



**CRCLEME**

Cooperative Research Centre for  
Landscape Evolution & Mineral Exploration



**CSIRO**  
EXPLORATION  
AND MINING



Australian Mineral Industries Research Association Limited ACN 004 448 266



**OPEN FILE  
REPORT  
SERIES**

# **MINERALOGY AND GEOCHEMISTRY OF WEATHERED SHALE PROFILES AT THE PANGLO GOLD DEPOSIT, EASTERN GOLDFIELDS, WESTERN AUSTRALIA**

*K.M. Scott*

**CRC LEME OPEN FILE REPORT 11**

September 1998

(CSIRO Division of Exploration Geoscience Report 32R, 1989.  
Second impression 1998)

CRC LEME is an unincorporated joint venture between The Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining, established and supported under the Australian Government's Cooperative Research Centres Program.







Australian Mineral Industries Research Association Limited ACN 004 448 266



**CRCLEME**

Cooperative Research Centre for  
Landscape Evolution & Mineral Exploration



# **MINERALOGY AND GEOCHEMISTRY OF WEATHERED SHALE PROFILES AT THE PANGLO GOLD DEPOSIT, EASTERN GOLDFIELDS, WESTERN AUSTRALIA**

*K.M. Scott*

**CRC LEME OPEN FILE REPORT 11**

September 1998

(CSIRO Division of Exploration Geoscience Report 32R, 1989.  
Second impression 1998)

© CSIRO 1989

## RESEARCH ARISING FROM CSIRO/AMIRA REGOLITH GEOCHEMISTRY PROJECTS 1987-1993

In 1987, CSIRO commenced a series of multi-client research projects in regolith geology and geochemistry which were sponsored by companies in the Australian mining industry, through the Australian Mineral Industries Research Association Limited (AMIRA). The initial research program, "Exploration for concealed gold deposits, Yilgarn Block, Western Australia" (1987-1993) had the aim of developing improved geological, geochemical and geophysical methods for mineral exploration that would facilitate the location of blind, buried or deeply weathered gold deposits. The program included the following projects:

**P240: Laterite geochemistry for detecting concealed mineral deposits (1987-1991).** Leader: Dr R.E. Smith.  
Its scope was development of methods for sampling and interpretation of multi-element laterite geochemistry data and application of multi-element techniques to gold and polymetallic mineral exploration in weathered terrain. The project emphasised viewing laterite geochemical dispersion patterns in their regolith-landform context at local and district scales. It was supported by 30 companies.

**P241: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1987-1991).** Leader: Dr C.R.M. Butt.

The project investigated the distribution of ore and indicator elements in the regolith. It included studies of the mineralogical and geochemical characteristics of weathered ore deposits and wall rocks, and the chemical controls on element dispersion and concentration during regolith evolution. This was to increase the effectiveness of geochemical exploration in weathered terrain through improved understanding of weathering processes. It was supported by 26 companies.

These projects represented "an opportunity for the mineral industry to participate in a multi-disciplinary program of geoscience research aimed at developing new geological, geochemical and geophysical methods for exploration in deeply weathered Archaean terrains". This initiative recognised the unique opportunities, created by exploration and open-cut mining, to conduct detailed studies of the weathered zone, with particular emphasis on the near-surface expression of gold mineralisation. The skills of existing and specially recruited research staff from the Floreat Park and North Ryde laboratories (of the then Divisions of Minerals and Geochemistry, and Mineral Physics and Mineralogy, subsequently Exploration Geoscience and later Exploration and Mining) were integrated to form a task force with expertise in geology, mineralogy, geochemistry and geophysics. Several staff participated in more than one project. Following completion of the original projects, two continuation projects were developed.

**P240A: Geochemical exploration in complex lateritic environments of the Yilgarn Craton, Western Australia (1991-1993).** Leaders: Drs R.E. Smith and R.R. Anand.

The approach of viewing geochemical dispersion within a well-controlled and well-understood regolith-landform and bedrock framework at detailed and district scales continued. In this extension, focus was particularly on areas of transported cover and on more complex lateritic environments typified by the Kalgoorlie regional study. This was supported by 17 companies.

**P241A: Gold and associated elements in the regolith - dispersion processes and implications for exploration.** Leader: Dr. C.R.M. Butt.

The significance of gold mobilisation under present-day conditions, particularly the important relationship with pedogenic carbonate, was investigated further. In addition, attention was focussed on the recognition of primary lithologies from their weathered equivalents. This project was supported by 14 companies.

Although the confidentiality periods of the research reports have expired, the last in December 1994, they have not been made public until now. Publishing the reports through the CRC LEME Report Series is seen as an appropriate means of doing this. By making available the results of the research and the authors' interpretations, it is hoped that the reports will provide source data for future research and be useful for teaching. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authorisation to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian Mineral Industry.

This report (CRC LEME Open File Report 11) is a first revision of CSIRO, Division of Exploration Geoscience Restricted Report 032R, first issued in 1989, which formed part of the CSIRO/AMIRA Project P241.

**Copies of this publication can be obtained from:**

The Publication Officer, CRC LEME, CSIRO Exploration and Mining, PMB, Wembley, WA 6014, Australia. Information on other publications in this series may be obtained from the above or from <http://leme.anu.edu.au/>

**Bibliographic reference:**

This publication should be referred to as Scott, K.M., 1998. Mineralogy and geochemistry of weathered shale profiles at the Panglo Gold Deposit, Eastern Goldfields, WA. Open File Report 11, Cooperative Research Centre for Landscape Evolution and Mineral Exploration, Perth, Australia.

**Cataloguing-in-Publication:**

Scott, K.M.

Mineralogy and geochemistry of weathered shale profiles at the Panglo Gold Deposit, Eastern Goldfields, WA

ISBN 0 642 28242 0

1. Geochemistry 2. Mineralogy 3. Weathering - Western Australia.

I. Title

CRC LEME Open File Report 11.

ISSN 1329-4768

## PREFACE

The CSIRO-AMIRA project "Exploration for Concealed Gold Deposits, Yilgarn Block, Western Australia" has as its overall aim the development of improved geological, geochemical and geophysical methods for mineral exploration that will facilitate the location of blind, concealed or deeply weathered gold deposits.

This Report presents results of research conducted as part of Module 2 of this project (AMIRA Project 241): "Gold and Associated Elements in the Regolith - Dispersion Processes and Implications for Exploration".

The objectives of this module are:

- i. To obtain a better understanding of the nature and genesis of lateritic and supergene gold deposits.
- ii. To determine characteristics useful for exploration, especially in areas of transported overburden for: a) further lateritic and supergene deposits, and b) primary mineralization - including that with no expression as appreciable secondary mineralization.
- iii. To increase knowledge of the properties and genesis of the regolith.
- iv. To provide data applicable for exploration for other commodities in and beneath the regolith.

In particular this report (a) documents geochemical and mineralogical associations of gold present in weathered shales in the Eastern Goldfields by comparing mineralized and barren profiles, (b) suggests several pathfinders for Au in that environment.

## Table of Contents

SUMMARY	Page
1. INTRODUCTION	1
2. SAMPLING PROCEDURE	1
3. ANALYSIS	1
4. RESULTS	2
4.1 Mineralogy of barren holes	2
4.2 Mineralogy of mineralized holes	3
4.3 Geochemistry of PSRC 340 and PSRC 342	3
5. DISCUSSION	4
6. CONCLUSIONS	7
7. RECOMMENDATIONS FOR FUTURE WORK	7
8. ACKNOWLEDGEMENTS	8
9. REFERENCES	8

## LIST OF TABLES

Table 1	Chemical composition of samples, drill hole PSRC 340
Table 2	Chemical composition of samples, drill hole PSRC 342
Table 3	Average values for zones (and mineralized sub-zones), PSRC 340
Table 4	Average values for zones (and mineralized sub-zones), PSRC 342

## LIST OF FIGURES

Figure 1	Plan of mineralization at Panglo (after mapping by Pancontinental Mining Ltd)
Figure 2	Mineralogical profile through the barren hole PSRC 110
Figure 3	Mineralogical profile through the barren hole PSRC 340
Figure 4	Mineralogical profile through the mineralized hole PSRC 111
Figure 5	Mineralogical profile through the mineralized hole PSRC 342
Figure 6	Mineralogical zonation along section 4200N

## SUMMARY

Profiles through weathered shale derived from reverse circulation drill holes at Panglo have been analysed mineralogically by X-ray diffractometry. Quartz, muscovite, kaolinite, Fe oxides and halite are ubiquitous through such profiles but zones characterized by the presence of alunite or paragonite or the carbonates, siderite and dolomite, may be usefully employed during exploration. In weathered shale at Panglo alunite appears to be developed to a greater depth above mineralization whereas paragonite occurs to higher levels in barren sequences. Carbonates occur between the mineralized intervals in one hole and may represent original hypogene wall-rock alteration.

