1957. Two stations were occupied, one in 25 m. and the other in rather more than 100 m. of water. Observations were made at various depths throughout the water column. For the greater part of the period the surface was frozen to a maximum recorded depth in September of 115 cm. Water samples were taken in the normal manner with Nansen bottles but using modified operating techniques to meet the severe conditions. Plankton hauls, mainly vertical and entailing considerable difficulty, were run with *N*50 and *N*70 nets.

From the water samples, and in addition to records of temperature, measurements were obtained of *p*H, E_h, buffer capacity, dissolved phosphates and oxygen, and chlorinity. Measurements of submarine solar radiation were taken down to a maximum depth of 10 m. A high-speed continuous centrifuge was used to extract phytoplankton both for the determination of chlorophyll and for qualitative and quantitative examination.

Although the results are too extensive to be described in detail in this communication, it may be of interest to indicate briefly some of the features of particular interest. Chlorinity values obtained during winter were low, mean figures ranging from 16·00 to 18·70‰. These chlorinities, combined with mean temperatures between −1·90° C. and −1·60° C., commonly produced freezing conditions extending well down into the water column and appeared to cause the formation of ice crystals in free suspension, apart from the sea ice formed at the surface. Chlorinities were appreciably higher during summer except for a temporary shallow surface zone of extremely low salt content produced by the melting of the sea ice. Evidence was obtained which indicates a process by which the summer waters undergo incomplete mixing and remain close to the coastline until their replacement by relatively homogeneous water of higher chlorinity with the onset of the following summer.

As might be expected in these latitudes, the incidence of submarine solar radiation was found to exhibit marked seasonal differences, being negligible during the long winter period partly because of the low elevation of the Sun and partly because of the highly reflecting layer of sea ice. Consequent upon such conditions, phytoplankton was virtually absent during the winter period although small numbers of zooplankton organisms were taken in the nets. It is of interest that phytoplankton appeared and began to increase and attached diatoms were found actively growing on the under surface of the sea ice while the ice itself was more than 100 cm. thick. Large-scale blooms did not occur, however, until the ice was in an advanced stage of disintegration during the thaw.

The striking qualitative differences between the phytoplankton extracted with the continuous centrifuge and that taken with the nets was particularly illuminating, especially as the greater part of the chlorophyll estimated must have been contributed by forms either rare or absent in the material gathered by conventional methods. Based on chlorophyll concentrations, it was estimated that the carbon content in the standing crops of summer phytoplankton lay between 0·30 and 14·80 mgm./m.³.

Full details of the above investigation will be published elsewhere.

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ARCHÆOLOGY

Apple-Scoops

Being a private collector of items relating to bygone dentistry, I was naturally interested to read Prof. Raymond A. Dart's communication (*Nature*, March 21, p. 844) on "An 'Australopithecine' Scoop from Herefordshire".

Apple-scoops (occasionally termed gouges) were freely used in apple-growing districts by edentulous persons to scrape small thin pieces off the fruit and thus facilitate mastication. This custom was particularly prevalent prior to the introduction into Great Britain, in 1855, of vulcanite as a base for artificial dentures. Until then, such restorations were expensive due to the time and labour necessary to carve them from hippopotamus or walrus tusks with the precision that would ensure an accurate fit: the alternative being natural or ivory teeth attached to a swaged gold foundation.

The most popular apple-scoops were undoubtedly home-made and fashioned from the metacarpus or metatarsus of sheep. Others were constructed of ivory. A silver (Birmingham hallmark 1830) specimen, which I possess, unscrews from its hollowed ivory handle and fits into this for portability. Incidentally, there is a small but very comprehensive collection of apple-scoops in the Folk Museum, Gloucester.

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METALLURGY

Ductile Cleavage Fracture of Molybdenum

Most metals other than those having a face-centred cubic structure show a more or less rapid transition from ductile to brittle behaviour as the temperature is lowered. Well above the transition temperature the fracture surfaces are mainly fibrous with only a few cleavage facets, but at intermediate temperatures fracture occurs by cleavage after a strain of a few per cent. So far little attention has been paid to the mechanism of this ductile cleavage fracture. Recently, we have examined cleavage facets and longitudinal sections of a number of fractured specimens in which cleavage occurred after straining about 10 per cent at room temperature at a rate of strain of $0{\cdot}88 \times 10^{-4}$ sec.$^{-1}$. The tensile specimens, which had grain diameters of about 2 mm., were prepared from arc-cast deoxidized molybdenum and were 0·1 in. in diameter[1]. The results throw some light on the mechanism of fracture.

Part of a typical fracture edge is shown in Fig. 1. It is made up mainly of straight-line segments which often occupy one complete grain (see *A* in Fig. 1). Within about 0·5 mm. of each fracture edge a number of subsidiary cracks are observed (see *B* in Fig. 1) and often these are arranged in a characteristic configuration, an example of which is shown in Fig. 2. The cracks do not cross grain boundaries and those making up a configuration are always contained in one grain. Occasionally an 'ear', such as that shown at *C* in Fig. 1, is observed on the edge of the fracture. Such ears have been shown to be the result of the joining of two overlapping cracks on different cleavage planes by the shearing of the material

