CONTENTS ENVELOPE 2421 M.C. No. 305

TENEMENT: Mineral Claim No. 305

TENEMENT HOLDER: Thomas H.N., Billy Spring Explorations
Pty. Ltd. - Technisearch Limited
Joint Venture

REPORT: Progress REport;M.C. 305 Kanyaka, S.A. (pgs. 3-17)

NO PLANS

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MC 305 KANYAKA

PROGRESS REPORT - NO 3

H. N. THOMAS
12/3 ROCKLEY ROAD
SOUTH YARRA, 3141
TELEPHONE (03) 24 1017

BILLY SPRING EXPLORATIONS - TECHNISEARCH LTD
PTY LTD.

Technisearch LIMITED

BILLY SPRING EXPLORATIONS PTY. LTD. - TECHNISEARCH LIMITED

JOINT VENTURE

PROGRESS REPORT: MC305 KANYAKA S.A.

DATE 30th November, 1974

CONTENTS

Test Work: E.McG. Dawson F.R.M.I.T.(MET).
Supervision: A.M. Henderson B.MET.E. (MELB).
Report Summary: A.M. Henderson
H.N. Thomas
Billy Spring Exploration
Pty. Ltd.

The advice and assistance of specialists is acknowledged in the text with gratitude.

Technisearch LIMITED

TEST WORK LEACHING CARBONATE ORE FROM KANYAKA S.A. AND PRECIPITATION OF COPPER COMPOUNDS ON CARBON FROM AMMONIACAL SOLUTION

PROGRESS REPORT NO. 3 DATE NOVEMBER, 1974

INTRODUCTION

This report in summary describes and discusses the results of work conducted on ore from the Kanyaka deposit located 1½ miles north of the main road joining Quorn and Hawker on Kanyaka Station near the old Kanyaka Station ruins.

The work is described in two sections: the first, related to leaching oxidised copper minerals from high grade hand picked specimen material. The second section of the report deals with experience gained of the removal of copper from ammoniacal solution per medium of activated carbon. An important side issue which developed out of this work was the apparent anomalous results observed where only 10% or there abouts of the carbon promoted a deposit of copper compound upon the surface of particles. A further intriguing facet revealed was that there are factors as yet unidentified which vary the rate of strip from the solution. The encouraging feature of the work is that it seems evident that a copper concentrate can be produced which would be economical to transport over long distances and this product should be simple to treat in a central refinery.

This is a summary of more detailed results in process of editing as at 30th November, 1974.

Scope of Work: - Leaching
- Deposition on Carbon

A. SAMPLING

Copper was selected from the Kanyaka deposit. Note: All Kanyaka ore is predominantly carrying copper as carbonate - malachite and azurite, with occasional silicate - probably chrysocolla and some sulphides. Ammonia leaching strips about 80% of the contained copper unless the proportion of silicate mineral rises. Acid leaching of the balance after ammonia leaching can provide access to 20% and upwards of the remaining soluble copper.

The ore is of three distinct varieties which can be selectively mined but there is a tendency for types to merge.

(i) Sandy ore with nodules of malachite and azurite in a friable matrix;

(ii) Clayey ore with malachite azurite and some sulphides intermixed probably as a precipitation product;

(iii) Hard silicate ore with nodules of coated malachite, and azurite encrusted by limonite in a matrix of silicate.

