salient boundaries of crystals of the former were also observed in contact with H and chalcopyrite. The new minerals F and G were first recognised towards the end of the year 1932 in the laboratory of the E.T.H. at Zurich while the present research work was in progress, when the writer benefited greatly by the valued advice and criticism of Professors P. Niggli and R. Parker. The author, therefore, proposes the name "Niggliite" for the former (F), and "Parkerite" for the latter (G).

Mineral G (Parkerite) appears to be a new nickel sulphide. The partial quantitative analysis of a few milligrams of material by W. E. Schilz suggests that its formula corresponds either to Ni_2S_3 or NiS_2; the former symbol seems to be the more likely one. Microchemical tests prior to analysis indicated the presence of nickel and sulphur only, while the spectroscope revealed traces if iron in addition to nickel. Of the standard etch reagents, only KCN and KOH gave negative results. Etched surfaces of polished sections sometimes revealed the presence of minute irregular areas, which remained unstained. The true nature of these could not be investigated owing to the limited amount of material on hand. It is noteworthy that the mineral dissolves readily with effervescence in 50 per cent. HNO_3.

Fragments of the mineral may easily be recognised under the microscope owing to the fact that it cleaves in three directions yielding rhomboidal plates which closely resemble cleavage fragments of calcite. The lustre of the flakes is analogous to that of molybdenite, and like the latter, the mineral G is soft enough to mark paper. Under the microscope, the hardness of the mineral, which was determined by means of an improvised micro-sclerometer, appeared to be slightly less than that of galena.

Polished surfaces of the mineral G are perfectly smooth, the reflectivity is approximately 45 per cent., whilst the colour is creamy white with a faint mauvish tint. It is strongly anisotropic, and is almost invariably characterised by multiple lamella twinning (Pms. 89 and 90). The pleochroism is sufficiently distinct to enable recognition of the presence of the twin lamellae—a phenomenon which is enhanced by the use of oil immersion lenses. The study of polished sections leads one to conclude that the mineral G cleaves most readily in one of the three above-mentioned directions. In twinned crystals, the trace of this cleavage makes an angle of about 50° with the composition face. As a result of the twinning, a continuous cleavage trace suffers displacement at the junction of alternate lamellae.

This direction of cleavage appears to be the only one visible in polished sections, and when present the zig-zag trace (Pm. 84) is sufficiently characteristic to permit the recognition of the mineral parkerite. It is noteworthy that $FeCl_3$ is a useful etch reagent for bringing out the twin lamellae and cleavages.

A small quantity of the mineral G removed from the concentrate previously mentioned was sent to the E.T.H. Laboratory in Zurich for X-ray examination, and Professor P. Niggli's conclusions are as follows:—

> " Zur Bestimmung der Symmetrie wurde eines der rhombusförmigen Blättchen zu einer Laue-Aufnahme verwendet. Es wurde dabei das Bilt (Fig. 14) erhalten, welches spiegelbildlich gebaut ist. Die Spur der Spiegelebene verläuft parallel der längeren Diagonale, halbiert also den spitzen Winkel des Blättchens. Demnach dürfte der Parkerit dem monoklinen System zuzuzählen sein, wobei die Blättchenebene einer Flache aus der Zone der b-Achse entspricht. Eine Drehaufnahme um die kurze Diagonale (b-Achse) ergab den Parameter b=3·2 A°.

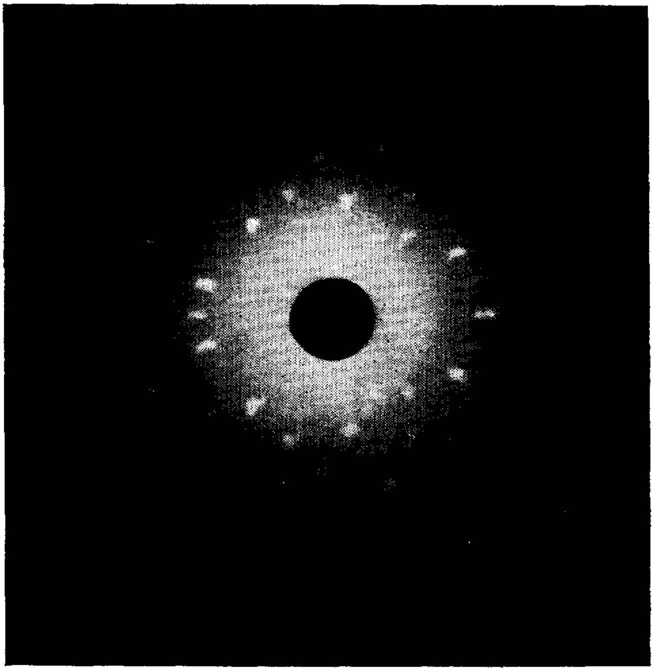

Fig. 14.—Laue photograph of parkerite.

> Zur Charakteristik des Minerals wurde eine Pulveraufnahme angefertigt. Das Ergebnis der Auswertung ist hierunten zusammengestellt. Die 1 Kolonne gibt die Intensität der beobachten Linien (s=schwach, m=mittel, st=stark, b=breite Linie); die zweite Kolonne enthält die Ablenkungswinkel und die dritte die zugehörigen Netzebenenperioden d. Die Aufnahmen wurden mit CuK_{α}-Strahlung gemacht. Schwache Linien könnten eventuell von Verunreinigungen herrühren (?).

