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GEOCHEMICAL PROSPECTING IN THE KATHERINE-DARWIN REGION NORTHERN TERRITORY

by

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SUMMARY

Reconnaissance geochemical mapping in the Katherine-Darwin region was carried out in an attempt to delineate areas in which base metal mineralization was, in general, above average. Stream sediments in the Mt. Shoebridge, Grove Hill, Northern Hercules and Frances Creek areas were tested by the dithizone method, using ammonium citrate as extractant. Results show that the method is suitable for reconnaissance mapping, but that contamination from small mine workings and dumps locally creates difficulties in interpretation. The area covered by the survey was too small for a regional interpretation of mineral distribution to be made, but further work is advocated in the area around Iron Blow Mine.

INTRODUCTION

Geochemical work during the 1959 field season was restricted to four areas within the Katherine-Darwin region (Fig.1). These areas were:-

a. Bridge Creek and the adjacent creeks in the vicinity of the Mt. Shoebridge Granite.

b. the headwaters of the Margaret River near Grove Hill.

c. the upper Mary River and its tributaries around Northern Hercules (Moline).

d. Frances Creek, a tributary of the Mary River.

For convenience in discussion the areas will be referred to as the Mt. Shoebridge, Grove Hill, North Hercules, and Frances Creek areas. They are covered by the following one inch to one mile mosaics:-

a.	Mt. Shoebridge	- Tipperary
b.	Grove Hill	- Ban Ban
c.	Northern Hercules	- Goodparla South
d.	Frances Creek	- Burrundie

In the field, these mosaics, together with the geological field sheets, were used as base maps. The object of the survey was an attempt to isolate areas of anomolous mineralisation within which mineral deposits might be expected to occur by the testing of creek sediments using a rapid geochemical technique.

2. FIELD METHOD.

The analytical method used during the 1959 field season was that employing the organic compound dithizone (diphenylthiocarbazone). Methods utilising dithizone have been used widely in soil, sediment, and water testing. Full details of the use of dithizone in geochemical prospecting are given by Huff (1948,1951), Lovering, Huff, and Almond (1950), Almond and Morris (1951), and Lakin, Stevens and Almond (1949). The rapid field method described by Bloom (1955), with certain modifications, was employed in the Katherine-Darwin Region. These modifications were :

1. No attempt was made during the survey to obtain any quantitative results. This was largely due to the problem of the emulsification of the dithizone solution with fine sediments, making the distinction of colour shades difficult.

2. The method was used exclusively as a total metals test. i.e. for copper, lead, and zinc. No specific tests were carried out for lead and zinc, but a test was carried out for copper which differs from that of Bloom, and is described below.

3. TEST FOR THE DETERMINATION OF COPPER.

a. Preparation of Reagents

i. Biquinoline Solution.
Dissolve 0.01 gms. biquinoline in 500 mls. of amyl alcohol.

ii. Buffer solution
Dissolve 25 gms. of sodium acetate and 6.25 gms. of sodium potassium tartrate in 500 mls. of water.

b. Field Procedure.