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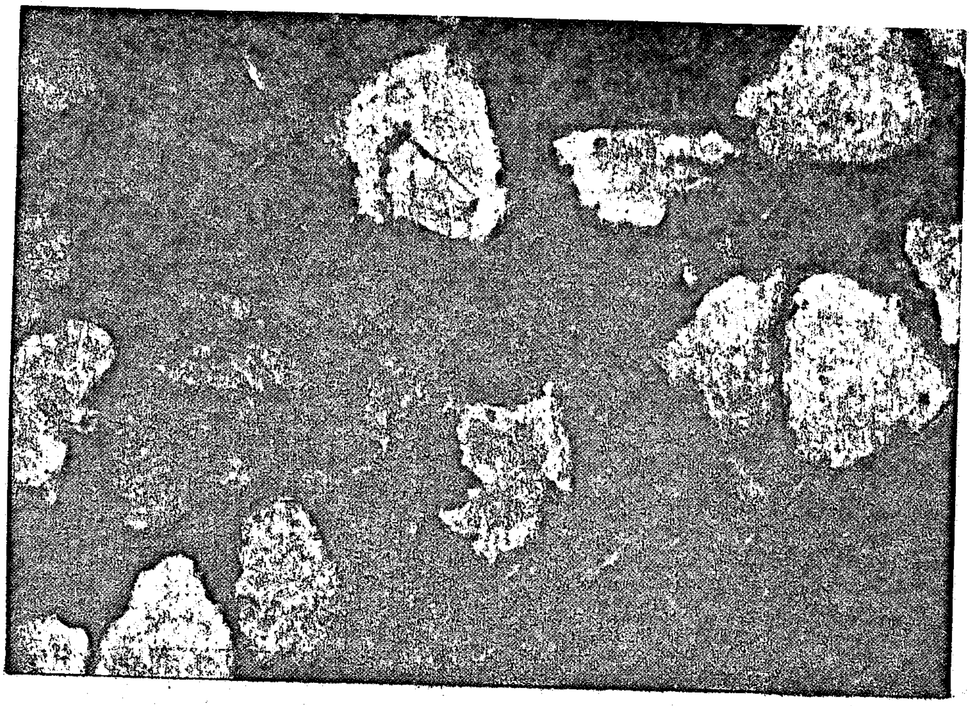
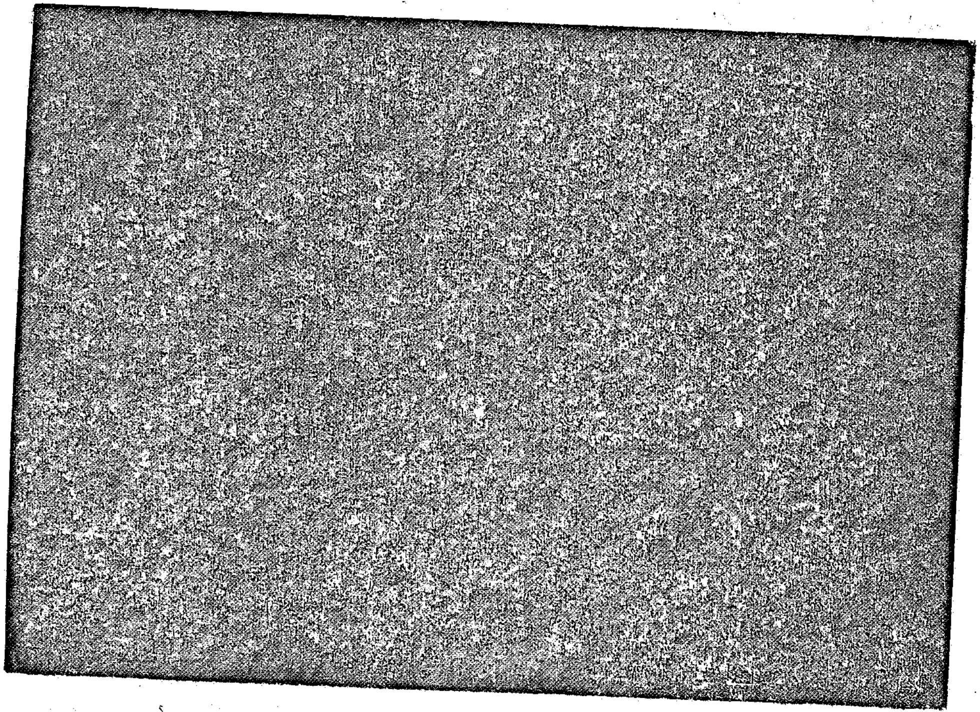
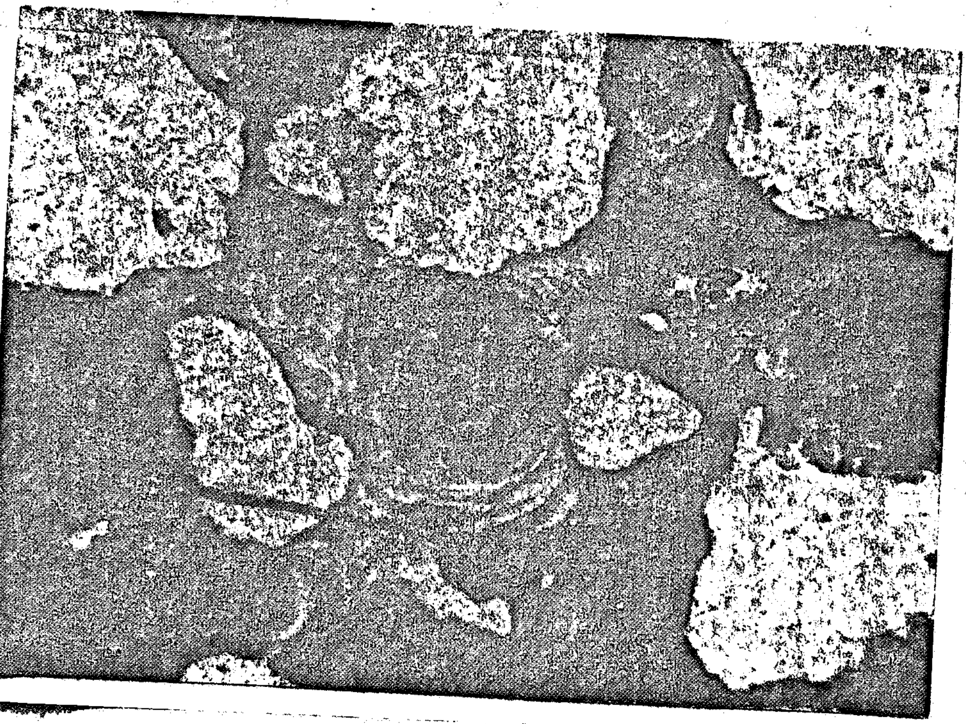


