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DEPARTMENT OF MINES
SOUTH AUSTRALIA

REPORT ON THE SLIDING ROCK MINE

Flinders Range, South Australia

LOCATION

The mine is situated about 14 miles east-north-east of Beltana, the nearest railway station on the Quorn-Alice Springs Line.

INTRODUCTION

This report is divided into three sections, as follows:-

1. General geology of the mine area.
2. The copper mine and its possibilities.
3. The underground water supply.

GENERAL GEOLOGY OF THE MINE AREA

The Sliding Rock mine lies in a folded and faulted rock environment composed of a conformable series of sediments of Precambrian and lower Cambrian age overlain near the Sliding Rock creek by coarse Recent gravels.

The plan (NOT TRACEABLE) of the area records the geological information obtained during the examination and also presents a complete interpretation of the geological structure.

Topography

The region is one of good relief with well defined water courses. The mine is situated at the point of entry of the Sliding Rock creek from a basin composed of limestone rocks into a relatively narrow strike valley flanked by steep-dipping massive quartzite rocks. This valley is the only outlet to an extensive rainfall catchment area east of the mine and it also appears to be the only outlet for the underground drainage. The detailed character of the terrain is largely a reflection of the geological structure and has resulted from the relatively easy erosion of the lower Cambrian calcareous sediments.

Rock Succession

The rock succession from bottom to top may be summarised as follows:-

Quartzite-sandstone series (1000 feet plus)

These rocks are exposed in the core of an anticlinal fold west of the mine, also in the main open cut on the footwall side of the lode. The precipitous bluff on the northern side of Sliding Rock creek is composed of a dense white quartzite, 200 feet thick, at the top of the series. Lower down red sandstones and thin layers of purplish sandy shales are more abundant. The series is correlated with Mawson's "Pound Formation" (Trans. Royal Soc. S. Aust., 65, (2).) and Segnit's "Flinders Range Sandstone - Quartzite Series, D7." (Bull. 18, G. S. S. A.).

Clay shale series (200 feet)

Between the massive white quartzites and the overlying limestones there is a thin formation of friable shales containing bands of limestone and calcareous sandstones. Outcrops of this formation are located in the mine open cut and in small water courses on the western side of and near the base of the limestone ridge extending south from the mine. In all these exposures the rocks are highly decomposed and impregnated with gossany material which has a possible genetic relationship with the copper mineralisation. The clay shales are grouped separately as they are of interest in connection with the copper deposit. On a small scale map they would be included in the overlying limestone series.

Limestone series (1120 feet plus)

This series consists of massive grey dolomitic limestone with intercalated shales. The top of the series is not exposed in the area mapped. Manganese is present in traces throughout the different horizons and in the top members has a high enough concentration to suggest possible ore values. The massive dolomitic limestone reappears at several horizons in the series in a slightly different form. Near the base it shows stratification planes on its weathered surfaces without any other prominent features. This basal limestone is overlain by shales which are appreciably harder than the underlying clay shales. The shales are brownish in colour and have a uniform grain with poorly defined bedding planes. Above the shales the dense grey limestone reappears, this time showing a concretionary structure, the individual concretions having the shape and size of hen's eggs and are composed of the same minerals as the mass of the rock. The concretionary band is succeeded by calcareous shales intercalated with thin lenticular limestones showing a few scattered fragments of archaeocythinae. These calcareous shales are believed to be immediately below the strongly fossiliferous archaeocyathinae limestone horizon exposed west of the mine on the western side of the Sliding Rock fault. The different thicknesses of the members of the limestone series are given on the rock column shown on the geological plan.

Recent formations

These rocks comprise the unconsolidated gravels and alluvium present in the Sliding Rock creek and forming terraces at elevations up to 50 feet above the lowest course of the creek, also the talus deposits at the base of the hard quartzite bluffs on the north side of the creek. The gravel terraces are evidence of temporary periods of quiescence in the erosion history of the Sliding Rock creek when it lost its eroding force. The total thickness of the gravels is estimated to have been of the order of 100 feet. This thickness has been considerably reduced by Recent degradation processes still operative.

