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MINERALOGICAL NOTES: No. I.

By

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(Plates xii.-xiii.)

THE OCCURRENCE OF GARNET AT BOWLING ALLEY POINT, NEAR NUNDLE,
NEW SOUTH WALES.

(Plate xii.)

The discovery of colourless garnets occurring in the Great Serpentine Belt at Bowling Alley Point was made by Mr. D. A. Porter. In a personal letter he supplies the following information:—"I first noticed them in 1884, at about 200 yards north of Anderson's Rock, and the first specimen I found was loose on the surface, and the garnet crystals were seated on and about quite a fine prism of green vesuvianite; I have never seen as fine a specimen since. Professor Liversidge got it eventually."

The Museum collection contains about three hundred specimens from here. They were collected by Mr. D. A. Porter, Dr. C. Anderson (the Director), and the writer.

No detailed description of the garnets has been published, although as early as 1888 Professor Liversidge¹ records them as grossularite. Later Professor Benson² applied to them the name, topazalite. The same writer has described the Great Serpentine Belt of New South Wales very exhaustively in several papers. He also treats the subject of the included garnet-rocks, more particularly at Bingara, New South Wales.

The garnet consists of small, colourless, glassy crystals, and also of white opaque masses. The crystals always display the same habit, being dodecahedra. In size they vary from 1 mm. to 5 mm. in diameter. At times they exhibit a faint honey-yellow colour, but for the most part, are colourless and transparent. Material for chemical analysis was picked carefully and was very pure. The result of that

¹ Liversidge—Minerals of New South Wales, 1888, p. 204.

² Benson—Proc. Linn. Soc. N.S.W., xxxviii, 4, pp. 569-596 and 662-742.

analysis is given below, together with an analysis of the grossularite from Roding River, New Zealand, for comparison.

	I.	II.	III.
Si O ₂ ...	39·96	36·33	2·9
Al ₂ O ₃ ...	23·21	25·64	} 1·0
Fe ₂ O ₃ ...	0·68	abs.	
Fe O ...	0·95	0·50	} 2·8
Mg O ...	0·53	0·20	
Ca O ...	35·04	36·19	
Na ₂ O ...	n. d.	} 0·14	.....
K ₂ O ...	n. d.		.....
H ₂ O ...	.....	0·62	.....
Ti O ₂ ...	.....	0·05	.....
Cr ₂ O ₃ ...	.....	0·05	.....
Mn O ...	trace	0·15	.....
	100·37	99·87	.....

- I. Grossularite, Bowling Alley Point, New South Wales, Anal. T.H.S.
 II. Grossularite, Roding River, New Zealand, Anal. Maclaurin.
 III. Molecular ratios derived from I.

From the above analysis, it will be seen that the formula is approximately $3\text{CaO Al}_2\text{O}_3 3\text{SiO}_2$, which is that of grossularite. The specific gravity is 3.58. These crystals occur in numerous small fissures intersecting dykes which have intruded the serpentine, and are not found outside of these dykes except in curious masses of rock which resemble the dyke rock. The associated minerals are prehnite, chalcedony, and vesuvianite.

From the map of the area under discussion (Plate xii), it will be noticed at once that the dykes are confined to the western side of the serpentine, except where the serpentine belt becomes comparatively narrow. Their strike is roughly parallel to that of the serpentine itself. Their width varies from one foot to about six feet, while they can be traced along the direction of their strike only for a few chains at most. The variation in texture of the different dykes is most marked, and it may exist in any one dyke in the direction of the strike. There is also a variation in the mineral constitution of the rocks. In places it is a normal gabbro changing by almost imperceptible stages through garnet-gabbro and prehnite-garnet-pyroxene rock to garnet-pyroxene rock, the rodingite of H. P. Marshall.

The occurrence of basic and even acid dykes intruding serpentine has been recorded by several writers. H. P. Marshall³, in describing the dykes intruding the serpentine in the Mt. Dun region, New Zealand, expresses the opinion that the dykes (grossularite rock) are not derived by decomposition or by any metamorphic process. He considers that they are primary ultra-basic rocks, and gives the name rodingite to them.