KANYAKA ORE
TYPE (I)
NATURAL SIZE



KANYAKA ORE
TYPE II
NATURAL SIZE.



KANYAKA ORE
TYPE (III)

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SUMMARY - LEACHING

B. TESTING

1. A Series to determine the copper leaching capacity of a range of ammoniacal solutions.
2. A Series to determine the effect on leaching rates over shorter time intervals.
3. A Series to determine the effect of additives to the leach solution in reducing ammonia and carbonate losses.

1. ORE PREPARATION

Ore was passed through a jaw crusher for all particles to pass a 1" mesh screen except in one test. In this the material was reduced by grinding in a Braun type UA Laboratory mill for agitation leaching.

2. SERIES 1 AND 2 TESTS, RESULTS AND DISCUSSION

Details are listed in Appendix A to the main report. Tables 1 and 2 show in summary the results related to solutions, and time intervals during which significant results were obtained.

The copper concentrations in solution, ammonia and carbonate losses from solution are shown for varying initial ammonia concentrations.

Definitions:-

NH_3 loss - is the amount of NH_3 unaccounted for after determining the initial strength of solution and then assaying the ammonia content of residual solution and the ammonia content of the copper complex precipitated in the system. The difference represents the apparent loss.

TABLE 1

G/L - grams per Litre or g/l.

NH_3 - the ammonia in grams/litre regardless of whether it is present as NH_4OH or NH_4CO_3.