Molybdenum and Sb are the best pathfinders for Au with As, Tl and W also useful in specific cases. Elements like Ag, Cu, Pb, Sn and Zn are not consistently associated with the mineralization in the weathered shales at Panglo. The low Sr contents through the profile above mineralization may also be an indicator of mineralization.

## 1. INTRODUCTION

The Panglo gold deposit occurs 30km N of Kalgoorlie and 5km SE of Paddington. It is a new discovery made by Pancontinental Mining Ltd with reserves of 1m tonnes at 3.6 g/t Au. Because of the large amount of systematic drilling done to define the deposit and the fact that both mafic volcanics and black shales are present in the deposit, it was chosen as one of the study areas for AMIRA Project 241 (Gold and associated elements in the regolith-dispersion processes and implications for exploration). This report details the initial results from the study of holes through barren and mineralized shale. Subsequent reports will consider results from the study of the basic volcanics.

## 2. SAMPLING PROCEDURE

Reverse circulation drill holes from along the 3900N, 4200N and 5500N sections were chosen for study, mainly on the basis of whether they remained in a particular rock type for their whole length. Some holes which contained several rock types were also selected because their critical locations. Using these criteria 13 reverse circulation drill holes were sampled, namely PSRC 238, 239 on line 3900N, PSRC 75, 110, 111, 230, 231, 340, 342, 344 on line 4200N and PSRC 148, 149, 151 on line 5500N. All of these holes were drilled at 60°E and in subsequent discussion the distances along these holes are quoted rather than actual depth below the surface. The 3900N and 4200N lines pass through mineralization (Fig. 1) but the 5500N line occurs 800m north of economic mineralization.

To enable a quick generation of results, powder samples which had been prepared and assayed by Pancontinental Mining Ltd were used for this study. These were subsamples of 1m composites, generally taken every 2m down a drill hole, with complete sampling about a mineralized interval.

## 3. ANALYSIS

128 samples of shale were available from drill holes PSRC 110, 111, 340 and 342. These were analysed mineralogically using an X-ray powder diffractometer with a scanning speed of  $1/2^\circ 2\theta/\text{min}$ , copper radiation and a graphite-crystal monochromator. With each centimetre on the diffractogram

equivalent to  $1^{\circ}20'$ , resolution of the characteristic peaks of major and minor mineral components was accomplished. Abundances of the mineral phases present were estimated from the peak heights of a diagnostic peak of each mineral. Because matrices of each sample are similar (dominantly quartz, kaolinite and muscovite), the relative abundances of each specific mineral can be semiquantitatively determined through the weathered profile.

Using these results 43 samples from the mineralized hole PSRC 342 and 34 from the barren hole PSRC 340 were selected for chemical analysis. The major elements (except Na) were analysed by X-ray fluorescence spectrometry. Sodium, Ba, Co, Cr, Cu, Ni, Pb, Sc, Sr, Y and Zn were determined by inductively coupled plasma emission spectrometry. Semiquantitative optical emission spectrography was used for Ag, As, Bi, Ga, Ge, Mo, Sb, Sn, Tl and W. Gold values used are those originally determined during assaying of the holes.

#### 4. RESULTS

##### 4.1 Mineralogy of barren holes

The mineralogy down the barren holes PSRC 110 and 340 is shown in Figs. 2 and 3 respectively.

Five distinct zones are obvious in PSRC 110. (a) The upper 20m is characterized by the presence of alunite in quartz, kaolinite, muscovite, halite and Fe oxide assemblages. Goethite is particularly well developed in the initial 6m. (b) Between 21 and 28m an intermediate zone characterized by quartz, kaolinite muscovite, halite and goethite exists. (c) Below 29m and to 42 the assemblages are essentially the same except paragonite also occurs. (NOTE: The paragonite identification is based on the similarity of its X-ray diffraction pattern with that for paragonite from elsewhere in the Yilgarn Block but verification by electron microprobe work is needed.) (d) Between 43 and 55m the mineralogy is as in the intermediate zone (e) At the base of the hole, between 56 and 65m, halite and chlorite are better developed than elsewhere. Quartz, kaolinite, muscovite and goethite  $\pm$  hematite are also associated.



In PSRC 340 four zones are obvious. (a) The upper 12m are characterized by alunite (and/or natroalunite). Quartz, kaolinite, muscovite, halite and goethite  $\pm$  hematite accompany the alunite minerals (b) The interval between 13 and 40m is characterized by paragonite and goethite more abundant than hematite. Mixed-layer clays are also well developed in this zone. (c) Between 40 and 56m the mineralogy is characterized by more abundant hematite and the general absence of paragonite. (d) At the base of the hole (56-60m) halite is more abundant than higher in the profile, goethite again becomes the dominant Fe oxide and mixed-layer clays are not developed.

#### 4.2 Mineralogy of mineralized holes

Only the top 36m were available for sampling in PSRC 111 and so the mineralized interval was not sampled. However that portion of the hole available does give some information of zonation with depth. (a) The top 27m are characterized by alunite, with goethite rather than hematite in the initial 5m. (b) Between 27 and 34m kaolinite is well developed and Fe oxides are less abundant. (c) Paragonite is present between 35 and 36m but whether this is the top of the paragonite zone cannot be answered at this time.

In PSRC 342 four zones are present. (a) The top 29m are characterized by alunite and/or natroalunite. Goethite is the dominant Fe oxide in this zone. The top 6m where kaolinite is so dominant forms a distinctive sub-zone. (b) Between 30 and 43 the mineralogical assemblages are essentially similar to those above except for the absence of alunite-type minerals. (c) From 43 to 53 the carbonates, dolomite and siderite, and halite dominate the rocks with Fe oxides almost entirely absent. Paragonite also becomes a significant component in the lower portion of this zone. (d) Below the carbonate zone from 53-60m, Fe oxides are again present and chlorite and paragonite are also developed. Halite remains abundant.

#### 4.3 Geochemistry of PSRC 340 and PSRC 342

The compositions of the samples from the drill holes PSRC 340 and PSRC 342 are shown in Tables 1 and 2 with average values for the

mineralogically defined zones in Tables 3 and 4. (Mineralized samples within a particular zone are considered separately in these tables).

In the barren hole (PSRC 340) the alunite zone is characterized by its high  $\text{SO}_3$  and relatively high Cu content (Table 3). The underlying paragonite zone has high Na, Y and Zn contents with a mineralized subzone having elevated As, Au, Cr, Ga and Ni relative to barren equivalents. These upper two zones have significantly higher Sr and lower Fe, Mg Ti and Cr than the lower zones. In the underlying hematite-rich zone Ga is also abundant. The basal halite/goethite zone is slightly mineralized being characterized by elevated Ag, As, Au and Mo contents.

In the mineralized hole (PSRC 342), the kaolinite subzone has high Al, Fe, Ti, As, Cr, Ga, Ni, Sc and W whereas its parent alunite zone has high  $\text{SO}_3$  and As contents. The underlying mica/kaolinite zone has high K, Ag, As, Ba, Cr, Cu and Pb and its mineralized subzone elevated Ag, Au, Mo, Ni, Sb, Sn, Tl, Y, Zn and Zr relative to unmineralized samples. Carbonate-rich samples have high Mg, Ca, Co, Ni, Sn, Sr, Tl, Y and Zn and low Si and As. The basal paragonite zone is characterized by high Na and Sr and low K with its mineralized subzone having elevated Au, Mo and Sb contents.

## 5. DISCUSSION

Zonation within the section provided by the four drill holes shows a consistent development of an upper alunite zone and an underlying paragonite zone with, in some cases, an intermediate muscovite/kaolinite/Fe oxide zone (Fig. 6). Similar muscovite/kaolinite/Fe oxide zones are developed below the paragonite zone in the barren holes PSRC 110 and 340. Abundant halite is present in the basal portions of the holes with such development being most extensive in the mineralized hole (PSRC 342). The carbonates, dolomite and siderite, are also present in this hole between the two mineralized zones (Fig. 6).

Alunite appears to occur down to greater depths above mineralization whereas paragonite occurs to shallower depths in barren holes (Fig. 6). Thus their vertical distributions may give some indication of the presence of underlying mineralization. Furthermore carbonate alteration is commonly associated with the W.A. Archaean gold deposits (e.g. Groves &

Phillips, 1987) so that its presence between two mineralized zones could reflect residual hypogene alteration in PSRC 342.

These significant zones can also be recognised chemically - alunite by  $\text{SO}_3$  contents and paragonite by elevated Na contents (although the high halite content in all the samples does make this recognition difficult). The dolomite/siderite zone is made conspicuous by its grey-black colour in the midst of lighter coloured rock and  $\text{CO}_2$  determinations or high Mg or Ca contents readily identify it as carbonate-bearing. In the field it should also be recognized by acid-treatment of samples.

