

NICKEL MINERALS FROM BARBERTON, SOUTH AFRICA:  
 IV. REEVESITE, A MEMBER OF THE  
 HYDROTALCITE GROUP

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ABSTRACT

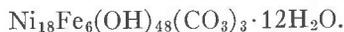
Reevesite, having the formula  $[\text{Ni}_{16.69} \text{Fe}_{0.33}^{2+} \text{Mg}_{0.41} \text{Co}_{0.07}] \text{Fe}_{6.00}^{3+} (\text{OH})_{48} (\text{CO}_3)_3 \cdot 12\text{H}_2\text{O}$ , has been found in the nickel ore from the Bon Accord area in the Barberton Mountain Land, South Africa. The mineral occurs in druses as minute hexagonal platelets. It is moderate greenish yellow, has  $\omega = 1.72$ ,  $\epsilon' (\approx \epsilon) = 1.63$ , and a measured specific gravity of 2.87. Forty-eight  $d$ -spacings obtained by X-ray diffraction have been indexed according to a hexagonal unit cell with  $a = 6.164 \pm 0.003 \text{ \AA}$  and  $c = 45.54 \pm 0.02 \text{ \AA}$ . The infrared spectrum of the reevesite corresponds closely to that of sjögrenite, another member of the hydro-talcite group.

INTRODUCTION

The re-investigation of the alleged nepouite-trevorite deposit in the Bon Accord area, about two miles west of the Scotia Talc Mine in the Barberton Mountain Land, South Africa, led to the discovery of a series of nickel minerals, *viz.*, ferroan trevorite (de Waal, 1969), a nickel-rich chlorite nimate (de Waal, 1970a), and a nickel-rich talc willemseite (de Waal, 1970b). This paper contains some new information on reevesite.

The relevant nickel ore forms a tabular body about two feet thick and twenty feet wide on the contact between the Moodies Quartzite and the ultramafic rocks of the Jamestown Igneous Suite. The ferroan trevorite and willemseite constitute the bulk of the ore, whereas nimate appears as veins in the former minerals. Violarite and millerite are present in small quantities. The reevesite occurs in druses where the weathering of the rock is in an advanced stage. Minute quartz crystals, thin films of opaline silica, and goethite, the last named usually not more than a mere brown stain, are associated with the reevesite.

Reevesite is a relatively rare mineral that has the ideal formula of



The only existing literature on this mineral is a paper by White *et al.* (1967) on the weathering products of the Wolf Creek meteorite in Western Australia.

EXPERIMENTAL METHODS

Microscopy formed the basis of approach in the study of the reevesite.

All colors allotted macroscopically are according to the Rock Color Chart (Rock-color Chart Committee, 1963).

The refractive indices were determined by the immersion method. A narrow-band interference filter with maximum transmittance at 589 nm (sodium light) was used, and the refractive indices of the matching liquids were read off with a Leitz-Jelley refractometer.

The determination of the specific gravity of reevesite proved to be difficult owing to the small size of the crystals. Four methods were employed. The first was to centrifuge the mineral in a density gradient, and the second was to centrifuge the mineral in a mixture of methylene iodide and acetone. Acetone was gradually added to the mixture, and the point where a major portion of the floating mineral started to sink to the bottom of the container was taken as an indication of the specific gravity of the mineral. The same experiment was repeated with Clerici solution, mainly because of the tendency of the mixture of acetone and methylene iodide to form vortices when the centrifuge was brought to a stop. The fourth method was the use of the Clerici cell, as described by Jahns (1939). The specific gravity was also calculated from the cell volume and cell formula, a value of  $6.0228 \times 10^{23}$  being used for Avogadro's number.

The X-ray-diffraction work was done with a Debye-Scherrer camera (radius 114.6 mm). Co K $\alpha$ -radiation was used and an exposure time of 16 hours was allowed. The cell data were refined with the computer programme CELFIT<sup>1</sup>, adapted for FORTRAN IV.

