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RESONANCE (EPR) OF THE ROCKS IN THE PINNACLES AREA:
WALL ROCK ALTERATION AND EXPLORATION STUDIES**

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INTRODUCTION

The Pinnacles area is located about 11 km north of the Rosebery mine. There are two small massive sulphide deposits (old workings), Brown's Tunnel and Thomas' Tunnel, and a minor showing Leo's Find; all these deposits occur in the host rock shale. The rocks of the area (Fig. 1) are the Stitt Quartzite in the southwest, volcanic and sedimentary rocks in the Rosebery fault zone (felsic volcanics, quartz-feldspar porphyries and black shale), quartz-feldspar porphyries to the west of the Thomas' Tunnel deposit, footwall (pumiceous mass flows) covering almost half of the study area in the southeast, a narrow zone of the host rock associated with all known deposits, hanging wall in the north and White Spur Formation in the extreme north of the study area. The rocks trend NE generally parallel to Pinnacles shear and East Pinnacles shear zones. Anticlinal and synclinal structures occur in the footwall and hanging wall respectively. The study area is bounded in the west by the Rosebery fault.

AIMS OF THE STUDY

The study was set out to investigate the wall rock alteration in the Pinnacles area, to identify the types of alteration, to evaluate the known mineralisations and to determine the mineralisation potential of the area.

SAMPLING AND ANALYSES

A total of 58 rock samples (36 surface rock samples and 22 drill core samples near the surface) is involved in this study (Fig. 1). The samples were mainly collected from the footwall, host rock and hanging wall near and around the Pinnacles Shear zones. There is a good distribution of the samples in the hanging wall and host rock in the western part,

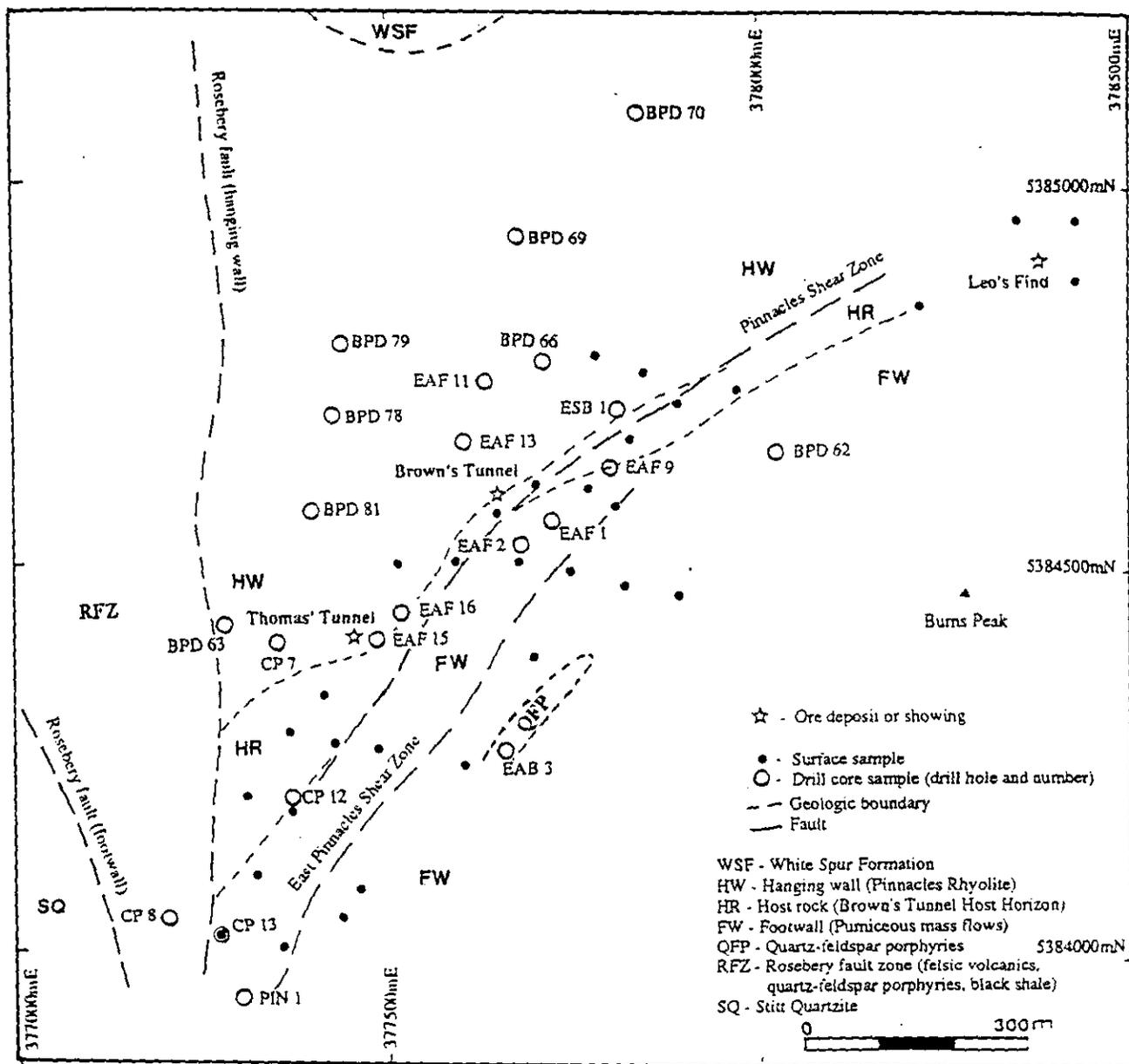


Fig. 1. Location, geology and sample points of the Pinnacles area. (geology based on *interpretative geology map* of Pasmenco Exploration, 1993)

especially in mineralised areas (Brown's Tunnel and Thomas' Tunnel), but the sample density in the hanging wall and footwall in the northeast of the area is relatively low. All rock samples were crushed and ground to 50 μm . After a hot HNO_3 leach, the residual powder samples were analysed for 24 elements (K, Fe, Al, Ca, Na, Ti, Mn, Cl, Ba, Ga, Rb, Sr, Y, Zr, Nb, Tl, Th, Co, Cu, Zn, Pb, As, Ni and V) by PIXE/PIGME (proton induced x-ray emission/proton induced gamma ray emission spectroscopy) methods on the 3MV van de Graaff at Lucas Heights. EPR analyses were made by routine X-band EPR powder spectroscopy (JEOL JES FE3 X analogue spectrometer) in the Central Science Laboratory of the University of Tasmania. The intensity of paramagnetism is expressed as the peak heights of the first derivative EPR signals at the effective spectroscopic splitting factor at g 2.0025 in $326.5 \pm 5\text{mT}$ sweeps and the broad 70mT wide central signal in $326.5 \pm 100\text{mT}$ sweeps (van Moort and Barth, 1992).

METHODS OF APPROACH

The methods of data processing and presentation in this study are similar to those of previous studies on the wall rock alteration and mineralisation potential in the Rosebery mine area (van Moort and Aung Pwa, 1993 and 1994, and Aung Pwa and van Moort 1994). This study involves the determination of wall rock alteration, identification of alteration related to mineralisation, and examination of mineralisation potential (including evaluation of known mineralisations). The determination of the areal distribution of geochemical and EPR parameters is the most important study to meet these objectives. The geochemical and EPR data of fifty five samples out of fifty eight are involved in the study of the areal distribution of these data. Duplicate samples from sample points P2A (siliceous vein), P3B (possibly dyke or later siliceous vein) and P19A (black slate) are not included in the study.

DETERMINATION OF WALL ROCK ALTERATION

Geochemical Signatures: Areal Distribution of Geochemical Indices Related to Wall Rock Alteration

Geochemical Index of K-Rb:

The geochemical index of K-Rb defines the enrichment in K and Rb which is the geochemical signature associated with wall rock alteration in the Rosebery mine area. The areal distribution of the geochemical indices of K-Rb in the rocks of the Pinnacles area is

shown in Fig. 2. Most parts of the area display a high geochemical index of K-Rb ($> 2 \times 10^6$) in the rocks. There is a large zone with a geochemical index of K-Rb greater than 2×10^6 in the central and northeastern parts of the area where Brown's Tunnel, Thomas' Tunnel and Leo's Find are located. All these deposits occur in the zones with a K-Rb index more than 4×10^6 . The zone associated with Brown's Tunnel opens towards the east where the Burns Peak area is located. There is another small zone of geochemical indices of K-Rb greater than 2×10^6 in the southwestern part of the area. Two small zones with an index value of more than 4×10^6 occur in the SW zone but have no association with mineralisation. The footwall below the host rock associated with known mineralisation, particularly below the Thomas' Tunnel, does not display significantly high values of the index.