1. Add 5 mls. of buffer solution to the 2 g.m sediment sample in the graduated tube

2. Add 2 mls. of biquinoline solution

3. Add a small quantity, half a gram, of hydroxylamine hydrochloride

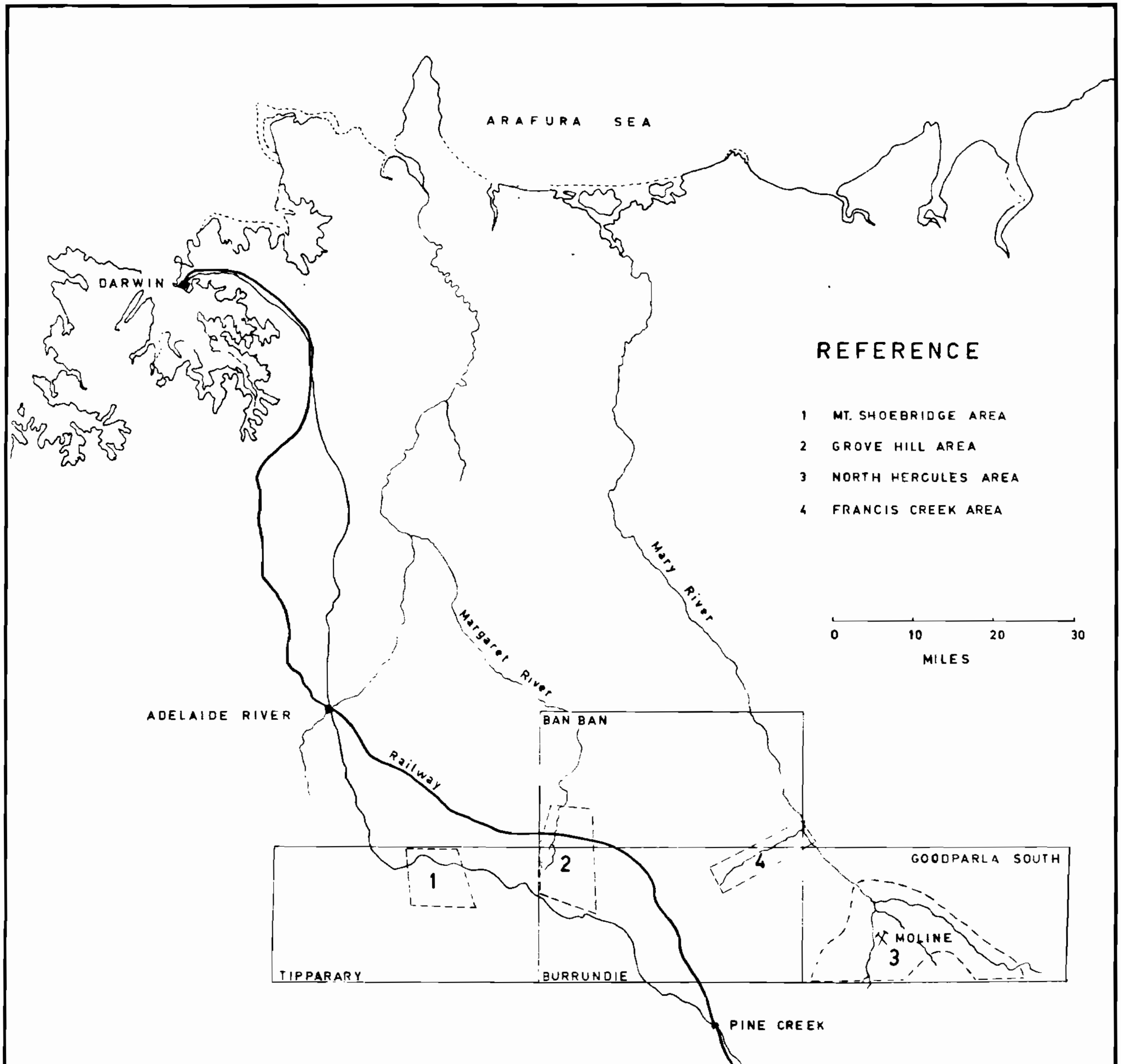
4. Shake vigorously for 30 secs.

A red coloration denotes the presence of copper.

It must be stressed that the dithizone method as used in the field was of limited accuracy. The omission of a digestion or fusion prior to determination resulted in a very incomplete extraction of metal. This was probably less than 10% of the total available.

FREQUENCY OF SAMPLING.

Samples were taken and tested every quarter of a mile. This frequency was increased in certain areas e.g. in the vicinity of a creek junction when attempting to locate the source of metal. Also, in areas where anomolous and variable results were obtained e.g. in sections of the Margaret and Mary Rivers, sampling points were closer. It is believed that a quarter mile spacing of sampling points is satisfactory for reconnaissance purposes and that no important anomoly will



THE NORTHERN PART OF THE KATHERINE – DARWIN REGION

SHOWING LOCATION OF AREAS GEOCHEMICALLY SURVEYED 1959 will be missed using such a frequency.

On the map showing the results of the survey, continuous lines have been drawn to represent the reactions obtained in a creek, rather than marking each sampling point with a dot. This procedure is believed to be valid in creeks where strong reactions are obtained, as metal can be transported over considerable distances and isolated pockets of sediment giving negative reactions would have no significance.

In testing creeks giving a constant negative reaction it is highly unlikely that an anomoly would be missed, and if it were, it would be so small as to have little importance.

5. GEOCHEMICAL PROSPECTING IN THE KATHERINE-DARWIN REGION.

A. The Mt. Shoebridge Area.

a. Geology

The rocks exposed in the area belong to the Golden Dyke Formation of Lower Proterozoic age. They are predominantly siltstone, with some marl, dolomite, and breccia. The formation is intruded by the Mt. Shoebridge Granite, a small boss of Lower Proterozoic age. Flat topped mesaes of Cretaceous rocks rise above the fairly level Proterozoic basement.

b. Drainage

The major creek in the area is Bridge Creek, which flows northwards and crosses the outcrop of the Mt. Shoebridge Granite. Attention was concentrated on Bridge Creek and its tributaries, but a number of creeks flowing S.E., tributaries of Hayes Creek, were also tested.

During the period of the survey, Bridge Creek carried a series of small waterholes, but the other creeks investigated were dry.

c. Creek Sediments and the Form of Drainage Channels.

The sediments of Bridge Creek are a medium to coarse sand, being derived for the most part from the Mt. Shoebridge Granite. All other creeks in the area have sandy bottom sediments, usually of medium grade, but silts are found in some localities.

