

*Hydrozincite from Narlarla, West Kimberley district,
Western Australia.*

By REX T. PRIDER, B.Sc., Ph.D., F.G.S.

Department of Geology, University of Western Australia.

With a chemical analysis by MAURICE CRABTREE, B.Sc.

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HINTZE (1930) has pointed out the considerable variation in analyses of hydrozincite and the various formulae assigned to this mineral. Further data concerning this comparatively rare mineral are therefore desirable. Hydrozincite has been found at Narlarla, Western Australia, and this material is described below.

Narlarla is situated in the Napier Range, West Kimberley district (long. $124^{\circ} 43'$ E., lat. $17^{\circ} 16'$ S.), 75 miles due east from Derby, on the south side of the Barker River gorge (fig. 1). Several small silver-lead-zinc ore-deposits occur in the hills at Narlarla which are made up entirely of Devonian limestone. The occurrences have been described by Woodward (1907, p. 11), who, in his report, gives the results of assays of several specimens of the ore. These occurrences are unique as they are the only known post pre-Cambrian primary ore-deposits in Western Australia. (Secondary gold deposits occur in the Donnybrook sandstone which is considered to be probably of Permian age (Forman, 1936).) The unique character of the Narlarla deposits has been noted by Simpson (1939, p. 218), who, however, offers no explanation as to their genesis. The absence of any post-Devonian igneous intrusives, other than the leucite-lamproite plugs (Wade and Prider, 1940) which are intrusive into the Permian rocks of the Fitzroy River area to the south of Narlarla, seems to indicate that these deposits are genetically related to the lamproite magma. The nearest known occurrence of the leucite-lamproites is at Mt. North, some 15 miles to the south (fig. 1), but there may be closer occurrences as the area has not been very closely examined, and the widespread distribution of the lamproite magma has been demonstrated (Wade and Prider, 1940).

During a recent trip through the West Kimberley area in connexion with an examination of the leucitic volcanic rocks, I visited the northern lead ore-deposit in the Narlarla Hills and noted the presence, in con-

siderable amount, of a white to pale pink fibrous mineral which on later examination proved to be hydrozincite. This mineral has been analysed and is described below.

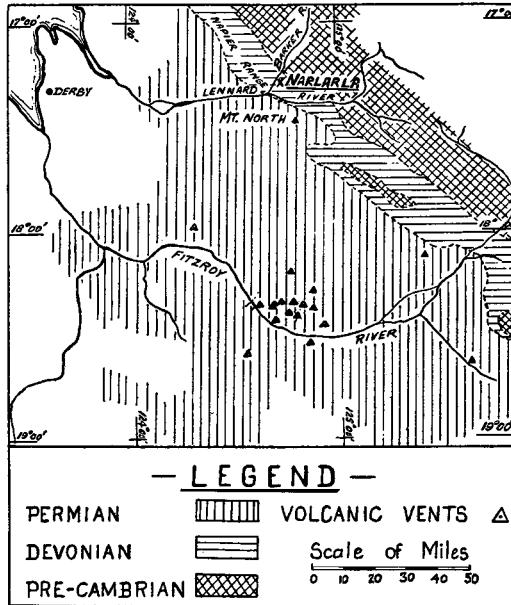


FIG. 1. Geological sketch-map of part of the West Kimberley district, showing the location of Narlarla with respect to the post-Permian volcanic vents.

The material collected came mostly from broken ore lying on the surface, and in these specimens the following minerals were noted: galena, blende, cerussite, hydrozincite, limonite, and very small amounts of malachite and chessylite. In a shallow shaft on the south-west side of the outcrop the ore consists largely of cerussite and limonite forming a flat band two feet thick, with bands six inches wide of greyish mudstone both above and below, separating the ore from the normal limestone country. This mudstone is spotted and veined with white hydrozincite. The richest hydrozincite specimens, however, came from broken ore fragments on the surface and the oxidized specimens obtained at random all contain from 30 to 40 % of hydrozincite segregated into irregular areas up to $\frac{1}{2}$ cm. across. These specimens are earthy lusted, mottled pink and white coloured, and have a drusy structure. The groundmass is earthy, fine-grained, pinkish in colour, and is composed

mainly of carbonate minerals (including zinc carbonate) and clayey material coloured with finely dispersed limonite. The druses, which form on the average approximately 40 % by volume of the rock, and which vary in size up to $\frac{1}{2}$ cm. across, are lined and in most instances completely filled with white hydrozincite. In the larger druses the hydrozincite is seen to have a very pale pinkish colour and in several places it shows very slight staining by malachite or aurichalcite. Examination under the microscope shows that the hydrozincite occurs as thin water-clear plates, usually elongated and bounded by parallel faces. The plates all lie on the same face (100) and other orientations were only obtained with difficulty as the plates are exceedingly thin. Extinction on (100) is straight and the optic elongation positive. Interference-figures obtained on (100) were the characteristic 'flash figure', indicating that the optic axial plane is outside the field of view. No basal sections could be obtained (slices could not be cut as the minute separate crystals decompose on the slightest heating). Plates on edge, i.e. on (010), show extinction-angles $\gamma : c$ to 40° . Some of the (100) plates were highly birefringent, others showed low grey interference-colours (due entirely to their extreme thinness). The refractive indices obtained on these plates by immersion in oils were α 1.635, γ' 1.745.

Ford and Bradley (1916) on hydrozincite from Nevada stated that the optic axial plane and vibration-direction γ are apparently parallel to (100). Larson (1921, pp. 90, 267) on material from other localities gave $\alpha = b$ and $\gamma : c$ moderate, and in his second edition (1934, p. 194) $\gamma : c$ as 13° . The properties of the Narlarla hydrozincite may be summarized as follows:

Colour: pale pink to white (transparent).