Ammonium carbonate leach of carbonate ore. (i)

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TABLE 1

Initial NH_3 in Sol'n g/l (2)	Leach Duration Hours	NH_3 Loss from Sol'n g/l	Final Cu in Sol'n g/l	NH_3 Loss gm/gm of Cu in Sol'n
eries 1 337 to 500 hours leaching				
5.3	500	2.6	1.0	2.6
10.9	500	4.0	3.9	1.0
14.8	484	4.4	5.9	0.75
20.2	483	4.3	8.5	0.51
32.5	337	11.4	13.6	0.84
62.5	576	14.5	22.2	0.65
eries 2 163 to 190 hours leaching				
4.7	190	2.3	0.8	2.9
10.1	166	2.6	3.2	0.81
15.1	164	2.7	4.9	0.55
20.6	163	4.0	8.1	0.49
30.8	163	6.8	11.4	0.60

TABLE 2

Ammonium carbonate leaching carbonate ore - (i).

Variables:- Concentration and leaching time NH_3CO_4 expressed as g/l NH_3.

TIME LEACHING

Initial NH_3 in Sol'n g/l	Leach Duration	CO_3 Loss from Sol'n g/l	Final Cu in Sol'n g/l	CO_3 Loss gm/gm of Cu in Sol'n
10.9	500	9.6	3.9	2.5
14.8	484	9.0	5.9	1.5
20.2	483	14.4	8.5	1.7
32.5	337	10.1	13.6	0.74
62.5	576	44.3	22.2	2.0

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OPTIMUM AMMONIA CONCENTRATION

In the Series 1 and 2 tests the minimum loss indicated per unit of copper dissolved occurred in the range of 20.2/20.6 grams of NH_3 per litre of leach solution. This concentration (20 g/l nominal) was selected to assess the effect of added sodium carbonate.

3. EFFECT OF ADDED SODA ASH (COMMERCIAL GRADE)

Test Conditions:- A solution containing 20.2 grams of NH_3 (as NH_4CO_3) was used to leach ore without agitation to compare the effects of adding (A) 50 g/l and (B) 100 g/l notional sodium carbonate. Results Tabulated Table 3.

TABLE 3

$NaCO_3$ g/l	Leach Duration	Final Cu g/l	Leach Rate g/l/hr.	NH_3 Loss	CO_3 Loss
0	483	8.5	0.018	0.51	1.2
50	359	11.8	0.033	0.16	1.2
100	363	12.8	0.036	0.12	0.94

The addition of commercial Soda Ash to the leach solution at the rates of 50 g/l and 100 g/l increased the rate of dissolution of copper by 83% and 100% respectively and reduced the NH_3 loss to 31.1% and 23.5% for these concentrations. It is prospective that the addition of Soda Ash can be of economic significance to the system.

Optimum additions require determination and will be related to:

a. operating temperature.
b. application of a seal membrane over a heap or agitator.
c. loss of solution from heap or agitator in disposing of tailings.
d. the amount of wash water which can be economically applied to the removal of valuable chemical components from leached tailings.

4. AMMONIA LEACH OF SILICATE ORE - (iii)

Scope of Work: Tests were used to determine the effect of Ammonium Carbonate leaching on silicate ore by percolation of lump material passing 1" mesh and by agitation of the product from a Braun type UA disc pulverisers. A solution containing 62 g/l of NH_3 as carbonate - Appendix C of main report.

THE AIM - was to test the leachability of the more difficult ore in the minimum time without concern for chemical losses - Appendix D main report.

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TABLE 4 AMMONIUM CARBONATE LEACHING OF SILICATE ORE TYPE 1(ii)

Ore Type	NH_3 in Sol'n g/l	Cu in Sol'n after 220 hrs. g/l	Leach Duration Hours	Final Cu in Sol'n g/l	Liquid Solids Ratio
ilicate	62.0	8.7	640	16.6	0.83
arbonate	62.1	20.5	576	22.2	0.83

AGITATION LEACHING

A sample was ground in a Braun type UA disc pulveriser and placed in a solution containing 62.5 g/l of NH_3 as Carbonate and a liquid solid ratio of 3:1 in a paddle agitator.

Result 17 hours agitation resulted in a solution containing 5.7 g/l Cu at a liquid solids ratio of 3:1.