Chemical analyses show that Fe is enriched toward the surface in the mineralized hole but depleted with proximity to the surface in the unmineralized hole (Tables 3 and 4). The elements As, Cr, Sc and W tend to follow this Fe distribution with Sr varying inversely (Tables 3 and 4). Indeed As is enriched five times, Cr up to three times, Sc twice and W up to twice whilst Sr is depleted five times in the top 40m of the mineralized hole relative to the unmineralized hole.

The significance of the massive enrichment in Al, Ti and Ga in the kaolinite rich sub-zone in the top 6m of PSRC 342 but not in PSRC 111 is not known but it may be due to that portion of the hole in PSRC 342 being at the contact between shale and volcanics (Fig. 6).

The presence of highly silicified samples (50489, 50501, 50503) in the alunite zone of PSRC 342 but not PSRC 340 also deserves comment. These samples have higher Si and lower Al, Ti, Ba, Sc, Sr and Zr than adjacent samples (Table 2). However, the drill logs do not indicate an increased abundance of quartz veins so that the "silicification" may be pervasive at these horizons (11-12 and 23-25 m) or it may simply reflect derivation from more siliceous rocks within the shale sequences.

The elements Ag, As, Cu, Mo, Pb, Sb, Sn, Ti, W and Zn are commonly used as pathfinders for Au (Boyle, 1974). Thus their association with Au in the black shales at Panglo is briefly assessed below.

Ag shows an association with Au in main mineralized zone between 40 and 43 m in PSRC 342 (Table 4). However it shows no association at 57-60m in the same hole. The association with Au is also weak when the Au grade is low as in the mineralized zones in PSRC 340 (Table 3).

As is generally elevated above 43m in the mineralized hole but is not strongly associated with the lower mineralization in the same hole (Table 4). It is weakly enhanced with the low grade mineralization in PSRC 340 but, as seen above, As distribution is related mainly to Fe content.

Cu occurs in substantial amounts in the muscovite/kaolinite zone, including the mineralized sub-zone, in PSRC 342 (Table 4). In PSRC 340, Cu contents are slightly elevated in poorly mineralized zones (Table 3) but as such abundances are well less than those recorded through the length of PSRC 342 they are not particularly useful.

Mo occurs with both high and low grade mineralization at both levels in the holes (Tables 3 and 4).

Pb is enriched in the muscovite/kaolinite and underlying carbonate zones in PSRC 342 but does not appear to be directly related to Au.

Sb occurs with mineralization at both levels in PSRC 342 (Table 4) but with the high limit of detection for the determinations it is not seen at all in the lower grade intersections in PSRC 340 (Table 3).

Sn is present with Au in the upper mineralized zone in PSRC 342. It is also enriched in the samples from 10m away in either direction (Table 4). However it is not associated with Au in the other mineralized zones.

Tl becomes abundant below 40m in PSRC 342, there it occurs with the two Au zones and in the intervening rocks (Table 4).

W is abundant above ore in PSRC 342 (Table 4) and the mineralized intervals in PSRC 340 also show elevated W contents.

Zn occurs mainly with the carbonate zone (?within siderite) but also appears to be enhanced in the upper mineralized zone in PSRC 342 (Table 4).

The differing behaviour of elements (like As) between mineralized and poorly mineralized (barren) sequences suggests that the composition of the rocks was different prior to weathering and/or weathering has affected the rocks differently. Thus distinguishing pathfinder elements suitable for these rocks is difficult at this time when the reasons for the distributions of the elements are poorly understood. However Mo and Sb do seem to be consistently developed with Au and the elevated Fe, As and W



above the main mineralization in PSRC 342 may also be indicative underlying Au. The persistence of Tl from the upper mineralized zone through the intervening rocks to the lower mineralized zone in PSRC also make Tl potentially useful.

## 6. CONCLUSIONS

Alunite appears to be developed to a greater depth above mineralization whereas paragonite occurs higher in the profile in barren sequences. Siderite and dolomite are present between the mineralized interval in drill hole PSRC 342. These minerals characterize zones which can be distinguished from the muscovite/kaolinite/Fe oxide zones on the basis of mineralogy on chemistry.

Of the potential pathfinder elements for Au, only Mo and Sb are consistently developed. Nevertheless the presence of As and W and absence of Sr with Fe above mineralization and the occurrence of Tl with ore grade mineralization and in the interval between Au zones make these elements potentially useful too.

## 7. RECOMMENDATIONS FOR FUTURE WORK

- (1) Extension of the sampling from PSRC 111 and sampling of PSRC 341 and 112 is required to confirm the significance of the mineralogical zonation trends reported above.
- (2) Examination of barren hole(s) through shale to the north of the mineralization where anomalous As occurs may also help explain the effect of weathering on As.
- (3) Samples of unweathered shale could also help resolve questions about the sources (e.g. pyrite) for some of the elements seen within the weathered profile.
- (4) Fragments from paragonite-bearing sequences are required to confirm the X-ray diffraction identification of this mineral.

(5) Comparison of the zones within the shales with those within the mafic volcanics may also help resolve whether alteration and/or weathering is responsible for certain mineralogical/chemical features.

(6) Textural studies to relate features seen in reverse circulation drilling fragments to the mineralogical/chemical zones should also be done to determine whether such zones can be identified in the field or only by laboratory study.

#### 8. ACKNOWLEDGEMENTS

The management of the Exploration Division of Pancontinental Mining Ltd. (especially Doug Currie) is thanked for a willingness to provide pulped samples, logs and plans of the Panglo deposit. In particular the ready assistance of Bob Howard (Project Geologist - Panglo) in advising of the best sections to sample and organizing that sampling is acknowledged.

X-ray diffractograms were run by A.R. Horne. Chemical analyses were performed by L.E. Dotter, H.R. Han, H. Orban, A. Martinez and N.C. Morgan all of the North Ryde laboratories of the CSIRO Institute of Minerals, Energy and Construction.

#### 9. REFERENCES

- Boyle, R.W., 1974. Elemental associations in mineral deposits and indicator elements of interest in geochemical prospecting (revised). Geol. Surv. Canada Paper 74-45 (40pp).
- Groves, D.I. and Phillips, G.N., 1987. The genesis and tectonic control on Archaean gold deposits of the Western Australian Shield - a metamorphic replacement model. Ore Geology Reviews 2: 287-322.

