COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF SUPPLY AND SHIPPING.

MINERAL RESOURCES SURVEY.

REPORT No. 1945/13.

(Plans No.1181-1183).

REPORT ON THE CRYSTAL KING MINE, TALLANGALOOK, NEAR MANSFIELD, VICTORIA.

By

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I. INTRODUCTION.

A. General. The presence of quartz crystals in one of the dumps of an old gold mine, known as Black Charlie's mine, in the Strathbogie Ranges led to the re-opening of part of the workings in the search for crystal suitable for piezo-electric applications. To date the search has met with success, and has resulted in the recovery of crystals from the old workings and the discovery of a second crystal deposit nearby. The project is being conducted by a syndicate of five members, two of whom (Messrs. E.E. Hughes and R. Terry) are engaged in mining the crystal deposits. Another member of the syndicate, Mr. J. Willey, prepares finished piezo-electric plates from the recovered crystal in Melbourne, at the premises of Quartz Crystal Laboratories, a subsidiary of John Browning Pty. Ltd.

The mine which is now named the Crystal King mine was visited by the writer on 9th December, 1944, and again on 22nd January, 1945. On the first occasion no crystals were showing in situ, but at the time of the second visit crystals were being extracted from a quartz body occurring in the newly discovered deposit.

B. Location and Access. (See locality map on Plate 1). The mine is situated in the Parish of Tallangalook, County of Delatite and is about 11 miles a little east of north from Bonnie Doon. Bonnie Doon is a small township on the railway between Tallarook and Mansfield and is 118 miles by rail northeast from Melbourne, and by good roads via Alexandra 119 miles, or via Yea, 100 miles. From Bonnie Doon to the mine there is a good road for 7 miles but the remaining 4 miles is by a steep and narrow track which passes near the old Golden Mountain mine.

C. Topography. The mine is on the northern slope of the Strathbogie Ranges and at the head of Black Charlie's Creek, tributary to Broken River. The elevation at the mine is approximately 2900 feet above sea level, and about 50 feet below the crest of the divide.

II. GENERAL GEOLOGY.

The area is occupied by granite which is intrusive into Silurian sediments. The contact lies about 1½ miles south from the mine at its nearest point and trends easterly.

The granite is a light-coloured coarse-grained rock. Hand specimens show abundant orthoclase associated with translucent quartz and biotite.

Gold occurs in the Strathbogie Ranges and there are extensive alluvial workings on the southern slopes between Bonnie Doon and the Crystal King mine. In the vicinity of the mine gold workings followed narrow quartz veins and clay-filled joints in the granite. In Black Charlie's mine it appears that, as mentioned above, gold was found in association with a quartz crystal deposit.

III. ECONOMIC GEOLOGY.

A. General. The quartz crystals occur in bodies of quartz which are associated with vertical pipes of aplite in the biotite granite. Both the pipe rock and the enclosing granite are considerably weathered to the greatest depth to which the workings are accessible (70 feet) but the original fine and coarse-grained textures of the respective rocks are still preserved. The weathering of the granite extends for some distance in the vicinity of the pipes and no outcrops of fresh rock occur within a radius of about 50 feet.

The weathered aplite consists almost wholly of white clay, slightly gritty to the touch and containing small flakes of white mica. In a few places it displays graphic intergrowth of quartz and felspar (weathered to clay) on a small scale, but elsewhere quartz is virtually absent.

The quartz bodies which contain the crystals in vughs of large dimensions, occur within the pipes and are cylindrical in shape with the central axis parallel to that of the pipe in which they occur.

B. Description of the Deposits. (See Plate 2). Two pipes are being mined for crystal, and prospecting for further deposits is conducted as circumstances permit.