R. P. D. Graham⁴, in describing the injection of the granite rocks into the serpentine of the Black Lake-Thetford Area, Quebec, Canada, suggests that "the Granite injections were accompanied by hydrothermal waters capable of producing somewhat intense pneumatolitic action." He bases this statement on the presence of dykes of vesuvianite, grossularite and diopside cutting the serpentine. He further considers that "the granitic magma, as it made its way along fissures in the peridotite and associated rocks, was able to exert a powerful solvent action on the very basic minerals it encountered, owing mainly, no doubt, to its own extreme acid composition and to its content of aqueous and other volatile constituents;"

W. N. Benson⁵, in describing the masses of pale green or white grossularite rocks in the serpentine at Bingara, New South Wales, expresses the opinion "that the addition of lime was obtained during the process of serpentinisation" and that the gabbro was intruded before the hydration of the serpentine.

In regard to the view that these grossularite rocks are primary, the whole of the field evidence obtained from the area under review seems to be opposed to it. They are certainly the result of the alteration of the original gabbro. The argument of the extreme acid composition of the original dyke rock is not applicable in this case, as the original dyke rock was basic in composition.

The following is a list of the secondary minerals found both in the serpentine and the dykes:—

<i>Dykes:</i>	<i>Serpentine:</i>
Chalcedony, etc.	Chalcedony, etc.
Calcite (very little).	Magnesite.
Grossularite.	Asbestos.
Prehnite.	Serpentine.
Vesuvianite.	

This at once suggests that these secondary minerals originate from the action of the same agency on the two different rocks, i.e., the metamorphism of the gabbro and the peridotite to grossularite rock and serpentine respectively is the result of the one agency. It is important to note in this connection that the dyke rock has been subjected to much strain, and, like the serpentine, is much slickensided. This implies the injection of the gabbro rock before the conversion of the original ultra-basic rock into serpentine.

³ Bell, Clarke and Marshall—Bull. Geol. Surv. N.Z., 12, 1911.

⁴ Graham—Economic Geology, 1917, pp. 154-202.

⁵ Benson—Am. Jour. Sci. (4), xlvi, 276, 1918, pp. 694-731.

In regard to the curious masses included in the serpentine, it is found that they are confined entirely to near the western boundary. They are either rounded or more or less lenticular in shape, and vary in size from about one foot to as much as ten feet measured along the longer diameter of the lens. At first sight they suggest fragments of country rock (limestone) caught up in the peridotite intrusion and subsequently altered. There is, however, no field evidence in support of this view; on the other hand, the larger masses show a distinct lithological similarity to the dyke rock. Furthermore, no contact between limestone and serpentine was found. Thus one is forced to the conclusion that they both have the same origin. It might be suggested that the peridotite intrusion accompanying large orogenic earth movement has tapped the magma reservoir from which it is derived, from its base. This offers an explanation of these curious masses. They would then represent portions of the overlying gabbro magma caught up by the very viscid ultra-basic magma. The distribution and the shape of these masses are in accord with this view. These portions of the gabbro magma need not necessarily have been solid at the time of their enclosure, indeed it seems improbable that they were. These, then, have been subsequently altered by the same agency as the dykes and the peridotites.

Many have been the writers on the subject of the agency by which the serpentine has been produced. W. N. Benson⁶ has summarised this work in his "Origin of Serpentine." The evidence in the present case supports the idea that the garnet was produced by magmatic solutions either accompanying the injection of the gabbro or closely following it. That these solutions were highly charged with silica is shown by the presence of chalcedony in the fissures of the dyke rock as well as fairly large masses of siliceous sinter and opal in close proximity to the dykes. There is a complete absence of crystallised calcite in the fissures of the dykes, but it is present as a decomposition product of the felspar of the gabbro, indicating that carbonic acid was present in the magmatic waters, but not nearly to the same extent as silica.

The processes which led to the formation of the grossularite may be summarised thus:—

- (1) Intrusion of the ultra-basic rock. In the final stages portions of the overlying basic magma were caught up and included in it.
- (2) The intrusion of the gabbro either accompanied, or closely followed, by
- (3) The intrusion of magmatic waters containing silica and a little carbonic acid, effecting the alteration both of the serpentine and the gabbro, and depositing the grossularite and its associated minerals in the fissures of the altered gabbro rock.

⁶ Benson—loc. cit.

ON THE CHEMICAL COMPOSITION OF MOLYBDITE.