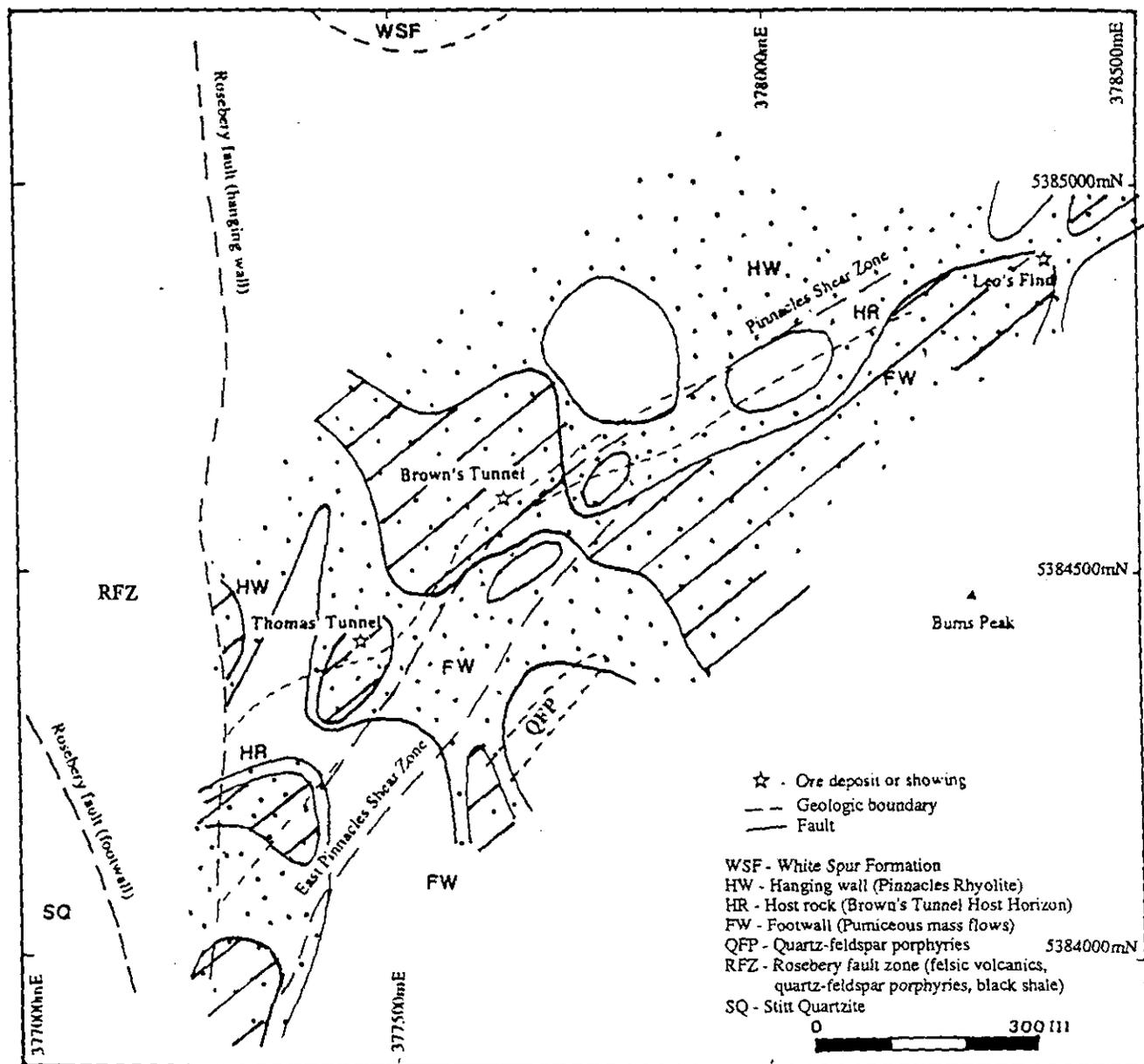
Geochemical Index of K-Rb-Ca-Na-Sr

The geochemical index of K-Rb-Ca-Na-Sr defining the enrichment in K and Rb, depletion in Ca, Na and Sr is a typical indicator of wall rock alteration in the Rosebery mine area. The areal distribution of K-Rb-Ca-Na-Sr index in the Pinnacles area is shown in Fig. 3. Fifty out of fifty five rock samples of the area have a K-Rb-Ca-Na-Sr index of more than 1 which is the value defining the wall rock alteration in the Rosebery mine area. Most parts of the Pinnacles area occur in the zone with an index of more than 100. It appears that most of the rocks in the study area are enriched in K and Rb, and depleted in Ca, Na and Sr. A noticeable feature is that the zone with more than 100 of the K-Rb-Ca-Na-Sr index is extensive into the hanging wall as well as the footwall. Unlike the Rosebery area (where the surface geochemical alteration halo is limited) the geochemical alteration halo is extensive in the hanging wall.

EPR Signatures for Wall Rock Alteration

EPR Intensity measured at Magnetic Flux Density Sweeps over $326.5 \pm 5 \text{ mT}$

The distribution pattern of the EPR intensity ($326 \pm 5 \text{ mT}$) is generally similar to those of K/Na, Rb/Sr, Ca, Na and Sr, which are all related to the wall rock alteration in the Rosebery area (van Moort and Aung Pwa, 1993a). The areal distribution of EPR intensities measured at magnetic flux density sweeps over $326.5 \pm 5 \text{ mT}$ in the rocks of the Pinnacles area, shown in Fig. 4, displays significant relation to the known mineralisations, the Brown's Tunnel, Thomas' Tunnel and Leo's Find. Most of the samples have EPR intensities of more than 9



Geochemical Index of K-Rb ($\times 10^6$)

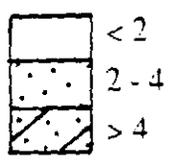
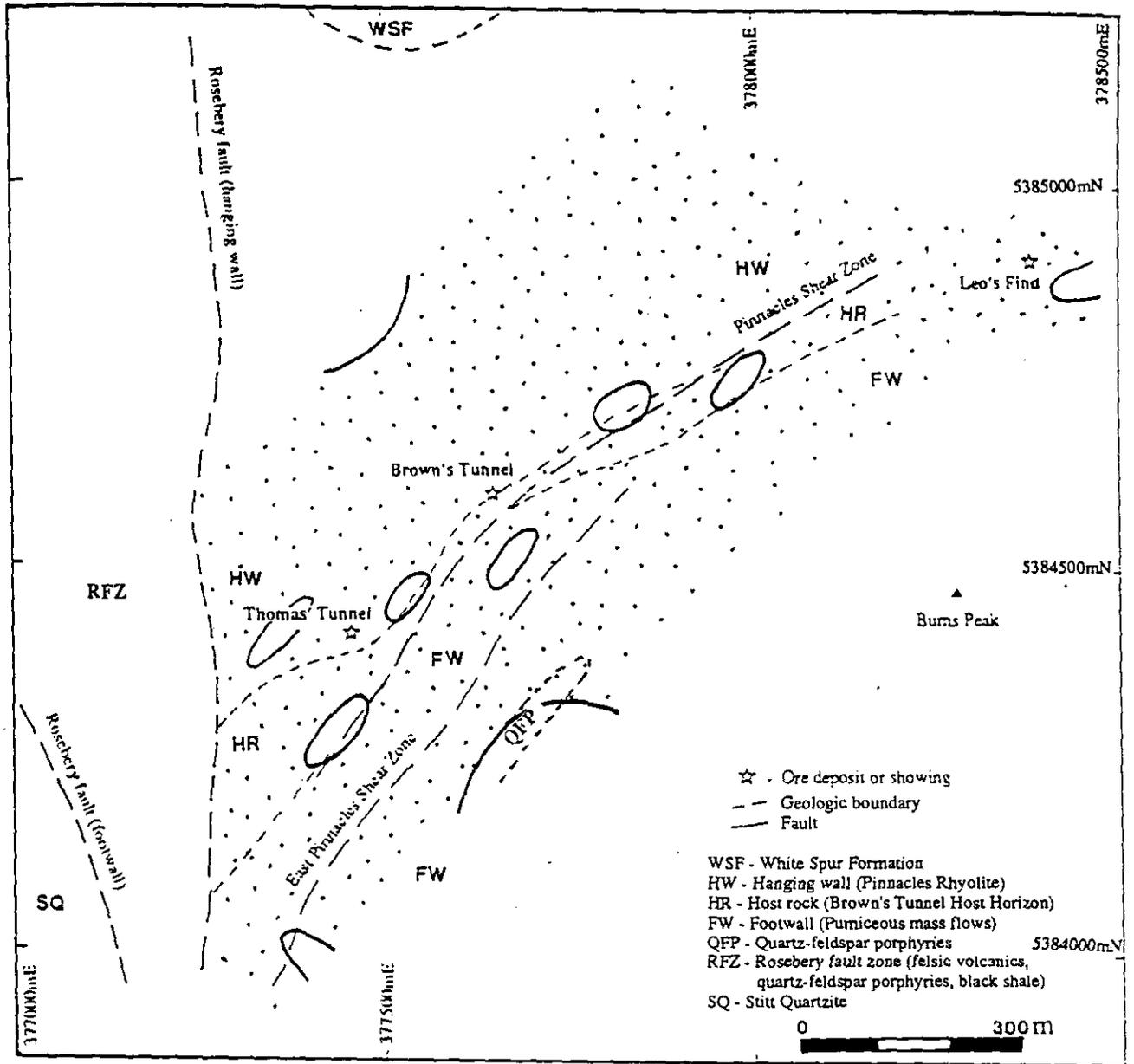


Fig. 2. Distribution of geochemical indices of K-Rb in the rocks of the Pinnacles area. Most parts of the area display high K-Rb indices ($> 2 \times 10^6$) indicating the enrichment in K and Rb which are geochemical signatures of wall rock alteration.