TABLE 5 COMPARISON BETWEEN COARSE AND FINELY GROUND SILICATE ORE AGITATED AND NON-AGITATED LEACHING

Method	Leach Duration Hours	Liquid Solids Ratio	Cu in Sol'n g/l	Cu in Sol'n as %age of ore
Unagitated	640	0.83	16.6	1.4
Agitated	17	3.0	5.7	1.7

Discussion: It appears that the silicate ore will partially leach by penetration of ammoniacal solution. It is suspected that the copper dissolved is derived from Carbonates in the main at relatively coarse sizing.

5. PRESSURE OVER SEALED SOLUTIONS

It was decided to investigate the likely effects of sealing leach heaps with a membrane. If, within the temperature range encountered a significant increase in pressure can be maintained under a seal then an increased rate of percolation and extraction should result, with decreased evaporative loss of ammonia and carbonate.

To estimate the additional pressure likely to follow increases in temperature within a sealed off heap, leach solutions were placed in a flask connected to a mercury manometer and sealed. The solution temperature was raised to 55°C and manometer readings taken during cooling of the system - Appendix 7 of main report.

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TABLE 6 PRESSURE OVER SEALED OFF LEACH SOLUTION

Solution Strength NH_3	Pressure Differential Mercury Manometer in lbs. per sq. inch			
	Temp °C	32	40	55
10.3		1.4	2.4	5.2
21.7		1.3	2.4	5.9
62.0		2.1	3.9	8.5

These figures were not reduced to standard temperature and barometric pressure - the atmospheric pressures may have changed. It is considered that the effect of a membrane requires specific test procedure.

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SECTION II

DEPOSITION OF COPPER

PRECIPITATION OF COPPER COMPOUNDS FROM AMMONIACAL SOLUTIONS BY THE ACTION OF ACTIVATED CARBON PARTICLES

INTRODUCTION

Following the successes experienced with the adsorption of gold and silver from cyanide solutions commercially at the 'Golden Cycle' Mill, Victor Colorado and 'Homestake', Lead, South Dakota, U.S.A. it was considered that a similar procedure would enable a concentrate of copper compounds to be accumulated on carbon particles. The advantage to be obtained by the installation of a low cost plant of semi portable size would enable small higher grade copper deposits to be worked provided that the concentrate obtained was of sufficiently high grade as to be economically transported over long distances to a central refinery. Initially it was thought that the aim would be to acquire a concentrate of about 20% metallic copper or better.

Test work was carried out using "Pittsburg" activated carbon - size range - 10# + 20#. Initial work used new carbon supplied by U.S. Bureau of Mines Metallurgy Research Centre, Salt Lake City, Utah. This carbon emanates from coconut char and has been lightly activated by high temperature (950°C or more) and activated by exposure to steam.

Because of the unavailability of coconut char in Australia at the time of the test work this was continued using previously used carbon after stripping with hot strong nitric acid.

INITIAL TEST WORK: PRECIPITATION OF COPPER ON CARBON PARTICLES

Method: Carbon was exposed (50 grams) to a variety of solutions (150 ML) for a great range of time intervals with a renewal of solutions each time the copper content of the carbon was checked by assay and up to seven cycles of solution change were made. The time intervals varied between 95 and 1032 hours. An examination of Appendix D1 of the main report shows that most removal of copper from solution occurred in the first 20 hours.

TABLE 7

Sol'n Strength grams/litre	1st Time Hrs.	Solution Residual Copper	% Strip	2nd Time Hrs.	Solution Residual Copper	% Strip
2.1	18	Nil	100%	95	0.1	95%
3.9	18	0.4	89%	96	0.6	84%
5.6	18	0.2	96%	672	0.4	92%
10.7	16.5	0.4	96%	442	2.8	74%
21.3	20	6.7	68%	141	15.8	36%
43.3	20	26	40%	145	35.5	18%

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Stage 3 about 12 years experience of research into the properties of activated carbon. He and Dr. W. Denholm suggested that there existed a plateau upon which deposition of copper became inhibited and it therefore became relevant to

1. Determine the chemical nature of the deposits.
2. Having determined by X-ray diffraction the composition resembled malacnite (CSIRO Mineral Chemistry) they proposed that Redox potential factors in combination with pH could cause promotion or inhibition of deposition.