Age of the Basement Rocks

The limestone series is lower Cambrian in age, abundant and well preserved archaeocyathinae fossils having been found in it about 1500 feet above its basal member. The limestones are unfossiliferous for at least 1200 feet when a few fragments of archaeocyathinae make their appearance.

The determination of the age of the clay shales and the quartzites is purely circumstantial owing to the absence of fossils in both these formations. The quartzites are placed in the uppermost part of the Precambrian and the clay shales at the base of the Cambrian for the following reasons:-

1. There is a definite change from quartzose sediments to calcareous ones as the bottom of the clay shales.

2. Archaeocyathinae is a low Cambrian fossil type and the base of the Cambrian should be placed as close to this fossil horizon as lithological changes permit.

The clay shales although having strong limestone affinities, can be best regarded as a transitional series. Exposures are too poor in this area to determine whether a disconformity is associated with these rocks.

Geological Structure

The fold pattern can be clearly seen on the surface and is factual. The faults are not exposed and have been interpreted from stratigraphic and structural evidence in the rocks themselves. The stratigraphic column is broken in the mine area but a reconnaissance cross-section made south over an area free from faults of regional magnitude established the relationship of the sandstone-quartzite to the lower Cambrian limestones. A number of characteristic horizons in the rock column can be easily distinguished. Current bedding in the quartzites was used to determine the tops of the beds.

Folding

Only one major fold is present in the mine area. It is an anticline having a N. 70° W trend and a tendency to develop a flat easterly pitch. The fold is asymmetrical, the northern limb dipping steeply north but not overturned, the southern limb dipping south at about 50°.

Faulting

The anticline is ruptured by three oblique faults which give the impression that they have a separate existence to the folding movement. The most westerly fault is the most important structural break in the area. Its presence is inferred from the occurrence of quartzites in close proximity to the highly fossiliferous archaeocyathinae limestone formation as shown on the western side of the map, a stratigraphic break of about 1500 feet. Further evidence of a regional fault is the apparent truncation of the strong sandstone-quartzite series, north east of the mine in Sliding Rock creek. This fault is termed the Sliding Rock fault on account of the large horizontal displacement of beds on either side of it. The other faults including the lode structure are subsidiary fractures from the main Sliding Rock fault. Throws associated with them are relatively small and have larger horizontal components than vertical ones. The general result of the faulting has been an "east block north" movement, the east block also having a slight downthrow causing a large accumulation of lower Cambrian limestones in a basin structure upstream from the mine.

THE COPPER MINE AND ITS POSSIBILITIES

Historical Summary

Operations commenced in 1871, and continued intermittently until 1907. The property has remained idle since 1907.

Copper production was confined to the initial period of exploitation, 1871-1876. Thereafter deeper development was attempted with unsuccessful results. The development work consisted of the sinking of a new shaft about 3 chains north east of the old workings. The shaft was sunk to a depth of 361 feet with levels at 150 feet and 310 feet. No ore was raised from it and no connection was made with the old workings.

Production

The gross value of copper ore raised amounts to £100,000 which suggests that the production was of the order of 5,000 tons of 20-60% copper ore. Returns for sales of ore to the E. and A. Copper Co. Port Adelaide are tabulated in the appendix to this report. These returns include sales of copper matte produced at the mine.

There are no ore reserves in the mine.

The slag dump contains about 1,000 tons. Its copper content has not been investigated, but the slag itself does not show any trace of metallic copper in the hand specimen.

Nature of the Deposit

The copper is present in the deposit predominantly as native copper. Maladhite, cuprite, chalcocite are less prominent. Copper sulphides and black copper oxide are recorded also. The presence of cobalt is reported in the workings south of the main open cut.