1. Southern (No.1) Pipe. This pipe has been developed from a vertical shaft 100 feet deep sunk from a site a few feet north of the pipe. This shaft was put down many years ago in a search for gold which apparently occurred in narrow quartz veins occupying vertical joints in the granite. The early miners extracted the pipe to a depth of 30 feet from the surface, and also for a depth of 20 feet below a fault which intersects the pipe at a depth of 43 feet. From these facts it appears that auriferous veins extended into the pipe for at least portion of its depth.

The whole of the pipe has been stoped to a depth of 90 feet, that is 20 feet below water-level, and consequently its original dimensions can be gauged only approximately from those of the workings. The pipe had a diameter of about 8 feet and was approximately circular in plan. It is nearly vertical with a steep pitch to the south. The fault, which intersects the pipe at 43 feet below the surface, dips to the northwest at 20 degrees and has displaced the pipe about 8 feet in a southwesterly direction. At the surface the northern edge of the pipe is 4 feet from the south wall of the shaft. At 90 feet this distance from the shaft has increased by 10 feet of which 6 to 8 feet is due to displacement on the fault.

One vugh above the fault was discovered and it is reported that it yielded about 2 tons of crystals including one stated to have weighed about 350 lb. The present owners continued sinking in the pipe below the old workings and recovered another ton or more of crystal. It is now proposed to sink the shaft to 150 feet and crosscut south to the pipe at this level thus providing between 50 and 60 feet of pipe which can be exposed by a rise adjacent to it.

2. Northern (No. 2) Pipe. This pipe, which was discovered by members of the present syndicate, is shown in some detail in Plate 3. The pipe is being worked from a vertical shaft sunk partly in the northern wall. Any quartz bodies in the pipe are exposed in the southern side of the shaft and are extracted by stripping.

The pipe is vertical and is probably circular or elliptical in plan with an average diameter of from 6 to 10 feet, but it is not fully exposed anywhere in the workings and its width and shape, can be determined only by inference.

Three quartz bodies containing crystals have been found. The first was completely removed at the time of the earlier visit in December 1944 and was stated to have yielded 1½ tons of crude crystals. The body extended down the central axis of the pipe from about 6 feet

to 26 feet below the surface. Its diameter probably ranged from 4 feet to 6 feet. The top of the second body showed as a gentle dome of massive quartz about 5 feet in diameter, lying about one foot below the bottom of the first body. Except for a small clay-filled vugh solid quartz was encountered for 5 or 6 feet when a vugh containing 5 hundredweight of crystals was opened at the base of the body. The whole mass of quartz including the solid cap and the vugh was about 9 feet long and extended to a depth of 36 feet from the surface. The top of a third body was met at about 37 feet. This was opened down the north side and at the time of the second inspection of the mine presented the appearance shown in Plate 3. The central cavity was filled with quartz crystals embedded in white and cream-coloured to pale brown clay and was stated by the operators to be similar to other vughs encountered previously.

Detailed descriptions of this body and of the crystals recovered from it are given in the following sections.

C. The Quartz Bodies. (See Plate 3). The quartz body which occupies No. 2 Pipe between 37 feet and 44 feet from the surface is cylindrical in shape, about 4 feet in diameter and 7 feet long. It is approximately concentric with the pipe and of lesser diameter.

The body is hollow with walls ranging in thickness from about 1 foot to 4 inches. As previously stated the central cavity is filled with white, cream and pale brown clay in which the quartz crystals are embedded. The walls of the chamber are composed of subtranslucent 'massive' quartz which is grey and cloudy by reflected light. In the vertical walls of the body the quartz is divided by numerous horizontal fractures which divide the quartz into roughly tabular slabs from 2 to 4 inches thick. Some of this quartz breaks along faces which show incipient crystal growth. Such faces show small triangular facets with common orientation which are part of imperfectly formed terminal rhombohedra.

In thin section the 'massive' quartz is seen to contain very large numbers of cavities more or less filled with liquid and arranged in narrow bands. These cavities are very irregular in outline and their size ranges from a larger diameter of 20 microns to less than one micron and below the limits of resolution. Most of them contain a gas bubble immersed in the liquid. If the gas bubble is too small to extend from wall to wall of the cavity it shows Brownian movement. The thin section gave a biaxial interference figure under convergent polarized light.