Geochemical Index of K-Rb-Ca-Na-Sr x 10²

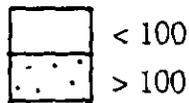
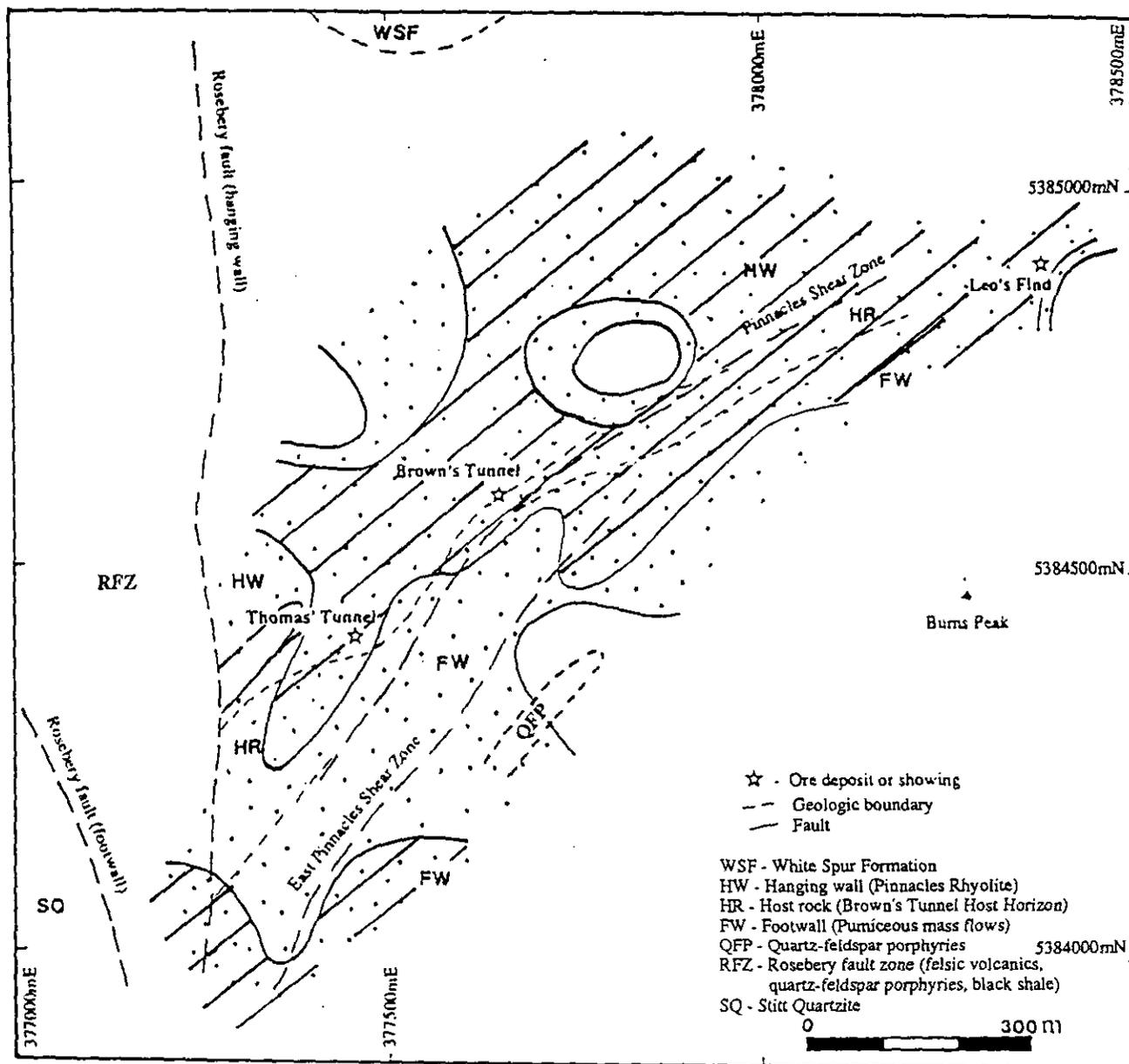


Fig. 3. Distribution of geochemical indices of K-Rb-Ca-Na-Sr in the rocks of the Pinnacles area. Most parts of the area also display high indices (> 100 x 10²) indicating the enrichment in K and Rb and depletion in Ca, Na and Sr in the rocks which are typical geochemical signatures of wall rock alteration.



EPR Intensity (± 5 mT) in cm

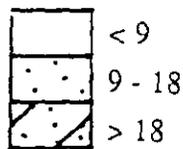


Fig. 4. Distribution of EPR intensities measured at magnetic flux density sweeps over 326.5 ± 5 mT. Most of the samples show an EPR intensity higher than 9 cm.

cm. All known deposits occur in a well defined zone (opening to the north and northeast) with EPR intensity of more than 18 cm measured at magnetic flux density sweeps over 326.5 ± 5 mT. There is another zone of more than 18 cm EPR intensity in the southwestern part of the area. The zone is opening towards the south.

IDENTIFICATION OF WALL ROCK ALTERATION RELATED TO MINERALISATION

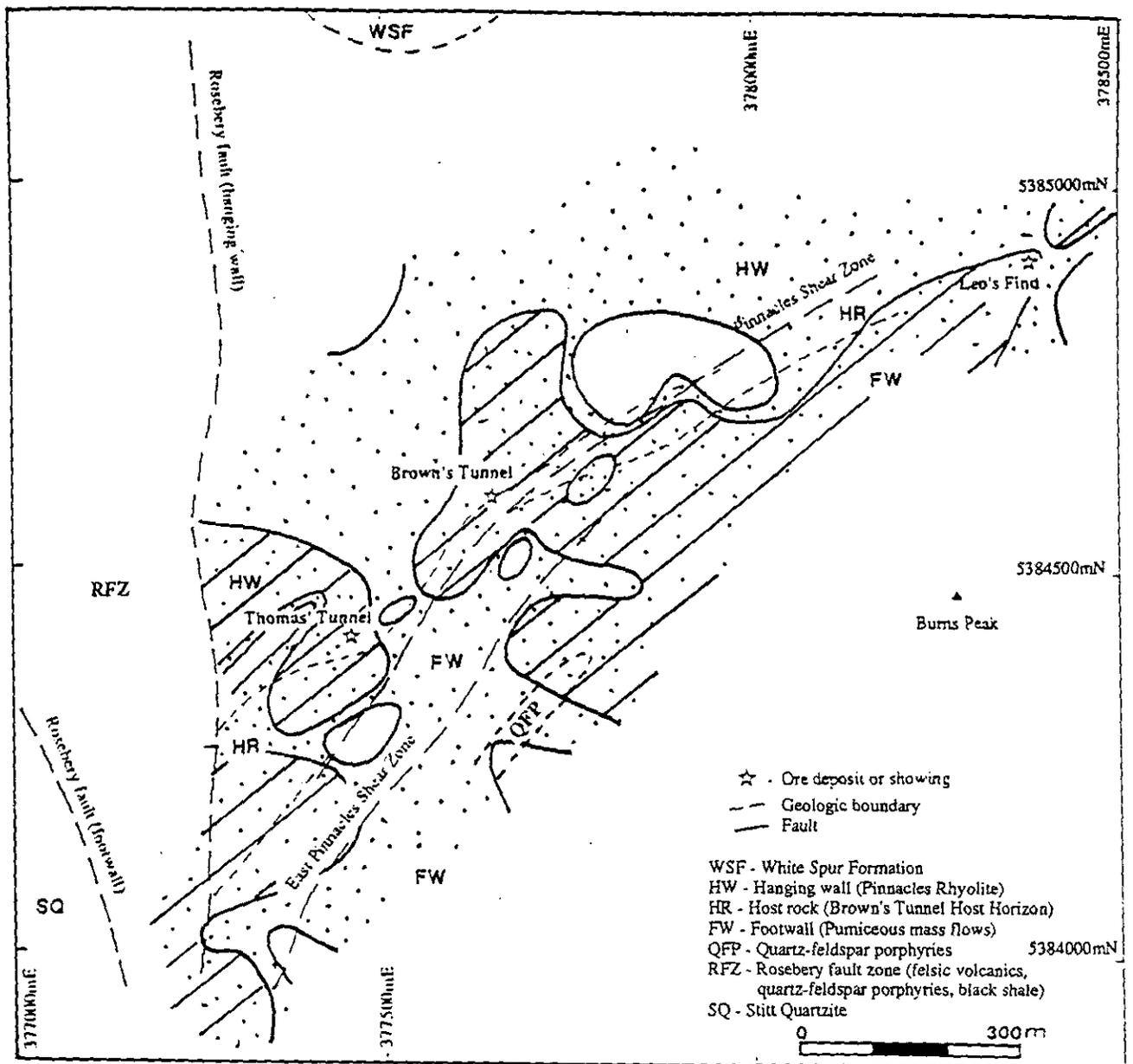
Geochemical Signatures: Areal Distribution of Geochemical Indices Related to Wall Rock Alteration

Geochemical Index of K-Mn-Ba-Rb-Ca-Na-Sr

Fig. 5 shows the distribution of the geochemical index of K-Mn-Ba-Rb-Ca-Na-Sr indicating the enrichment in K, Mn, Ba and Rb, and depletion in Ca, Na and Sr, which are the geochemical signatures of the wall rock alteration related massive sulphide in the Rosebery mine area. Most parts of the Pinnacles area including all known deposits have a K-Mn-Ba-Rb-Ca-Na-Sr index of more than 1×10^4 which is the minimum value defining the alteration in the footwall of the Rosebery deposit. There are three significant zones with a K-Mn-Ba-Rb-Ca-Na-Sr index more than 50×10^4 : a large zone in the middle and southeastern parts outlining Brown's Tunnel, and Leo's Find deposits, a small zone associated with Thomas' Tunnel, and another small one in the southwestern part of the area opening towards south.

Geochemical Index of Mn-Ba-Ca-Na-Sr

The distribution of the geochemical index of Mn-Ba-Ca-Na-Sr has been effectively used in identification of wall rock alteration related to mineralisation in the Rosebery mine area. Most parts of the Pinnacles area have a Mn-Ba-Ca-Na-Sr index more than 1×10^2 which indicates the presence of wall rock alteration related to massive sulphide mineralisation (Fig. 6). The zone with a Mn-Ba-Ca-Na-Sr index greater than 10×10^2 outlines all known deposits and seems to have extensions outside the study area, as it opens in all directions. The Brown's Tunnel and Thomas' Tunnel deposits occur in the zones with an index of more than 50×10^2 . There are few samples (less than 20% of the total samples) with a Mn-Ba-Ca-Na-Sr index less than 1×10^2 .



