the rise in percentage frequency of tree birch pollen). This improvement, dated on our time scale to between 10,750 BC and 11,000 BC, is deduced from simultaneous changes in lithostratigraphy, in percentage pollen spectra and in pollen input per unit area per year. In none of these is there any evidence for recession between this amelioration and the tree birch period (Alleröd); on the contrary, the sequence can be interpreted as a continuous ecological succession. This reinforces the suggestion of Kirk and Godwin's dated pollen diagram from Loch Droma[14] that the onset of interstadial conditions began in western Britain early in the eleventh millennium BC, and that between this time and the height of the Alleröd interstadial there was no general climatic recession of sufficient amplitude to deflect the plant succession or to give rise to increased soil erosion. Our absolute pollen diagram provides evidence that the much earlier environmental fluctuation recorded in the stratigraphy of the Blelham Bog deposits was not accompanied by any significant change in pollen production by the local vegetation.

The sequence in this profile contrasts with that found at Danish sites such as Böllingsö[12,13], where a minor interstadial defined by the curve for tree birch pollen, Zone Ib dated as 10,450 BC to 10,050 BC[9], is separated from the overlying Alleröd deposits by a minerogenic layer with little tree pollen, Zone Ic. This indicates a regional difference between western Britain and Denmark in the lithostratigraphic sequence and in the pollen curves, which can most readily be explained as the result of a regional differentiation in Late-Weichselian climate.

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Fossil Ice in Hawaii?

PERENNIAL ice was found late in 1969 near the summit of Mauna Kea, a dormant volcano rising 4,200 m above the sea on the island of Hawaii, 19° 49′ N and 155° 28′ W. A part of the ice-lava mixture lies close to the rocky surfaces near the bases of the south walls of the Goodrich Cone and Summit Cone craters (Fig. 1). Seismic refraction measurements have indicated a minimum horizontal extent of ice of hundreds of metres, and a thickness of many decametres. This ice may be the remains of known Pleistocene glaciation[1]. It is thought to survive near the surface in present climatic conditions because radiation effects make certain areas of the craters colder.

Fig. 1. Photograph of Mauna Kea summit looking north-north-east over Lake Waiau, which is in Waiau Cone crater, towards the Astrophysical Observatory of the University of Hawaii. The highest point, just to the right of the observatory, is immediately above the crater where the first old ice was found. Goodrich Cone crater, where more of the ice occurs, is to be seen between the lake and the summit. (Photograph by A. J. Abbott, Hawaii Institute of Geophysics.)

Carbon dating of Lake Waiau (Fig. 1) sediments[2] and temperature measurements in perched lake and ground waters[3], motivated by earlier geological and seismic exploration[1,4], led to the discovery of the ice. Brief examination at many locations revealed: (1) that the ice completely fills the interstices between the lava rocks and boulders; (2) the remains of insects imbedded in the ice; and (3) that the ice is clear, bubble-free, and tritium-free a few centimetres down.

Plans for further work concerning Mauna Kea include publication of seismic results, climatological studies in the craters, further seismic exploration, and drilling to collect deep ice samples. Evidence of climatic, biological and other conditions during Hawaii's remote past may be preserved in the ice.

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