## PANGLO SECTION 4200N (EAST)

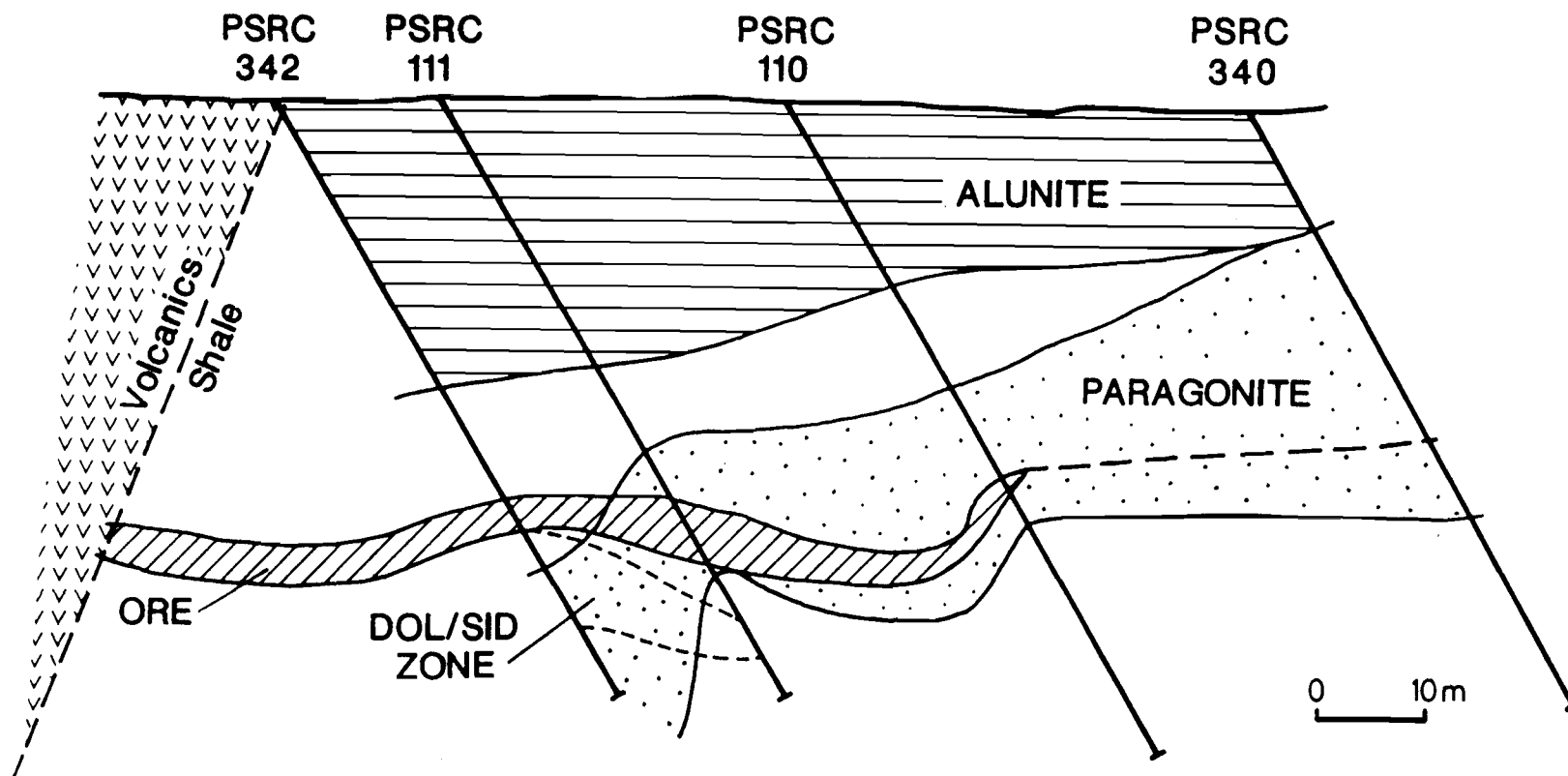


Fig. 6 Mineralogical zonation along Section 4200N

Table 1. Chemical composition of samples, drill hole PSRC 340 (majors, wt%, minors, ppm)

Depth (m)	50353 1-2	50355 3-4	50357 5-6	50359 7-8	50361 9-10	50363 11-12	50365 13-14	50367 15-16	50369 17-18	50371 19-20	50373 21-22	50375 23-24	50377 24-25	50379 26-27	50381 28-29	50383 30-31	50385 32-33	50387 34-35
SiO <sub>2</sub>	72.4	70.3	66.2	66.0	64.3	63.3	65.3	69.3	67.9	68.1	68.1	68.0	67.8	66.6	66.1	68.5	67.6	63.4
Al <sub>2</sub> O <sub>3</sub>	14.5	15.3	17.4	16.9	18.7	21.2	19.2	16.9	19.2	19.3	18.8	18.9	18.9	18.3	17.4	18.9	19.7	18.7
Fe <sub>2</sub> O <sub>3</sub>	2.63	2.19	2.12	2.62	2.69	3.11	4.91	3.97	3.52	3.33	3.43	3.04	3.42	4.68	6.34	2.12	2.11	7.45
MgO	0.23	0.27	0.14	0.17	0.20	0.20	0.11	<0.1	0.12	<0.1	<0.1	0.12	0.10	0.10	0.11	<0.1	0.15	0.20
CaO	0.06	0.06	<0.04															
Na <sub>2</sub> O	0.71	1.14	1.06	1.04	1.06	1.60	1.60	1.33	1.63	1.51	1.40	1.40	1.48	1.68	1.54	1.50	1.63	1.32
K <sub>2</sub> O	2.63	2.65	2.77	2.51	2.82	2.75	2.22	1.84	2.28	2.28	2.08	2.25	2.13	2.11	1.94	2.32	2.75	2.71
TiO <sub>2</sub>	0.49	0.48	0.49	0.41	0.50	0.64	0.53	0.46	0.52	0.55	0.54	0.50	0.51	0.50	0.48	0.52	0.53	0.49
P <sub>2</sub> O <sub>5</sub>	<0.1																	
MnO	<0.04																	
SO <sub>3</sub>	0.89	1.77	2.77	3.46	2.08	0.41	0.13	0.16	0.11	<0.1								
Ag	<0.1	0.8	0.2	0.2	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
As	<100													150	200	100	100	200
Au	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	<0.01	<0.01	0.01	<0.01	0.03	0.02	0.29	1.65	0.28
Ba	750	660	600	450	590	570	490	420	500	500	500	550	540	490	430	480	550	600
Bi	<3																	
Co	<5																	11
Cr	100	52	83	80	70	170	240	150	240	190	210	130	140	230	140	190	180	240
Cu	21	32	59	85	67	30	9	34	29	15	28	15	19	47	46	27	31	69
Ga	25	20	20	20	20	25	20	20	25	30	30	25	30	30	20	25	25	30
Ge	<1					1	1	<1	<1	1	<1	1	1	1	<1	1	<1	1
Mo	8	15	10	20	8	6	5	8	5	7	6	6	6	7	8	4	4	20
Ni	<20	<20	28	<20	23	46	28	40	44	<20	38	36	32	33	38	32	<20	95
Pb	<50																	
Sb	<30																	
Sc	7	7	11	22	18	16	17	14	14	24	18	16	20	18	17	19	23	20
Sn	1	2	2	1	2	3	3	2	3	2	3	2	2	2	2	2	2	3
Sr	130	160	190	200	210	330	320	240	320	270	230	240	260	280	260	280	300	250
W	<10																	30
Y	4	4	5	8	5	7	7	6	7	12	7	7	7	7	6	7	12	8
Zn	26	24	23	34	38	44	24	58	52	47	44	47	43	53	52	22	30	110
Zr	190	180	190	170	180	210	180	180	180	190	190	150	180	170	160	150	190	150



Table 1. (continued)

Depth (m)	50389 36-37	50391 38-39	50392 39-40	50393 40-41	50395 42-43	50397 44-45	50399 46-47	50401 48-49	50403 49-50	50405 51-52	50407 53-54	50409 55-56	50410 56-57	50411 57-58	50412 58-59	50413 59-60	
SiO <sub>2</sub>	64.4	63.7	62.7	60.7	49.8	59.7	59.4	67.0	66.0	64.8	61.3	64.0	66.6	65.4	63.9	72.3	
Al <sub>2</sub> O <sub>3</sub>	19.3	20.9	19.0	20.1	24.6	19.1	19.7	21.7	20.2	18.3	18.6	19.6	18.9	15.8	19.0	13.2	
Fe <sub>2</sub> O <sub>3</sub>	4.39	3.05	6.20	6.97	10.1	9.46	10.5	2.04	3.34	7.16	9.68	5.95	4.10	7.80	5.36	6.20	
MgO	0.20	0.22	0.19	0.19	0.24	0.25	0.23	0.30	0.26	0.27	0.23	0.33	0.31	0.29	0.30	0.24	
CaO	<0.04																
Na <sub>2</sub> O	1.18	1.28	1.12	1.14	1.14	1.22	1.09	1.08	1.18	1.14	1.21	1.55	1.41	1.36	1.29	0.96	
K <sub>2</sub> O	2.09	2.10	2.16	2.07	2.56	2.28	1.82	3.24	3.20	2.72	2.28	2.65	2.75	2.75	3.35	2.23	
TiO <sub>2</sub>	0.64	0.66	0.65	0.67	0.78	0.68	0.80	0.73	0.78	0.68	0.77	0.73	0.74	0.59	0.80	0.54	
P <sub>2</sub> O <sub>5</sub>	<0.1																
MnO	<0.04																
SO <sub>3</sub>	<0.1	0.13	<0.1	0.11	0.11	0.12	<0.1					0.11	0.12	0.13	0.12	0.10	<0.1
Ag	0.2	0.1	0.1	0.2	0.1	0.1	<0.1	0.1	0.1	0.1	0.3	0.2	0.8	0.8	2	0.8	
As	150	150	200	250	250	200	150	<100	<100	100	100	100	100	150	150	400	
Au	0.01	0.09	0.75	0.45	0.02	0.05	0.02	<0.01	0.01	0.05	0.10	0.18	0.69	0.09	0.90	0.84	
Ba	590	380	560	490	560	530	440	630	640	530	440	470	490	490	590	410	
Bi	<3																
Co	<5	15	<5														
Cr	220	240	330	340	160	280	270	130	410	390	350	280	330	270	340	260	
Cu	28	17	15	13	19	10	9	6	6	8	10	6	8	50	27	43	
Ga	30	30	40	50	50	40	40	30	40	40	30	25	30	25	25	20	
Ge	1	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	
Mo	20	25	15	10	15	10	15	10	10	8	8	10	6	40	8	20	
Ni	34	36	32	26	21	<20						56	27	26	40	31	
Pb	<50																
Sb	<30																
Sc	20	19	22	21	16	24	22	14	22	20	30	9	25	18	27	19	
Sn	3	3	3	3	3	3	2	2	4	2	3	3	4	3	3	2	
Sr	220	180	190	150	160	140	96	150	170	130	110	110	120	120	120	86	
W	<10	70	<10												50	25	40
Y	10	8	9	9	7	7	6	5	7	6	12	<1	7	6	8	9	
Zn	31	27	39	22	39	23	26	14	17	21	30	11	23	50	34	37	
Zr	160	200	170	160	210	170	200	150	170	160	160	130	150	140	150	100	