Geochemical Index of K-Mn-Ba-Rb-Ca-Na-Sr $\times 10^4$

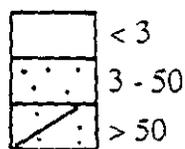
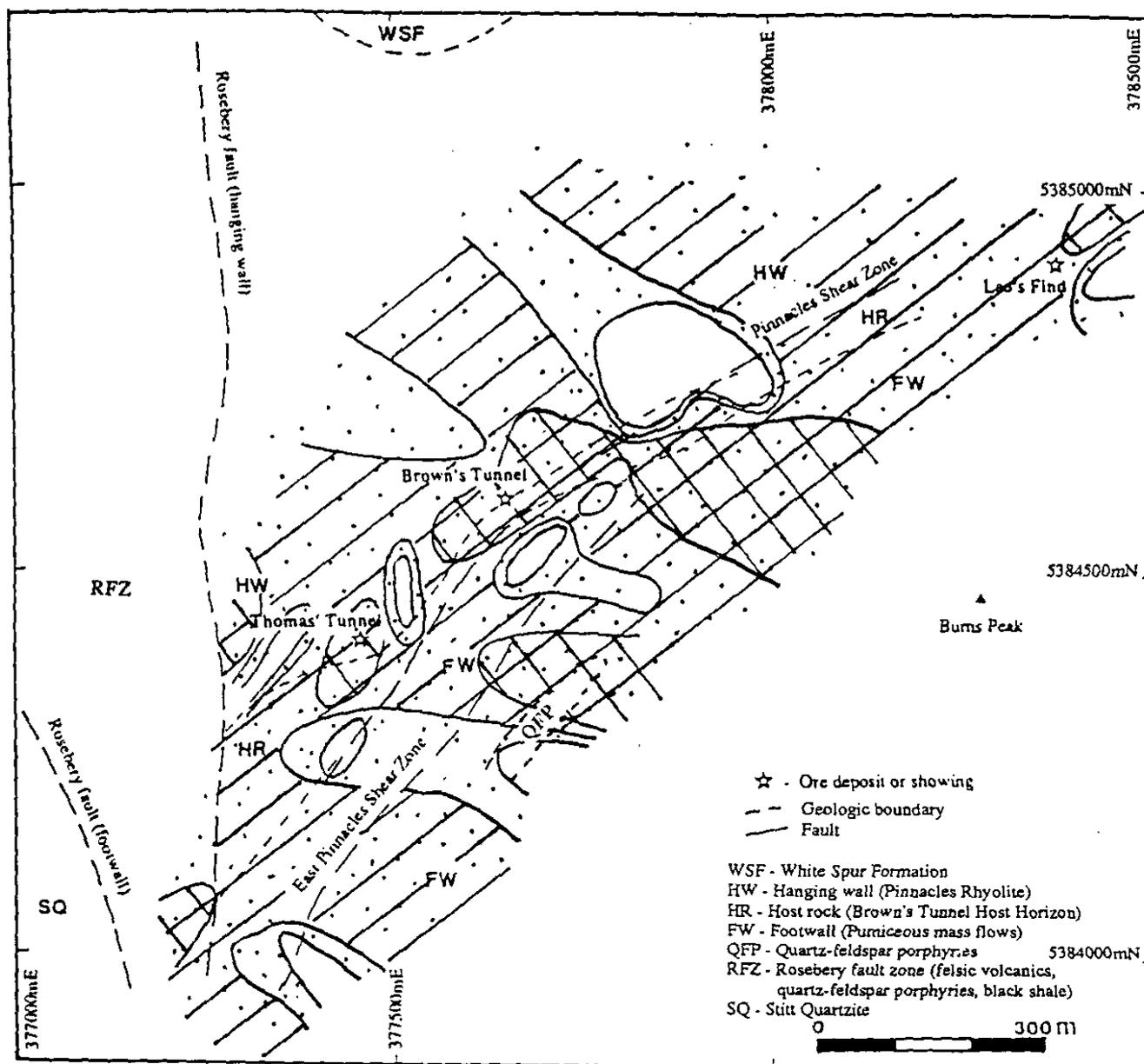


Fig. 5. Distribution of geochemical indices of K-Mn-Ba-Rb-Ca-Na-Sr in the rocks of the Pinnacles area. High values of the indices ($> 3 \times 10^4$) throughout the area indicate that the alteration in the area is related to massive sulphide mineralisation. All the known mineralised areas occur in the zones with a K-Mn-Ba-Rb-Ca-Na-Sr index more than 50×10^4 .



Geochemical Index of Mn-Ba-Ca-Na-Sr ($\times 10^2$)

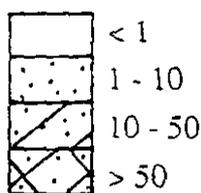


Fig. 6. Distribution of geochemical indices of Mn-Ba-Ca-Na-Sr in the rocks of the Pinnacles area. High geochemical indices ($> 1 \times 10^2$) through out the area indicate that the alteration in the area is related to massive sulphide mineralisation. The Brown's Tunnel and Thomas Tunnel deposits occur in the zones with a Mn-Ba-Ca-Na-Sr index more than 50×10^2 .

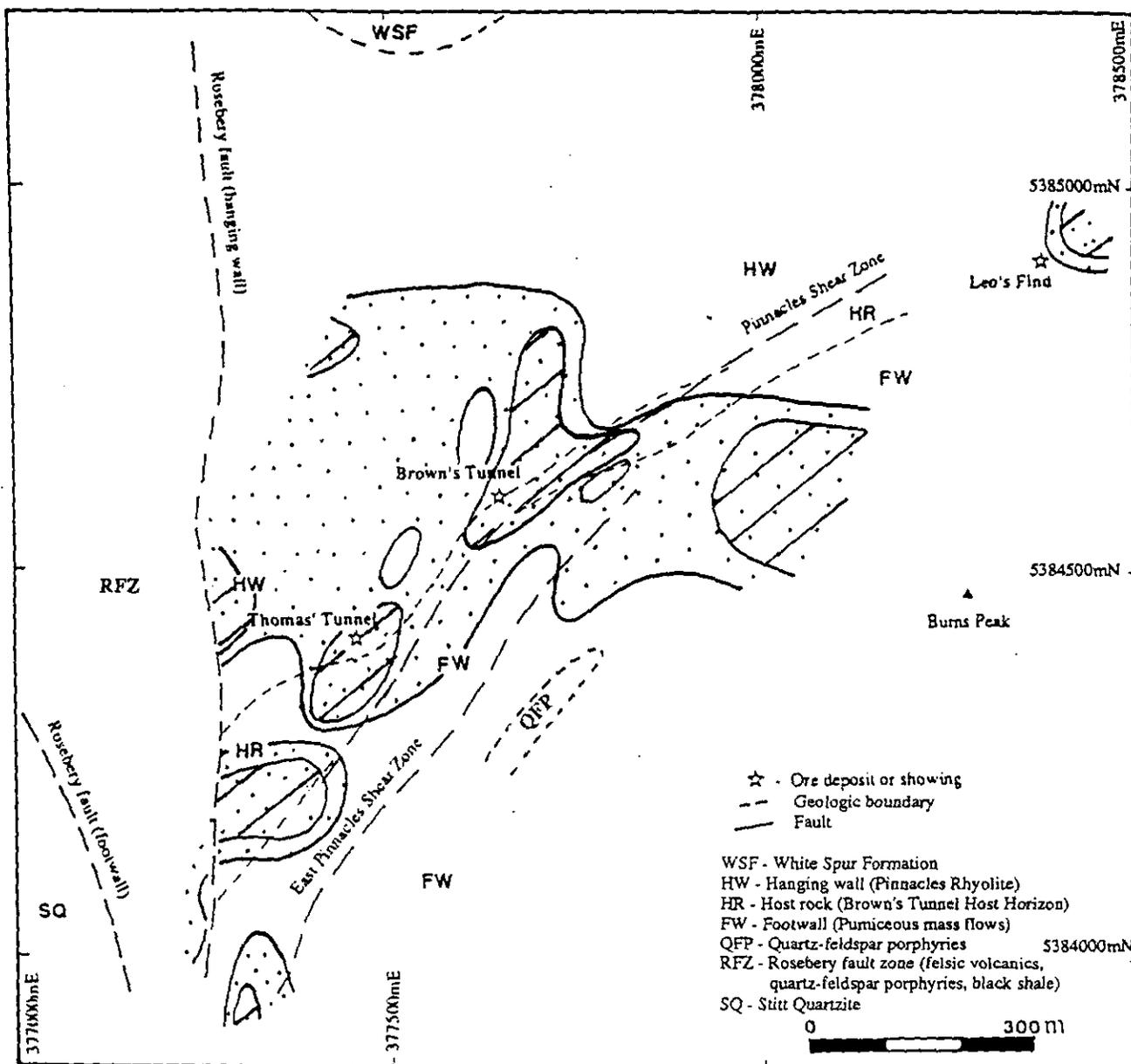
Geochemical Index of Mn-Ba

The geochemical index of Mn-Ba has also been used in the identification of wall rock alteration related to massive sulphide mineralisation, and in the determination of mineralisation potential in the Rosebery mine area (van Moort and Aung Pwa, 1993b; Aung Pwa and van Moort, 1994). Mn and Ba are elements commonly associated with the massive sulphide mineralisation. The distribution of the Mn-Ba index in the rocks of the Pinnacles area shown in Fig. 7 displays a large and well defined zone of more than 5×10^{-4} with an EW trend outlining two main deposits, the Brown's Tunnel and Thomas' Tunnel. There are three important small zones with a Mn-Ba index higher than 10×10^{-4} within the above EW zone; two in the host rock are associated with the Brown's Tunnel and Thomas' Tunnel deposit each, and the third one in the east of the Brown's Tunnel deposit is opening towards Burns Peak. Another three zones of a Mn-Ba index more than 5×10^{-4} also occur in the northeastern and southwestern parts along the direction of Pinnacles shear zones, but no known mineralisation is recognised except for the Leo's Find showing near the northeastern zone.

EPR Signatures for Wall Rock Alteration Related to Mineralisation

EPR Intensity Measured at Magnetic Flux Density Sweeps Over $326.5 \pm 100 \text{ mT}$

This EPR intensity has not only been used for alteration study but also for determination of mineralisation potential (van Moort and Aung Pwa, 1993a & b). The distribution pattern of the EPR intensity is generally similar to those of Mn, Ba and Zn, which display close relation to massive sulphide mineralisation in the Rosebery mine area. The areal distribution of EPR intensities ($\pm 100 \text{ mT}$) measured at magnetic flux density sweeps over $326.5 \pm 100 \text{ mT}$ in the rocks of the Pinnacles area is shown in Fig. 8. Most of the samples have EPR intensities of more than 5 cm. All known mineralisations, the Brown's Tunnel, Thomas' Tunnel and Leo's Find deposits occur in the zones of more than 10 cm. There are four small zones of more than 20 cm of EPR intensities measured at magnetic flux density sweeps over $326.5 \pm 100 \text{ mT}$: two zones associated with Brown's Tunnel and Thomas' Tunnel deposits each, one in the east of the Brown's Tunnel opening towards the Burns Peak area and other in the southwestern part of the area opening toward south.



