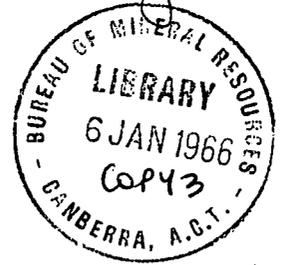


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**DEPARTMENT OF NATIONAL DEVELOPMENT
BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS**

RECORDS:

1965/172

VISIT TO KALGOORLIE AND NORSEMAN GOLDFIELDS BY
N.W. LE ROUX AND I.R. PONTIFEX, JULY, 1965.

The information contained in this report has been obtained by the Department of National Development, as part of the policy of the Commonwealth Government, to assist in the exploration and development of mineral resources. It may not be published in any form or used in a company prospectus without the permission in writing of the Director, Bureau of Mineral Resources, Geology and Geophysics.

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SUMMARY

N.W. Le Roux (chemist) and I.R. Pontifex (mineralogist) visited the following companies in Kalgoorlie from July 13th to July 20th, 1965.

Western Mining Corporation	(W.M.C.)
Great Boulder Mines	(G.B.M.)
Lake View and Star	(L.V.S.)
New Consolidated Goldfields	(N.C.G.)

The purpose of the visit was to discuss the Kalgoorlie geochemical programme with geologists of these companies. Accordingly, the general geology of the rock types and ore mineralization in the field were studied; the results of the investigation so far obtained by the B.M.R. were discussed, and the research being conducted in the field by W.M.C. was generally reviewed.

July 21st and 22nd were spent at Central Norseman Gold Mines (C.N.G.). Various aspects of lode geology were studied and some results of C.N.G. exploration, based on mineralogical and chemical research in the field, were discussed.

In Perth the general nature of the geochemical programme at Kalgoorlie was discussed with Mr. J. Lord, Director, Western Australian Geological Survey. While in Kalgoorlie the authors visited the Kalgoorlie School of Mines and a joint address entitled "Recent Geochemical and Ore Genetic Studies Carried Out by the Bureau of Mineral Resources" was presented to the local branch of the A.I.M.M. During the trip a brief, informal visit was also made to the copper mine and lithium bearing pegmatite at Ravensthorpe. These activities are not further commented on in this record.

GENERAL INTRODUCTION

In February 1964 a geochemical programme was initiated by the B.M.R. to work in conjunction with the mining companies in the Kalgoorlie Goldfield and with complete liaison with the W.A.G.S.

J.F. Ivanac and A.L. Mather visited the field from 15/3/64 to 25/3/64 and discussed geochemical sampling and prospecting problems, (report dated 9/4/64, file 656753).

The aims of the project set out by Ivanac and Mather were essentially,

- (a) "Regional Geochemistry". To determine the extent and nature of trace element haloes around gold mineralization and to determine critical elements, elemental ratios and their significance.

- (b) "Semi-detailed geochemistry". To determine the extent and nature of trace element haloes around high and low grade gold lodes.

The objects were to develop an efficient prospecting tool for concealed Kalgoorlie-type mineralization in the Eastern Goldfields and to provide a guide to the juxtaposition of gold mineralization and associated trace element haloes in underground and surface drilling.

This programme was to be carried out in two stages, first the analysis of samples from underground workings of all types of gold mineralization in the field then the analysis of samples, from a series of vertical holes drilled across the Goldfield to outline the extent of the haloes found in the first stage.

It was also proposed that special rapid techniques for the analysis of Te, Hg, As and Au should be developed and that multi-element analyses would be done on automatic analytical equipment in the B.M.R. laboratory.

All Companies in the field were reported as willing to co-operate although it was apparent that some difficulties would arise regarding the release of information since the programme involved the analysis of material from a number of different properties.

W.M.C. appears to have been more enthusiastic about the project than other Companies since they were actively conducting chemical and mineralogical research in the field. Consequently W.M.C. provided most samples to the B.M.R., from their leases and from G.B.M. and L.V.S. leases. In addition W.M.C. had accumulated abundant detailed geological and chemical data pertinent to the B.M.R. work.

To gain access to as much of this data as possible the B.M.R. policy on the release of information as formulated by Noakes (15/4/65) to Woodall (W.M.C.) was,

- (a) the results of B.M.R. research on analytical techniques would be made available to all enquirers, and published
- (b) any information supplied by W.M.C. would remain completely confidential and would not be released or published without written consent from W.M.C.