Stage A The electro-chemical testing indicated that a Redox reaction could have taken place when carbon was added to an amine solution. When added to water the carbon promoted a pH consistent with the activation of the carbon by nitric acid.

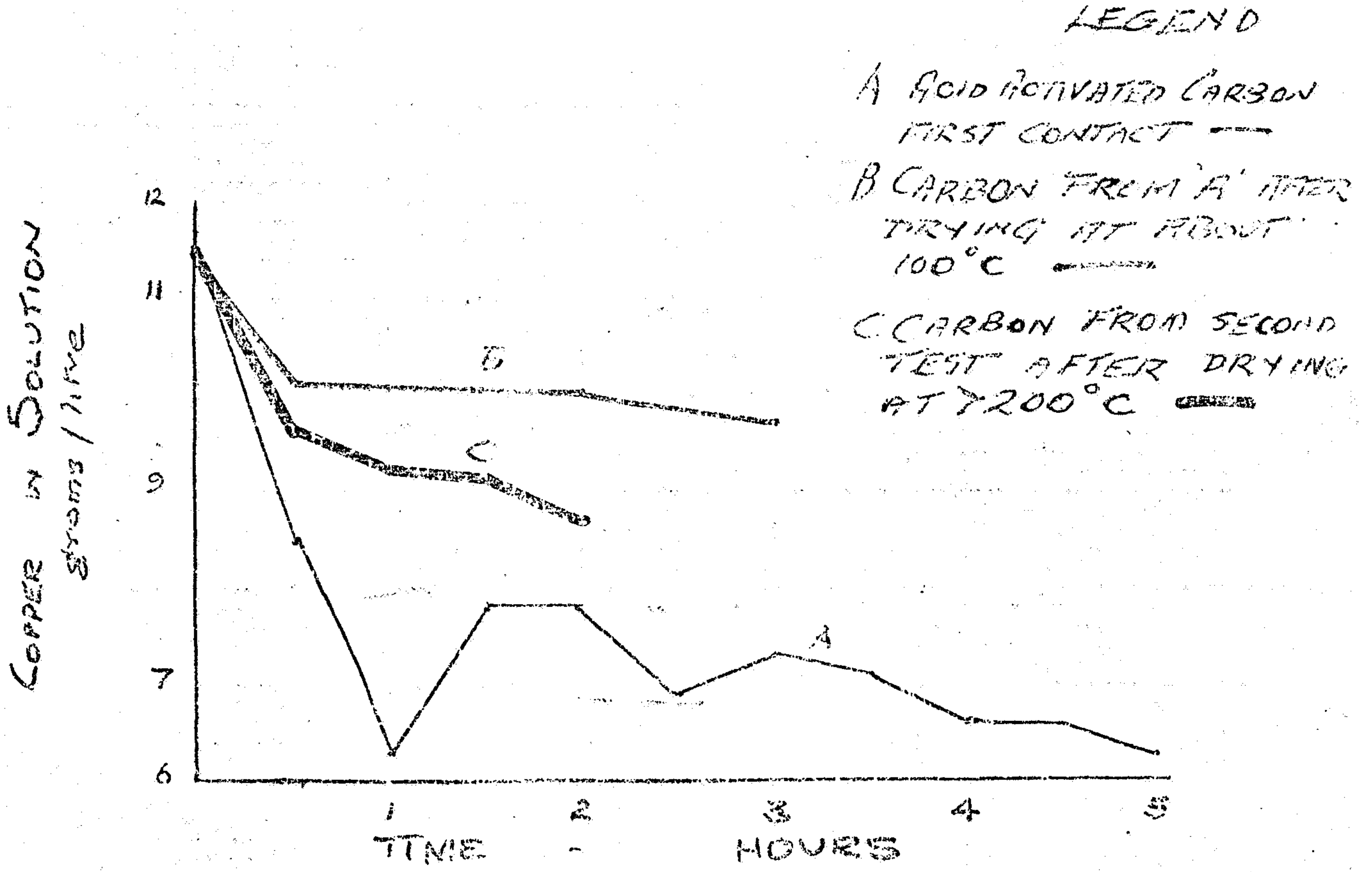
8. FURTHER DEPOSITION TESTING

Aim: To determine the effect of drying carbon between exposures to copper amine solution.

Solution concentration 11.3 grams/litre time intervals 0-11 hours.

Significantly: 0-2 hours. Table 8 and graph.

COPPER REMOVED FROM AMINE SOLUTION



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. Further tests were conducted using three spearate samples of rbon with varying exposure times to a solution containing 43 g/l f copper. The solution was removed when the rate of removal of pper from the solution reached an apparently insignificant level.

en a further addition of copper amine solution was added and the te of copper removal monitored. It should be noted that these sts were run in a closed vessel except for the times when a small mple of solution was removed for assay.

MPLE 1 Carbon - Wt. 25 grams.
Initial Solution - 43 g/l copper.
Second Solution - 43 g/l copper.