Geochemical Index of Mn-Ba ($\times 10^4$)

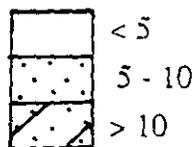
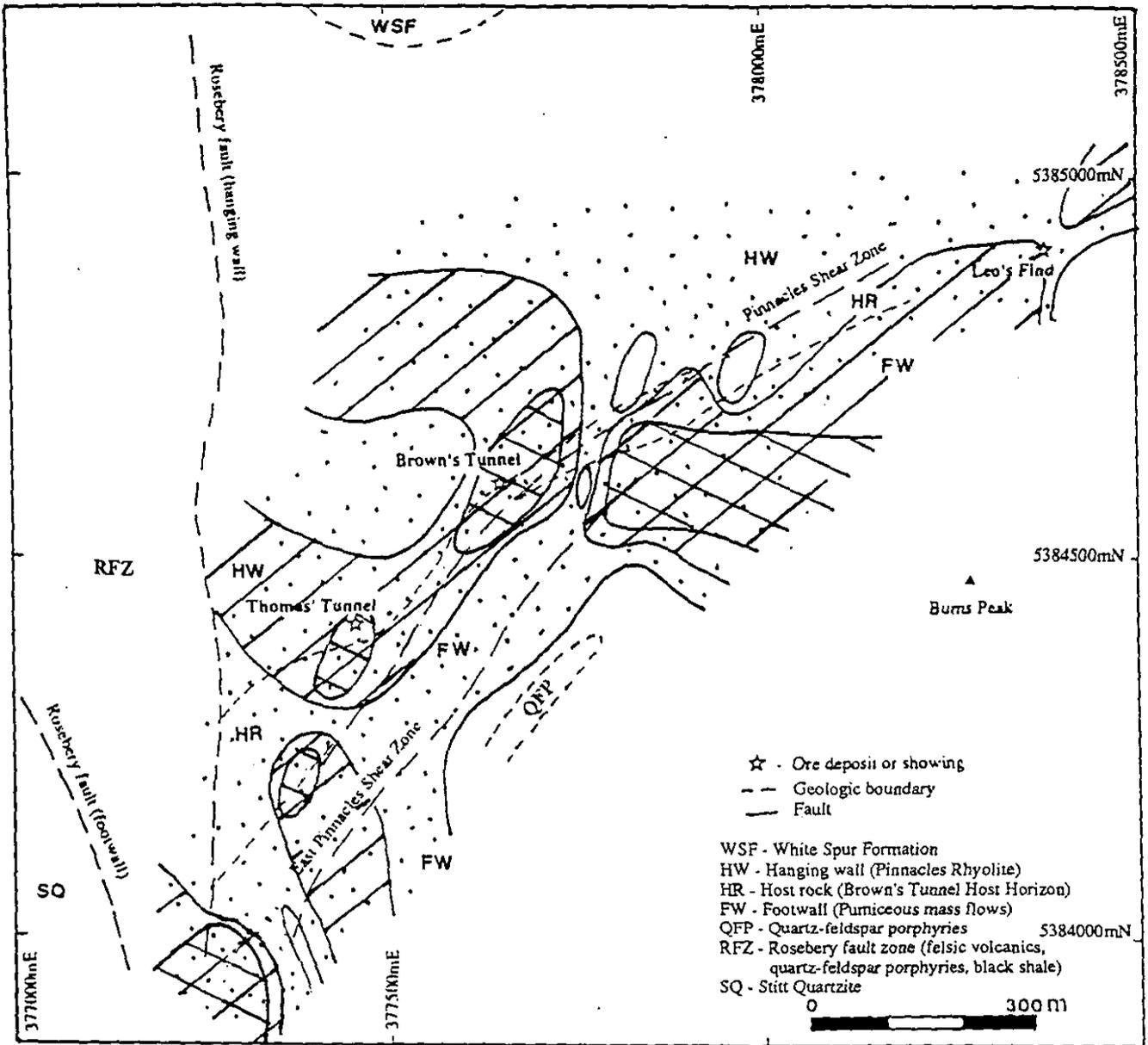


Fig. 7. Distribution of geochemical indices of Mn-Ba in the rocks of the Pinnacles area. A zone with a Mn-Ba index more than 5×10^4 trending EW outlines the Brown's Tunnel and Thomas Tunnel deposits. The Leo's Find showing is located outside of a zone with high Mn-Ba index ($> 5 \times 10^4$).



EPR Intensity (± 100 mT) in cm

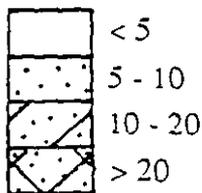


Fig. 8. Distribution of EPR intensities measured at magnetic flux density sweeps over 326.5 ± 100 mT. Most of the samples show a EPR intensity higher than 5 cm. All known mineralised areas occur in the zones of more than 20 cm EPR intensity (326.5 ± 100 mT).

EPR Intensity Index

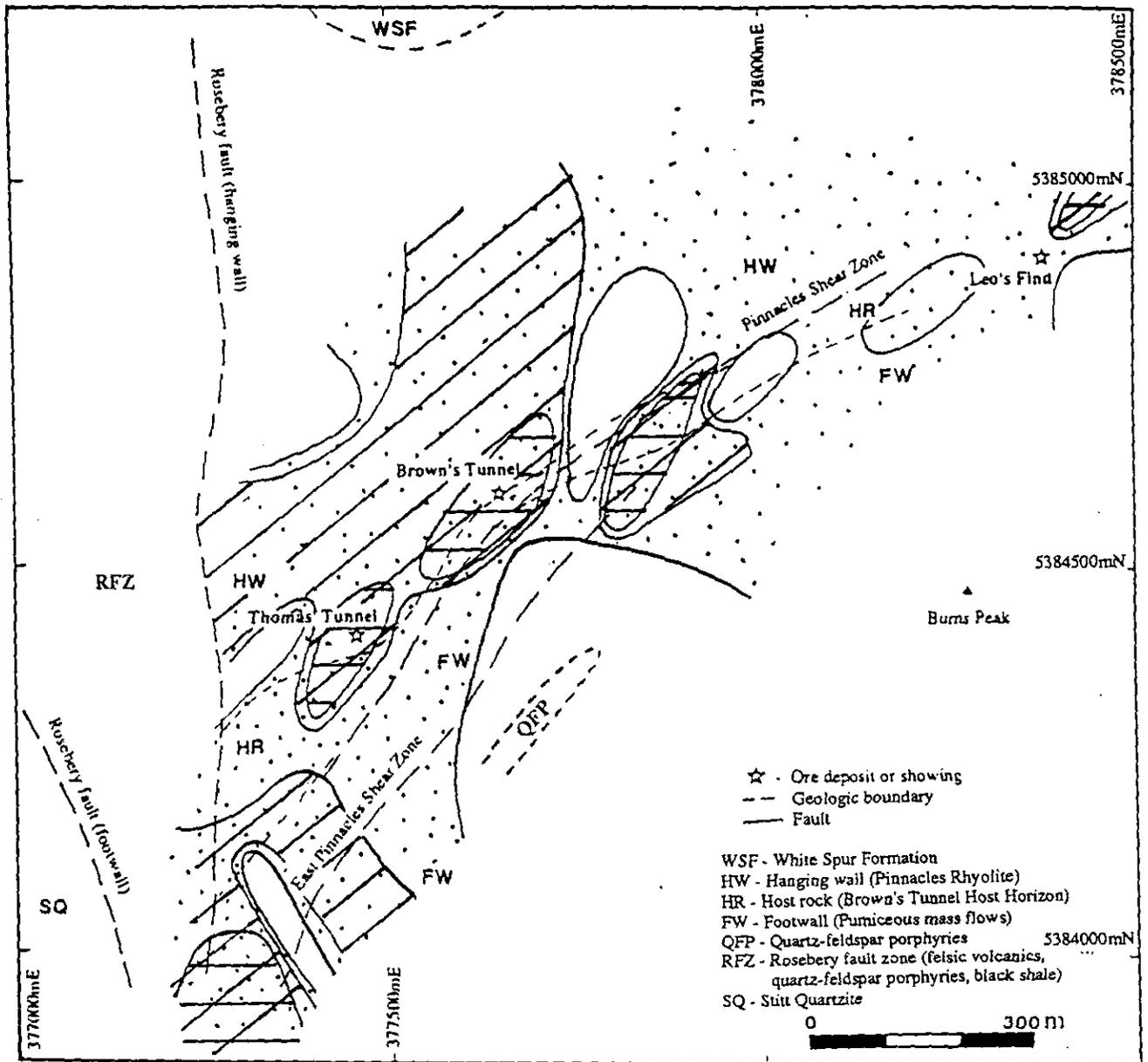
EPR index is the parameter which identifies the wall rock alteration related to mineralisation in the Rosebery mine area. Figure 9 shows the areal distribution of EPR intensities (measured at magnetic flux density sweeps over $326 \pm 5 \text{mT}$ and $\pm 100 \text{mT}$). Most parts of the area occur in the zone of more than 80 of the EPR intensity. There are three zones with an EPR index more than 200; one mainly in the hanging wall and partly in the host rock outlines the Brown's Tunnel and Thomas' Tunnel deposits in the middle part of the area, the second one located in the southwestern part opens towards south, and the third zone is a small one between two Pinnacles shear zones in the east of the Brown's Tunnel deposit. The EPR index seems to be lower to the east in the footwall compared to the hanging wall, and in the northern part of the area.

EXAMINATION OF MINERALISATION POTENTIAL

Geochemical Signatures for the Determination of Mineralisation Potential

The geochemical indices of Mn-Ba, Zn-Pb and Mn-Ba-Zn-Pb will be considered to determine the mineralisation potential of the Pinnacles area.

As mentioned above the Mn-Ba index (Fig. 7) displays a significant relation to the known mineralisations. The zone of Mn-Ba index more than 5×10^{-4} (which is the same value of the index defining the host rock of the Rosebery deposit and associated footwall alteration zone (Aung Pwa and van Moort, 1994)) trending EW outlines the Brown's Tunnel and Thomas' Tunnel deposits. The zone is extensive into the hanging wall and open towards the west indicating the possibility of extension to the west outside the study area. The zone in the footwall is small compared to that in the hanging wall and opens towards the east where Burns Peak area is located.



EPR Index

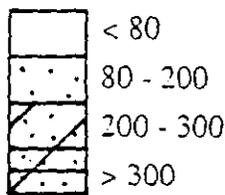


Fig. 9. Distribution of EPR intensity indices (Combination of both EPR intensities measured at magnetic flux density sweeps over 326.5 ± 5 mT and 100 mT) in the rocks. All known mineralised areas occur in the zones of an EPR index more than 80, and the Brown's Tunnel and Thomas Tunnel deposits are located in the zones of more than 300 of the index.