About the middle of the nineteenth century D. D. Owen⁷ analysed a specimen of molybdic ochre and found that it contained 35 per cent. of ferric iron and 15 per cent of water. According to E. S. Dana⁸, Genth proved that the specimen was a mixture of limonite and molybdic ochre. However, Owen especially mentions the purity of his sample, and the writer suggests that only part of the iron was present in the form of limonite.

In 1891, W. T. Schaller⁹ analysed samples of molybdite from various American localities, and found that their composition agreed very nearly to the formula $\text{Fe}_2\text{O}_3 \cdot 3\text{MoO}_3 \cdot 7\frac{1}{2}\text{H}_2\text{O}$. He also pointed out that the optical properties of the mineral were quite distinct from those of the artificially produced oxides of molybdenum.

In 1918, L. C. Ball¹⁰ reported as follows:—"While testing my specimens it was found that certain molybdic ochres are rich in iron and moisture, the inference being that beside the oxide of molybdenum there is a hydrated molybdate of iron, in which I am supported by Mr. F. E. Connal, of the Government Analyst's staff."

Through the kindness of Mr. Inspector G. Smith a fine specimen of molybdite from Wilson's Downfall, New South Wales, was obtained. It occurred as a fibrous radiating aggregate lining cavities in quartz. A little earthy, yellow limonite was associated with the mineral. A number of very small crystals of quartz, some being doubly terminated, were found to be wholly surrounded by the fibrous mass of molybdite. A little over a quarter of a gram was obtained for analysis. This material was carefully picked as free from impurities as possible, and examined under the microscope. The method of analysis used by W. T. Schaller was followed, and the results obtained are given in the table below:—

	1	2	3	4
H ₂ O ...	18·40	18·77	7·42	18·57
Fe ₂ O ₃ ...	22·81	23·27	1·00	22·01
Mo O ₃ ...	56·81	57·96	2·86	59·42
Insoluble	1·67	.....	.....	.....
	99·69	100·00	.....	100·00

No. 1 Column is the actual analysis made.

No. 2 Column is the analysis with the insoluble deducted and reduced to 100 per cent.

No. 3 Column is the ratio.

No. 4 Column is the theoretical analysis for $\text{Fe}_2\text{O}_3 \cdot 3\text{MoO}_3 \cdot 7\frac{1}{2}\text{H}_2\text{O}$.

⁷ Owen—Proc. Acad. Nat. Sci. Philad. vi, 1852, p. 108.

⁸ Dana—System of Mineralogy, 6th ed., 1892, p. 202.

⁹ Schaller—Am. Jour. Sci. xii, 1891, p. 138.

¹⁰ Ball—Ann. Rept. Dept. Mines, Queensland 1918, p. 202.

It is seen that the ratios approximate the theoretical formula. The iron is somewhat high, probably being due to a small admixture of limonite which is associated with the mineral.

Under the microscope the mineral is seen to be crystallised in very small acicular crystals. By transmitted light the colour is pale yellow to almost colourless. There is a very strong absorption parallel to the long axis of the crystals. This absorption is so marked that in this position the appearance of the mineral in thick sections is almost black. Between crossed nicols all crystals show straight extinction. The double refraction is strong.

Artificial molybdenum trioxide and molybdic acid were examined under the microscope. It was found that in neither case did the optical properties agree with those stated above. Thus an examination under the microscope seems sufficient to distinguish the oxide from the hydrous ferric molybdate.

As the mineral generally occurs as an encrusting mineral, it is often impossible to obtain enough material for analysis. However, specimens from the following New South Wales localities were examined under the microscope:—Wilson's Downfall, Hugh Weir's Claim (about thirty miles south-east of Tenterfield, near Moonbi), Bald Knob (about fourteen miles north-east of Glen Innes), Elliot's Block (near Jingera), Glen Eden, and Mt. Metallic Mine, Jingera.

It is interesting to note that those specimens that appear earthy, even under the pocket lens, are found to be well crystallised under the microscope. In every case the habit and optical properties were identical with those cited above. This fact precludes the idea of there being a mixture of the oxide with the hydrous ferric molybdate.

From the convergence of evidence from America, Queensland and now from New South Wales, it is proved that the hydrous ferric molybdate is a definite mineralogical compound. On the other hand, the writer can find no proof that the trioxide of molybdenum does occur in nature. There is a very rare mineral, ilsemannite, with the composition of $\text{MoO}_2 \cdot 4\text{MoO}_3$ which, so far, has only been found at Bleiberg, Carthia and Cripple Creek, U.S.A. It is entirely different from molybdite both in colour and solubility. The colour is a deep prussian blue, and the mineral is soluble in water.

