caused agricultural land abandonment and forest re-growth, with consequent carbon uptake from the atmosphere. the biggest of these carbon drawdown episodes probably occurred in the americas after ad 1492, when european diseases killed >90% of the indigenous population and led to land abandonment and the growth of secondary forest (nevle and bird, 2008).

is ruddiman right? debate has been lively, with one group of critics pointing out that new evidence from the long epica ice core (2004) indicates that mis 11—the closest interglacial analogue to the holocene in terms of the earth’s orbital configuration—lasted up to 28 000 years, with co₂ and ch₄ levels staying high, rather than declining progressively during the interglacial. other critics include computer modellers who have calculated that the required land use-derived co₂ emissions would have to be three to four times higher than originally estimated (joos et al., 2004). whatever the precise truth, the ruddiman hypothesis has forced scientists to reconsider the scale and antiquity of potential human impact upon the earth system.
Figure 6.4 Expected and observed trajectories for atmospheric carbon dioxide and methane concentrations during the Holocene (modified from Ruddiman, 2005). Reproduced with permission of Princeton University Press.