The clay in which the crystals are embedded has a varied appearance. The white portions are very fine and devoid of any traces of earlier structure. This clay unlike that from the pipe external to the quartz bodies does not crumble when immersed in water. The cream and pale brown portions of the clay possess a finely granular appearance, are slightly gritty to the touch and contain flakes of white mica.

The quartz crystals are evenly distributed throughout the vugh in which there is no free space, all interstices being filled with clay. No crystals firmly attached to the walls of the vugh were noticed and the free crystals do not possess any marked orderly arrangement, nor is there a greater accumulation of crystals near the bottom of the vugh than at the top. The crystals are tightly packed in the clay and require force to release them.

The butts of some crystals show numerous small triangular facets and presumably such crystals have been broken from places on the walls of the vugh where the 'massive' quartz shows similar crystal faces which provide a false cleavage across the base of the crystal.

D. The Quartz Crystals. The following description refers to crystals from No. 2 Pipe. Several hundred crystals from this pipe have been seen, and some examined closely. A few crystals from No. 1 Pipe which were seen in Melbourne, are similar but this pipe has yielded several very large crystals weighing as much as 350, 250 and 200 lb. each. These are larger than any so far discovered in No. 2

Pipe.

1. Size, Shape, Colour and Clarity. The crystals range in size from one with a diameter of 11 inches and weighing about 100 lb. to sizes less than 1 inch diameter. Crystals with diameters of 3 to 6 inches form the bulk of those seen and crystals less than 1½ inches diameter are comparatively rare.

In shape the crystals are short and stumpy. The prism faces are poorly developed and many individual crystals consist of rhombohedral (pyramidal) faces, with little or no development of the prism, projecting from a base of 'massive' cloudy quartz. Crystals in which the length of prism exceeds its thickness are uncommon. Only one double-ended crystal, that is with one with pyramidal termination at each end of the prism, has been found. This point is of some significance and bears directly on questions of the growth of the crystals.

The colour of the crystals ranges through shades of smoky grey and brown to colourless. Some crystals of the former colour range are black by reflected light and brown or greyish brown by transmitted light. Colourless and nearly colourless crystals are uncommon. Many crystals have undergone interruptions to their growth and show one or more 'ghosts' of earlier crystal enclosed in successive sheaths of quartz with the same orientation. This later quartz is usually clear and nearly colourless.

All crystals are cloudy of slightly milky at the base and become clearer towards the pyramid end. In some instances the degree of clarity increases gradually from the butt to the point, but where there have been successive growths of the crystal each succeeding layer of quartz is clearer than the earlier one on which it has been deposited.

2. Defects. The crystals contain numerous defects and twinning is common. Prevalent blemishes include bubbles, veils, ghost structures and inclusions of foreign minerals. The principal form of twinning is shown by the presence of irregular areas of different texture developed on the rhombohedral faces.

In some crystals bubbles occur in parallel streaks and sheets and two or more sets of streaks may cross each other forming a network or lattice. The streaks do not appear to be arranged in any simple relationship to the crystal axes. Such streaks and similar cloudy areas are common near the base of each crystal but rarely are in evidence near the apex.

A few crystals contain rosettes of white mica usually about 1 c.m. in diameter and either wholly embedded in the crystal or exposed on a face and projecting into the crystal. Many crystal enclose clusters of fine reddish-brown needles which probably are composed of rutile. The needles are about 0.5 c.m. in length and commonly occur radiating from a point on the surface of a 'ghost' into the later generation of quartz.

A thin section cut near the apex of a crystal and parallel to the basal plane was examined under the microscope. The section appears clear to the unaided eye but shows some bubbles under magnification. Many of the larger bubbles possess a hexagonal outline and contain more gas than was noticed in the section of massive quartz. A narrow band of small bubbles appears to occupy a healed fracture.