Intensitäten.	Ablenkungswinkel θ.	Netzebenenperioden d.
m	7° 48′	5·66 x
m	11° 12′	3·96
m	14° 45′	3·02
st	15° 42′	2·84 xx
mst	19° 18′	2·32
s	19° 45′	2·27 (5)
ms	22° 27′	2·013
m	22° 51′	1·979
s	23° 54′	1·897
ms	24° 30′	1·854
m	25° 24′	1·792
s	25° 33′	1·782
s	26° 39′	1·714
st	27° 57′	1·640
s	28° 36′	1·606
ms	28° 54′	1·590 (5)
s	29° 21′	1·568
st	32° 36′	1·427
m	32° 57′	1·413
sb	33° 57′	1·376
m	34° 54′	1·343 (5)
s	35° 33′	1·322
msb	37° 15′	1·270
st	39° 27′	1·209 (5)
s	40° 21′	1·187
ms	41° 18′	1·165
s	42° 24′	1·140
s	43° 33′	1·115 (5)
st	45° 39′	1·075
m	51° 45′	0·9788
sb	54° 33′	0·944
m	56° 18′	0·9240
m	58° 48′	0·8987
ms	59° 36′	0·8912
ms	61° 24′	0·8755
s	63° 30′	0·8589
msb	69° 18′	0·8217

From the foregoing it seems likely that parkerite is monoclinic. The mineral G is not uncommonly associated with irregular cubanite, and these two sulphides may form narrow vein-like offshoots from the main mass of ore into the surrounding silicates. Such veins have been observed to include idiomorphic crystals of sperrylite. The mutual nature of the boundaries between the two above-mentioned sulphides precludes one from determining which is the younger. It is likely that parkerite has an extended range of crystallisation, and that sperrylite can continue to separate after the precipitation of the pyrrhotite. The mineral G and pyrrhotite have not been observed to occur together in the same polished section. It is most commonly associated with the alloy H, galena and chalcopyrite. Fringes of blende may appear along parkerite-chalcopyrite contacts. The mineral G occasionally presents salient angular margins to, and seems to be exploited by, veinlets of chalcopyrite, the chalcocite-bornite intergrowth, H and J, and it is possible that it is earlier than any of these in the crystallisation sequence. The fact that it envelops grains of the minerals F and E, as well as sperrylite, suggests that it is probably later than any of these. The mineral parkerite appears to invade galena (L) along directions parallel to the cleavage of the latter, and is probably also later than pentlandite in the paragenetic sequence. The stability and resistance of the mineral G to alteration is suggested by the juxtaposition of perfectly fresh parkerite with crystals of pentlandite altered to bravoite, as well as pentlandite associated with decomposed vallerite. The association of pentlandite, niccolite and parkerite with the chalcocite-bornite intergrowths is interesting, as it is suggestive of the hypogene origin of the copper-bearing sulphides.

Mineral H. The presence of metallic grains composed of 66 per cent. nickel, 5 to 6 per cent. of each of copper, iron, silver, and about 15 per cent. of gold was reported by W. H. Goodchild in concentrates of the ore at Waterfall Gorge, Insizwa. The present investigation tends to show that the material assayed was in all probability primarily a mixture of the minerals G and H. In referring to these metallic grains, A. L. du Toit suggests that the native elements probably owe their origin to the action of carbonaceous matter (present in the sediments underlying the intrusion) on the ores while in the fluid state. In this respect it is interesting to note that carbonaceous matter (probably derived from the graphitic shales in the upper Pretoria Series) in the form of graphite is a common constituent of the magmatic sulphidic nickel ore at Vlakfontein in the Transvaal. Even though these Bushveld nickel ores have been investigated by P. A. Wagner, H. Schneiderhöhn and C. M. Schwellnus, no one has as yet noted the presence of analogous metallic grains. It does not seem likely, therefore, that the carbon, as such, has affected the postulated reduction.

The presence of a copper-bearing electrum in the chalcopyrite-cubanite ores was observed during the investigation of polished sections. The subsequent microscopic examination of the non-magnetic concentrate, previously referred to, revealed the presence of minute irregular metallic nuggets which could be individually identified by applying the malleability test. In this manner the writer collected 1·17 milligrams of the alloy, which was assayed by Dr. W. E. Schilz. Since microscopic examination suggests that the mineral H varies considerably in composition from place to place, and even within the same grain, the results of the analysis can only be regarded as giving an indication of the average composition of the metallic nuggets.

Percentage ratio Au : Cu : Ag : 9 : 3 : 5 Au ... 53·0%
Atomic ratio Au : Cu : Ag : 5 : 4 : 5 Cu ... 17·1%
Ag ... 29·9%

The study of polished sections leads one to the conclusion that the average percentage of silver may be higher and that of gold lower than is indicated by the analysis. In electrum the Au:Ag ratio appears to vary from 1:1 to 2·5:1, and under certain circumstances copper