Up to June 1965 about 650 samples of various lodes, wall-rock and mill feed from underground at Kalgoorlie and of soil samples from Kalgoorlie and Norseman were analysed for various elements As, Co, Cu, V, and Ni (Le Roux, 1965).

At the completion of this work it was felt that a visit by B.M.R. officers would be advantageous, in order to discuss the results so far obtained and decide on the nature of future work by the B.M.R. in the area.

WESTERN MINING CORPORATION

1. General Geology

Discussions were held with R. Woodall, Chief Geologist, and G. Travis, Research Geologist, regarding their current interpretation of the general geology of the Kalgoorlie Field. Emphasis was placed on the recognition of rock units in the stratigraphic succession and the regional faults and folds, as given by Woodall, (1965).

A visit to numerous surface type-localities provided a general appreciation of most rock types and some of the structures in the geological succession.

Accompanied by Travis and Chugg (Gold Mines of Kalgoorlie) we examined the ore bodies in the Mount Charlotte Mine, at the north end of the Golden Mile. The ore is highly siliceous and telluride-free in contrast to most ores at Kalgoorlie. The gold is free milling and it is typically associated with pyrite in narrow quartz veins; these are bordered by bleached, pyritic zones which grade into the Golden Mile Dolerite wall-rock. These ores are described by Haycraft, (1965).

Examples of gold-telluride lodes were examined in workings from the Paringa Shaft at the southern end of the Golden Mile in the Eastern Lode System. Here, the Kelly Lode, "B" Lode, and part of the Federal Lode System were seen with Chugg. These are described in detail by Simpson (1912) and Stillwell (1929, 1931).

2. Research by W.M.C.

W.M.C. are currently active on geochemical and mineralogical research on,

- (a) the original rocks in the Kalgoorlie area,
- (b) the regional alteration
- (c) the gold mineralization and associated wall-rock alteration.

This work involves numerous specific projects including extensive remapping, the study of CO₂ metasomatism in the Golden Mile Dolerite, a study of the abundance of As and Sb₂ and other elements in zones of alteration and adjacent to ores, differentiation of various rock units, the gold-pyrite association, and others.

All projects are directed by Woodall and are being carried out by 4 to 6 research geologists many of whom have done and will be doing work overseas. In addition many As analyses have been done and other As and Sb analyses will be done by the Government Chemical Laboratories (G.C.L.) in Perth. Trace element analyses are being done spectrographically by A.M.D.L.

The results of this work are confidential; generally however, they indicate that many aspects of the Kalgoorlie geology, once considered simple are now known to be complex and that chemical and mineralogical variations have a significant bearing on gold mineralization.

All the W.M.C. work is on underground material, generally from the primary zone. They have no immediate plans to analyse soil profile samples.

3. B.M.R. results and future work

(a) Woodall was shown plots of the results on 3 cycle semi-log scale. In some places, notably across the Horseshoe Lode, W.M.C. have correlated variations in the B.M.R. trace element values with differentiated zones of the Golden Mile Dolerite which they have defined on the basis of their research. The detailed information on the classification of these differentiated zones is not available to the B.M.R.

(b) With the exception of arsenic, which appears to be closely associated with the gold lodes, and with the rare exception of the relationships mentioned in (a), there is no apparent correlation or consistent relationship between trace element distribution and the geology, or proximity to lodes.

It seems that it will be difficult to establish the existence of any such relationships, or to correlate between the results of each traverse in the wall-rocks, without the control of much of the mineralogical and chemical analyses obtained independently by W.M.C.

(c) Future analytical work on samples so far received by the B.M.R. was discussed. Although the B.M.R. automatic, multi-element analytical equipment is not currently available for Kalgoorlie work, it was suggested to Woodall that the large quartz spectrograph and the atomic adsorption unit may be available to analyse for elements previously not attempted. Woodall requested some indication of what elements could be analysed for and within what detection limits.

(d) Woodall was informed that the B.M.R. could not presently analyse for Hg but in the event of a Hg detector being bought, Kalgoorlie samples could be analysed.

(e) As tourmaline and scheelite are commonly associated with gold mineralization at Kalgoorlie it was agreed that an analysis of boron and tungsten should be carried out on selected samples to estimate the significance of these elements as indicators of gold mineralization.

(f) It was reported that N.J. Marshall (B.M.R.) was developing a method for the detection of tellurium on the Atomic Absorption Spectrophotometer.