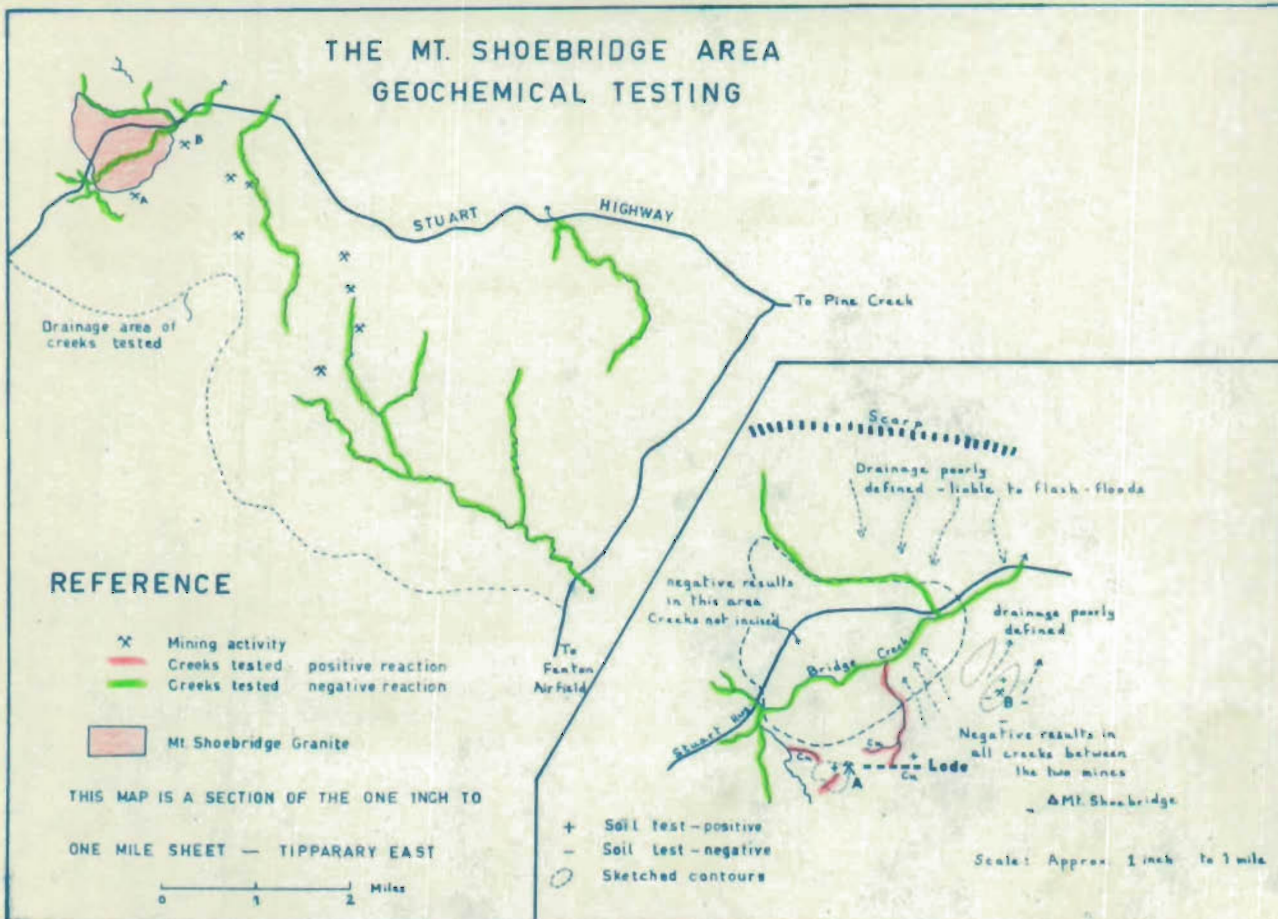
The drainage channels of the large creeks are well defined, with steep banks about 3 feet in height. Many of the smaller tributaries of Bridge Creek are however merely shallow depressions, presumably liable to flash floods during the wet season.

d. Previous Mining Activity.

