Table 2. Chemical composition of djerfisherite in the St. Marks meteorite. Electron-microprobe data averaged for 12 grains and corrected for background and dead time, fluorescence (*11*), absorption (*12*), and atomic number (*13*).

Element	Percentage (weight)
Fe	50.7
S	33.8
K	8.7
Cu	4.2
Cl	1.0
Ni	0.8
Na	0.3
	99.5

well as some alkali iron sulfides, have been reported, but the only alkali copper-iron sulfides found in the literature are: $K_3Fe_2Cu_4S_7$, $K_3Fe_2Cu_5S_7$, or $K_5Fe_3Cu_{12}S_{14}$ (*4*); none resembles djerfisherite in composition.

I have tried in preliminary experiments to synthesize the mineral, but it has been impossible to obtain a single phase by heating a mixture of appropriate chemicals, proportioned according to the formula, in sealed, evacuated, silica tubes. Three phases are usually obtained: troilite; a phase of unidentified composition, yielding an x-ray pattern identical with that of natural djerfisherite; and one unidentified. Temperatures of about 650°C appear to be necessary. A preparation containing the desired phase, heated to 750°C in evacuated and sealed tubes, undergoes a transition that is not reversed by heating at 600°C for 3 weeks. The difficulties encountered in these experiments suggest a narrow field of stability, the successful determination of which would be of considerable importance to the problem of origin of those djerfisherite-bearing meteorites.

Existence of the mineral is notable in several respects. It is the only sulfide mineral known that contains potassium as a major constituent—or even as a minor element (*5*). The only other alkali sulfide-bearing mineral reported is gerstleyite, a sodium sulfantimonite-sulfarsenite from the borate mines of California (*6*). Thus, the chalcophilic nature of potassium is established in addition to its hitherto lithophilic nature; in meteorites it is the third mineral, in addition to the two recently discovered silicates, merrihueite (*7*) and roedderite, known to contain essential potassium. The presence of native copper in Hvittis (*8*) contrasts with its chalcophilic behavior in these two enstatite chondrites and marks another dissimilarity that many investigations have shown to exist between Hvittis and other meteorites in its class.

Using the abundances of elements in various enstatite chondrites (*9*), I could not correlate the incidence of djerfisherite wth potassium content. Thus, the 1000-ppm K content of St. Marks is less than the 2700-ppm K content of Hvittis, which fact implies the existence of a potassium-containing mineral, perhaps djerfisherite, in Hvittis; however, the 3.3 (weight) percent S in Hvittis is less than the 5.5 percent S in St. Marks. If all of the potassium content of St. Marks were present as djerfisherite, the mineral would constitute about 1 percent of the meteorite—far more than the content observed. Even if one allows for the nonuniform distribution of djerfisherite, it appears that the bulk of the potassium is contained in another mineral phase in the meteorite. No chemical data exist on Kota Kota, but it is interesting to note that this meteorite contains the potassium-magnesium silicate mineral, roedderite, as well as djerfisherite. A possible reaction that could provide potassium sulfide to account for the coexistence of these two minerals is

$$\underset{\text{troilite}}{FeS} + \underset{\text{roedderite}}{K_2Mg_5Si_{12}O_{30}} \rightleftharpoons K_2S + \underset{\text{enstatite}}{5MgSiO_3} + \underset{\text{metal}}{Fe} + \underset{\text{silica}}{7SiO_2} + 1/2O_2$$

The removal of oxygen from the system favors the formation of K_2S.

For all classes of meteorites considered, calculations, based on reactions concerning selected minerals present, show that the enstatite chondrites have the lowest oxygen fugacities governing subsolidus equilibration (10). At 1000°K (the upper limit for formation of djerfisherite, as deduced from the synthesis experiments), $\log_{10}f(O_2)$ (atm) is −30 and reduces to −55 at survival temperatures of 600°K. An equilibrium expression that includes actual phases in the meteorite would be more meaningful than the above reaction in which potassium sulfide is not an observed phase. However, such an expression cannot be written until another copper-bearing mineral is found to coexist with djerfisherite; this association is in fact predicted by the presence of the latter.

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References and Notes

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14. Work supported by the AEC. The new mineral is named after D. Jerome Fisher, professor emeritus of mineralogy, Univ. of Chicago, and past president of the Mineralogical Society of America and the International Mineralogical Association; the name is approved by the I.M.A. I thank Brian Masan, Edward Henderson, Roy Clarke, Jr. (U.S. National Museum), and Edward Olsen (Field Museum of Natural History) for supplying the meteorites. The electron-probe analyses were made independently by Norbert Stalica of this laboratory and Charles Knowles of the Department of Geophysical Sciences, Univ. of Chicago. Edward Olsen assisted in correcting the data. I thank also Elizabeth Gebert for measuring the x-ray film and George Montet for a critical review.

7 April 1966

Mummified Pleistocene Ostracods in Alaska

Abstract. *Preserved soft parts of ostracod specimens were recovered from beach and lagoon sediments from the Gubik Formation, of Quaternary age, at Barrow, Alaska.*

During study of microfossils obtained from the perennially frozen sediments of the Gubik Formation at Barrow, Alaska, chitinous parts of several ostracods were found preserved inside closed valves. When a closed specimen of *Paracyprideis pseudopunctillata* was pried open, remains of soft parts were found still attached to the dorsal hinge area of the right valve (Fig. 1*a*). Other closed valves were pried open, revealing preserved soft parts in several specimens. The soft parts were the chitinous appendages: legs, antennae, maxilla, mandible, for the most part disarticulated; some were shrivelled from desiccation.