Habit: thin elongated monoclinic plates ((100) plates elongate parallel to c).

Extinction straight on (100), $\gamma : c = 40^\circ$ on (010).

Optical elongation positive.

Biaxial, optical sign unobtainable, optic axial plane normal to (010).

Refractive indices α 1.635, γ' 1.745; birefringence $\gamma' - \alpha$ 0.110.

Does not fluoresce under ultra-violet light.

Blowpipe tests: in closed tube decrepitates and water evolved. The residue is bright golden-yellow when hot and pale sea-green when cold.

Soluble with effervescence in cold dilute acids.

Microchemical test for zinc with potassium mercuric thiocyanate gives characteristic feathery crosses with slight purplish colour due to the presence of copper.

Material from the drusy cavities was analysed and the result is shown in table I. This material contained a very small amount of the limonitic clayey material of the groundmass of the rock and some cerussite. In

the calculation of the analysis Fe_2O_3 has been calculated as limonite, Al_2O_3 as allophane, and PbO as cerussite. Microchemical tests were made to determine whether any lead was in the hydrozincite. A sample such as that analysed was dissolved in 1 : 10 HNO_3 , evaporated to dryness, taken up with 0.5 % acetic acid, and tested with KI , yielding an abundance of yellow lead iodide. Some of the purest material from the larger druses was tested in a similar manner and only a slight reaction for lead obtained—this indicates that the hydrozincite itself contains little, if any, lead.

The portion recorded as 'insoluble' in the analysis was material insoluble in HCl and probably represents silica resulting from the decomposition of the clay mineral. The alumina has been calculated as allophane rather than as kaolin because: (1) it has gone into solution with HCl ; (2) there is only sufficient SiO_2 to satisfy Al_2O_3 in a 1 : 1 ratio; and (3) if it is calculated as kaolin then there is a considerable excess of negative ions over positive ions in the residue.

TABLE I. Analysis and calculation of hydrozincite from Narlarla.
(Analyst, M. Crabtree.)

	%	Mol. prop.	Limonite.	Allophane.	Cerussite.	Residue (hydrozincite).
Insoluble (SiO_2)	1.15	0.0191	—	0.0177	—	0.0014
Al_2O_3 ...	1.80	0.0177	—	0.0177	—	—
Fe_2O_3 ...	2.64	0.0165	0.0165	—	—	—
CaO ...	trace	—	—	—	—	—
MgO ...	0.04	0.0010	—	—	—	0.0010
PbO ...	3.96	0.0177	—	—	0.0177	—
ZnO ...	62.10	0.7638	—	—	—	0.7638
CuO ...	1.75	0.0220	—	—	—	0.0220
CoO ...	0.09	0.0012	—	—	—	0.0012
NiO ...	0.18	0.0024	—	—	—	0.0024
CO_2 ...	15.19	0.3451	—	—	0.0177	0.3274
SO_3 ...	0.01	0.0001	—	—	—	0.0001
$H_2O^{+100^\circ C.}$	10.17	0.5648	0.0247	0.0885	—	0.4516
$H_2O^{-100^\circ C.}$	0.96	—	—	—	—	—
	100.04					

In the residue the ratio of anions to cations is 789 : 779, almost 1 : 1, and the ratio $CO_2 : H_2O = 327 : 452$. This ratio lies closer to 3 : 4 than 2 : 3, and the formula for the Narlarla hydrozincite therefore appears to be $3ZnCO_3 \cdot 4Zn(OH)_2$ with slight replacement of Zn by Cu , Ni , and Co .

Hintze (1930, p. 3352) has pointed out the considerable variation in analyses of hydrozincite and the various formulae assigned to this mineral. Ford and Bradley (1916) and Perrier (1916) consider that hydrozincite has the formula $2ZnCO_3 \cdot 3Zn(OH)_2$. In a later paper by

Biehl (1919) an analysis of hydrozincite of unknown locality gave the formula $\text{ZnCO}_3 \cdot \text{Zn}(\text{OH})_2$. Larsen (1934, p. 194) lists hydrozincite as having the formula $7\text{ZnO} \cdot 3\text{CO}_2 \cdot 4\text{H}_2\text{O}$. The Narlarla mineral appears to be closer to the formula given by Larsen than to other suggested formulae.

Since the relative proportions of CO_2 and H_2O are of the greatest importance in connexion with the formula of this mineral, it may be of interest to state the method by which these constituents were determined in the analysis quoted above. The $(\text{H}_2\text{O}^+ + \text{CO}_2)$ was determined by loss on ignition on material dried at 100°C . The CO_2 was estimated by treating a separate portion with HCl and absorption of CO_2 in $\text{Ba}(\text{OH})_2$ —the excess $\text{Ba}(\text{OH})_2$ was neutralized with HCl using phenolphthalein and then the BaCO_3 was titrated with HNO_3 using methyl orange as an indicator. The H_2O^+ was obtained by difference on these two results. It was unfortunate that absolutely pure material could not be obtained for this analysis—it contains some clayey material in which one cannot be certain of the actual amount of water. Judging from the ratio of anions to cations in the residue (table I) there should be slightly more water present in the residue—even if this be added to balance, the formula still lies closest to that suggested by Larsen.

Summary.—Hydrozincite from Narlarla is similar optically to that listed by Larsen with the exception that $\gamma : c = 40^\circ$ (13° according to Larsen). Its formula approaches most closely to $3\text{ZnCO}_3 \cdot 4\text{Zn}(\text{OH})_2$ with slight replacement of Zn by Cu , Co , and Ni . The ore-deposit where this mineral has been noted is unique, being the only post pre-Cambrian primary ore-deposit known in Western Australia, and it is suggested that it is genetically related to the post-Permian lamproite magma of the Fitzroy River basin.

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