The copper minerals occur as streaks and aggregates in a brown tenaceous clay which appears to occupy a fault zone in friable calcareous shales and sandstones. The clay consists chiefly of kaolinized country rock, partly of fault gouge.

The outcrop of the clay deposit was relatively poor in copper content, but at depth of 30 feet rich values were encountered. Below this depth the grade of the ore is stated to have decreased with increasing depth.

The open cut section of the lode is roughtly 300 feet in length and 30 feet wide. Old records state that at a depth of (90) feet and 150 feet the lode was 22 feet wide, and at 210 feet, 10-20 feet. The only reference to ore grade is given in a report of the Tasmanian Copper Company, "rich patches of malleable copper going 80-90% were discovered in the early days but it is now estimated that the lode will yield from 3-4%."

The dip of the lode cannot be ascertained from exposures in the open cut but it is reported to be 50-60 degrees east.

Origin of the Deposit

The genesis of native copper deposits, in general, has been a matter of controversy amongst geologists. Two main hypotheses have been supported, namely (1) deposition from ascending hypogene solutions in an oxidising environment, (2) deposition from descending solutions in a reducing environment.

Further detailed work, including deeper testing of the lode channel, is necessary before the mode of origin of the Siding Rock deposit can be postulated with fair precision. Two interesting features, however, are worthy of note in this connection. Firstly the absence of lava flows eliminates the possible origin of the deposit from that source of copper, secondly the localization of rich values near the water table suggests the possible origin of the native copper from other copper minerals.

Prospects

The actual data relating to the size, shape, yield and grade of the Sliding Rock mine are not available and further exploration can only be planned as if the deposit had never been exploited.

Deeper exploration cannot be recommended until a sufficient length of ore has been proved.

The geological mapping has revealed a possible southern extension of the lode and the gossan outcrops found suggest the possible occurrence of an oreshoot south of the old mine.

The finding of a northern ore extension would require diamond drilling or shaft sinking, both expensive and difficult operations on account of the presence of bad ground and copious water.

Recommendations

As the Sliding Rock Mine area has been withdrawn from the operation of the Mining Act and declared a Waterworks Reserve, the following suggestions are made only in the event of the demand for water to supply the Leigh Creek Coal Field ceasing at a future date and the mineralized area becoming available again for mining.

Although no encouragement is offered by the assay results of outcropping material it is suggested that small trenches be dug on the southern gossans to a sufficient depth to expose the formations for careful examination. This work should determine whether the southern extension of the Siding Rock lode is worth further exploration and whether deeper exploration is justified.

WATER SUPPLY

Introduction

The result of the detailed geological work has been the confirmation of statements made in the preliminary report on the underground water possibilities. The following notes are written to record geological data which have a bearing on the proposed utilization of the mine as the water supply for the Leigh Creek coal field.

Underground Water Conditions

The source of the water being pumped from the mine is the ground water which may be defined as the water accumulated in the rocks below the surface. The ground water has been derived from the rainfall in the immediate neighbourhood of the mine and is augmented periodically by that part of the rainfall which is absorbed by the rocks.

The ground water is in constant but slow movement and in areas of simple geological structure it can be usually represented by ground water contours. At Sliding Rock, however, this procedure cannot be adopted because the natural ground water movement is not evenly distributed in a flat porous rock horizon but its path of relatively free movement follows a tortuous corse which cannot be defined or predicted with any certainty. In one place this path or aquifer may be a steep-dipping cavernous limestone bed, in another place it may be a strong fault. The important fact to bear in mind is that a large supply of water can only be obtained by tapping such a channel of concentrated ground water movement. The present pumping shaft penetrates a strong fault zone which happens to be a particularly good aquifer. On the other hand a number of shallow workings within a radius of 1000 feet of the pump shaft have very different water levels to that in the pump shaft and would probably give entirely different yields if tested.