Since the foregoing was written it has come under the notice of the writer that W. T. Schaller¹¹ has shown that ilsemannite is a hydrous sulphate of molybdenum.

In conclusion, the suggestion is made that the name molybdite be applied to the hydrous ferric molybdate, leaving a new name for the trioxide when it is proved to occur as a natural compound.

¹¹ Schaller—*Jour. Wash. Acad. Sci.*, vii, 1917, pp. 417-420.

WOLLASTONITE.

South Blocks Mine, Broken Hill, New South Wales.

Two specimens were obtained by Mr. Geological-Surveyor A. Coombe, now of the Geological Survey of Uganda, from the No. 4 level (530 feet) of the South Blocks Mine, Broken Hill. One of these he very kindly presented to the Trustees. Wollastonite has been recorded from the East Consols Mine, Broken Hill, by Mr. Inspector George Smith¹², of the Mines Department, Sydney. However, the specimen received from Mr. Coombe was of such peculiar appearance and habit that it was thought worthy of description.

It occurs as tabular crystals scattered irregularly throughout a mass of cubical galena. The colour is pale brownish-red, and the crystals in one or two cases are slightly curved. They measure up to 25 mm. x 15 mm. x 2 mm. The presence of three well-developed cleavages parallel to the b axis, i.e., the longer direction, gives the mineral a fibrous appearance. The cleavage parallel to $(\bar{1}01)$, which is usually not so perfect, is remarkably well developed. The optical axial angle is large, and the optical character is negative. $x \wedge c = 32^\circ 30'$ approximately. There are present many inclusions of diopside, galena and manganese and iron ores.

Owing to the presence of these numerous inclusions it was impossible to obtain material sufficiently pure for analysis.

Six crystals were measured by Dr. C. Anderson, and from his measurements the following forms have been identified:— $c(100)$, $u(001)$, $v(101)$, $t(\bar{1}01)$. One of the crystals had small terminal faces, but, as they gave either no signal at all or else a very poor one, it was impossible to recognise the forms to which they belong.

The following table gives the mean measured ϕ and ρ angles, together with the calculated angles.

Form	Measured		Calculated		Difference	
	ϕ	ρ	ϕ	ρ	ϕ	ρ
	° ' /	° ' /	° ' /	° ' /	' /	' /
$u(001)$	90 00	5 24	90 00	5 30	0	6
$c(100)$	90 1	89 58	90 00	90 00	1	2
$v(101)$	90 00	45 30	90 00	45 33	0	3
$t(\bar{1}01)$	89 58	39 43	90 00	39 35	2	8

¹² Smith—Mem. Geol. Surv. N.S.W., Geology No. 8, 1922, App. iv, p. 416.

TOPAZ.

Blatherarm Creek, New South Wales.

(Plate xiii, Figures 1-4.)

The Trustees obtained seven crystals of topaz from Blatherarm Creek, four and a half miles north of Torrington, by exchange with Mr. Inspector George Smith. These crystals were obtained from alluvial tin workings, but they are also associated with the wolfram and tin lodes of this district. All were measured on a two-circle goniometer and the results embodied in these notes.

The Director (Dr. C. Anderson) has described topaz from Emma-ville, Oban¹³, Carpet Snake Creek (near Torrington)¹⁴, and Cow Flat (near Torrington)¹⁵.

The crystals vary in size from 17 mm. x 18 mm. x 20 mm. down to 5 mm. x 9 mm. x 8 mm., measured approximately along the *a*, *b* and *c* axes. In no case were they doubly-terminated. They are clear and colourless, except three which have a faint bluish tinge. In the case of crystal vi, some mineral with a prismatic habit and an hexagonal cross section, has penetrated the crystal approximately parallel to the *b* axis. The mineral, however, has been removed, leaving only the cavity which it previously filled.