The infrared absorption spectrum of the reevesite was obtained with a Beckman spectrophotometer.

The reevesite was analysed with an A.R.L. electron microprobe, pure elements being used as the standards. Corrections were applied by use of the computer programme MAGIC<sup>2</sup>, adapted for the IBM 360-150 computer by staff members of the National Institute for Metallurgy.

## RESULTS AND DISCUSSIONS

Reevesite can be seen in hand-specimens and in thin and polished sections as hexagonal platelets up to 100 microns in diameter. It occurs in cavities, often in close proximity to the violarite from which it formed. The mineral is often stained by goethite. Opaline silica is present in places in the vugs that contain the reevesite, and in some instances very small crystals of quartz were observed in the reevesite platelets.

The physical and optical properties of the reevesite are given in Table 1, in which the data for the reevesite from Wolf Creek are included for comparison.

The determination of the specific gravity proved to be difficult, mainly because of the very finite grain size of the reevesite. Each of the four methods applied has certain merits, but the density-gradient column is undoubtedly the best for this kind of work. It has the advantages that no convection currents of any sort can develop at any stage and it can be

<sup>1</sup> Bracher, B. H. (1967). CELFIT—a computer programme to refine crystal unit cell dimensions. United Kingdom, Atomic Energy Authority Research Group, Ceramics Division. Report AERE-R5412.

<sup>2</sup> Wise, W. N. (1968). Modification of a computer program for converting electron microprobe data to true chemical composition. National Lead Company of Ohio, Cincinnati, Ohio. NLCO-1014.

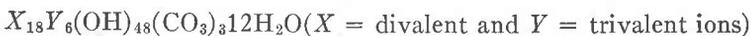
TABLE 1. PHYSICAL AND OPTICAL PROPERTIES OF THE REEVESITE FROM BON ACCORD, BARBERTON, AND FROM THE WOLF CREEK METEORITE, WESTERN AUSTRALIA

Colour	Reevesite, Barberton Moderate greenish yellow (10Y7/4)	Reevesite, Wolf Creek Bright yellow
Habit	Hexagonal platelets	Hexagonal platelets
Refractive indices	$\omega = 1.72$ $\epsilon' (\simeq \epsilon) = 1.63$	$\omega = 1.735$ $\epsilon$ about 1.65—estimated from birefringence
Specific gravity	Calculated: 2.87 Measured: Gross average: 2.88 (a) Density gradient (two runs) (1) $\simeq 2.90$ (range 2.87–2.90) (2) $\simeq 2.90$ (range 2.70–3.10) (b) Centrifuge (Methylene iodide-acetone) $\simeq 2.89$ (range 2.86–2.90) (c) Centrifuge (Clerici solution) $\simeq 2.88$ –3.00 (d) Clerici cell $\simeq 2.87$ –2.88	Calculated: 2.78 Measured: $\simeq 2.80$
Infrared absorption	Major bands at 1363, 1630, and 3425 $\text{cm}^{-1}$ . Two (OH)-spikes at 3664 and 3676 $\text{cm}^{-1}$ .	

centrifuged, when prepared in a suitable tube, so that the mineral grains quickly settle to the correct density environment. The centrifuge methods have the disadvantage that, when the centrifuging is discontinued, vortices tend to develop in the tubes, so that the behaviour of the mineral grains cannot be observed properly. Furthermore, both the centrifuge method (where no density-gradient technique is involved) and the Clerici-cell method are plagued by the development of convection currents. The Clerici cell, which is usually a very reliable technique when mineral grains of 100 to 1000 microns are used, was found to be the most inaccurate for the determination of the specific gravity of the reevesite.

The infrared pattern of the reevesite resembles that of the sjögrenite given by Mumpton *et al.* (1965).