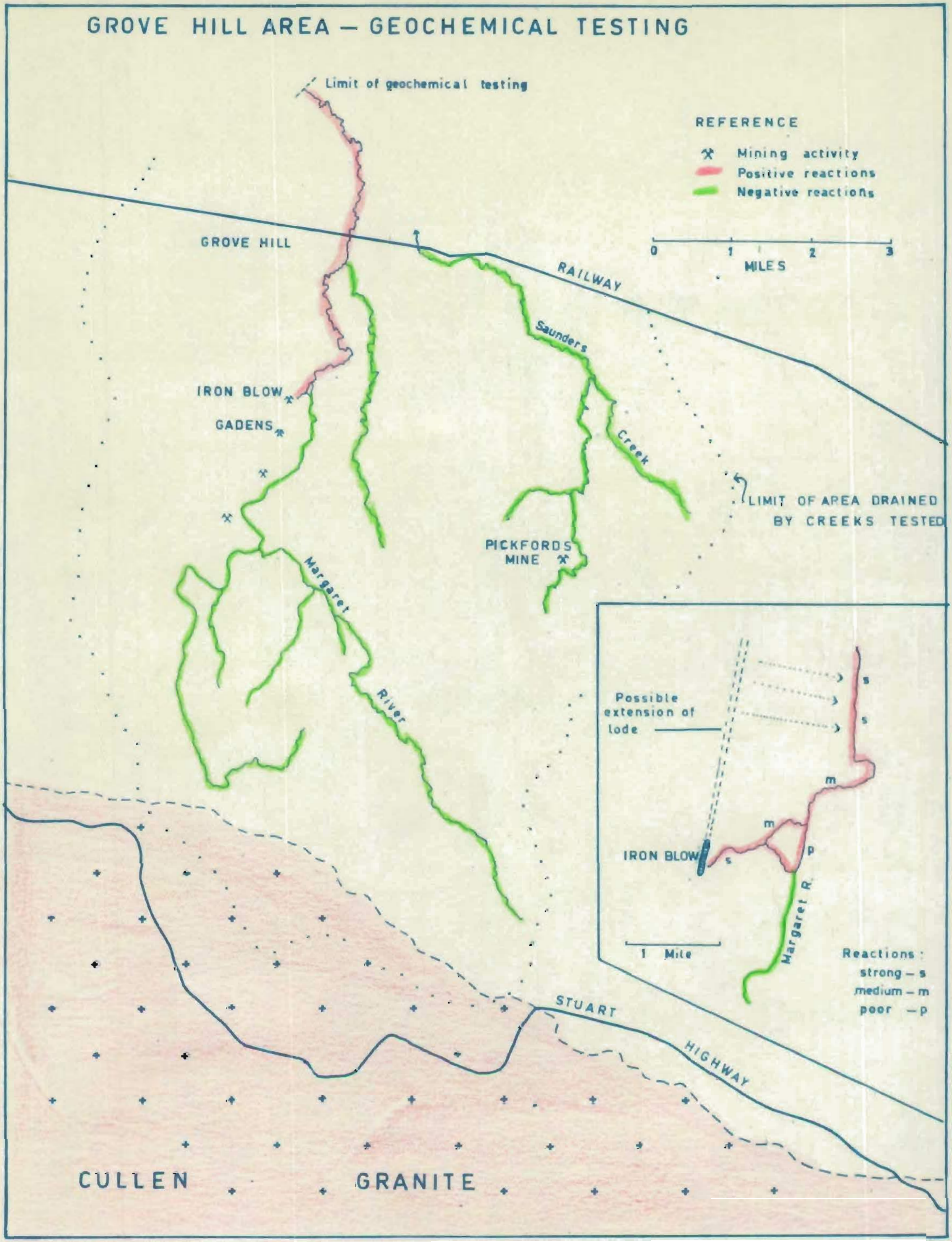
Numerous small workings exist in the area investigated. Copper, lead, tin, and manganese have been extracted.

e. Geochemical Testing of Creek Sediments.

Exploratory work around the granite and at least one geochemical traverse run across the boundary, had led to the view that a zone of mineralised sediments might be expected to surround the granite (W.Patterson - Enterprise Exploration Co. - personal communication). Two small workings had been dug within the sediments and close to the granite boundary. Consequently the early geochemical work was concentrated on the marginal sediments in an attempt to define the extent of the mineralisation.



THE MT. SHOEBRIDGE AREA
GEOCHEMICAL TESTING
STUART HIGHWAY
To Pine Creek
Drainage area of creeks tested
To Fenton Air Field
REFERENCE
Mining activity
Creeks tested positive reaction
Creeks tested negative reaction
Mt Shoebridge Granite
THIS MAP IS A SECTION OF THE ONE INCH TO
ONE MILE SHEET — TIPPARARY EAST
0 1 2 Miles
Scarp
Drainage poorly defined - liable to flash-floods
negative results in this area
Creeks not incised
drainage poorly defined
Bridge Creek
Stuart Hwy
Lode
A
B
Negative results in all creeks between the two mines
Mt Shoebridge
Soil test - positive
Soil test - negative
Sketched contours
Scale: Approx. 1 inch to 1 mile



GROVE HILL AREA — GEOCHEMICAL TESTING
Limit of geochemical testing
REFERENCE
Mining activity
Positive reactions
Negative reactions
0 1 2 3
MILES
GROVE HILL
RAILWAY
Saunders Creek
IRON BLOW
GADENS
Margaret River
PICKFORDS MINE
LIMIT OF AREA DRAINED BY CREEKS TESTED
Possible extension of lode
IRON BLOW
Margaret R.
1 Mile
Reactions:
strong — s
medium — m
poor — p
STUART HIGHWAY
CULLEN GRANITE

Work was commenced on Bridge Creek, testing both bottom and bank sediments. Approximately five miles of the creek were tested, above, within, and below the granite outcrop. None of the samples tested gave a positive reaction i.e., a red coloration with the dithizone solution.