3. History. It is tentatively suggested that massive quartz was introduced into the pipes at a late stage of igneous activity. It must be assumed that ample free space existed in the interior of each body and that silica solutions circulated for a considerable period. Interruptions to the supply of mother liquor or changes in its composition are reflected by renewed growth of the crystals in successive layers.

At some stage the crystals were broken from the walls of the vugh but the presence of some material, now represented by clay, prevented them from falling. There was, however, some freedom of movement which is evidenced by the random orientation the crystals have assumed since they were freed from the walls. It is suggested that the hydrothermal solutions which circulated in the vughs deposited felspathic material contemporaneously with or later than, the growth of the quartz crystals.

It is probable that the expansion of this felspathic material under the influence of sub-aerial weathering produced stresses sufficient to crack the walls of the vugh (see Section IIIc) and dislodge the crystals. Simultaneous weathering and expansion of the aplite outside the quartz body also might have assisted in this process.

Alternatively it is possible that the faulting which is in evidence in the locality could have supplied the necessary force to break the crystals from the walls, but in this event, by the foregoing hypothesis, the vughs would have been filled with felspathic rock, and the crystals could have had little free movement until weathering reduced this rock to clay.

It is apparent from the absence of double-ended crystals (with one exception) that the growth of the crystals did not continue after they were freed from the walls of the vugh.

IV. PRODUCTION.

A. Production to Date. The crude crystals raised are not weighed and the following figures for crystal production are based on estimates by the owners. Judging from the crystals seen at the mine and in Melbourne it is considered that these figures may be somewhat conservative.

		Crude Crystal Raised. Tons.	Quartz, Clay and Rock Mined. Tons.
No. 1 Pipe:			
Above fault	...	2	80
Below fault	...	1½	65
No. 2 Pipe:			
1st Quartz body	...	1½	
2nd Quartz body	...	¼	75
3rd Quartz body	...	Incomplete	Incomplete
		5¼	220

It is not possible to indicate what proportion of the recovered quartz crystals is usable. The operation of manufacturing piezo-electric plates from this quartz has not yet reached a stage where an average value for all crystal recovered at the mine can be assumed.

The crude crystal is subjected to a preliminary inspection at the mine and the obviously useless material discarded. The rejected quartz amounts to 30 to 50 per cent. by weight of the total. The remainder is despatched to Melbourne for cutting. Only a very small proportion has so far been sawn into slabs and bars in which form the proportion of untwinned quartz may be determined, and the result is stated to be satisfactory.

In this connection it may be indicated that the finished plates are very small. They measure about 19 x 19 x 1 mm. and weigh 1 gram or less. From this it follows that large crystals, though heavily twinned, and containing blemishes, are likely to contain areas of usable quartz large enough to yield plates.

B. Future Prospects. Future prospects of the mine are thought to be good. It is expected that the deposits now being mined will continue to a greater depth than disclosed so far, and it is also thought that additional discoveries will be made in the vicinity.

1. Future Production from the Known Pipes. Definite conclusions regarding the continuance of the pipes with the regularity of size and direction so far displayed cannot be drawn owing to the relative shallowness of the workings and the incomplete information relative to the old workings for gold. The same factors also limit any forecast regarding the abundance or otherwise of the quartz bodies within the pipes, but the results achieved to date indicate a fairly regular and close spacing of the crystal-bearing vughs.

The succession of vughs in No. 2 Pipe suggests that the occurrence of further vughs in similar manner can be expected with some confidence. With regard to No. 1 pipe although the available information is incomplete it is apparent that the yield of crystals has been high as in addition to the quantities recovered by the present owners ($3\frac{1}{2}$ tons) some crystals were found by the earlier miners. Additional crystal-bearing vughs could reasonably be expected in this pipe.

Operations at the mine are hampered by lack of labour and production could be increased materially by the employment of two or three more men.