Limitations of the Supply

The annual increment of water added to the ground water from the annual rainfall in the catchment area east of the mine is the maximum quantity of water which can be safely pumped from the shaft, otherwise the ground water table will tend to fall causing the supply to dwindle and ultimately fail.

Unfortunately in the Sliding Rock area a close estimate of the annual amount of water entering the rocks is not practicable and any development of the supply as a permanent source of water must necessarily involve a high risk factor. The risk factor can be reduced considerably by the adoption of a more stringent testing routine than that which would be required in a region of more assured rainfall.

The yield of water is not likely to be uniform for the following reasons:

1. The uncertain rainfall and the possible occurrence of droughts are likely to cause seasonal variations in the supply.

2. The irregular daily fluctuations of water level due to sudden surges of ground water in the porous rock environment are likely also to continue indefinitely. These variations cause the water to become charged with fine suspended matter which will necessitate the installation of a filtering or settling plant for its removal.

Conclusions and Recommendations

1. Pumping tests to date ranging from ½ million to ¾ million gallons per week (max. 996,445 gallons week ended 25.8.42) are not strong enough if the supply required for the coal field is to be of the order of ¾ - 1 million gallons per week.

2. The pumping plant to be installed permanently should only be capable of pumping up to 75% of the tested yield from the shaft which means that the testing rate of pumping should be raised to 1¼ to 1½ million gallons per week.

This recommendation is made to minimise the danger from a possible falling off in yield resulting from the tests being carried out in a favourable year; also to reduce the possibility of the pump chamber being filled with debris and silt and to allow a certain amount of loose clayey material to be flushed out of the ground water channels near the shaft before permanent pumping equipment is installed.

3. Recordings should be made periodically of water level in existing wells in the groundwater drainage basin upstream from the Sliding Rock mine in order to keep a check on the general behaviour of the ground water table from year to year in the vicinity of the mine. It may be deemed necessary to sink a few boreholes to augment this data. Such a procedure is likely to giv information regarding the permanency of a satisfactory yield of water.

4. From the initiation of the supply strict economy measures should be enforced. A uniform supply cannot be expected on account of the erratic rainfall. Pumping tests over short periods are liable to lead to a high estimate of the yield.

S.B. Dickinson

12.11.1942. DEPUTY DIRECTOR OF MINES

SLIDING ROCK MINE

...cality or Mark	Description	Gold per long ton dwt.	Silver per long ton dwt.	Copper %	Width ft.	Width ins.
...OPEN CUT						
...No. 1	Clayshale	Nil	---	0.31	22	3
2	"	Nil	---	0.63	21	6
3	Ferruginous clayshale	0.4	---	1.72	11	3
4	"	Nil	---	0.14	3	8
5	Siliceous clayshale	Nil	---	0.09	9	6
6	Ferruginous clayshale	Nil	---	0.26	32	8
... OUTCROPS						
...No. A1	Ironstone and quartz	Nil	---	Nil	--	--
A2	Ferruginous grit	Nil	---	Nil	--	--
A3	Ironstone	Nil	---	Nil	--	--
A4	Ironstone	Nil	---	Nil	--	--

THE ENGLISH AND AUSTRALIAN COPPER COMPANY LIMITED

Statement of Copper Ore and Rough Copper purchased from the Sliding Rock Company between February 1871 and April, 1877.