Geochemical Index of Zn-Pb

The geochemical index of Zn-Pb is an useful indicator for massive sulphide deposits as these elements are major constituents. The distribution Zn-Pb index in the rocks shown in Fig. 10 is generally similar to that of the Mn-Ba index. A large zone with a Zn-Pb index more than 50 trending EW outlines the Brown's Tunnel and Thomas' Tunnel deposits. The values of Zn-Pb indices are generally low in the footwall particularly the area below the host rock of the Brown's Tunnel deposit. There are two zones with more than 50 of Zn-Pb index in the northeast and southwest of the area. The one in the northeast opening north is associated with the Leo's Find deposit and the other in the southwest opening towards south has no association with known mineralisation.

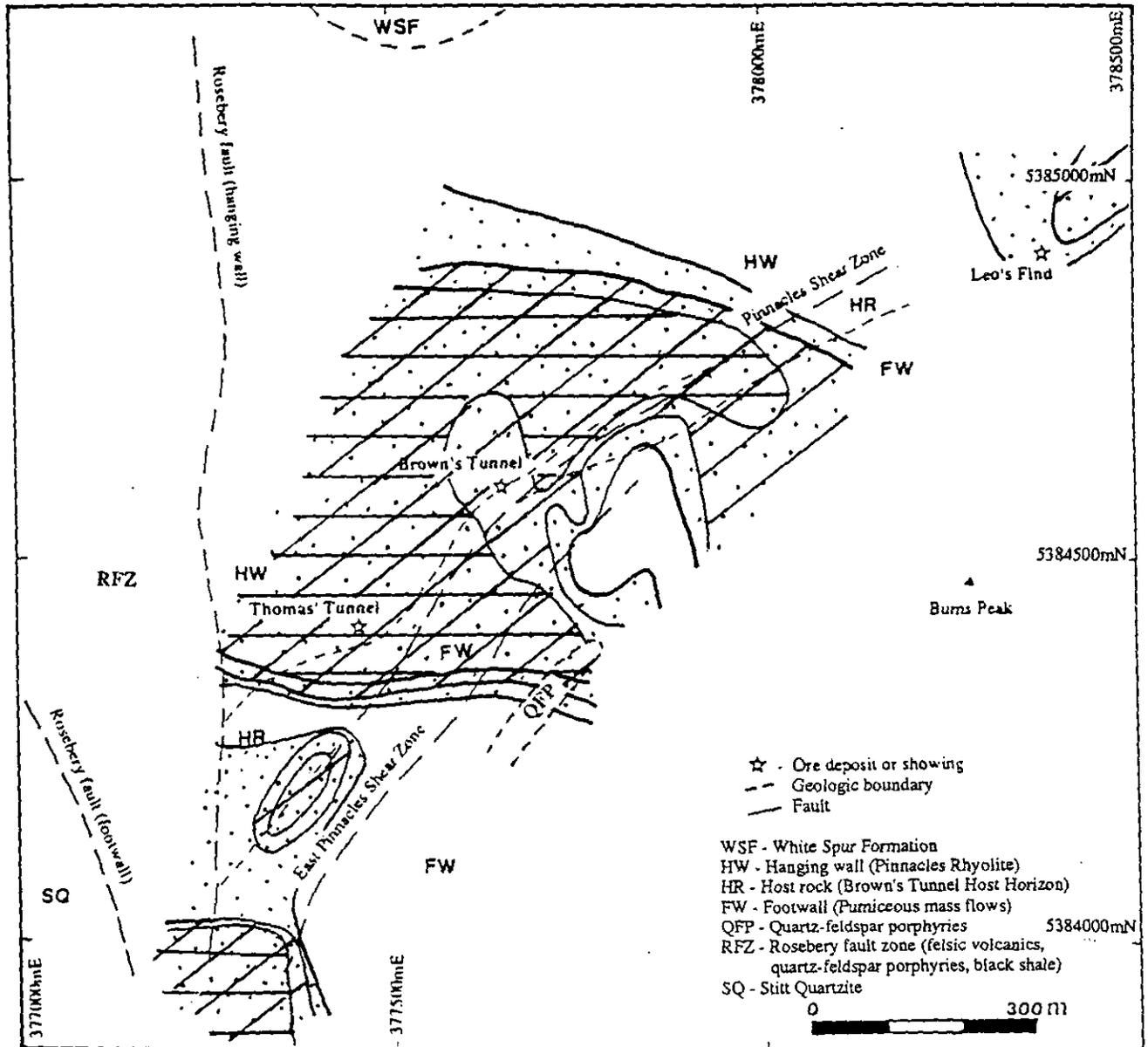
Geochemical Index of Mn-Ba-Zn-Pb

The distribution of the geochemical indices of Mn-Ba-Zn-Pb in the rocks of the Pinnacles is shown in Fig. 11. There is a pronounced zone with a Mn-Ba-Zn-Pb index more than 5×10^6 in the middle of the area where the Brown's Tunnel and Thomas's Tunnel deposits are located. The zone seems to have an EW trend across the stratigraphic trend and passes through from east to west the footwall, host rock and hanging wall. There are four zones with a Mn-Ba-Zn-Pb index more than 20×10^6 within the above zone. Among these a well defined zone with a NE-SW trend uniquely outlines the Brown's Tunnel and Thomas's Tunnel deposits, and the one in the east of the Brown's Tunnel deposit is opening toward the Burn Peak area.

Two zones with an index more than 5×10^6 in the southwestern and northeastern parts of the area also occur in the footwall and host rock. The former one opening southward is larger than the latter and seems to be significant.

EPR Signatures for the Determination of Mineralisation Potential

EPR intensity measured at magnetic flux density sweeps over 326 ± 100 mT has been used to determine the mineralisation potential in the Rosebery mine area. As mentioned above the distribution patterns of EPR intensity measured at magnetic flux density sweeps over 326 ± 100 mT (Fig. 8) and of EPR intensity index (Fig 9) in the rocks of the Pinnacles area are closely related with known mineralisations particularly with Brown's Tunnel and



Geochemical Index of Zn-Pb

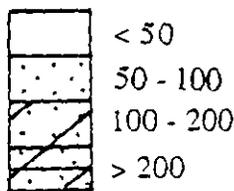
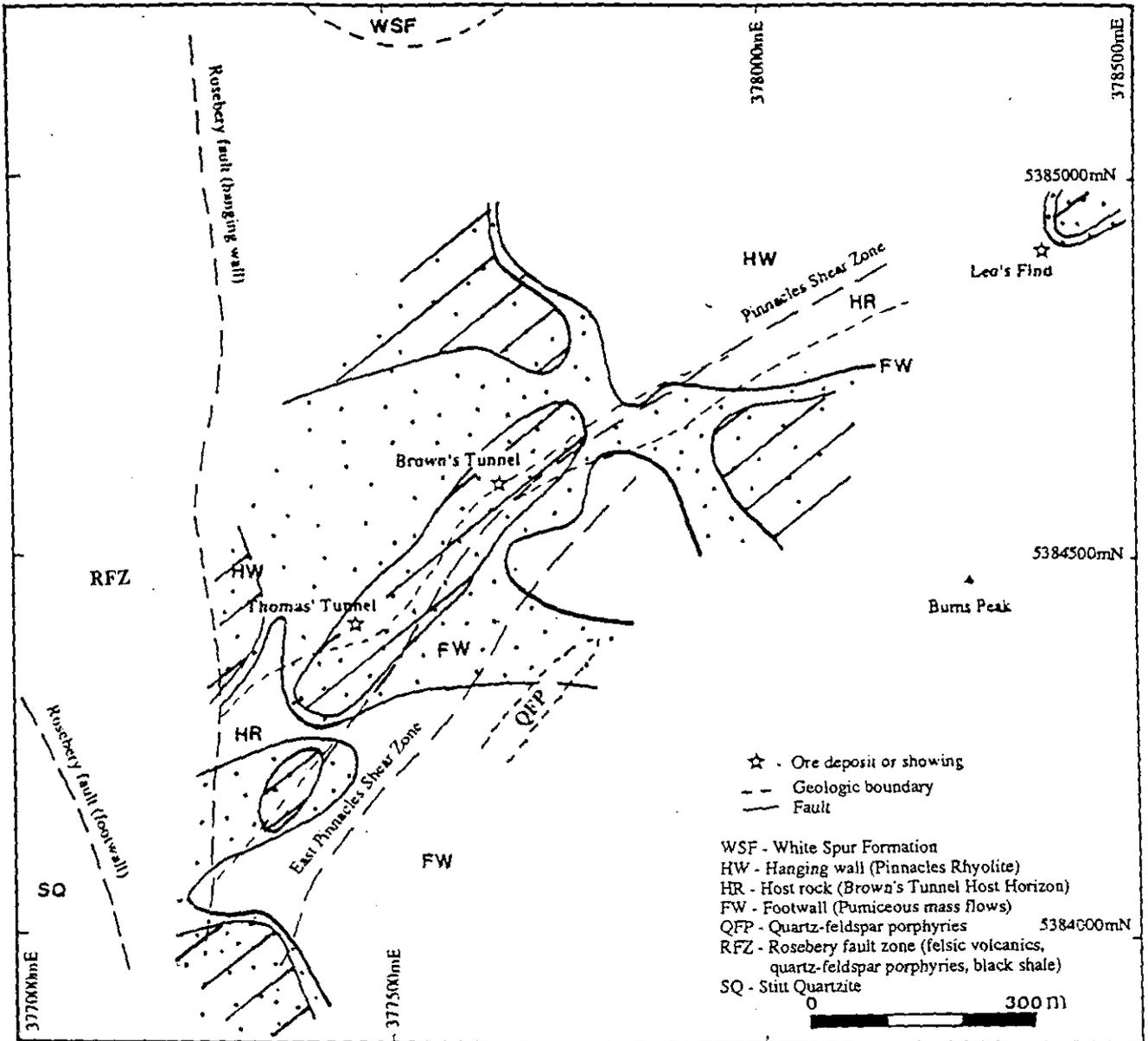


Fig. 10. Distribution of geochemical indices of Zn-Pb in the rocks of the Pinnacles area. All the known mineralised areas occur in the zones with a Zn-Pb index more than 50. The Brown's Tunnel and Thomas Tunnel deposits are located in a well defined zone of a Zn-Pb index more than 200 trending EW.