2. Prospects of Discovery of More Deposits. Surface indications of the crystal-bearing pipes are not common owing to the depth of soil and clay and hopes based solely on the presence of quartz crystals on the surface are likely to be disappointing. Whole crystals and fragments have been found on the slopes to the north and east of the workings but these may have been derived from the known pipes as the equidimensional shape and lightness of the mineral combined with the steepness of the stopes would bring about wide distribution. In addition to the foregoing considerations, it is noteworthy that crystals derived from the old gold mine have been widely scattered by human agency.

Two promising prospects await further examination -

(a) At about $\frac{1}{4}$ mile northeast of the workings a tunnel was driven many years ago to prospect narrow vertical quartz veins for gold. The spoil from the tunnel consists of granite, clay and fragments of milky quartz. In Black Charlie's Creek, which flows north past the toe of the dump quartz crystals showing little trace of damage occur amongst the gravel and boulders in the creek bed. It was at first thought by Messrs. Hughes and Terry that these crystals had been washed from the tunnel dump but inspection after a fire had destroyed the thick scrub showed that this is not so. The crystals are practically confined to an area of about 200 square feet of the creek bed, and it may be reasonably inferred that a pipe containing crystals occurs in or near this area and could be located by careful search.

(b) At 90 feet south-southeast from No. 1 shaft a prospecting pit on a site chosen by Mr. Hughes disclosed fragments of quartz crystals in the soil and the subsoil to a depth of 4 feet. At the bottom of the pit on the south side the subsoil contains fragments of weathered rock showing micro-graphic intergrowth of quartz and felspar (clay). This rock is similar to that occurring outside the quartz bodies in parts of No. 2 Pipe. It is considered that there is a good prospect of discovering another pipe under or near this pit.

The provision of the additional labour mentioned above would permit the examination of these two prospects and release Mr. Hughes for further prospecting at which he displays considerable skill.

It is desirable to discover additional pipes in order to defer the necessity of mining below water level or entering hard rock in which the use of explosives will be necessary with consequent risk of damage to the crystals.

