from the results obtained from various marine animals; (*b*) this is also the case for other crustaceans—there seems to be a general tendency toward positive values determined (with some evidence) by biological fractionation effects.

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Fossil Ice Wedges in Hampshire

THREE large fossil ice wedges have been discovered in a coastal section exposed at Highcliffe in Hampshire (*M.R.* 215931). They are to be found within the Plateau Gravel in the uppermost part of the cliff at about 100′ *O.D.* Here 2·4 m of gravels rest on Barton Beds, at this point consisting of an impermeable glauconitic clay. On top of the gravels is an uneven layer of brown loam up to 80 cm thick.

The gravels are made up of sub-angular pebbles and smaller chips and flakes of flint; some derived Eocene material, particularly rounded and blackened small pebbles; and quartz and silica sand. There is some differentiation within the gravels, with a lower horizon of coarser stratified material which stands out slightly from the cliff, and thin seams and lenses of finer material incorporated into the gravels above. Two samples taken from the coarser gravel had median grain sizes of 7 mm and 9 mm; they were not well sorted and were strongly skewed towards the finer sediments. A sample from a pinched out lense of finer material, which was some 3 m long with a maximum depth of 20 cm, had a median grain size of 0·35 mm, and consisted largely of medium and coarse sand with patinated chips of flint.

The loam is a structureless deposit, strong brown in colour (Munsell colour 7·5 *YR* 5/6, dry). A layer about 20 cm deep at the surface is weathered to a dark brown (7·5 *YR* 3/2). Four samples taken from the loam had median grain sizes of 14–57μ, but while this falls within the size range characteristic of loess deposits, the samples were not, in fact, well sorted (Trask sorting coefficients from 0·16–0·33), and more closely resembled flood loams. Small pebbles are incorporated into the deposit. Analogous loams may also be found within several New Forest valleys adjacent to the streams along the valley bottoms.

The wedges appear as 'V'-shaped forms of disturbed gravel, often with pebbles inclined vertically, which extend down into the horizontally bedded gravels, and in one case to the top of the clay which is slightly arched up. There is no surface indication of the features on the ground, possibly because the area has been developed as a car park, although there may well have been none. The pattern of the wedges in plan cannot be established; however, they do extend as wedges back into the cliff. They are particularly noticeable because the material within them is partially bleached to a pale brown (10 *YR* 6/3) as compared with the reddish or strong brown of the local material (7·5 *YR* 5/6 or 6/8), although this, too, is also bleached in parts. This is probably because percolating water has found an easy passage down the disturbed gravel[1].

Two of the wedges are almost vertical; the other is inclined with a disturbed area near where it disappears behind scree at about 2 m. The deepest wedge reaches 3 m to the Barton Clay; all three vary from 0·9 m to 1·2 m in width near the top, tapering downwards.

The material fill at first glance appears to be no different from the local gravel, except for the pebble alignment and colour. However, mechanical analysis of samples from one of the wedges reveals that it has a higher proportion of both coarser and finer fragments than the local gravels; median grain size is 14 mm, but 7 per cent is finer than 2 mm (compared with less than 1 per cent), and 43 per cent is more than 16 mm (compared with about 25 per cent). There is no distinctive element from the overlying loam within the wedge. The most likely explanation for all this is that the wedge was an open feature filled from above by fine dust and larger pebbles before the deposition of the loam. Some form of surface depression still existed at that time, however, because the loam thickens immediately over the wedge where the coarser infill does not quite rise to the level of the gravel on either side. Thus, the former existence of an open crack is shown by the nature of the infill, the aligned pebbles and by the thickening of the loam. In two of the wedges there is distortion of the bedded gravels on either side, suggesting ice growth. However, this is not generally marked.

These features are consistent with those of true ice wedges[2], and in size they are closely comparable with those found near Cambridge[3] and in Yorkshire[1]. A number of opinions have been put forward concerning the climatic requirements for the formation of wedges. Corbel[4] suggested that in Alaska they formed under cold continental conditions with little plant cover and low annual precipitation, with a summer maximum, and no considerable snow cover or moisture in winter. He postulated a mean temperature in the warmest month of 10° C, a January–February temperature of −10° to −20° C; Péwé[6] put forward a mean annual temperature of −6° to −8° C persistent for several years.

In the face of these opinions, it may at least be concluded that the fossil ice wedges were formed under a cold continental climate. Temperatures were low enough for permafrost. The wedges may date from the last (Weichsel) glaciation, or conceivably from the Gipping glaciation, as the ground is almost level and may have suffered little disturbance since then. An earlier date is unlikely because the gravels which here form a terrace feature can be correlated with the Goodwood–Slindon raised beach[7], itself assigned to the previous interglacial.

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An Unusually Radioactive Fossil Fish from Thurso, Scotland

THE results obtained by Diggle and Saxon[1] on a *Homosteus* plate from Clardon Haven, Thurso, do not, as they suggest, differ in any significant way from those published previously by Atkin and myself[2]. We showed that "whereas both uranium and thorium form organic complexes or compounds with hydrocarbon, only uranium is fixed by bone apatite". This means that a radioactive fish plate without much associated hydrocarbon would have a higher ratio of uranium : thorium than one with abundant hydrocarbon. Thus if the plate studied by Diggle and Saxon was mainly composed of bone apatite