Attention was next turned to the old workings, marked A and B on the map (fig. 2). They lie within the sediments to the south of the granite. Both are small and consist of a number of shallow holes and a few small spoil heaps. The workings at A have produced lead and copper, and B has produced lead and zinc(?).

Around B a strong dithizone reaction was obtained in the surface soil. This is as would be expected, the soil carrying a high proportion of waste material from the workings. The drainage around the workings is very poorly defined, and tests carried out in the area showed that the metal (lead and possibly zinc) was not being transported more than 200 yds., and that none was reaching Bridge Creek.

Tests carried out around the workings at A showed that copper is detectable and can be traced for a distance of a mile or more under favourable conditions. It is believed that a fairly high concentration of copper is required before it can be detected by geochemical means under the conditions employed. All tests made on the minor creeks between the two workings, and running across the granite boundary into Bridge Creek, gave negative results. Similarly all tests carried out on the northern side of the granite were negative. Here drainage channels are very poorly defined and are liable to flash floods, which would tend to quickly disperse any metals deposited.

No evidence was found of a mineralised zone in the sediments that surround the granite, but this may well be due to the limitations of the method.

South-east of the Mt. Shoebridge granite, a series of creeks flow southeast eventually to unite and join Hayes Creek. Metals recovered from small workings in the area include lead, copper and tin. The bottom sediments in this region are fine sands. Positive reactions were obtained in the soil around one small copper show, but all other tests gave negative results. One creek flowing northwards was tested, but results were negative.

B. <u>The Grove Hill Area</u>.

Testing was carried out in the headwaters of the Margaret River and its tributary the Saunders Creek (see Fig.3).

a. <u>Geology</u>

Lying immediately to the north of the Cullen Granite, the area comprises rocks of the Koolpin Formation of Lower Proterozoic age, with extensive dolerite intrusions. The Koolpin Formation is composed principally of siltstone, with some dolomite, breccia and chert.

b. <u>Topography and Drainage</u>

The area does not show any pronounced topographic features. Low hills occur in the south, but the country to the north, adjacent to the railway, is level. Drainage is by means of the headwaters of the Margaret River and its tributaries. The Margaret River itself carried a small flow during the course of the survey. Saunders Creek carries some waterholes, but the smaller tributaries were dry.

c. Creek Sediments and the Form of Drainage Channels.

Creek sediments throughout the area are sandy, being derived principally from the weathering of the Cullen Granite. These sands are medium to coarse in grade. Drainage channels of the larger creeks are incised, with steep banks up to six feet high.

d. Previous Mining Activity.

There has been considerable mining activity in the area, particularly to the west of the Margaret River where several old workings occur e.g. Iron Blow and Gadens. Geological and Geophysical Reports on the Iron Blow area have been produced by the A.G.G.S.N.A. (Reports Nos. 13 and 14). On the Saunders Creek, Pickford's lead Mine is the only large working. Many of the sediments in the area are iron rich and the rocks at Iron Blow contain a large proportion of pyrite.

e. Geochemical Testing of Creek Sediments.

Approximately 45 miles of the Margaret River were surveyed geochemically. Sampling was mainly confined to bank sediments, it being impossible to obtain bottom sediments from the deep lagoons along the Margaret River. Several tests carried out on both bank and bottom sediments in the same locality, indicated that bank sediments would be more likely to give satisfactory results. Frequent tests of bottom sediments were carried out to check the bank sampling.