Geochemical Index of Mn-Ba-Zn-Pb ($\times 10^6$)

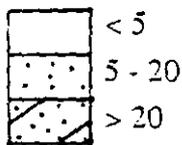


Fig. 11. Distribution of geochemical indices of Mn-Ba-Zn-Pb in the rocks of the Pinnacles area. A zone of an index more than 5 outlines the Brown's Tunnel and Thomas Tunnel deposits are specifically located in a zone of more than 20 of Mn-Ba-Zn-Pb index.

Thomas' Tunnel deposit. These deposits are located in the zones of an EPR intensity more than 20 cm measured at magnetic flux density sweeps over 326 ± 100 mT and of an EPR index more than 300. There are two more such zones in the footwall in the southwestern and middle parts of the area.

DISCUSSION AND INTERPRETATION

The geochemical indices of K-Rb and K-Rb-Ca-Na-Sr demonstrate that most of the the rocks in the Pinnacles area are enriched in K and Rb, and depleted in Ca, Na and Sr similar to the alteration signatures of the Rosebery mine (van Moort and Aung Pwa, 1993a and b). The visible mineralogical alteration zone is limited in extent, particularly in the hanging wall, but the geochemical alteration zones of K-Rb and K-Rb-Ca-Na-Sr are more extensive and easily detectable in the area. These geochemical indices demonstrate that a general wall rock alteration occurs throughout the Pinnacles area. Unlike in the Rosebery mine area, the geochemical alteration zone in the hanging wall in the Pinnacles area is well pronounced and comparable to that of the footwall in terms of areal extent and intensity of alteration. The trend of these zones, however, is not clear as it is in the Rosebery mine area. The EPR intensity measured at magnetic flux density sweeps over 326 ± 5 mT also supports the above alteration features - most parts of the area have EPR intensities of more than 9 cm (which is the value defining the general wall rock alteration in the Rosebery mine area). Moreover the EPR intensities measured at magnetic flux density sweeps over 326 ± 5 mT seem to be stronger in the hanging wall compared to the footwall. Such pattern is also different with that of the Rosebery mine area. This may be caused by the fact that the area is less metamorphic than the Rosebery area. The 326.5 mT signal is reduced by metamorphism (van Moort and Barth, 1992).

It may be considered that typical geochemical and EPR alteration signatures (such as enrichment and depletion) in the Pinnacles area are similar to those of the Rosebery mine area. However the difference is that there are extensive and intensive halos of K-Rb and K-Rb-Ca-Na-Sr indices and EPR intensity measured at magnetic flux density sweeps over 326 ± 5 mT in the hanging wall of the area. In the Rosebery mine area the extent of alteration in the hanging wall above the Rosebery deposit is limited (Aung Pwa's Ph.D. research).

The geochemical indices of K-Mn-Ba-Rb-Ca-Na-Sr, Mn-Ba-Ca-Na-Sr and Mn-Ba demonstrate that the wall rock alteration in the Pinnacles area is mainly related to mineralisation. All these indices display high values in the rocks near and around the known mineralised areas particularly in the areas of the Brown's Tunnel and Thomas' Tunnel. Well

defined zones with a K-Mn-Ba-Rb-Ca-Na-Sr index more than 50, Mn-Ba-Ca-Na-Sr index more than 10, and Mn-Ba index more than 5 outline the known deposits (except for Mn-Ba index in Leo's Find deposit). The distribution patterns of K-Mn-Ba-Rb-Ca-Na-Sr and Mn-Ba-Ca-Na-Sr indices are not clear although the Mn-Ba index displays a significant EW trend. The distribution of EPR intensities measured at magnetic flux density sweeps over $326\pm 100\text{mT}$ and EPR intensity indices in the rocks also show significant relation to the known mineralisations. All known ore deposits occur in the areas with strong EPR intensities of $326\pm 100\text{mT}$ ($> 10\text{ cm}$). The southwestern part of the area underlain by the footwall and host rock have high geochemical indices of K-Mn-Ba-Rb-Ca-Na-Sr, Mn-Ba-Ca-Na-Sr and Mn-Ba, strong EPR intensity measured at magnetic flux density sweeps over $326\pm 100\text{mT}$ and high EPR intensity indices.

The areal distribution of the geochemical indices of Mn-Ba, Zn-Pb and Mn-Ba-Pb in the rocks show close relation to the major known mineralisations; Brown's Tunnel and Thomas' Tunnel deposits are outlined in the zones with a value of more than 5 of the Mn-Ba index, 200 of the Zn-Pb index and 20 of the Mn-Ba-Zn-Pb index. A noticeable feature is that these zones display a significant EW trend across the stratigraphic trend. The halos of these indices in the hanging wall of the Brown's Tunnel and Thomas' Tunnel deposits are relatively more extensive and intensive than those of the footwall immediately below the host rock. The rocks near the Leo's Find deposit do not show significant high values of these indices. In the southwestern part of the area there is a zone opening to the south with high Mn-Ba, Zn-Pb and Mn-Ba-Pb indices. As mentioned above EPR intensity measured at magnetic flux density sweeps over $326\pm 100\text{mT}$ is closely related to mineralisation.

CONCLUSIONS

On the basis of geochemical and EPR signatures in the rocks of the Pinnacles area the following conclusions are made:

Most parts of the Pinnacles area are geochemically altered, the enrichment in K and Rb, depletion in Ca, Na and Sr are the typical geochemical signatures of the rocks of the area. The EPR intensities measured at magnetic flux density sweeps over $326\pm 5\text{mT}$ are also strong in these rocks. Similar to the Rosebery mine area the geochemical indices of K-Rb and K-Rb-Ca-Na-Sr are useful geochemical parameters to define the wall rock alteration in general.

The alteration geochemical and EPR signatures such as the geochemical indices of K-Mn-Ba-Rb-Ca-Na-Sr, Mn-Ba-Ca-Na-Sr and Mn-Ba, and EPR intensity measured at magnetic flux density sweeps over 326 ± 100 mT and EPR intensity index in the Pinnacles area are similar to those of the Rosebery mine area.

The wall rock alteration in the area is related to massive sulphide mineralisation.

Both Brown's Tunnel, Thomas' Tunnel and possibly Leo's Find deposits occur within the intensive alteration zones.

The alteration trend is not as clear as in the Rosebery mine area.

The geochemical and EPR alteration halos of the Pinnacles area are more intensive and extensive in the hanging wall than in the Rosebery mine area.

The geochemical indices of Mn-Ba, Zn-Pb and Mn-Ba-Zn-Pb in the rocks display close relation to major known mineralisations, the Brown's Tunnel and Thomas' Tunnel but do not show significant high values in the Leo's Find deposit. These indices indicate that there is a possibility of depth extensions of the Brown's Tunnel and Thomas' Tunnel mineralisations.

Significant extensive and intensive geochemical and EPR halos related to wall rock alteration and to mineralisation in the hanging wall demonstrate that there are two possibilities: (1) possibility of mineralisation in the hanging wall and (2) element dispersion in the hanging wall related hidden mineralisation within the host rock. The latter possibility may be the result of epigenetic or secondary dispersion in the hanging wall such as leakage anomaly.

The southwestern part of the area associated with the halos of high geochemical indices of K-Mn-Ba-Rb-Ca-Na-Sr, Mn-Ba, Zn-Pb and Mn-Ba-Zn-Pb as well as those of high EPR intensity measured at magnetic flux density sweeps over 326 ± 100 mT and EPR intensity index has a high potential for mineralisation. Opening of these halos toward the south indicates that mineralisation potential may continue outside the study area.

The Leo's Find deposit is not interesting on the basis of the present data. One sample from the northeastermost part of the area (NE of the Leo's Find) shows interesting geochemical and EPR signatures.

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APPENDIX I

SAMPLE LOCATIONS IN THE PINNACLES AREA

Surface Samples

Sample No.	AMG E	AMG N
P1	377885	5384715
P2 A	377835	5384760
P2 B	377835	5384760
P3 A	377775	5384780
P3 B	377775	5384780
P4	377965	5384735
P5	377810	5384665
P6	377805	5384580
P7	377815	5384480
P8	377745	5384495
P9	377675	5384510
P10	377645	5384580
P11	377700	5384600
P12	377760	5384595
P13	378215	5384850
P14	378345	5384965
P15	377430	5384045
P16	377350	5384005
P17	377280	5384015
P18	377320	5384100
P19 A	377360	5384185
P19 B	377360	5384185
P20	377305	5384200
P21	377365	5384290

APPENDIX I cont.

Surface Samples

Sample No.	AMG E	AMG N
P22	377425	5384275
P23 A	377480	5384265
P23 B	377480	5384265
P24	377410	5384335
P25	377510	5384510
P26	377590	5384510
P27	377875	5384465
P28	377695	5384385
P29	377600	5384245
P30	377460	5384080
P31	377420	5384965
P32	377425	5384800

Drill Core Samples

Sample No.	Drill hole	location (in meter)
P33	ESB 1	16 - 17
P34	EAF 16	8 - 9
P35	EAF 15	8 - 9
P36	EAF 9	5 - 7
P37	CP 7	5 - 7
P38	PIN 1	10 - 11
P39	EAB 3	3 - 4
P40	BPD 62	9 - 10
P41	BPD 63	9 - 11
P42	EAF 13	20 - 21
P43	EAF 11	18
P44	EAF 1	9 - 24
P45	EAF 2	20

APPENDIX I cont.