The following table gives the combinations observed in the seven crystals:—

Forms	1	2	3	4	5	6	7
<i>c</i> (001)	<i>c</i>	c	c	c	c	c	c
<i>m</i> (110)	<i>m</i>	m	m	m	m	m	m
<i>l</i> (120)	<i>l</i>						
<i>g</i> (180)	<i>g</i>	<i>g</i>	...	...	...	...	...
<i>M</i> (230)	<i>M</i>	<i>M</i>	...	...	...	...	...
<i>n</i> (140)	...	<i>n</i>	...	...	...	...	...
<i>d</i> (201)	<i>d</i>	<i>d</i>	<i>d</i>	<i>d</i>	...	...	...
<i>h</i> (203)	<i>h</i>	...	...	...	...	...	...
<i>f</i> (021)	f	f	f	f	f	f	<i>f</i>
<i>y</i> (041)	<i>y</i>	<i>y</i>	<i>y</i>	<i>y</i>	...	...	...
<i>o</i> (221)	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	<i>o</i>	...	...
<i>u</i> (111)	<i>u</i>	<i>u</i>	<i>u</i>	<i>u</i>	<i>u</i>	...	...
<i>i</i> (223)	<i>i</i>	<i>i</i>	...	...	...	...	...
<i>r</i> (241)	<i>r</i>	...	...	...	...	...	...

¹³ Anderson—*Rec. Austr. Mus.*, v, 5, 1904; *Ibid.*, vi, 2, 1905.

¹⁴ Anderson—*Ibid.*, vii, 4, 1909.

¹⁵ Anderson—*Ibid.*, vii, 1, 1908, *Ibid.*, viii, 2, 1910.

In all fourteen forms have been recognised, of which one—*r*(121)—has not been recorded previously for any locality in New South Wales. The forms are *c*(001), *m*(110), *l*(120), *g*(130), *M*(230), *n*(140), *d*(201), *h*(103), *f*(021), *y*(041), *o*(221), *u*(111), *i*(223), *r*(241). The forms π (250), *x*(243), *o*(560), and *b*(010) have been recorded by Dr. Anderson for other New South Wales localities, but apparently are not present in the crystals under consideration.

Crystal i (Plate xiii, Figures 1-2):—Measures 9 mm. x 16 mm. x 16 mm., when measured along the *a*, *b*, and *c* axes respectively.

The base is somewhat pitted and dull, giving a rather blurred signal. Of the brachydomes *f*(021) and *y*(041), the former has two faces developed while the latter is only represented by one face, which is much brighter though smaller. Of the orthodomes present, the form *h*(203) is larger, and both are rather dull. The pyramids are developed in a somewhat curious manner. The form *o*(221) is represented by two long, narrow faces only, *u*(111) has its full complement of four faces, two of which are long and narrow and two fairly large, *i*(223) is represented by three fairly large faces, and *r*(241) has three small faces. The brightness of the pyramids increases as their value of ρ increases. The prisms *l*(120) and *m*(110) are both striated parallel to the prism edges. The other prisms present are narrow, but have their full complement of four faces, except *g*(130), of which only two faces are developed. They are all bright.

Crystal ii (Plate xiii, Figures 3-4):—Measures 16 mm. x 26 mm. x 19 mm. This crystal is characterised by the development of a very large face belonging to the form *f*(021). It shows evidence of etching, the etched figures being more or less pear-shaped with the flat part towards the base. The other brachydome *y*(241) has two bright faces, which are striated parallel to the *a* axis. The only orthodome present has large, bright faces. The pyramids are all dull, not giving very good signals. The base is pitted and dull. The prisms are all bright, though striated parallel to the prism edges, except the form *m*(110), which has striations at right angles to these, but not so well developed.

Crystals iii and iv:—They are similar in habit and size, measuring about 5 mm. x 8 mm. x 15 mm. The brachydome *f*(021) is very large and somewhat dull. In crystal iii it is striated parallel with the edge of *o*(221). The other brachydome *y*(041) is small and bright. In crystal iv, it is striated parallel to the *a* axis. The pyramids are represented by *u*(111) and *o*(221), both of which are equally developed. The base is much pitted, and appears as an area of bright spots. Of the two prisms present *m*(110) is much the larger.

Crystal v:—Measures 10 mm. x 20 mm. x 14 mm. It is similar to crystals iii and iv, except that the domes *y*(041) and *d*(201) are absent.

Crystals vi and vii:—They are simple in habit, and about equal in size, measuring approximately 14 mm. x 16 mm. x 20 mm. The base is very narrow and much pitted. The only other terminal face is the brachydome $f(021)$, which is large and dull. In the case of Crystal vii, it has the etched figures as described in crystal ii. The prisms $m(110)$ and $l(120)$ are both striated, and the former is the larger.