i. The Margaret River

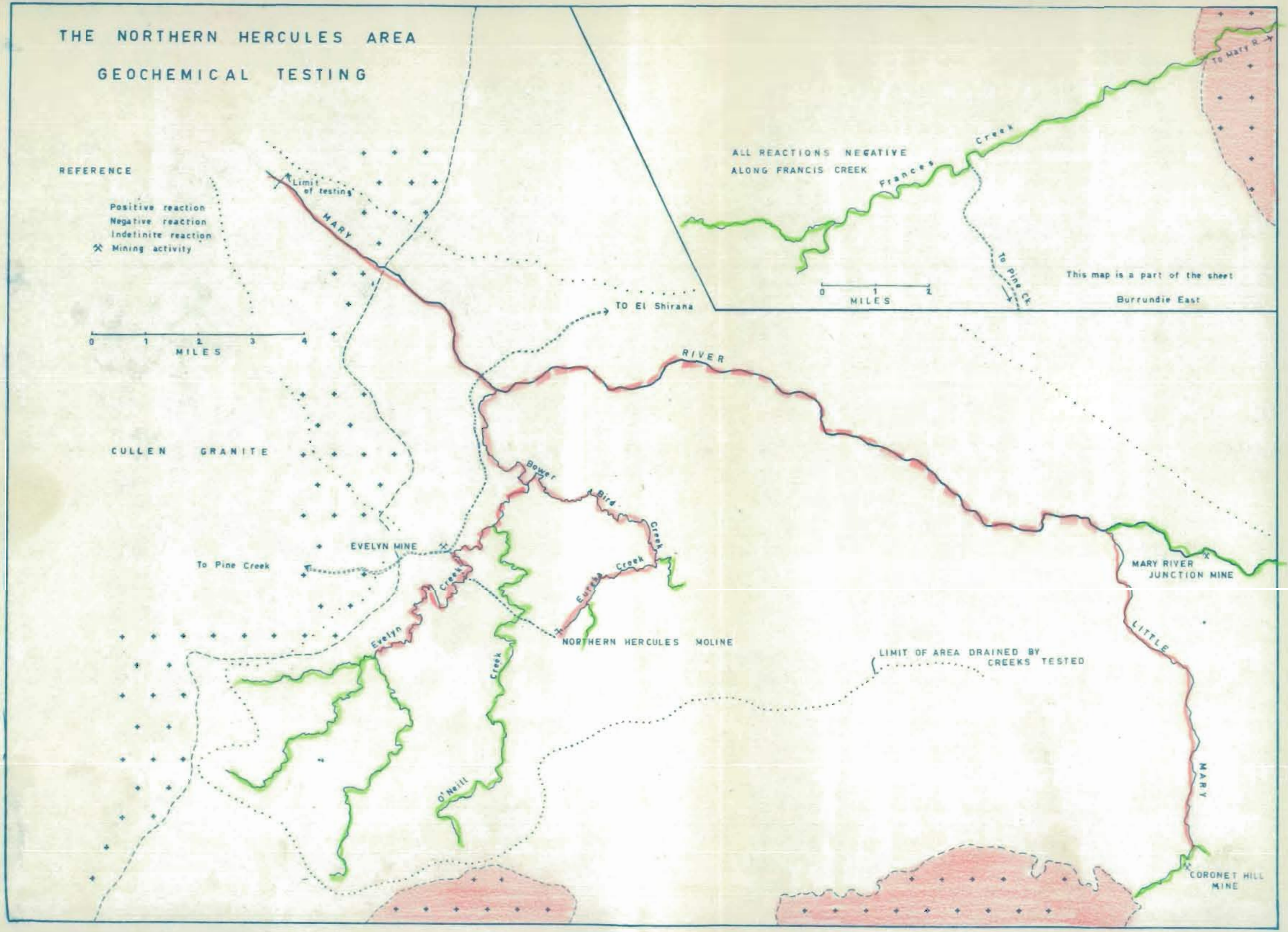
No positive results were obtained from creek sediments above the junction of the two major headstreams (see fig. 3). Two miles north of this junction and a quarter of a mile from the left bank of the river is Iron Blow, an old mine working, and once a producer of gold; very strong dithizone reactions were obtained around the mine, in the gutter draining from the mine, and in the Margaret River below the point of entry of the gutter. Reactions were negative in the Margaret River upstream from the gutter. A sample of pyrite from the mine which was chemically analysed (Analyst A. McClure) gave the following results :

160 ppm. Copper
600 ppm. Zinc
2000 ppm. Lead

A field test on the sample gave a strong dithizone reaction, but a copper test proved negative. The low solubility of lead in natural waters suggests that it is zinc which gives the strong reactions in the Margaret River. This belief is supported by the analysis of an ironstone rock sample collected a mile and a half downstream on the left-hand bank of the river. Results from this sample showed :

1400 ppm. Copper
2400 ppm. Lead
5500 ppm. Zinc

Field tests showed that even a fairly high concentration of copper in the rocks did not give a reaction with biquinoline, and the river sediments would be expected to carry a considerably lower concentration of metal. The strong reactions in the Margaret River were traced for six


THE NORTHERN HERCULES AREA
GEOCHEMICAL TESTING
REFERENCE
Positive reaction
Negative reaction
Indefinite reaction
Mining activity
0 1 2 3 4
MILES
CULLEN GRANITE
Limit of testing
MARY
RIVER
TO El Shirana
ALL REACTIONS NEGATIVE
ALONG FRANCIS CREEK
Frances Creek
To Mary R.
To Pine Ck.
0 1 2
MILES
This map is a part of the sheet
Burrundie East
Bower Bird Creek
Eureka Creek
EVELYN MINE
To Pine Creek
Evelyn Creek
O'Neill Creek
NORTHERN HERCULES MOLINE
MARY RIVER
JUNCTION MINE
LITTLE
MARY
LIMIT OF AREA DRAINED BY
CREEKS TESTED
CORONET HILL
MINE

miles, to a point north of the railway line, before they become weaker and finally undetectable. The fact that there is no apparent 'dilution' of metal (Zn) content in the river sediments suggests that metal is being derived from the country north of Iron Blow and to the west of the river.