V. SUMMARY AND CONCLUSION.

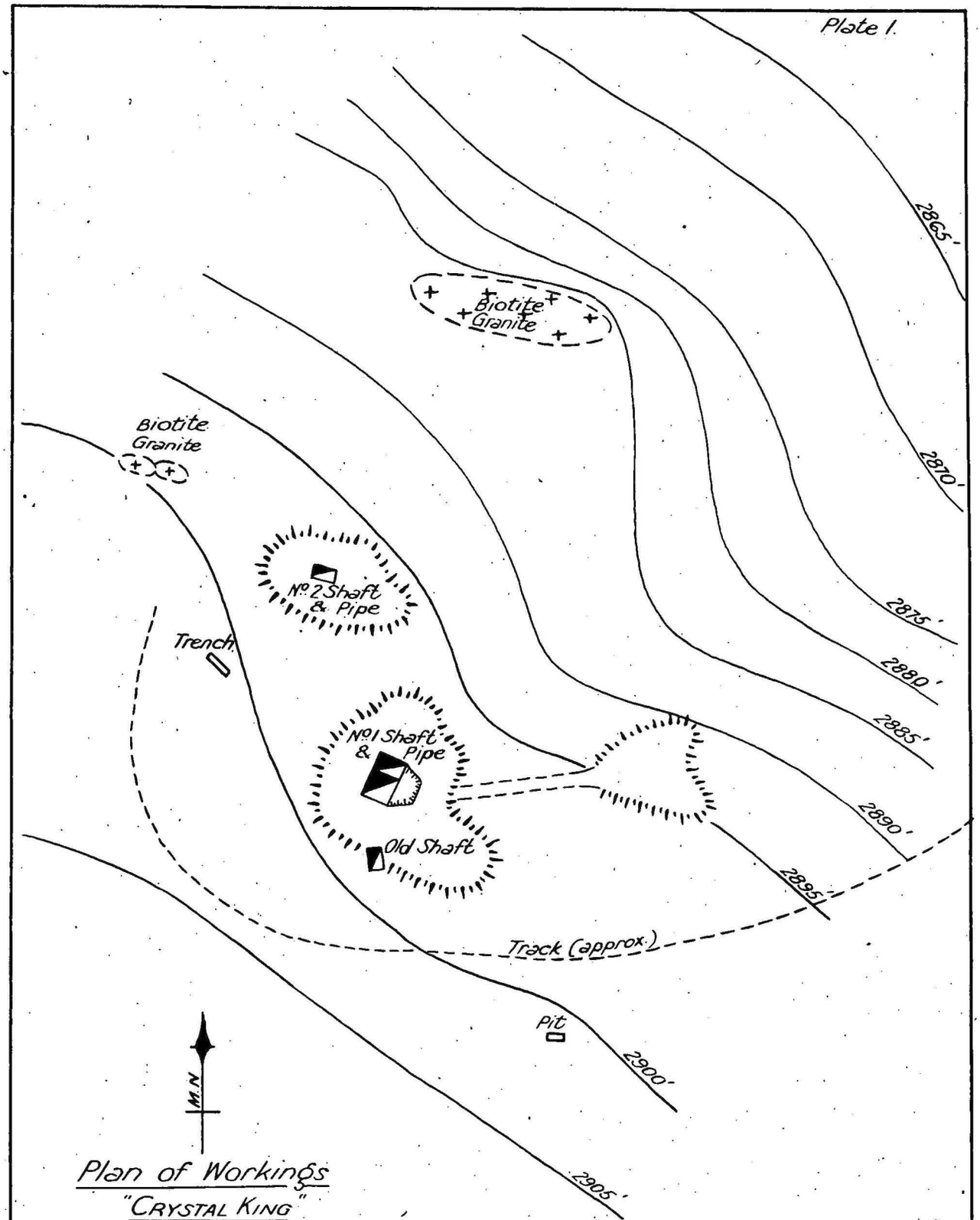
Quartz crystals occur in quartz bodies in aplitic pipes enclosed in granite in the Strathbogie Ranges, near Mansfield, Victoria. The extraction of approximately 220 tons of pipe-rock has yielded 5¼ tons of crude crystals which range in colour from clear to smoky brown. The crystals range in size from about 350 pounds weight to sizes too small for use. Twinning and other blemishes are common but the yield of quartz usable for piezo-electric purposes, though not yet accurately determined, is believed to be satisfactory. This is due to the size of many of the crystals which are large enough to yield plates from areas between flaws or from untwinned portions.

Two pipes have been discovered and intensive search in the neighbourhood has discovered two good prospects which require further examination. Soil cover and wide distribution of fragments of crystals derived from earlier mining operations are serious handicaps to successful prospecting, and, at present, shortage of labour hampers production and further search.

CANBERRA.
7th February, 1945.

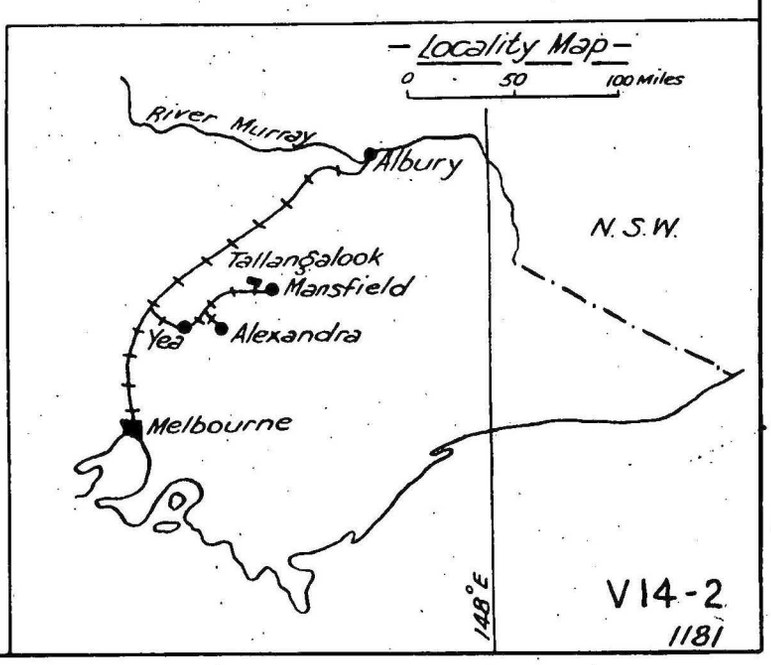
H. B. Owen
GEOLOGIST.