Table 2. Chemical composition of samples, drill hole PSRC 342 (majors, wt%, minors, ppm)

Depth (m)	50479 1-2	50481 3-4	50483 5-6	50485 7-8	50487 9-10	50489 11-12	50491 13-14	50493 15-16	50495 17-18	50497 19-20	50499 21-22	50501 23-24	50503 24-25	50505 26-27	50507 28-29	50509 30-31	50511 32-33	50513 34-35	50514 35-36
SiO <sub>2</sub>	45.3	40.8	40.0	59.2	55.0	81.2	46.1	66.2	71.8	70.6	68.5	78.5	81.1	70.2	73.7	72.1	68.0	59.6	65.4
Al <sub>2</sub> O <sub>3</sub>	34.7	29.5	28.7	13.3	22.7	10.7	17.2	16.6	16.4	17.1	19.0	9.95	8.53	15.8	15.0	13.1	14.3	16.6	17.2
Fe <sub>2</sub> O <sub>3</sub>	2.67	12.4	14.5	18.1	5.43	2.09	25.5	6.06	2.15	1.73	1.96	5.96	5.53	3.98	1.87	6.60	7.18	12.5	6.32
MgO	0.40	0.40	0.27	0.20	0.11	<0.1	0.28	0.20	0.44	0.65	0.78	0.21	0.13	0.68	0.46	0.44	0.49	0.62	0.49
CaO	<0.04																		
Na <sub>2</sub> O	0.73	1.00	0.84	0.59	0.93	0.59	0.53	0.79	0.71	0.59	0.54	0.35	0.33	0.44	0.61	0.54	0.58	0.69	0.64
K <sub>2</sub> O	4.72	3.75	2.19	1.60	1.97	1.03	1.79	1.83	3.28	4.26	4.23	1.54	1.24	5.01	4.29	3.61	3.47	4.16	3.32
TiO <sub>2</sub>	2.22	1.88	1.83	0.37	0.52	0.31	0.47	0.46	0.48	0.48	0.50	0.25	0.22	0.44	0.37	0.31	0.42	0.64	0.51
P <sub>2</sub> O <sub>5</sub>	<0.1																		
MnO	<0.04						0.04	<0.04				0.18	<0.04			0.04	0.29	0.05	0.29
SO <sub>3</sub>	<0.1	0.47	0.25	0.77	3.78	0.21	0.33	1.65	1.25	1.21	0.48	0.27	0.16	0.36	0.49	0.16	0.13	<0.1	<0.1
Ag	<0.1	0.1	0.1	<0.1					0.8	0.1	<0.1	0.1	0.1	0.1	0.2	0.2	3	0.5	1
As	400	700	600	400	1500	100	1500	200	<100	<100	<100	150	150	150	150	1000	1500	800	500
Au	0.01	0.01	0.02	0.02	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ba	530	420	250	220	510	140	240	280	330	360	330	210	190	440	510	440	590	580	690
Bi	<3																		
Co	5	7	10	<5								12	<5			3	<3		
Cr	360	330	310	210	210	75	210	95	60	63	53	55	79	96	120	83	140	1040	530
Cu	23	100	140	31	190	9	58	60	43	44	44	100	52	38	46	140	260	200	350
Ga	50	60	60	20	25	20	30	25	25	20	25	15	15	20	20	25	20	20	20
Ge	2	2	2	4	1	1	5	1	<1	1	2	2	2	3	3	4	4	4	3
Mo	6	4	5	7	10	15	10	8	10	6	10	5	6	10	8	15	10	8	7
Ni	<20	56	91	<20															
Pb	<50																		
Sb	<30																		
Sc	55	63	58	21	74	8	24	33	26	25	17	11	10	21	17	19	26	38	25
Sn	2	2	3	2	5	2	4	2	3	3	4	2	2	5	4	10	15	6	5
Sr	33	46	29	46	88	19	28	71	65	72	44	32	23	59	69	63	95	34	28
Tl	<3																		
W	15	25	25	10	60	20	20	30	<10	10	10	<10	<10	10	15	15	15	25	20
Y	11	13	14	4	5	3	6	7	5	4	5	3	2	5	5	8	8	5	4
Zn	50	170	160	33	33	14	130	74	38	33	30	98	150	45	26	130	120	95	62
Zr	140	120	120	120	120	68	130	140	110	120	150	72	62	110	110	100	96	85	89

Table 2. (Continued)

Depth (m)	50515 36-37	50516 37-38	50517 38-39	50518 39-40	50519 40-41	50520 41-42	50521 42-43	50522 43-44	50523 44-45	50524 45-46	50525 46-47	50528 47-48	50529 48-49	50530 49-50	50531 50-51	50532 51-52	50533 52-53	50534 53-54
SiO <sub>2</sub>	60.8	68.5	60.1	59.8	67.3	65.3	70.9	66.7	56.0	52.2	58.4	50.8	55.8	57.2	56.9	61.4	54.6	65.2
Al <sub>2</sub> O <sub>3</sub>	21.0	16.4	23.6	23.6	13.8	12.3	11.5	12.1	11.6	12.2	14.2	10.3	10.5	12.3	11.4	13.3	12.4	19.7
Fe <sub>2</sub> O <sub>3</sub>	5.95	3.94	3.34	3.35	8.85	10.8	1.03	2.81	6.21	6.52	4.55	6.75	7.24	4.89	4.97	2.78	7.23	3.66
MgO	0.38	0.44	0.39	0.39	0.45	0.60	0.78	1.30	3.48	4.33	2.70	5.05	3.96	2.98	3.40	2.47	3.74	0.23
CaO	<0.04							0.11	2.64	4.18	2.18	5.43	3.63	2.59	3.20	2.38	5.11	<0.04
Na <sub>2</sub> O	0.84	0.70	0.93	0.97	0.88	1.12	1.68	1.72	1.45	1.19	1.26	1.15	1.17	1.41	1.54	1.32	1.13	1.25
K <sub>2</sub> O	2.60	3.17	3.20	3.19	1.86	2.39	2.69	2.81	2.11	1.65	1.56	1.68	1.73	2.33	2.11	2.48	2.11	1.51
TiO <sub>2</sub>	0.66	0.57	0.77	0.78	0.36	0.48	0.81	0.79	0.57	0.49	0.53	0.47	0.41	0.62	0.59	0.56	0.57	0.57
P <sub>2</sub> O <sub>5</sub>	<0.1																	
MnO	<0.04	0.76	<0.04					0.27	0.40	0.17	0.08	0.11	0.12	0.08	0.09	<0.04		
SO <sub>3</sub>	<0.1					0.12	0.10	0.13	0.11	<0.1	0.10	0.11	<0.1				0.11	0.10
Ag	0.2	6	0.2	0.2	0.8	20	5	3	2	2	0.9	2	2	2	2	2	0.1	0.1
As	500	400	250	300	800	800	<100										900	200
Au	0.01	<0.01	<0.01	<0.01	1.52	2.70	0.26	0.10	0.12	0.16	0.06	0.16	0.12	0.08	0.13	0.06	0.09	0.01
Ba	380	900	490	500	310	440	500	510	350	290	280	280	270	380	370	400	360	240
Bi	<3						3	3	<3									
Co	7	300	<5	5	7	41	<5	110	160	88	49	60	63	50	48	24	19	6
Cr	130	250	130	120	82	96	120	110	100	80	76	89	57	90	94	88	120	63
Cu	80	250	99	99	300	220	39	22	40	32	31	44	38	48	47	23	160	41
Ga	25	20	25	50	30	25	30	30	20	20	25	20	25	40	40	50	40	30
Ge	5	4	3	4	7	4	5	3	3	3	4	4	4	4	4	5	7	6
Mo	6	8	5	8	10	15	5	25	6	4	7	6	6	4	5	6	10	6
Ni	<20	100	<20	<20	45	82	<20	54	98	66	69	64	65	48	45	23	32	<20
Pb	62	40	75	70	140	57	<50				57	100	78	75	75	61	66	<50
Sb	<30				30	70	<30										50	30
Sc	26	35	29	29	28	30	28	23	14	14	13	12	11	16	16	15	17	10
Sn	6	6	2	6	10	10	25	25	20	9	20	15	9	15	15	15	20	4
Sr	54	45	91	92	47	42	69	77	88	74	76	88	97	120	120	130	100	71
Tl	<3	<3	4	6	4	6	6	6	4	4	4	4	4	6	7	9	7	4
W	<10	25	<10															
Y	9	8	11	11	15	21	57	39	31	16	9	8	9	11	13	13	17	9
Zn	34	44	35	34	69	180	41	220	350	240	180	230	220	200	160	100	120	55
Zr	160	120	150	160	130	160	280	260	170	140	150	130	150	180	170	150	150	150