Below is a table of the forms observed, the average of ϕ and ρ angles, and the theoretical ϕ and ρ angles calculated from indices and elements:—

Form	Measured		Calculated		Error	
	ϕ	ρ	ϕ	ρ	ϕ	ρ
	° '	° '	° '	° '	'	'
<i>m</i> (110)	62 05	90 00	62 08	90 00	03	00
<i>l</i> (120)	43 23	90 00	43 25	90 00	02	00
<i>g</i> (130)	32 16	90 00	32 14	90 00	02	00
<i>M</i> (230)	51 34	90 00	51 35	90 00	01	00
<i>n</i> (140)	25 16	90 00	25 19	90 00	03	00
<i>d</i> (201)	89 59	61 06	90 00	61 00	06	01
<i>h</i> (203)	90 00	30 17	90 00	31 02	00	45
<i>f</i> (021)	00 01	43 41	00 00	43 39	01	02
<i>y</i> (041)	00 00	62 23	00 00	62 20	00	03
<i>c</i> (001)	... ..	00 00	... ..	00 00	...	00
<i>o</i> (221)	62 08	63 53	62 08	63 54	00	01
<i>u</i> (111)	62 09	45 37	62 08	45 35	01	02
<i>i</i> (223)	62 20	33 43	62 08	34 14	12	31
<i>r</i> (241)	43 28	69 11	43 25	69 09	03	02

QUARTZ.

Tingha, New South Wales.

(Plate xiii, figure 5.)

An interesting crystal of quartz was obtained from a locality thirteen miles west of Tingha, but unfortunately nothing is known of its mode of occurrence or associated minerals.

It measures 18 mm. along the c axis, and is almost clear and transparent, having a faint, smoky brown appearance. It is not doubly

terminated. The crystal was measured on a two-circle goniometer, and from the readings a stereographic projection was drawn. From this it was obvious that the crystal was composed of two Dauphiné twins of left-handed quartz, *i.e.*—four individuals in all. These twins were intergrown in such a manner that their *c* axes were parallel but the horizontal axes of one twin were rotated through an angle of $2^{\circ} 55'$ with reference to those of the other. The junction line of the two twins is in the main irregular and visible to the eye. It was quite impossible to distinguish the junction lines of the individual parts of the twins and the crystal was etched with hydrofluoric acid which served also to distinguish the positive form from the negative forms. In pl. xiii, fig. 5, the relative position of the twins is shewn.

In the twin represented by the shaded portion, the following forms were identified: $m(10\bar{1}0)$, $e(60\bar{6}1)$, $e_1(06\bar{6}1)$, $i(50\bar{5}3)$, $i'(05\bar{5}3)$, $r(10\bar{1}1)$, $Z(01\bar{1}1)$, $x_1(61\bar{5}1)$, $\phi_1(71\bar{6}3)$, $s_1(2\bar{1}12)$. The same forms were developed in the other twin except for a complete absence of the form $\phi_1(71\bar{6}3)$. There seems to be no previous reference to this form although its positive form $\phi(6173)$ has been recorded. The signals for the faces of this form were only fair, and the faces themselves were small and striated.

The lettering and axial ratios are in accordance with those of Dana: the unit face being the first order pyramid $r(1011)$, *i.e.*, Goldschmidt's "G₂" position.