Other complete valves were examined with transmitted light to detect possible preservation of the soft parts. Remains of appendages were found in other specimens of *Paracyprideis pseudopunctillata* (Fig. 1, *b* and *c*) and in *Normanicythere concinella* (Fig. 1*d*) and an immature specimen of *Echinocythereis*. In most instances, however, the remains were jumbled in the anterior or ventral part of the valves, as can be seen.

The ostracods with these mummified remains were found in samples from only two localities: locality *A* (Fig. 1), a raised beach ridge that is exposed in a vertical section by a wave-cut escarpment just southwest of Barrow Village; and locality *B*, a sampled core hole in Elson Lagoon, the material examined coming from 5.2 m below the bottom of the lagoon. The possibility of contamination by sloughing of Recent material is ruled out.

The samples containing the specimens come from strikingly different depositional environments: The beach-cliff locality, consisting of clean sandy gravels typical of a rigorous nearshore environment, contrasts with the silts and silty sands from which the Elson Lagoon specimens were picked.

Positive dating of these sections is not yet completed, but on the basis of the stratigraphic position and dates from other sections in the area, it is reasonable to assume that they are at least older than 38,000 years and probably no older than mid-Pleistocene (*1*). Preserved soft parts had been found in marine pelecypods collected from an elevated beach in Greenland (*2*).

We assume that the ostracod specimens were preserved by rapid burial in a cold environment and subsequently frozen, remaining in this state until they were collected. Desiccation may have occurred either before or during the frozen period, so that only chitinous parts of the endoskeleton and appendages remain. The valves being tightly sealed reduced the likelihood of decay.

As a result of this discovery, closed valves of *Normanicythere concinella* from the Bootlegger Cove Clay (*BC* in Fig. 1), a Pleistocene cold-water deposit in south-central Alaska, were opened: a few specimens yielded disarticulated appendages less well preserved than the northern material.

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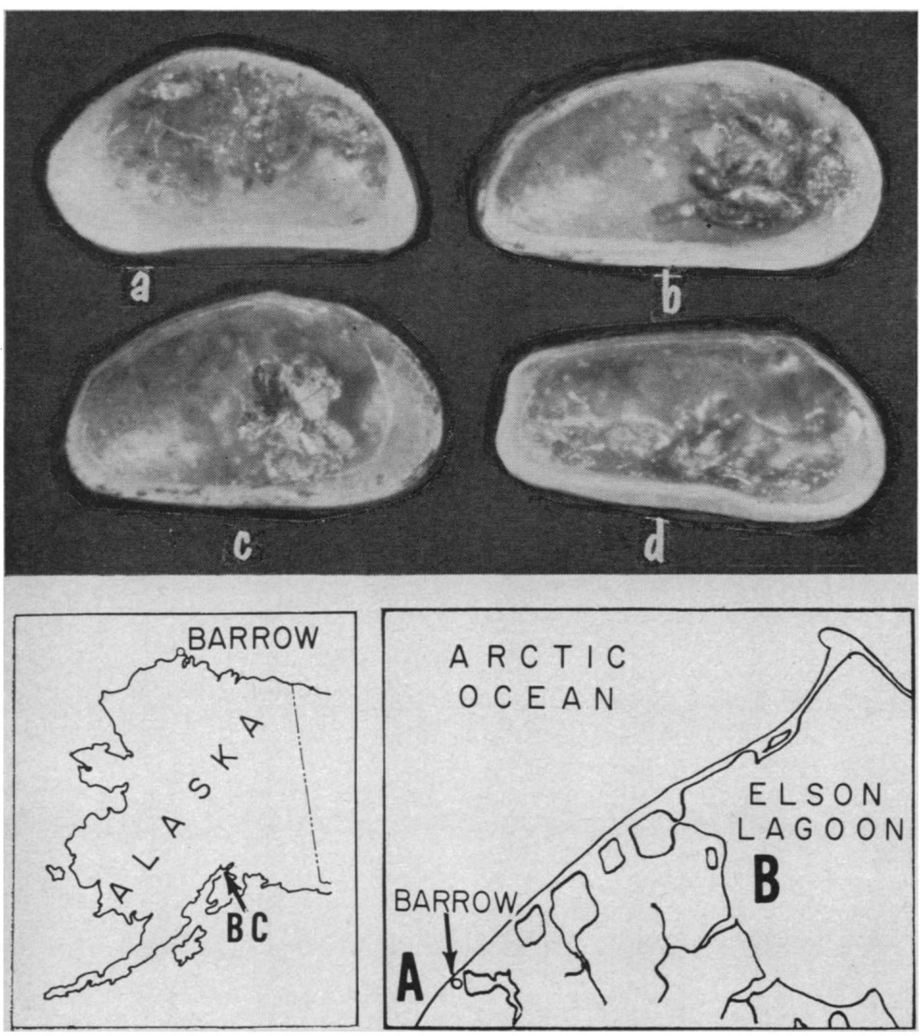

Fig. 1. Mummified Ostracoda and their sources. Specimens *a*, *b*, and *c* are from locality *A*; specimen *d*, from locality *B*. *Paracyprideis pseudopunctillata: a*, interior right valve; *b* and *c*, interior left valves. *Normanicythere concinella: d*, interior left valve. (× 50)

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Laser as Light Source for Optical Diffractometers; Fourier Analysis of Electron Micrographs

Abstract. *Fourier analysis of electron micrographs has been accomplished under optimum conditions with a gas laser as the light source for an optical diffractometer.*

Klug and co-workers have proposed a novel application of the optical diffractometer to analysis of electron microscopic images and have demonstrated the versatility and power of the technique in detecting structure not apparent on visual examination (*1, 2*).

The ideal conditions for the production of optical diffraction patterns and the means for their attainment have been established (*3*). Of primary importance are a source of coherent monochromatic light, the use of refracting elements of high quality, and a system