Table 2. (continued)

	50535	50536	50537	50538	50539	50540
Depth (m)	54-55	55-56	56-57	57-58	58-59	59-60
SiO <sub>2</sub>	64.2	63.4	63.8	61.9	63.4	64.5
Al <sub>2</sub> O <sub>3</sub>	21.3	22.5	20.1	19.2	22.2	21.5
Fe <sub>2</sub> O <sub>3</sub>	2.01	1.46	2.25	7.60	2.05	1.36
MgO	0.28	0.28	0.46	0.31	0.24	0.29
CaO	<0.04	<0.04	0.19	<0.04	→	
Na <sub>2</sub> O	1.40	1.54	1.79	1.27	1.01	1.46
K <sub>2</sub> O	1.85	1.94	1.99	1.49	2.02	2.14
TiO <sub>2</sub>	0.65	0.62	0.59	0.55	0.62	0.56
P <sub>2</sub> O <sub>5</sub>	<0.1	→				
MnO	<0.04	→				
SO <sub>3</sub>	0.12	0.14	0.15	0.12	<0.1	0.12
Ag	0.2	0.2	0.6	0.3	0.1	0.2
As	150	<100	150	250	100	100
Au	0.01	0.02	0.05	0.49	3.89	1.28
Ba	320	370	390	300	330	350
Bi	<3	→				
Co	<5	<5	8	16	<5	<5
Cr	71	60	85	78	88	51
Cu	52	20	45	66	25	39
Ga	40	30	30	30	40	40
Ge	4	3	3	3	3	4
Mo	5	7	6	25	10	8
Ni	<20	→		32	<20	<20
Pb	74	<50	54	56	<50	<50
Sb	<30	→		70	<30	<30
Sc	11	10	15	13	12	13
Sn	4	4	4	3	2	2
Sr	95	98	120	79	80	100
Tl	4	4	3	<3	4	4
W	<10	→				
Y	8	8	9	8	8	7
Zn	57	34	69	360	44	52
Zr	180	170	170	150	160	160



Table 3. Average values for zones (and mineralized sub-zones), PSRC 340  
(majors, wt%; minors, ppm)

Zone	Alunite	Paragonite	Paragonite (mineralized)	Hematite-rich	Halite/goethite
Depth (m)	0-12	13-39	30-41	42-56	56-60
SiO <sub>2</sub>	67.1	66.8	64.6	61.5	67.1
Al <sub>2</sub> O <sub>3</sub>	17.3	18.8	19.3	20.2	16.7
Fe <sub>2</sub> O <sub>3</sub>	2.56	4.01	4.97	7.28	5.87
MgO	0.20	0.11	0.16	0.26	0.29
CaO	<0.04	<0.04	<0.04	<0.04	<0.04
Na <sub>2</sub> O	1.10	1.46	1.34	1.20	1.26
K <sub>2</sub> O	2.69	2.12	2.40	2.59	2.77
TiO <sub>2</sub>	0.50	0.54	0.57	0.74	0.67
MnO	<0.04	<0.04	<0.04	<0.04	<0.04
SO <sub>3</sub>	1.90	<0.1	<0.1	<0.1	0.10
Ag	0.2	0.1	0.2	0.1	1.1
As	<100	<100	170	130	200
Au	0.01	0.02	0.68	0.05	0.63
Ba	600	510	540	530	500
Cr	93	190	260	280	300
Cu	49	26	31	9	32
Ga	22	26	34	37	25
Ge	<1	<1	1	2	1
Mo	11	9	11	11	19
Ni	21	34	39	<20	31
Sc	14	18	21	20	22
Sn	2	2	3	3	3
Sr	200	260	230	130	110
W	<10	<10	10	<10	30
Y	6	8	9	5	6
Zn	32	43	45	23	36
Zr	190	180	160	170	140

NOTE: Bi<3, Co<5, Pb<50, Sb<30, Tl<3 ppm.

Table 4. Average values for zones (and mineralized sub-zones), PSRC 342  
(majors, wt%, minors, ppm)

Zone Depth (m)	Kaolinite-rich 0-6	Alunite 7-29	Musc/Kaol 30-40	Musc/Kaol (min) 40-43	Carbonate 43-53	Paragonite 53-57	Paragonite (min) 57-60
SiO <sub>2</sub>	42.0	68.5	64.3	67.8	57.0	64.2	63.3
Al <sub>2</sub> O <sub>3</sub>	31.0	15.2	18.2	12.5	12.0	20.9	21.0
Fe <sub>2</sub> O <sub>3</sub>	9.86	6.70	6.15	6.89	5.40	2.35	3.67
MgO	0.36	0.35	0.46	0.61	3.34	0.31	0.28
CaO	<0.04	<0.04	<0.04	<0.04	3.15	0.06	<0.04
Na <sub>2</sub> O	0.86	0.58	0.74	1.23	1.33	1.50	1.25
K <sub>2</sub> O	3.55	2.67	3.34	2.31	2.06	1.82	1.88
TiO <sub>2</sub>	1.98	0.41	0.58	0.55	0.56	0.61	0.58
MnO	<0.04	<0.04	<0.04	<0.04	0.14	<0.04	<0.04
SO <sub>3</sub>	0.26	0.91	<0.1	<0.1	<0.1	0.13	<0.1
Ag	0.1	0.2	1.4	9	1.8	0.3	0.2
As	570	400	660	550	140	140	150
Au	0.01	<0.01	<0.01	1.5	0.11	0.02	1.9
Ba	400	310	570	420	350	330	330
Co	7	<5	49	17	67	5	7
Cr	330	110	300	99	90	70	72
Cu	88	60	190	190	49	40	43
Ga	57	22	26	28	31	33	37
Ge	2	2	4	5	4	4	3
Mo	5	9	8	10	8	6	14
Ni	52	<20	24	46	56	<20	<20
Pb	<50	<50	87	74	59	<50	<50
Sb	<30	<30	<30	38	<30	<30	33
Sc	59	24	28	29	15	12	13
Sn	2	3	7	15	16	4	2
Sr	36	39	63	53	97	96	86
Tl	<3	<3	<3	5	6	4	3
W	22	18	14	<10	<10	<10	<10
Y	13	5	8	31	17	9	8
Zn	130	59	69	97	200	54	150
Zr	130	110	120	190	170	170	160