me at which significant removal of copper ceased - 313 hours during ich time 32 g/l of copper was removed. The solution was changed 312 hours and the new solution remained in contact for a further 72 hours during which period a further 5 g/l of copper was removed.

tal copper stripped was equivalent to 22.2% of the weight of carbon.

MPLE 2 Carbon - Wt. 25 grams.
Initial Solution - 43 g/l copper.
Second Solution - 43 g/l copper.

e at which significant removal of copper ceased - 120 hours during ch time 9 g/l copper was removed. A new solution was then added remained in contact for a total of a further 1872 hours. At tact time interval of 168 hours the copper removed was 27 g/l and contact time interval 1872 hours total copper removed from the ond solution was 29 g/l. This is an equivalent of 22.5% of the ght of the carbon.

PLE 3 Carbon - Wt. 25 grams.
Initial Solution - 43 g/l copper.
Second Solution - 43 g/l copper.

e at which significant removal of copper ceased - 120 hours during ch time 10 g/l copper was removed. A new solution was then added remained in contact for a total of a further 1848 hours. At tact time interval of 144 hours the copper removed was 27 g/l and contact time interval 1848 hours total copper removed from the ond solution was 29 g/l. This is an equivalent of 23.5% of the ght of the carbon.

Graph over page

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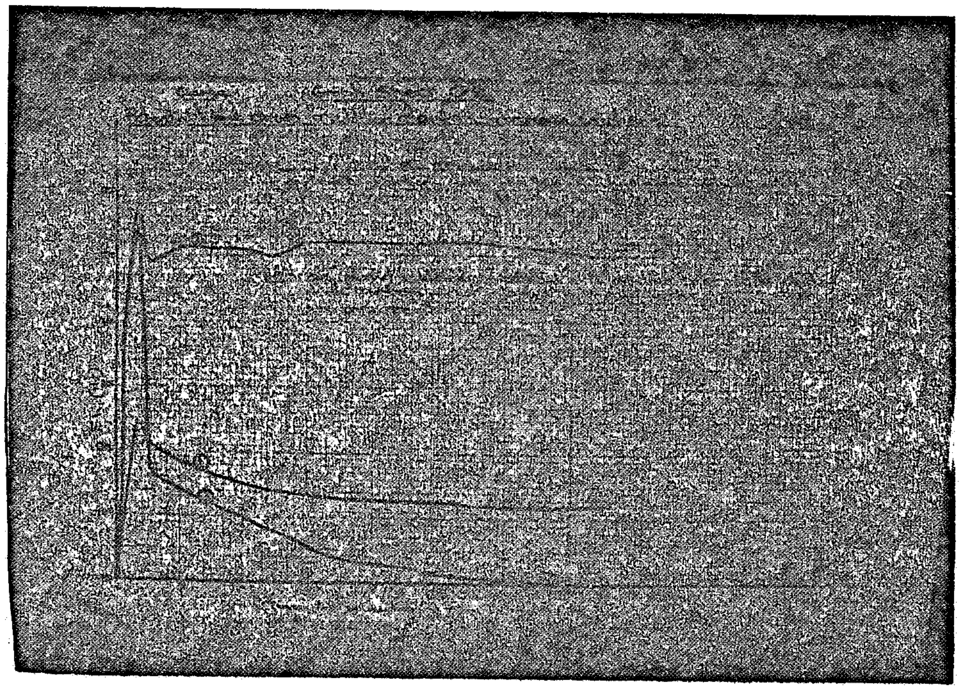