The chemical analyses (Table 2A) recalculated to the form



indicate that the composition of the reevesite from Barberton agrees

TABLE 2. THE CHEMICAL ANALYSES OF THE REEVESITE FROM BARBERTON COMPARED WITH THOSE OF IDEAL REEVESITE AND OF THE REEVESITE FROM WOLF CREEK, WESTERN AUSTRALIA

A. Original microprobe analyses	Percentage		
	Analysis 1		Analysis 2
Mg	0.31 ± 0.05		0.42 ± 0.05
Ni	36.51 ± 1.11		36.13 ± 0.95
Co	0.14 ± 0.02		0.17 ± 0.01
Fe	13.95 ± 0.22		14.35 ± 0.35
Si <sup>a</sup>	0.89 ± 0.44		0.35 ± 0.16

B. Recalculated to the number of ions on the basis of 24 (Ni, Fe, Mg, Co) and Fe <sup>3+</sup> = 6.000				
	Analysis 1	Analysis 2	Ideal reevesite	Reevesite, Wolf Creek
Ni	16.830	16.548	18	17.575
Fe <sup>2+</sup>	0.759	0.909	—	0.418
Mg	0.345	0.465	—	—
Co	0.066	0.078	—	0.007
Fe <sup>3+</sup>	6.000	6.000	6	6.000

<sup>a</sup> Probably opaline silica

closely with that of ideal reevesite and of the reevesite from Wolf Creek (White *et al.*, 1967).

The X-ray powder data and the unit-cell dimensions are provided in Table 3. The *hkl*- and *d*-values of 48 lines are listed, and, although the majority of the stronger lines correspond to those given by White *et al.* (1967), the indexing of the weaker lines differs notably from that of these authors.

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TABLE 3. THE X-RAY-DIFFRACTION POWDER DATA FOR THE REEVESITE FROM BARBERTON

<i>hkl</i>	<i>d</i> (obs.) Å	<i>d</i> (calc.) Å	I	<i>hkl</i>	<i>d</i> (obs.) Å	<i>d</i> (calc.) Å	I
004(?) } 005(?) }	10.7	11.4 } 9.1 }	10	004	1.327	1.325	10B
006		7.6		7.6	100	0.4.10	1.280
?	7.2	—	10	0.4.12	1.258	1.259	10
010	5.4	5.3	5	0.4.14	1.234	1.235	5
015	4.6	4.6	5	0.4.16	1.209	1.208	10
017	4.2	4.1	5	2.2.24	1.196	1.196	5
0.0.12	3.8	3.8	50	0.4.20	1.152	1.151	10
019(?)	3.61	3.67	10	0.4.22	1.122	1.122	10
0.1.12	3.12	3.09	5	1.3.28	1.096	1.095	10
114	2.96	2.97	5	0.4.26	1.062	1.062	10
116	2.85	2.86	5	0.4.28	1.034	1.032	—
118	2.71	2.71	5	3.3.9	1.007	1.007	—
022	2.65	2.65	10	2.4.10	0.986	0.985	—
024	2.60	2.60	50	3.3.18	0.952	0.952	—
026	2.51	2.52	15B	2.4.20	0.923	0.922	—
028	2.416	2.417	15	—	0.907	—	—
0.2.10	2.301	2.303	40	Hexagonal unit cell $a_0 = 6.164 \pm 0.003$ $c_0 = 45.54 \pm 0.02$ $c_0/a_0 = 7.388$ Volume = 1498.45 (Å) <sup>3</sup>			
0.2.13(?)	2.141	2.123	10				
0.2.14	2.064	2.063	10				
0.2.16	1.947	1.947	40				
128	1.903	1.902	10				
0.2.19	1.783	1.783	5				
0.2.20	1.735	1.732	20				
0.2.21	1.681	1.683	5				
0.2.22	1.636	1.636	10				
220	1.541	1.541	30				
226	1.510	1.510	30				
1.2.21	1.478	1.477	5				
0.2.26	1.465	1.464	10				
0.2.27	1.427	1.426	10				
0.2.28	1.392	1.390	10				

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