NOTE: Bi <3 ppm

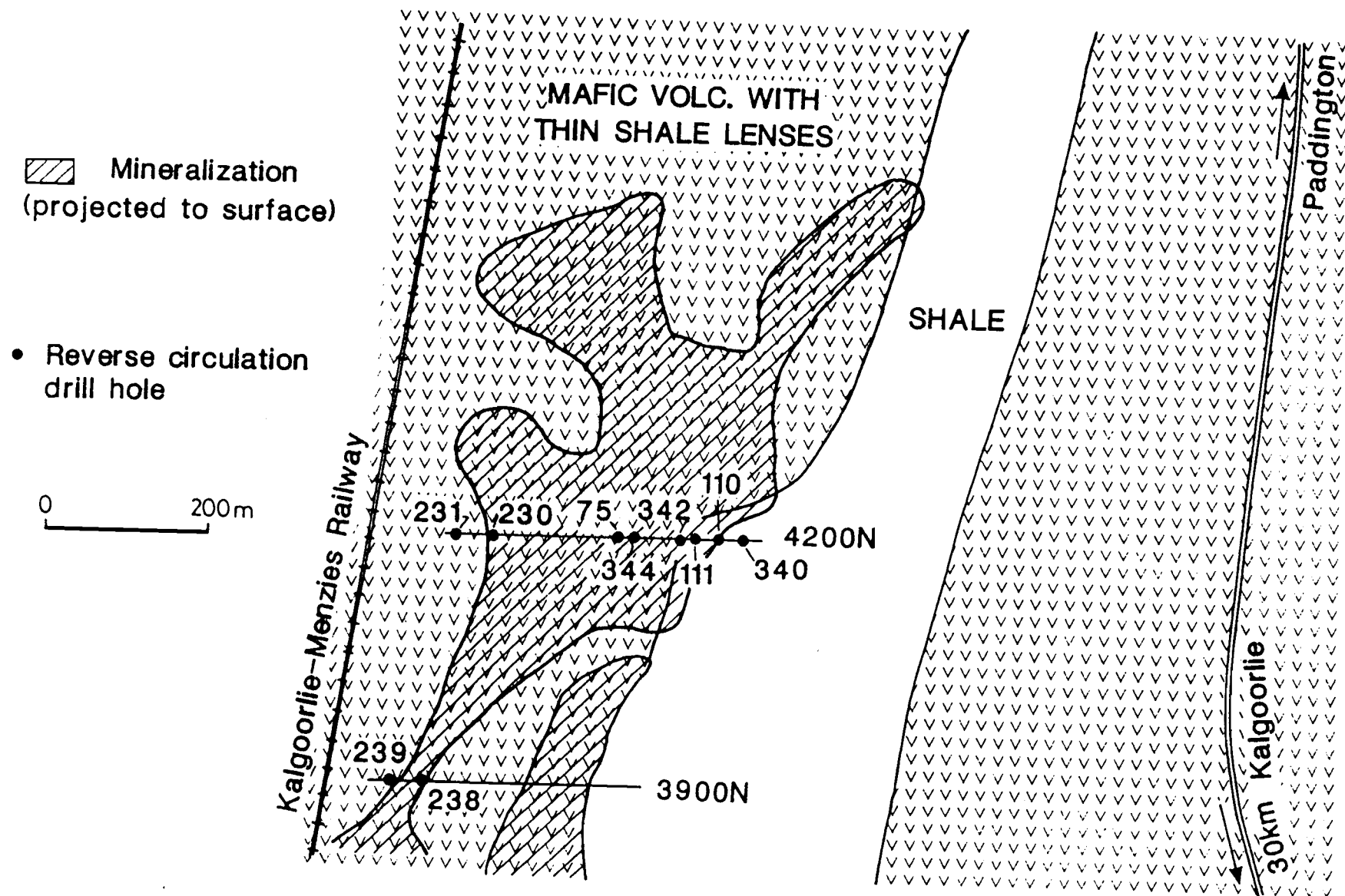


Fig. 1 Plan of mineralization at Panglo (after mapping by Pancontinental Mining Ltd).