(g) In view of the number of factors related to the gold mineralization it was agreed that the only way in which all parameters could be satisfactorily related would be by means of a punch card system. However, many of these factors, cannot be unequivocally defined, e.g. the degree of leaching, pyritisation or CO₂ metasomatism. Therefore since the coding of information would not be specific the conclusions derived from computing these factors with trace element distribution could be misleading. Some facts, such as distance from lodes, could be advantageously integrated by a punch card system. No conclusion was reached regarding the use of punch card systems or a computer for the integration of the results of this investigation.

(h) Additional Samples. 239 samples were sent from W.M.C. to the B.M.R. on July 30th. These are from different lodes and they represent different types of gold mineralization from various leases on the field. Some of these have been analysed by the G.C.L. and the results have been forwarded to the B.M.R.

Lake View and Star

A discussion was held with A. Wells, Chief Geologist, on his interpretation of the geology of the Kalgoorlie Goldfield, particularly of the east and west lode systems. His ideas differed in some respects from those of W.M.C. but most of his work appears to involve a structural interpretation of areas within, and adjacent to L.V.S. leases; as set out in Wells (1964).

Wells pointed out variations in the grade of ore and of the proportion of free milling gold to gold tellurides in different sets of shears and in different levels of the mine. He suggested that several generations of mineralization produced different types and grades of ore which are closely related to different fault patterns.

As yet Wells has not had the opportunity to study the geochemical results from the B.M.R. The impression was that although he was willing to co-operate in the provision of samples and information, he did not, at this stage, wish to become involved in the interpretation of results. He felt however, that there was some scope for the application of geochemical studies in exploratory drilling near workings where trace element assemblages could be used as guides to the proximity of ore.

L.V.S. are presently constructing a detailed 3 dimensional model of the geology in the vicinity of their underground workings by means of a series of sections painted on perspex sheets. The B.M.R. were invited to use this for plotting any geochemical results.

Great Boulder Mines

K. Finucane, Chief Geologist, presented his interpretation on the geology of the Kalgoorlie lodes; the emphasis was on the structural control of the ores as set out in Finucane (1964, 1965). It was evident that different types of mineralization are related to different structures and that there was considerable variation (generally a decrease) of the ore grade with depth in the G.B. leases.

K. Finucane considered the B.M.R. geochemical project objectively and holds the view that the more information known about the field the better. He had not had the opportunity to study the B.M.R. results sent to him and it seems that at this stage G.B.M. do not wish to become involved in the interpretation or the use of these results. They are however, prepared to allow the B.M.R. (independently or in co-operation with W.M.C.) to sample material from G.B.M. leases.

New Consolidated Goldfields

The area, about 8 miles north-west of Kalgoorlie, in which N.C.G. are conducting exploration was visited with K. Hughes and J. Best, geologists of N.C.G. The area is flat-lying and soil covered except for several small outcrops of dolerite. Much of the area has been drilled by a Proline drill to the base of the soil horizon and bottom-of-hole samples chemically analysed by the B.M.R. (Le Roux, 1965). Analyses on these samples (including Hg) have also been done by A.M.D.L.

Cuttings from the holes were examined by N.C.G. and this has provided a generalized sub-surface geological map; this information is not held by the B.M.R. I.P. surveys have been run over some of the area but continuation of this work has been postponed. Detailed aeromagnetic surveys by the B.M.R. have helped the geological interpretation.

The geochemical results do indicate a probable correlation between variations in trace element concentration and variations in rock type (drill cuttings). The significance of the several anomalies obtained has not yet been established.

Hughes was extremely grateful for the B.M.R. analyses and for advice on sampling methods and the factors to be considered for interpretation.

Conclusions; N.C.G.

The analyses from this area do provide a general indication of the order of magnitude of trace element variation in the soils in the Kalgoorlie area but to date these cannot be related to sufficiently well-documented geology or known ore mineralization to make significant contribution to the fundamental geochemistry of Kalgoorlie area.

Central Norseman Gold Mines (C.N.G.)

K. Williamson, Chief Geologist, presented a resume of the regional and lode geology. The Crown and Mararoa reefs were examined underground.

The C.N.G. geological staff are involved in chemical and mineralogical research on the gold mineralization in the Norseman Field and the results of this are being applied to exploration in the area. An assistant is employed on the

determination of As by the Gutzeit method, and facilities for the preparation and study of thin-sections are included in their laboratory.

In some parts of the field a close correlation between As and gold mineralization and various structures has been established both at the surface and underground.

C.N.G. has 2 surface diamond drills continuously testing possible ore zones delineated by geological, geochemical and geophysical surveys. The core from this work provides excellent material for orientation geochemical studies in this field.