Plate 1.



Plan of Workings
"CRYSTAL KING"
Quartz Crystal Mine
Ph. Tallangalook, Co. Delatite, Vic.

0 40 80 ft.



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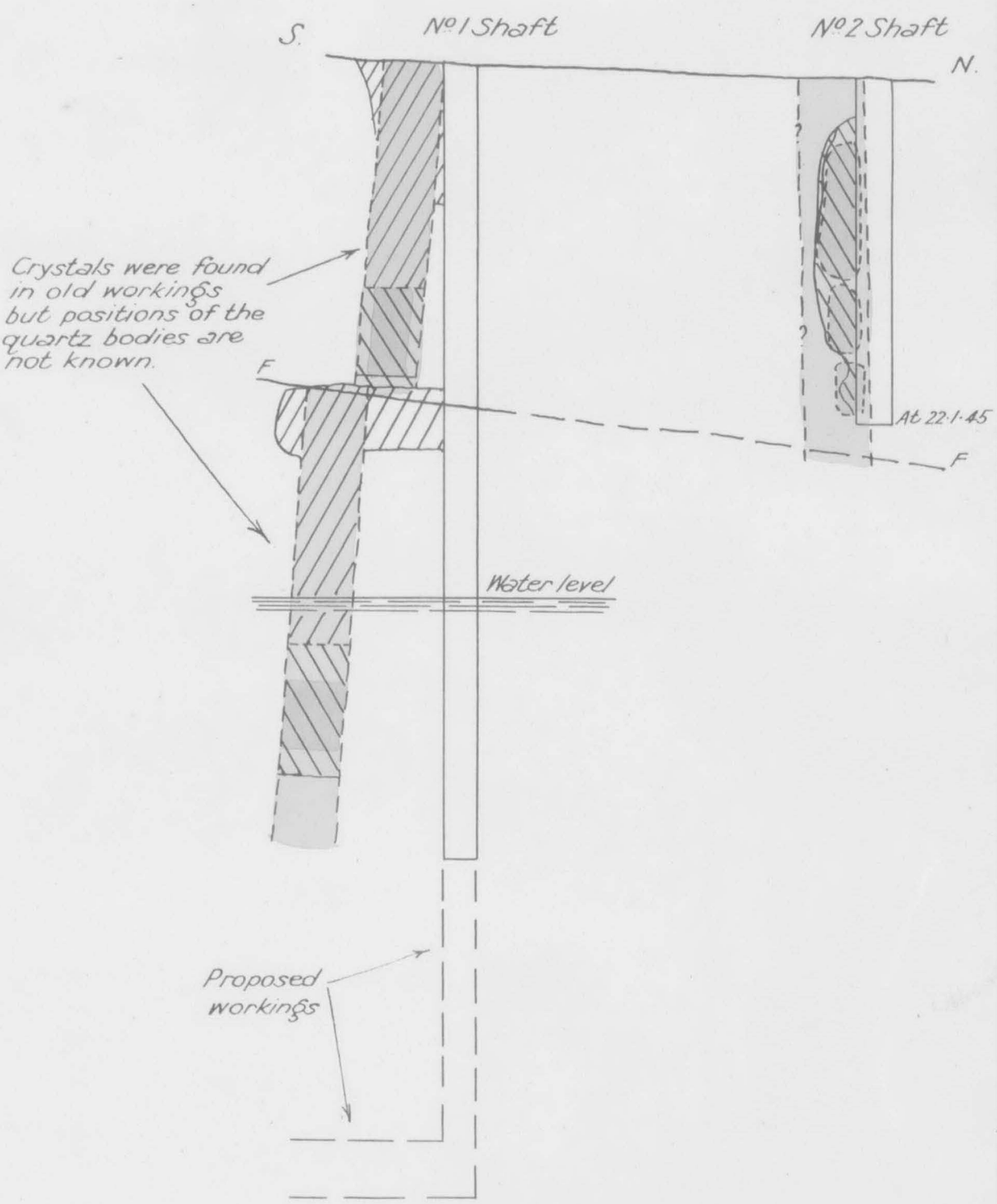