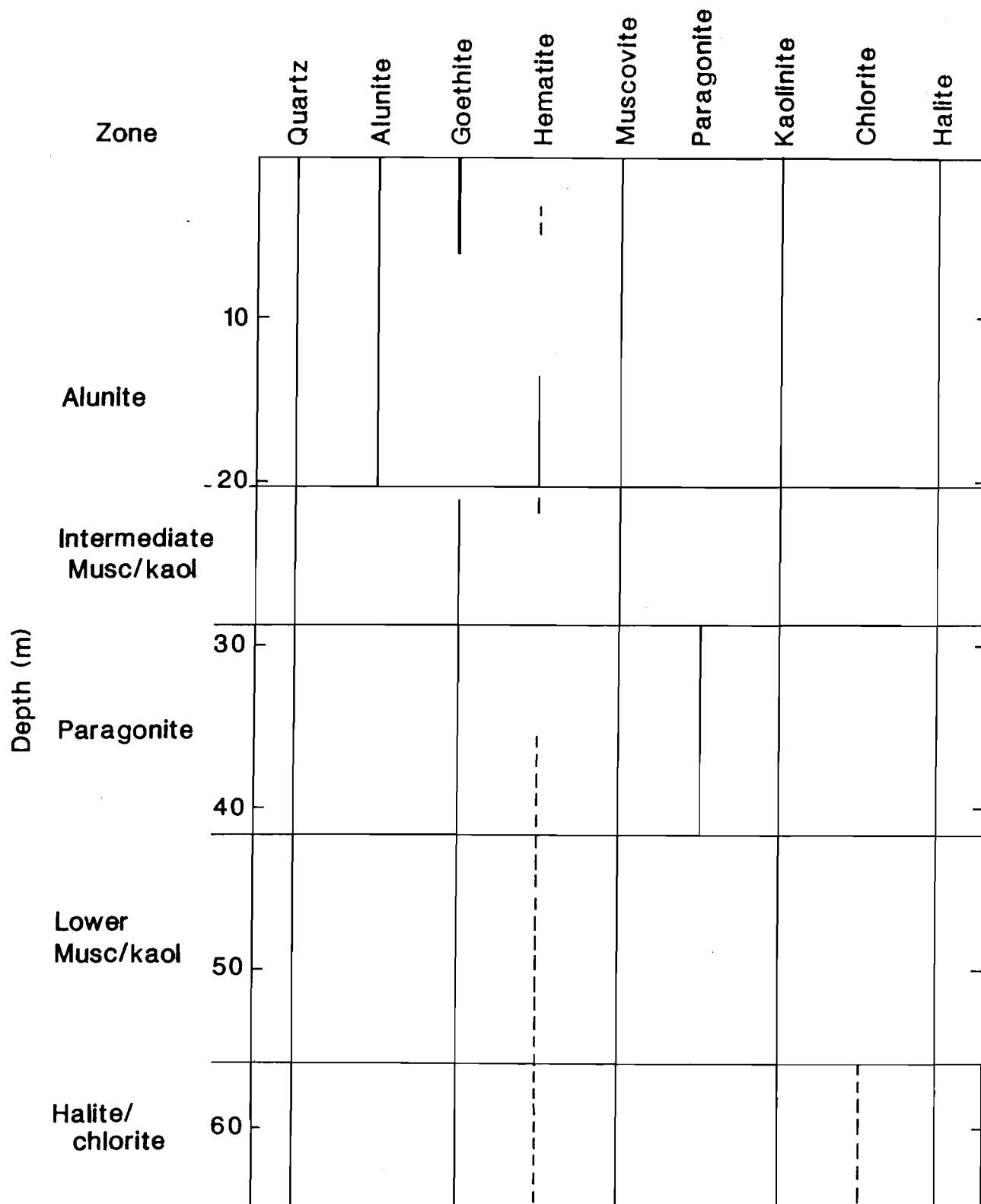


Fig. 2 Mineralogical profile through the barren hole PSRC 110

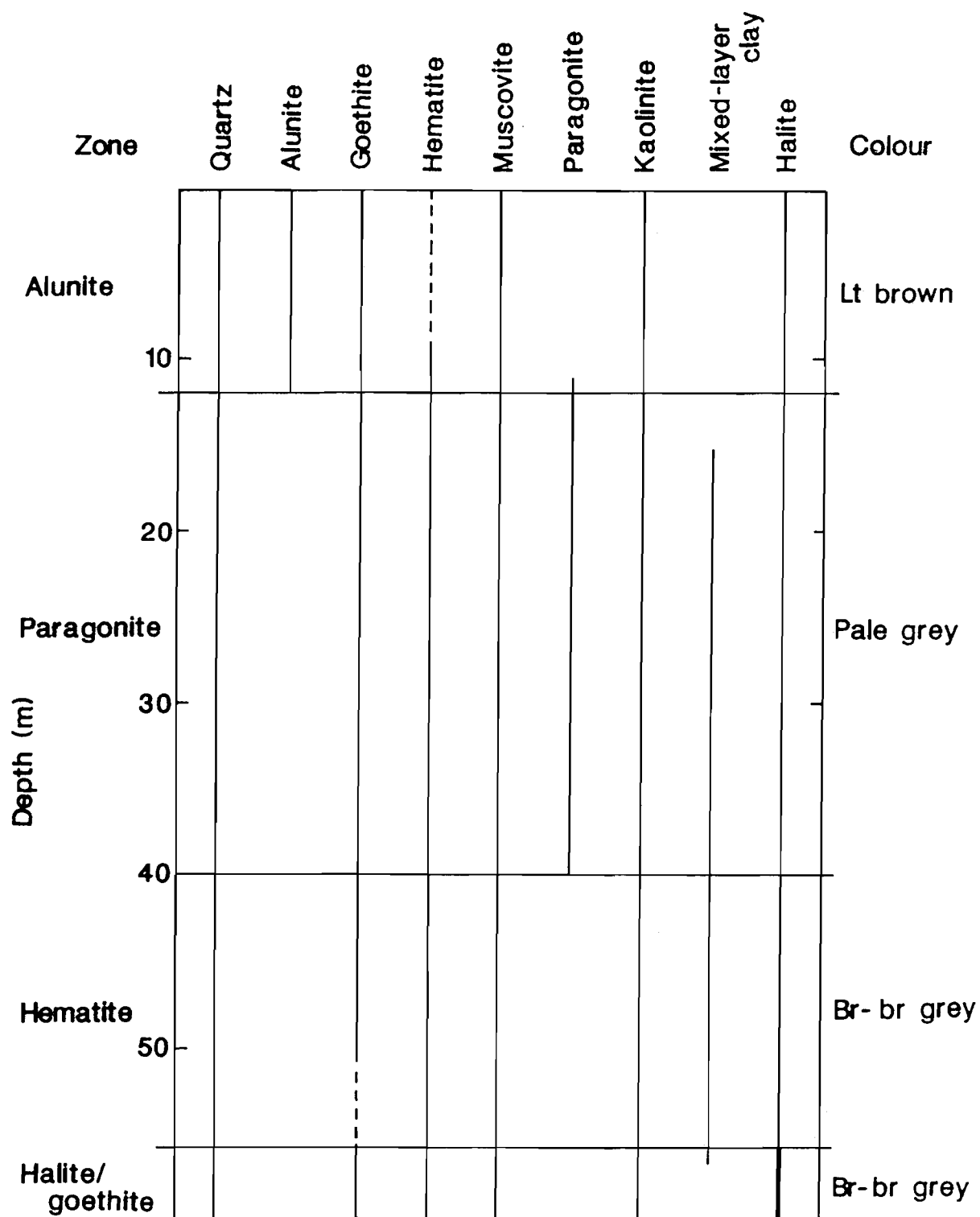


Fig. 3 Mineralogical profile through the barren hole PSRC 340

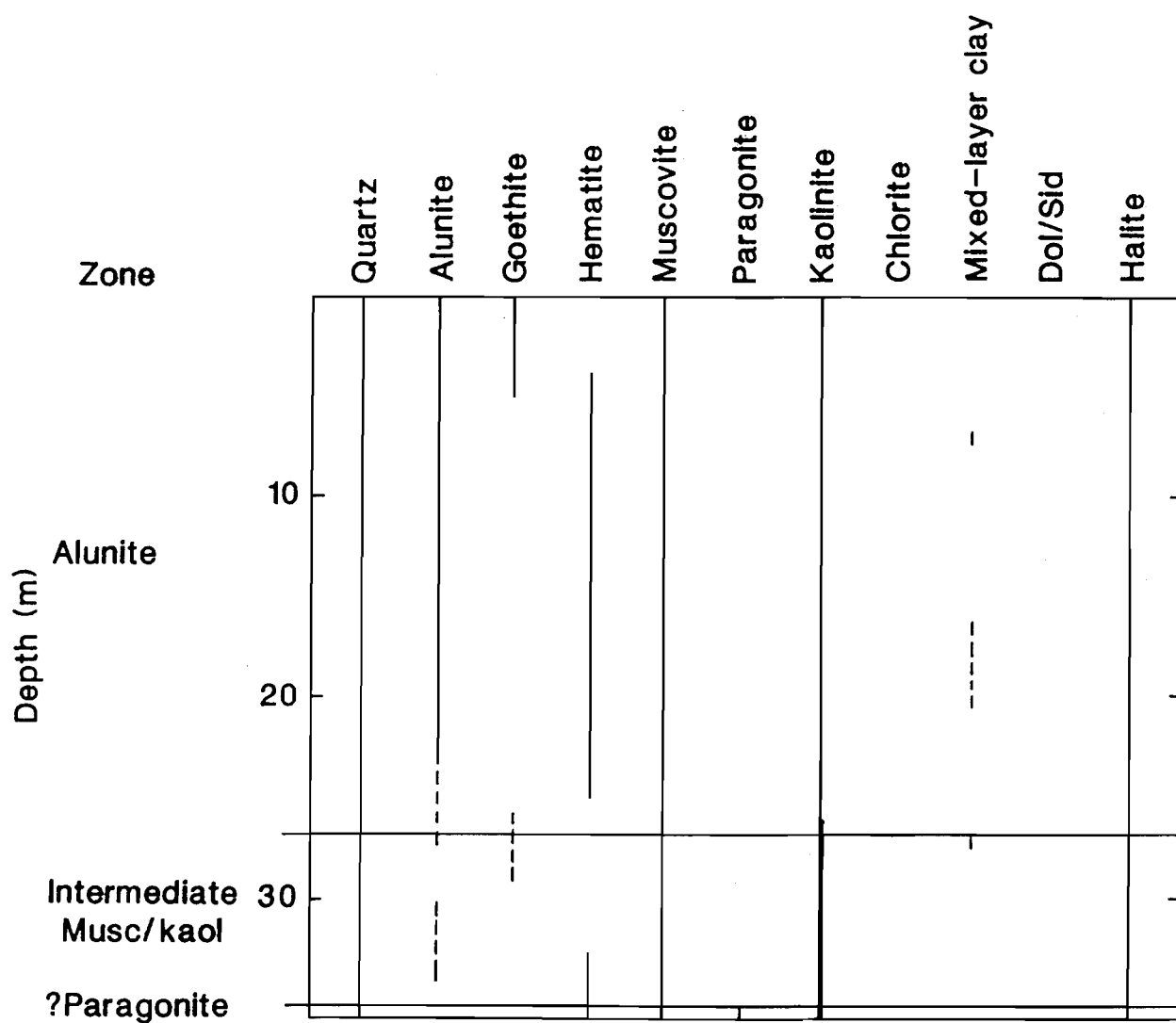


Fig. 4 Mineralogical profile through the mineralized hole PSRC 111



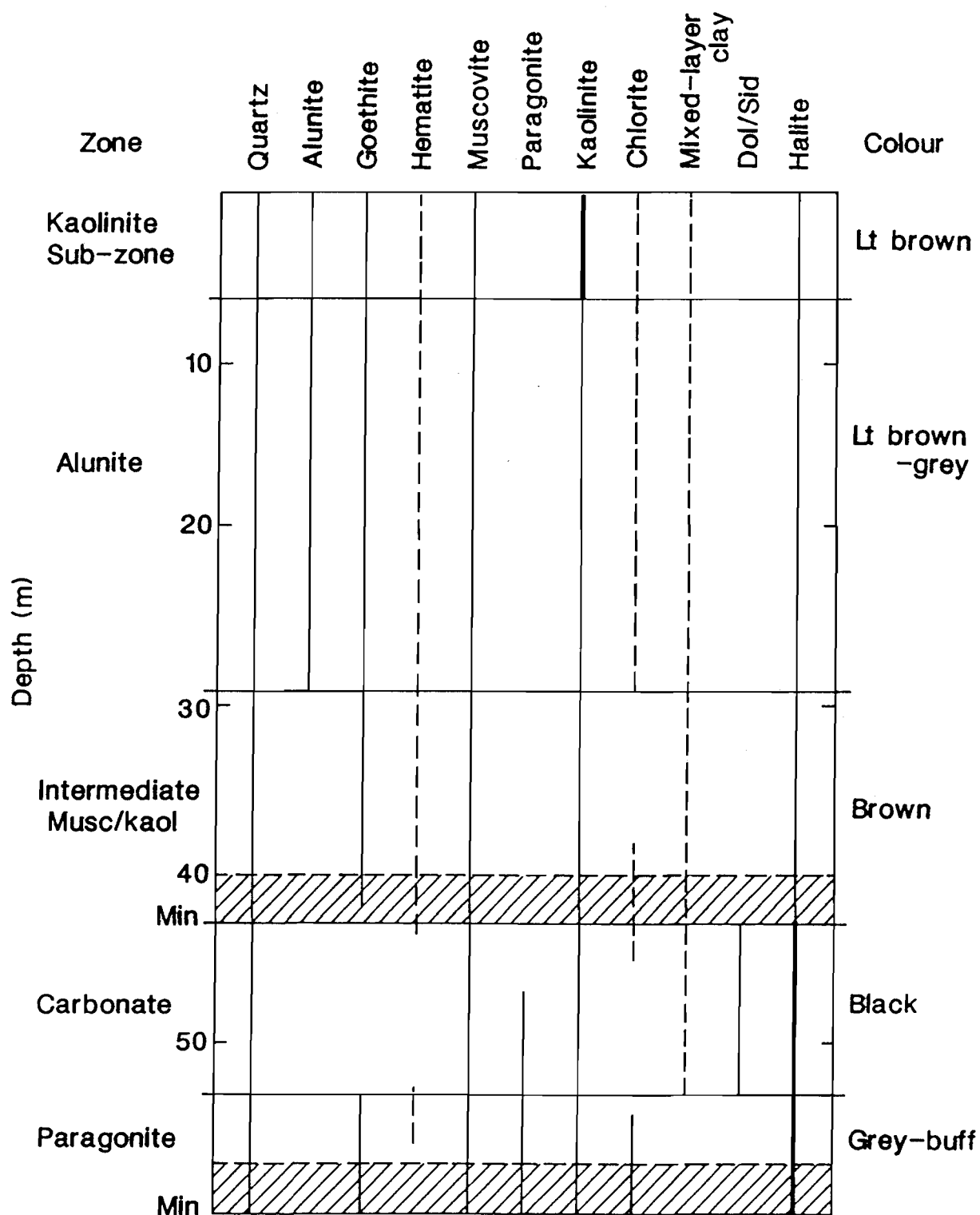


Fig. 5 Mineralogical profile through the mineralized hole PSRC 342