It may be significant that the geophysical survey carried out by A.G.G.S.N.A. (Rep. No. 18) gave an indication of a continuation of the Iron Blow lode to the north of its worked section. It is possible that the strong reactions in the Margaret River north of Iron Blow are indicative of a concealed northward extension of this lode. The negative reactions obtained in the Margaret River to the south of Iron Blow correspond well with the negative geophysical results in this area.

An alternative explanation of the geochemical results would be that the entire zinc content of the sediments tested had been derived from the Iron Blow workings. If this was so, it would be expected that there would be an appreciable diminution of zinc content with increasing distance from the deposit. Such a diminution was not apparent during the testing of the river - the 'fall-off' commencing north of the railway line, and then proceeding rapidly. Results, therefore, warrant a closer testing of the ground to the west of the Margaret River with a view to determining the source of the zinc causing the strong reactions in the river sediments.

Iron oxides are much in evidence in the Margaret River below Iron Blow, and some of the bottom sediments tested gave a brown coloration on shaking, probably due to the masking of the normal red colour by a suspension of fine iron particles.

A tributary joining the Margaret River from the east, a half mile to the south of the railway gave no positive reactions.

ii. The Saunders Creek.

Saunders Creek and its tributaries were tested southwards from the railway line for six miles. One fairly large old working occurs in this area - Pickfords Lead Mine. The mine is situated on a ridge about 75 yds. away from the creek and although tests carried out on soil samples around the mine gave strong reactions none of this soil is reaching the Saunders Creek. There is some copper in the area and a small digging immediately above the creek is not shedding any material down the 25 yd. slope. Another small digging in the same locality, right on the immediate banks of the creek gives a positive reaction in one locality, immediately below the digging; this was the only positive reaction obtained during the testing of the Saunders Creek.

C. The Northern Hercules Area (see Fig. 4)

Geochemical testing in this area was carried out on the headwaters of the Mary River, and its tributaries the Little Mary, Bower Bird, Eureka, Evelyn, and O'Neill Creeks. About 40 miles of creek were tested.

a. Geology

The area lies north and east of the Cullen Granite, and the surface rocks belong to the Golden Dyke Formation and the Burrell Creek Formation of Lower Proterozoic age. They are predominantly siltstones and greywackes, with some chert and dolomite.

b. Topography and Drainage.

The Mary River flows through fairly level country which becomes hilly and broken to the south with steep ridges formed by hard chert horizons. The northward flowing creeks, Eureka, Evelyn, Bower Bird, and O'Neill, have deeply cut, steep sided channels and contain numerous waterholes. The Mary River itself carries a considerable volume of water even in the dry season.

c. Previous Mining Activity

There has been considerable mining activity in the area. The largest plant is that of the Northern Hercules Mine (Moline); once an important gold producer, the mine is now treating uranium ore from El Shirana on the South Alligator River to the north. North-west of Moline, lies the Evelyn Mine, a former producer of silver-lead but now abandoned.

At the head of the Little Mary River are the Coronet and Ross Mines. Coronet Hill has produced copper, silver, bismuth and arsenic, and lead has been found in the vicinity. The Ross mine was a tin producer. On the Mary River itself, the Mary River Junction Mine has produced copper. No zinc has been found in the area.

d. Geochemical Testing of Creek Sediments

Sampling was confined to the low banks of the Mary River, and consequently the testing of wet samples further intensified the emulsification of the dithizone solution. It is difficult to assess the significance of the reactions obtained in the upper section of the Mary River and in the Little Mary River. Negative reactions were obtained in the Mary River below the Mary River Junction Mine, so that no metal was entering the drainage system from this source. Reactions in the Little Mary River below the Coronet Hill Mine were strong and continued for 10 miles downstream to the junction with the Mary River. The Mary River below the junction gave very variable results - strong to nil reactions occurring irregularly and despite re-testing, no satisfactory picture was obtained.

The dry tributaries, coming in to join the Mary River from the south have drainage channels of similar form to those at Mt. Shoebridge and Grove Hill, and results here were more consistent.

It is believed that the testing of water-saturated samples should be avoided where possible because of the emulsification problem. The source of the metal giving the reactions in the Little Mary River and Mary River sediments is most probably the Coronet Hill Deposit, though there exists the possibility of an influx of metal from the north or south of the Mary River below the junction of the Mary and Little Mary Rivers. However none of the larger tributaries which were tested before they entered the Mary River gave a positive reaction.

The Mary River below the junction with the combined Bower Bird, Eureka, and Evelyn Creeks gave consistently strong reactions, and these were traceable up the Bower Bird and Eureka Creeks to the Northern Hercules Mine, where the waste dumps were discharging large quantities of metal-bearing sediment. The Evelyn Creek gave variable reactions but all other creeks tested gave negative results.