Date	Description of Material	Gross Weight				Assay	Net Value
1871		T.	C.	Q.	lb.		£ s. d.
Feb.	Rough	9	6	-	12	95⅝	544. 0.10.
March	"	3	18	1	6	93½	214. 5. 3.
"	"	2	8	2	5	93	132.12. 6.
April	"	8	2	-	5	92⅛	440. 2. 6.
May	"	3	18	3	8	89	206.15.11.
June	"	2	12	1	23	89	
"	"	2	19	2	15	92	
"	"	4	13	1	18	92⅝	549. 9. 1.
"	Ore	9	1	-	-	44	222. 7. 8.
"	Rough	3	4	3	-	91⅝	173. 5. 4.
July	"	5	7	2	2	91¾	292.17. 4.
Aug.	"	3	7	1	12	91⅝	183. 0. 5.
"	"	3	11	2	4	91⅝	199.14. 5.
"	Ore	3	10	-	-	49⅞	99. 7. 5.
"	"	-	14	-	-	48¼	18.10.11.
1872							
March	"	1	1	-	-	58⅞	46. 0. 9.
"	Rough	5	9	2	27	91½	397. 8. 4.
"	"	4	17	2	-	89⅜	337.10. 3.
April	Ore	7	6	-	-	31¼	
"	"	2	9	-	-	60¼	267. 4. 5.
June	"	10	16	-	-	21⅜	
"	"	2	14	-	-	25⅞	

Date	Description of Material	Gross Weight				Assay	Net Value
1872		T.	c.	q.	lb.		£ s. d.
Sept.	Ore		13	-	-	52¾	
"	"	5	2	-	-	24⅝	
"	"	3	11	-	-	24½	189. 3. 7.
Oct.	"	4.	19	-	-	32⅛	
Oct.	"	3	19	-	-	67⅝	288.16. 6.
"	"	5	12	-	-	23¼	
"	"	21	3	-	-	56½	
"	"	1	4	-	-	23¾	947. 7. 0.
1873							
Jan.	"	43	8	-	4	54⅞	
"	Malleable	1	17	3	24	82½	
"	Ore	16	8	-	18	31¾	
"	Malleable	-	-	3	10	82½	2431. 7. 6.
May	Ore	52	10	1	27	41	
"	"	-	13	2	1	65½	1748.13. 7.
"	Rough	12	10	-	20	94⅝	1003. 8. 6.
June	Ore	10	12	-	-	36¼	262. 6. 6.
"	Rough	11	19	2	2	89	809. 6. 9.
July	Ore	42	16	-	-	49⅝	1467. 1. 5.
Aug.	"	31	3	-	-	45¼	1016. 1.10.
Oct.	"	13	1	-	-	46½	445. 9. 2.
"	Rough	3	5	3	21	88⅜	232. 0.10.
Nov.	"	5	5	-	25	92⅛	386.11. 2.

Date	Description of Material	Gross Weight T.	C.	Q.	lb.	Assay	Net Value £ s. d.
June	Ore	6	9	-	-	18¼	
"	"	10	6	-	-	28⅛	
"	"	2	9	-	-	23¾	
"	"	5	-	-	-	33⅝	
"	"	8	8	-	-	32⅛	
"	"	1	1	-	-	22⅜	
"	"	1	13	-	-	20	1004.18.11.
Aug.	"	6	4	-	-	27½	
"	"	8	12	-	-	24	
"	"	2	7	-	-	52⅝	
"	"	1	13	-	-	25½	435. 4. 7.
1874							
March	Rough	7	12	2	2	88⅛	484.18. 9.
April	"	12	11	3	23	88⅛	801. 0. 2.
"	Ore	17	12	-	-	63⅛	761.13. 0.
May	"	32	8	-	-	67⅝	
"	"	15	6	-	-	67⅝	
"	"	6	12	-	-	88⅜	
"	"	18	12	-	-	72¾	3475.18. 6.
"	Rough	13	2	1	4	93⅛	
"	"	8	9	-	8	92¾	1450. 0. 4.
June	Ore	13	17	-	-	66⅝	627.19. 1.
"	"	8	14	-	-	71¾	445. 4. 6.