REDOX - pH CHANGES

SSION:

ould appear as follows:

First set of tests would indicate that the most rapid removal of copper from solution took place in the time interval 0 - 20 hours over a significant range of solution strengths.

At a solution concentration of 43 grams/litre the significant removal of copper from solution took place in the first hour of contact.

Anomalous results occurred in the last series of tests showing in all cases a removal of copper equivalent to over 20% of the weight of carbon. The anomaly occurred in the differing rate of stripping of copper from solution.

E 1 Removal of copper from the first solution was 32 grams/litre. From the second solution it was 5 grams/litre.

o the second and third samples the rate of removal from first
ion was 9 and 10 grams/litre respectively and from the second
ion the rate of removal was 27 grams/litre in 168 and 144 hours
only two grams per litre over an additional 1800 hours.

USIONS:

Ammoniacal leaching is practical for the extraction of copper from:

a. Friable sandy nodular ore by percolation leaching.

b. Clayey ore, by agitation leaching.

c. Silicate ore to a partial degree by percolating leaching which may improve by substantial size reduction if economic. The time required for leaching finely divided silicate ore is dramatically reduced compared with percolation leaching.

Deposition of copper on carbon particles appears to offer the prospect of producing a high grade concentrate inside the economic limits of transportation over long distances. It seems evident that under apparently similar standard conditions in the tests that -

Generally copper will be removed from solutions of varying concentration within 20 hours.

i.e.	2.1%	Copper	100%	Removal
	3.9%	"	89%	"
	5.6%	"	85%	"
	10.7%	"	96%	"
	21.3%	"	68%	"
	43.3%	"	40%	"

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4. From an 11.3% Cu Solution.

The first hour in contact with carbon removed 45% of the copper. Drying at 100°C and re-exposure removed a further 9% of the copper. End result: 54% copper removed. Drying at over 100°C removed a further 11% of copper in one hour.

5. It would seem that conditions of the tests contained variables which have caused anomalous results. But in the overall it is possible to produce a copper - carbon ratio in the precipitate which would meet the economic requirements.

The variables could be occasioned by -

A. Activated carbon. Little seems to be known as to the mechanics of the system which causes metallic compounds to be removed from aqueous solution. An astounding factor is the observed condition where about 10% only of the carbon particles carry a heavy loading of copper compound. However this appears to be similar to gold and silver experience.

B. Redox and pH factors.

C. Added chemicals, i.e. Sodium carbonate.

The use of Soda Ash has had a significant effect in minising ammonia losses from solution.

Both copper and gold compounds are only spasmodically deposited on carbon particles.

RECOMMENDED FURTHER WORK

Evaluation in greater detail and scope as to the effect of variables on copper dissolution and deposition on carbon.

Investigation of the effects of drying between stages of deposition at varying temperatures.

Techniques required to obtain high copper solutions to the order of 150/200 grams copper per litre.

Effects of induced pH change on deposition of copper on carbon.

Effect of partial vacuum on subsequent loading of partly loaded carbon.

Determination of minimum economic head grades of a variety of ores amenable to ammonia leaching.

Determination of minimum solution strengths which will enable oxidised copper minerals to be extracted by heap and agitation leaching.

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