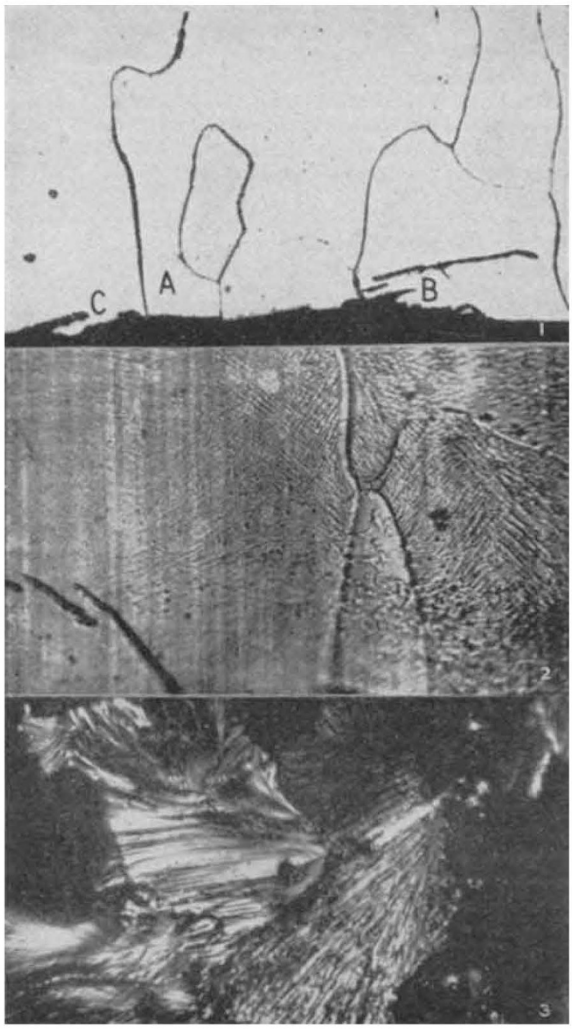

Fig. 1. Longitudinal section through the fracture surface of a molybdenum specimen which fractured after 10 per cent strain at room temperature. (× 250)

Fig. 2. A similar specimen to that of Fig. 1, but electro-etched, showing wavy slip lines and 'forced slip' near the grain boundaries. (× 250)

Fig. 3. Photograph of some cleavage facets on the fracture surface of a specimen similar to those shown in Figs. 1 and 2. (× 250)

between them[2]. The markings on the cleavage facets (Fig. 3) suggest that the growth directions are different for each crack.

We believe that these results show that fracture occurs by the joining of many cracks which grow co-operatively in a narrow band across the specimen. The grain boundaries provide barriers which are sufficient to prevent their propagation, and the final stage of the fracture is one of shearing at or near the grain boundaries to form the complete fracture surface. Some of the cracks are not needed to form the fracture surface, and these are left after fracture as subsidiary cracks such as those in Figs. 1 and 2. The existence of configurations of cracks such as that in Fig. 2 shows that cracks can occur on more than one crystallographic plane, even within one grain.

The wavy slip lines shown in Fig. 2 were revealed by electro-etching and are characteristic of body-centred cubic metals. Near the grain boundaries, 'forced slip' has occurred on intersecting slip systems and this would be expected to increase still further the difficulty of propagating a crack through a grain boundary.

A more detailed study of this type of fracture is being made and will be reported elsewhere. The work is being carried out while one of us (A. A. J.) is holding a University of London I.C.I. Research Fellowship and the other (B. J. S.) a U.K. Atomic Energy Authority Research Bursary.

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March 14.

[1] Johnson, A. A., *Phil. Mag.*, **4**, 194 (1959).
[2] Low, J. R., Madrid Colloquium on Deformation and Flow of Solids (Springer-Verlag, 1956).

A New Silicide in a 12 per cent Chromium Steel

In the course of an investigation into the tempering characteristics of a 12 per cent chromium steel (C 0·098, Mn 3·18, Si 3·02, Ni 4·06, Cr 12·56, Mo 0·49, V 1·09 per cent) a new phase was discovered. This phase (which we have called *H*-phase) could not be obtained in isolation but was always associated with $M_{23}C_6$. A residue extracted after tempering the steel for 50 hr. at 750° C., however, gave the maximum proportion of the new phase to $M_{23}C_6$. This was of the order of 2 : 1. This residue was examined in more detail by X-rays and a full chemical analysis was obtained.

The specimen was photographed in a 9-cm. diameter powder camera and a quadruple focusing camera, cobalt $K\alpha$ radiation being used in both cases. The interplanar spacings of the new phase fitted a cubic lattice with $a = 10{\cdot}735$ kX. The interplanar spacings are listed in Table 1, together with line intensities and indices. The X-ray pattern of the new phase shows marked resemblances to the pattern of M_6C. The space group of the new phase is probably $Fd3m$.

The full chemical analysis, converted to atomic percentages, is shown in Table 2. Due to the presence of $M_{23}C_6$ it is very difficult to form any definite conclusions about the composition of the new phase

Table 1. X-Ray Data for *H*-Phase ($a = 10{\cdot}735$ kX.)

Intensity	$h^2 + k^2 + l^2$	Corrected d	Observed d
vw*	11	3·237	—
vw*	12	3·099	—
vw*	16	2·689	—
vw	19	2·463	2·439
wm	24	2·191	2·176
s	27	2·066	2·051
wm	32	1·898	1·887
wm†	36	1·789	1·782
vw	44	1·618	1·612
w	51	1·503	1·497
w	59	1·398	1·394
vw	67	1·311	1·307
ms	72	$1{\cdot}265_1$	$1{\cdot}261_8$
wm	75	$1{\cdot}239_6$	$1{\cdot}235_9$
vw	84	$1{\cdot}171_3$	$1{\cdot}169_1$
m	99	$1{\cdot}078_9$	$1{\cdot}078_0$
wm	104	$1{\cdot}052_7$	$1{\cdot}051_8$
w	107	$1{\cdot}037_8$	$1{\cdot}037_1$
w	108	$1{\cdot}033_0$	$1{\cdot}031_7$
w	123	0·9679	0·9680
vw	132	0·9344	0·9342
wm	136	0·9205	0·9204

* Detected on the focusing camera film only.
† Interference due to an $M_{23}C_6$ line.