The measured and calculated ϕ and ρ angles are as follows:—

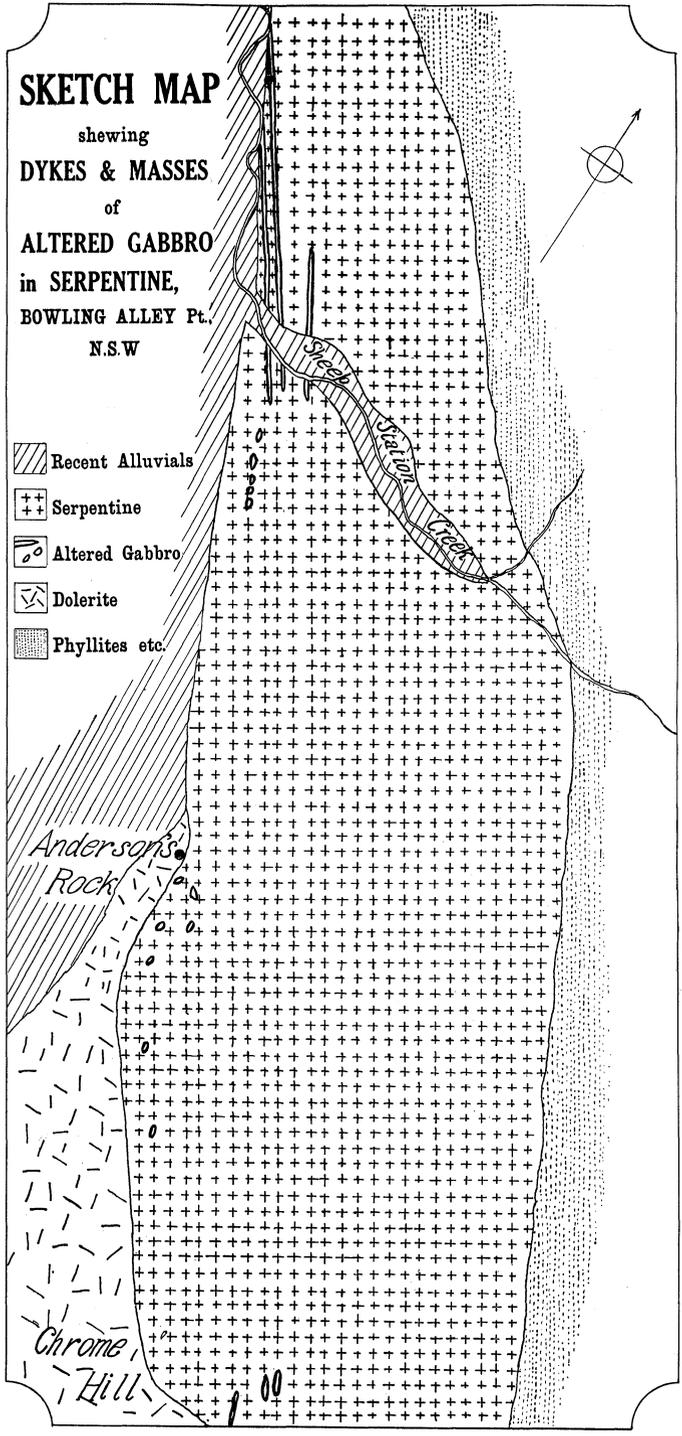
Form	Measured		Calculated		Difference	
	ϕ	ρ	ϕ	ρ	ϕ	ρ
	0 0	90 0	0 0	90 0	0	0
$m(1010)$	0 0	90 0	0 0	90 0	0	0
$r(10\bar{1}1)$	0 6	51 46	0 0	51 47	6	1
$z(01\bar{1}1)$						
$e(60\bar{6}1)$	0 17	82 17	0 0	82 31	17	14
$e_1(06\bar{6}1)$						
$i(50\bar{5}3)$	0 3	64 44	0 0	64 43	3	1
$i'(05\bar{5}3)$						
$s_1(2\bar{1}12)$	30 10	65 43	30 0	65 30	10	10
$x_1(61\bar{5}1)$	8 55	81 57	8 57	81 57	2	0
$\phi_1(71\bar{6}3)$	30 10	65 43	30 0	65 33	0	10

In conclusion, I wish to thank Messrs. G. Smith and A. Coombe for the donation of specimens, together with much useful information, and Mr. D. A. Porter for his very able assistance in the field. To the Director, Dr. C. Anderson, my thanks are due for much valuable guidance and help in this work, and also for measurements of crystals.

EXPLANATION OF PLATE XII.

Sketch Map, showing dykes and masses of altered Gabbro in Serpentine, Bowling Alley Point, near Nundle, New South Wales.

Scale: 1 inch = 16 chains.



T. HODGE SMITH, del.

EXPLANATION OF PLATE XIII.

Figs. 1-4. Topaz, Blatherarm Creek, Torrington, New South Wales.

Forms: c (001), m (110), M (230), l (120), g (130), n (140),
 d (201), h (203), o (221), u (111), i (223).

Fig. 5. Quartz, Tingha, New South Wales.

Forms: r ($10\bar{1}1$), z ($01\bar{1}1$), c ($60\bar{6}1$), i ($50\bar{5}3$), s ($2\bar{1}\bar{1}2$), x ($6\bar{1}\bar{5}1$),
 ϕ ($7\bar{1}\bar{6}3$).