D. The Frances Creek Area.

The Frances Creek is a tributary of the Mary River 20 miles downstream from the Evelyn Mine.

a. Geology

The country rocks in this area are quartz greywacke, siltstone and conglomerate of the Masson Formation of Lower Proterozoic age. In its lowest section, the Frances Creek cuts part of the Cullen Granite before joining the Mary River.

b. Creek Sediments

The Frances Creek has a deeply incised channel in all but the highest section, and in several localities the valley sides are gorge-like. Large water holes exist in the lower section of the creek. Sediments are usually sandy.

c. Geochemical Testing

The entire length of the creek was tested. All tests gave a negative reaction.

6. PROBLEMS ENCOUNTERED DURING THE SURVEY

1. The early stages of the work were considerably hampered by the rapid oxidation of the dithizone. Despite all precautions in the preparation and use of the solution, including the refrigeration of solvent before the making up of solutions and the use of a thermos flask in the field, four hours was found to be the average length of life of fresh solution. It was found later that the xylene itself was of insufficient purity and new supplies were found to be perfectly satisfactory - producing dithizone solutions with a life of up to 24 hours.

2. During the initial part of the survey, emphasis was laid on the testing of bottom sediments. These were dominantly sandy, and not ideal from the geochemical point of view, as the coarser sands do not carry the metal ions as efficiently as do the finer sediments.

3. When testing the finer sediments (silts and clays), the formation of emulsions on shaking proved to be a constant problem. These emulsions do not break down readily and make the determination of colour difficult.

7. DISCUSSION OF GEOCHEMICAL RESULTS

Geochemical tests carried out in the Canberra region prior to the commencement of the 1959 field season revealed many of the problems associated with the proposed method, and results were not very satisfactory. It was felt, however, that the method should be given a thorough trial under Northern Territory conditions, it being recognised that local factors of climate and drainage can affect the efficiency of geochemical techniques, which generally have to be modified to suit local conditions.

The survey was carried out in areas of known mineralisation, where numerous small workings were already in existance. Such areas are not in many respects ideal for an initial reconnaissance survey, as the prevalence of weathered metal-bearing material which readily enters drainage channels, tends to mask the true secondary geochemical anomolies and make interpretation of results difficult. However, working in mineralised areas of this type did make it possible to clearly define the limitations of the method.

Results obtained in the areas surveyed were very variable and it is difficult to draw any definite conclusions. The problems encountered during the pre-season trials were not overcome, but within the framework of the objectives of the survey, the results were of value.

The preliminary work at Mt. Shoebridge showed the limited distance travelled by copper from small deposits. Samples tested in the area were essentially bottom sediments, carrying recently weathered waste dump material. The sandy nature of the bottom sediments may have been partly responsible for the poor results here. Evidence collected at Mt. Shoebridge suggests that small mineral deposits (even when waste dump material is available) would not be found using the present method except by chance.

Drainage conditions at Grove Hill were similar in most respects to those at Mt. Shoebridge; however deep lagoons along certain sections of the Margaret River led to the sampling of bank rather than bottom sediments.

The strong reactions obtained in the Margaret River below Iron Blow would appear to be due to material discharged into the river from the waste dumps of the mine during the wet season. However, several complicating factors make this conclusion suspect :

1. There is no apparent fall-off in the strength of the reactions with increasing distance from Iron Blow. This could be due, however, to the imperfections of the method.

2. Bank sediments tested were almost certainly older than the mining activity at Iron Blow, and consequently the metal content of the sediments is not derived from weathered waste dump material. There is the possibility of the adsorption of metal derived from dump material on to the clay minerals composing the banks during prolonged flood conditions. It is feasible that this adsorption may be active for an inch or two from the surface, so that the sample taken may contain recently derived metal.

The evidence is therefore inconclusive, although the high metal content of the rock sample analysed (P.10) tends to support the conclusion that the geochemical results reflect the presence of a northward extension of the Iron Blow lode.

The results obtained on the Mary River below the Northern Hercules Mine showed that waste dump material, when available in large quantities, can be transported for many miles downstream (in this case more than 10 miles). It is believed that in the case of the waste material derived from Northern Hercules, a considerable amount of adsorption on to bank sediments must have taken place in the Eureka and Bower Bird Creeks. It is unlikely that any pronounced secondary dispersion pattern existed prior to the opening of the mine.

Reactions obtained in the upper part of the Mary River, i.e. above the confluence with the southern tributaries, showed the variability of results when using dump samples from the low banks of the river. No definite conclusions can be drawn from this part of the work.

The only area tested where follow-up could be advocated is north of Iron Blow, where a systematic soil survey on a grid pattern might give more definite information on the extent of the Iron Blow lode.

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