Drill Core Samples

Sample No.	Drill hole	location (in meter)
P46	CP 13	7 - 8
P47	CP 12	10 - 11
P48	CP 8	10 - 12
P49	BPD 69	5
P50	BPD 70	5 - 6
P51	BPD 66	8 - 9
P52	BPD 78	2 - 7
P53	BPD 79	11 - 14
P54	BPD 81	15 - 16

APPENDIX II

Sample	in percent						in ppm																	EPR(cm) ±15mT	EPR(cm) ±100mT	
	K	Fe	Al	Ca	Na	Ti	Mn	Cl	Ba	Ga	Rb	Sr	Y	Zr	Nb	Tl	Th	Co	Cu	Zn	Pb	As	Ni			V
P 1	2.82	0.39	4.49	0.02	0.03	0.08	231	285	479	13	118	6	9	76	7	1	4	18	3	11	9	0	0	49	20	20
P 2a	1.94	0.41	3.60	0.02	0.03	0.24	98	218	10	11	82	4	8	65	4	3	3	19	0	10	23	1	4	129	20	10
P 2b	1.55	0.52	3.92	0.02	0.03	0.13	128	170	10	8	60	4	19	127	9	0	11	33	2	95	19	6	17	32	6	8
P 3a	0.87	0.45	4.30	0.01	0.02	0.11	64	199	10	7	36	4	12	167	10	0	15	23	6	41	27	3	8	27	8	4
P 3b	2.64	0.24	3.72	0.03	0.67	0.08	40	261	1331	6	50	58	13	82	6	1	6	14	11	9	11	1	13	0	16	8
P 4	0.25	0.12	2.24	0.01	0.04	0.06	20	105	10	2	11	4	17	111	7	2	11	9	2	27	15	3	5	0	28	2
P 5	2.50	0.35	4.15	0.02	0.02	0.11	279	211	476	8	112	5	10	97	11	0	18	15	3	10	6	0	0	13	26	30
P 6	3.53	0.32	5.78	0.03	0.05	0.10	275	313	321	10	135	5	14	114	12	1	9	18	2	15	3	1	4	15	29	23
P 7	2.67	0.74	4.46	0.02	0.03	0.18	66	241	580	10	124	10	16	117	12	0	14	28	1	12	8	3	0	42	10	2
P 8	2.71	0.34	5.08	0.02	0.05	0.19	110	176	526	13	130	9	15	145	12	0	7	15	0	11	4	0	4	25	21	9
P 9	0.76	0.16	2.61	0.01	0.08	0.19	37	173	10	6	33	4	20	119	16	0	11	12	4	18	9	3	5	63	10	5
P 10	3.11	0.43	5.46	0.03	0.03	0.24	280	242	1173	11	130	7	15	155	14	0	6	16	1	12	12	5	0	80	27	24
P 11	3.19	0.41	5.67	0.02	0.03	0.16	233	175	1130	13	110	2	22	157	14	2	17	22	1	7	38	0	0	55	23	24
P 12	1.23	0.14	2.70	0.01	0.02	0.05	38	187	112	6	53	3	8	45	8	0	7	13	2	11	7	0	4	8	31	3
P 13	2.84	0.59	4.78	0.02	0.02	0.13	107	288	343	12	143	5	20	137	11	3	16	29	3	17	2	0	3	36	27	11
P 14	1.69	0.20	3.11	0.02	0.01	0.09	61	158	223	7	74	4	14	57	5	0	8	8	1	11	8	1	0	40	20	9
P 15	1.49	0.29	2.68	0.02	0.02	0.07	160	207	60	4	65	3	10	88	9	1	7	18	1	10	3	0	15	8	26	11
P 16	2.43	0.81	3.84	0.03	0.73	0.31	29	156	112	5	104	33	16	108	10	1	10	37	0	4	4	1	21	126	14	4
P 17	1.34	0.25	2.42	0.02	0.02	0.08	95	156	218	5	60	3	8	71	3	2	12	20	3	9	3	0	1	16	24	9
P 18	1.92	0.35	2.99	0.02	0.02	0.08	143	267	169	6	87	2	8	68	8	0	8	25	3	15	4	0	0	9	10	5
P 19a	1.99	0.26	4.29	0.02	0.03	0.29	68	256	93	12	104	4	9	101	5	3	10	18	3	6	6	0	1	144	15	8
P 19b	4.75	0.43	7.99	0.02	0.05	0.11	164	379	1809	23	191	6	17	126	10	1	15	21	3	16	13	1	0	37	18	16
P 20	3.11	0.47	6.19	0.02	0.10	0.09	91	246	1582	20	125	4	9	98	12	2	10	21	2	12	5	0	1	25	15	8
P 21	1.18	0.20	2.55	0.02	0.02	0.13	54	163	133	5	58	5	10	46	8	3	3	14	2	5	3	1	2	52	21	6
P 22	0.97	0.14	3.99	0.07	2.07	0.07	24	192	158	7	32	145	12	121	7	1	8	9	3	6	0	3	2	10	10	8
P 23a	1.05	0.18	2.16	0.01	0.01	0.08	47	217	10	5	46	1	10	57	2	2	9	14	2	4	2	0	1	27	14	9
P 23b	1.52	0.22	2.43	0.02	0.02	0.08	52	136	61	6	51	4	18	217	10	1	5	13	1	6	0	0	2	32	6	2
P 24	5.08	0.47	8.82	0.02	0.04	0.39	375	378	934	18	199	4	23	233	23	9	29	16	1	25	36	6	0	128	20	28
P 25	3.70	0.88	8.08	0.02	0.04	0.28	124	317	10	19	211	4	18	350	14	0	12	49	4	186	72	0	1	79	34	8
P 26	4.00	0.83	6.20	0.02	0.03	0.35	271	301	226	17	165	3	23	137	12	3	14	44	5	57	7	3	4	111	25	20
P 27	2.96	0.62	4.47	0.02	0.02	0.14	189	243	209	9	144	5	18	160	6	2	13	27	3	19	0	2	0	35	10	6
P 28	2.12	0.31	3.58	0.02	0.01	0.11	182	238	243	8	86	1	17	81	13	2	10	18	1	23	14	2	0	26	8	7
P 29	4.36	0.09	3.58	0.01	0.06	0.10	13	336	2930	5	85	28	23	81	9	0	7	3	3	6	8	0	0	15	12	1
P 30	1.64	0.33	2.58	0.01	0.01	0.05	134	195	44	6	75	2	6	78	9	1	8	23	3	10	0	2	0	15	22	11
P 31	3.33	0.17	5.52	0.02	0.03	0.07	123	283	1401	10	113	5	7	133	6	0	9	4	2	11	11	5	2	8	35	12
P 32	1.64	0.07	4.03	0.08	2.23	0.10	20	79	1072	5	37	105	9	114	4	1	7	5	2	3	5	0	2	17	13	1
P 33	1.44	0.26	5.54	0.05	1.97	0.13	38	164	380	10	55	96	15	139	11	2	11	11	3	12	22	2	3	38	11	4
P 34	2.64	0.73	6.47	0.03	0.41	0.39	164	203	461	13	122	23	19	180	11	2	6	35	11	52	11	2	2	90	12	11
P 35	2.96	0.73	4.99	0.02	0.02	0.25	271	231	949	12	126	4	15	178	7	3	14	34	0	25	13	4	1	56	20	18
P 36	1.50	0.24	3.02	0.01	0.03	0.06	150	158	302	5	72	10	15	96	9	1	10	12	3	13	8	0	1	9	27	13
P 37	0.18	0.20	5.05	0.05	3.92	0.24	57	124	10	4	7	104	19	314	13	0	7	16	3	20	15	1	10	57	4	13
P 38	3.78	0.72	6.45	0.02	0.02	0.22	359	317	267	17	180	4	22	333	14	0	15	32	1	28	10	1	2	74	20	28

APPENDIX II cont.

Sample	In percent							In ppm																	EPR(cm)	
	K	Fe	Al	Cu	Na	Tl	Mn	Cl	Ba	Ga	Rb	Sr	Y	Zr	Nb	Ti	Th	Co	Cu	Zn	Pb	As	Ni	V	±5mT	±100mT
P 39	2.24	0.21	4.24	0.04	1.56	0.10	33	161	760	8	60	41	17	66	8	2	5	16	6	5	0	1	7	20	13	2
P 40	6.68	0.68	9.92	0.03	0.04	0.15	412	391	2392	25	288	10	25	185	18	0	17	30	3	14	10	1	0	51	9	23
P 41	5.70	0.62	9.39	0.03	0.02	0.41	167	313	1540	26	221	10	31	320	26	0	28	23	1	33	23	9	0	117	17	15
P 42	3.04	0.54	5.77	0.02	0.14	0.08	111	263	318	15	139	8	11	94	8	1	10	30	4	18	6	0	0	10	20	9
P 43	3.05	0.83	4.90	0.02	0.04	0.09	174	225	350	14	123	2	6	188	8	4	10	40	5	54	4	0	3	2	25	11
P 44	4.60	0.43	7.67	0.03	0.03	0.37	100	267	873	20	203	5	35	280	21	6	20	25	2	17	6	3	0	111	18	10
P 45	3.13	0.25	4.85	0.03	0.32	0.12	67	267	1189	10	86	29	15	153	7	0	8	16	4	12	7	0	4	20	15	7
P 46	4.22	0.69	7.37	0.03	0.04	0.42	303	106	137	16	170	6	16	157	11	2	8	25	2	24	46	24	0	266	17	25
P 47	3.74	0.45	6.26	0.03	0.05	0.14	113	307	1904	16	132	5	16	174	9	2	13	26	1	16	17	3	0	32	12	21
P 48	2.38	0.33	4.34	0.02	0.03	0.19	94	169	980	11	108	3	13	128	18	2	10	17	4	7	7	2	2	46	25	10
P 49	2.36	0.46	4.04	0.02	0.05	0.07	70	189	152	9	105	3	4	55	6	0	5	27	2	20	4	1	3	0	45	7
P 50	3.01	0.35	3.08	0.02	0.03	0.06	71	271	876	7	87	5	10	147	5	3	9	18	5	12	2	1	1	0	31	6
P 51	0.46	0.44	99.59	0.01	0.01	0.02	9114	82	19	144	7	1	6	13	1	0	1	14	2082	73	26	2	28	75	18	15
P 52	5.44	0.90	9.50	0.03	0.18	0.14	180	254	450	29	204	9	7	151	21	1	8	34	3	43	5	0	7	22	6	11
P 53	2.44	0.51	4.90	0.02	0.27	0.10	143	216	797	11	91	19	11	108	14	1	12	23	8	26	8	1	5	2	14	11
P 54	2.37	0.25	3.48	0.02	0.03	0.06	93	151	505	7	77	3	9	100	5	3	6	14	1	38	10	13	2	13	32	9