Section of Crystal King Mine
(Partly sketched from oral description)
Scale 1" = 20 ft.

Pipes shown thus:-

Crystal-bearing quartz bodies shown thus:-

Stoping shown thus:-

Old stopes resulting from gold mining:-////

New stopes:-\\\\

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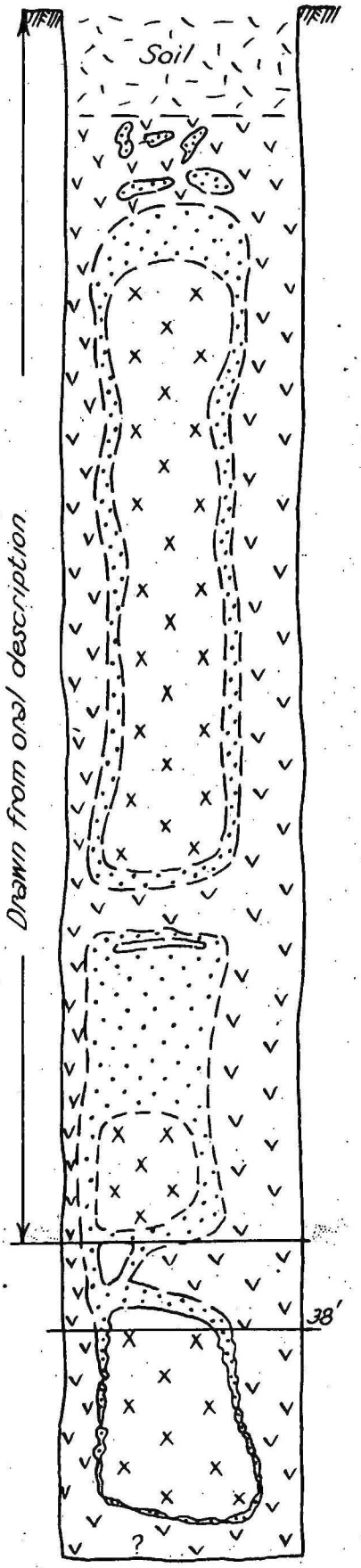
– CRYSTAL KING MINE –

Section disclosed in South wall of No 2 Shaft

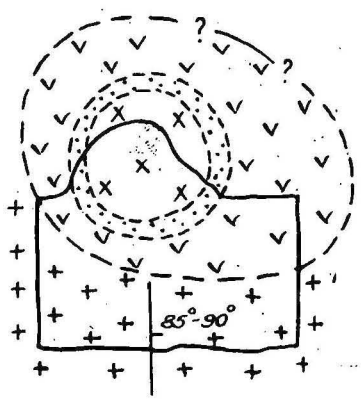
Scale 1" = 5ft.

– Reference –

- "Massive" quartz
- Quartz crystals in clay
- Pipe-rock - white clay (Weathered aplite)
- Biotite granite



Horizontal Section at 38' from Surface



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