Conclusions; Norseman

The work being done by C.N.G. is itself orientation geochemistry which is aimed at establishing indicator elements for prospecting in the area. Work by B.M.R. is not planned for this area.

CONCLUSIONS

1. The visit to the Kalgoorlie Field is considered to have been essential to appreciate the facts relating to the mode of occurrence of the ore mineralization and to visualise in proper perspective the geological phenomena to which the distribution and abundance of the trace elements have to be related. Consultation with companies was a vital part of the visit.
2. The Kalgoorlie pattern of host-rock variation, regional and local metasomatism, lode-fault geometry, and mineralization are complex and all of these factors will have a direct influence on the distribution of trace elements around gold mineralization.
3. The mining companies have recognized these factors to varying degrees. Traditionally the most significant of these with regard to finding ore has been the lode-fault geometry, hence this is the only aspect which has been studied in detail.
4. Since the interests of W.M.C. are not confined to their leases, but to the Goldfields generally, they have given more serious thought to all aspects of geology at Kalgoorlie. They are actively conducting systematic research, particularly on the chemical and mineralogical variations associated with ore mineralization. Their ultimate aim is to apply these results to exploration in the Field.
5. Their work is closely allied to the B.M.R. geochemical work at Kalgoorlie and in view of the complexity of the geology of ore mineralization indicated by their results it seems likely that for the B.M.R. to understand fully the nature of the distribution and abundance of all elements analysed for in the vicinity of the lodes, the W.M.C. findings should be closely integrated with the B.M.R. analyses.
6. On the basis of the geological information which the B.M.R. is currently given with each sample only an empirical relationship between trace elements and lodes can be established (e.g. anomalously high As values are generally associated with gold mineralization).

7. Considering 5 and 6, it seems that if the nature of geological information provided to the B.M.R. remains the same, then only the first aim of the programme (given by Ivanac and Mather) will be achieved and that the second aim will not be satisfactorily completed.
8. To overcome this, a closer, liaison with W.M.C. seems necessary, but in view of the confidential nature of their results they have indicated that they would be unwilling to allow publication of any interpretations based on them. It is unlikely that the policies of the B.M.R. would permit this situation.
9. Therefore the most important aspect of the programme from the B.M.R. point of view appears to be to establish the trace elements specifically associated with the different lode types and where possible, determine their distribution around these lodes. Consideration of the distribution of trace elements in the wall-rock, not specifically associated with lodes, will be of minor importance.
10. The samples obtained from the drilling of soil and weathered bed-rock should be analysed for elements previously found to be associated with the ore mineralization in the primary zone. This differs from Ivanac and Mather's original proposal to search for the distribution patterns of all trace elements in the secondary zone.
11. Discussions with L.V.S. and G.B.M. indicate that the parameters of structure and depth have an important influence on the type and grade of ore and undoubtedly these will also influence the trace element distribution. Hitherto these had not been considered during the interpretation of the results. It is essential that information on the type of structural control of lodes from which future samples are collected is supplied with the samples.
12. Since the programme is designed to delineate auriferous zones in a Kalgoorlie type area, it seems essential to establish the distribution of gold in the lodes and in the wall-rock.

RECOMMENDATIONS

1. Information received from W.M.C. should be placed in a confidential file.
2. Determine the trace elements diagnostic of the various lode types in the Kalgoorlie Field by analysing run-of-mine ore, selected ore samples, and adjacent wall-rocks from the different lode types e.g. main lodes, cross lodes, caunter lodes, Mount Charlotte type.
3. The 239 samples recently sent to the B.M.R. by W.M.C. represent several different lode types and their adjacent wall-rocks. These should be analysed first. Later, more comprehensive sampling along and across the strike of selected lodes should be carried out.

4. All samples should be analysed for as many elements as possible on the large quartz spectrograph.
5. Methods of analysis should be developed for Au, Te, Hg, B, and W. On a mineralogical basis these elements are expected to be highly diagnostic of auriferous zones. It is necessary for the chemical analyses to determine their practical use as indicator elements.
6. The distribution in the wall-rocks of trace elements which prove not to be specifically related to the ores should not be further considered.
7. Request from W.M.C. all As analyses (and in future Sb analyses) done by the G.C.L., together with all information available for each sample.
8. Consider the importance of S as an indicator element of gold mineralization, on a regional basis.
9. At the completion of this work, review the results together with geologists at Kalgoorlie and consider drilling and sampling the soil profile and weathered bedrock overlying known mineralization to establish the distribution of significant indicator elements in these horizons.

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