Date	Description of Material	Gross Weight T.	c.	q.	lb.	Assay	Net Value £ s. d.
Nov.	Ore	13	10	-	-	52⅞	540.13. 3.
Dec.	"	16	1	-	-	58⅛	
"	"	2	14	3	-	75⅛	
"	"	1	18	1	-	86⅝	
"	"	16	2	-	-	64⅜	
"	"	2	4	-	-	80⅛	1880. 6. 1.
"	Rough	10	-	2	5	89⅜	691.14. 8.
1874							
Feb.	"	10	11	2	7	89⅞	663.17. 4.
"	Ore	29	7	-	-	36⅜	696. 4. 3.
Mar.	"	21.	10	-	-	42¾	611. 6. 7.
1875							
Oct.	Ore	2	2	-	-	66	141.17. 6.
Dec.	"	2.	19	-	-	57½	126.16. 0.
"	Rough	6	13	2	12	92⅞	479.10. 0.
1876							
Jan.	Ore	12	16	-	-	71⅜	700. 1. 8.
Feb.	"	11	-	-	-	73⅞	622. 5. 9.
March	"	11	3	-	-	77⅝	630. 1. 5.
"	"	15	4	-	-	75½	822.15. 0.
April	"	12	2	-	-	79⅜	678. 5. 0.
June	"	12	5	-	-	78⅞	688. 4. 8.
"	"	24	8	-	-	78¾	1308.17.0.

Date	Description of Material	Gross Weight T.	c.	q.	lb.	Assay	Net Value £ s. d.
June	Rough	4	3	-	6	92½	445. 4. 6.
"	"	9	7	2	18	93⅞	
"	"	6	7	-	6	92½	1354. 3. 2.
July	Ore	17	9	-	-	69⅛	837. 6. 2.
Aug.	"	11	7	-	-	68½	
"	"	9	11	-	-	71⅝	977.14.10.
"	Rough	9	9	-	3	91¾	626.12. 6.
Sept.	"	11	19	1	21	92⅜	785.11.3.
"	Ore	8	20	-	-	72¾	440. 4. 3.
Oct.	"	23	9	-	-	69⅛	1188.11. 8.
Nov.	"	20	19	-	-	69⅞	1126.16.11.
Dec.	"	30	16	-	-	68¾	1617.17. 0.
"	Rough	6	6	1	19	93¼	464. 7. 9.
1875							
March	"	2	6	1	23	93⅛	161.15. 8.
"	Ore	6	9	-	-	68⅜	324. 2.11.
April	"	7	15	-	-	66	363.15. 6.
"	Rough	3	1	1	26	93½	
"	"	2	3	2	6	93½	373. 6. 9.
July	Ore	1	7	-	-	55¼	53.19. 1.
Aug.	"	1	18	-	-	78	
"	"	6	12	-	-	58½	382.12. 1.
"	Rough	2	15	3	12	89⅝	193.12. 1.
Oct.	Ore		14	-	-	79	
		887	-	2	2		£41395. 9. 1.

Date	Description of Material	Gross Weight T.	c.	q.	lb.	Assay	Net Value £ s. d.
June	Ore	10	16	-	-	76⅝	548. 3. 8.
Aug.	"	18	13	-	-	77⅛	855.10.11.
Sept.	"	6	9	-	-	74⅛	291. 9. 0.
"	"	9	5	-	-	75½	443. 6. 0.
"	Rough	6	9	1	22	93⅞	381. 4. 0.
"	"	3	4	-	18	93⅞	190. 6. 0.
Oct.	Ore	5.	15	-	-	75¾	304. 5. 0.
"	"	9.	13	-	-	77	561.12. 0.
Nov.	"	12	3	-	-	75½	621. 2. 0.
1877							
Feb.	"	7	19	-	-	75⅛	414.19. 0.
April	"	7	19	-	-	78	389. 5. 0.
		1085.	20	2	26		£52595. 5. 8.

The Rates of Returning charges during this period were:-

60/- per ton for Ore.
50/- per ton for Rough Copper.

For the English and Australian Copper Company Limited.

F.S. Chany, Manager.

Note.
This, of course, does not include the ore sent direct to Swansea, or the large amount of machinery, plant, supplies, etc.