GEOLOGICAL SURVEY
OF
WESTERN AUSTRALIA

REPORT 4

A COMPARATIVE STUDY OF THE GEOCHEMISTRY OF ARCHAEAN BEDROCK IN PART OF THE NORTHEAST YILGARN BLOCK

by R.L. Davy

1978

FOREWORD

This report describes the bed-rock geochemistry of Archaean rocks in part of the north-east Yilgarn Block. As such, it presents the results of a prototype investigation to determine the usefulness of bed-rock geochemistry in Western Australian conditions as a reconnaissance tool in regional mapping and exploration. It represents the largest geochemical project yet undertaken by the Geological Survey of Western Australia.

As the report indicates, despite the lack of outcrop, and the promblems of deep weathering, the data generated are most useful in supplementing the regional mapping by providing a better understanding of the nature and development of the rocks of the area and by pointing to areas appropriate for more detailed exploration.

Despite the success of this project it is unlikely, because of economic constraints, that the Survey will carry out further studies on this scale. However, it is anticipated that bedrock geochemistry, on a restricted basis, will continue to be used as an exploration tool.

J H Lord
DIRECTOR

15 December 1977

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National Library of Australia card number and ISBN
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A COMPARATIVE STUDY OF THE GEOCHEMISTRY OF ARCHAEAN BEDROCK IN PART OF THE NORTHEAST YILGARN BLOCK

by

R. L. Davy

ABSTRACT

Approximately 1 200 'fresh' and 300 altered or weathered samples of Archaean bedrock, from parts of the Leonora, Laverton and Rason 1:250 000 Sheet areas, have been analysed for seventeen elements and oxides. This work has allowed definition of the chemical attributes of most of the major rock types within the area sampled, and has aided the recognition of sub-groups not readily identified in the field.

Points of significance which have been drawn out from the data include: i) the presence of two main types of mafic rock; a low-K tholeiite which comprises most of the mafic rock of the greenstone belts, and a 'high'-K tholeiite which is restricted areally, and occurs in association with calc-alkaline volcanic and subvolcanic felsic rocks; ii) the recognition of previously unreported ultramafic rocks in the Diorite Hill area (Laverton sheet); iii) the recognition, from K/Rb and Rb/Sr ratios, that parts of different cycles of greenstones may be present; iv) a demonstration that the Mt. Venn layered sill, though of a low-K tholeiite magma type is compositionally different from other low-K mafic rocks; v) the recognition of regional trends in granitoids and of localized trends in mafic rocks in the Mt. Scott-Rutter Soak area (Rason sheet); and vi) the recognition, in some places, of more than one cycle of granitoid intrusion, each cycle of which is characterized by an increase in potassium as the rocks get younger.

Regional geochemical threshold values have been established for base metals and uranium, and on the basis of known mineralization and the distribution of anomalous values areas with potential for further prospecting have been recognized.

INTRODUCTION

In 1972 the Geological Survey of Western Australia initiated a programme of regional rock sample analysis to investigate the potential of Archaean bedrock geochemistry as:

i) an adjunct to regional mapping,

ii) a reconnaissance prospecting tool,

iii) a data source for the determination of possible metallogenic provinces, and

iv) an aid to the identification of possible major geochemical trends.

The area chosen for this study consisted of parts of the Leonora, Laverton, and Rason 1:250 000 map sheets (Figure 1) in the northeast part of the Yilgarn block. Most samples collected were of Archaean igneous rocks and their metamorphosed equivalents, but a few representatives of sediments, in particular cherts and conglomerates were also collected. During the programme, some 1 200 'fresh' samples and 300 altered, or weathered, samples were collected; emphasis was given to the collection of samples from major outcrop zones with the proviso that the samples should be as representative of the various rock types as possible. Altered and weathered samples were collected primarily for an examination of the effects of alteration, and the examination of possible associated movement of ore metals.

Separate reports have already been prepared for each sheet (Davy, 1976a; 1976b; and 1976c). This paper is intended to provide a synthesis of the main results and conclusions, and to provide some comparison with similar rocks of similar age from different parts of the world.

Plots showing the distribution of the samples collected are included with the individual sheet reports. Seventeen elements and oxides* were determined by x-ray fluorescence analysis on compressed powder briquettes, and one element, uranium, was determined by paper chromatography (Plamonden, 1968).

All analyses were carried out by the W.A. Government Chemical Laboratories. Details of the sample preparation and of the x-ray fluorescence analytical methods are given in Davy (1976a, b), together with a statement and discussion of the accuracy and precision of the results. Silica was not determined for samples from the Rason Sheet.

Thin sections of 238 specimens were prepared, and these have been used in the classification of the samples, and in the determination of their states of alteration.

* Ba, CaO, Cr, Cu, total iron as Fe_2O_3, K_2O, MgO, Na_2O, Ni, Pb, Rb, SiO_2 (Laverton and Leonora sheets only), Sr, TiO_2, V, Zn and Zr.

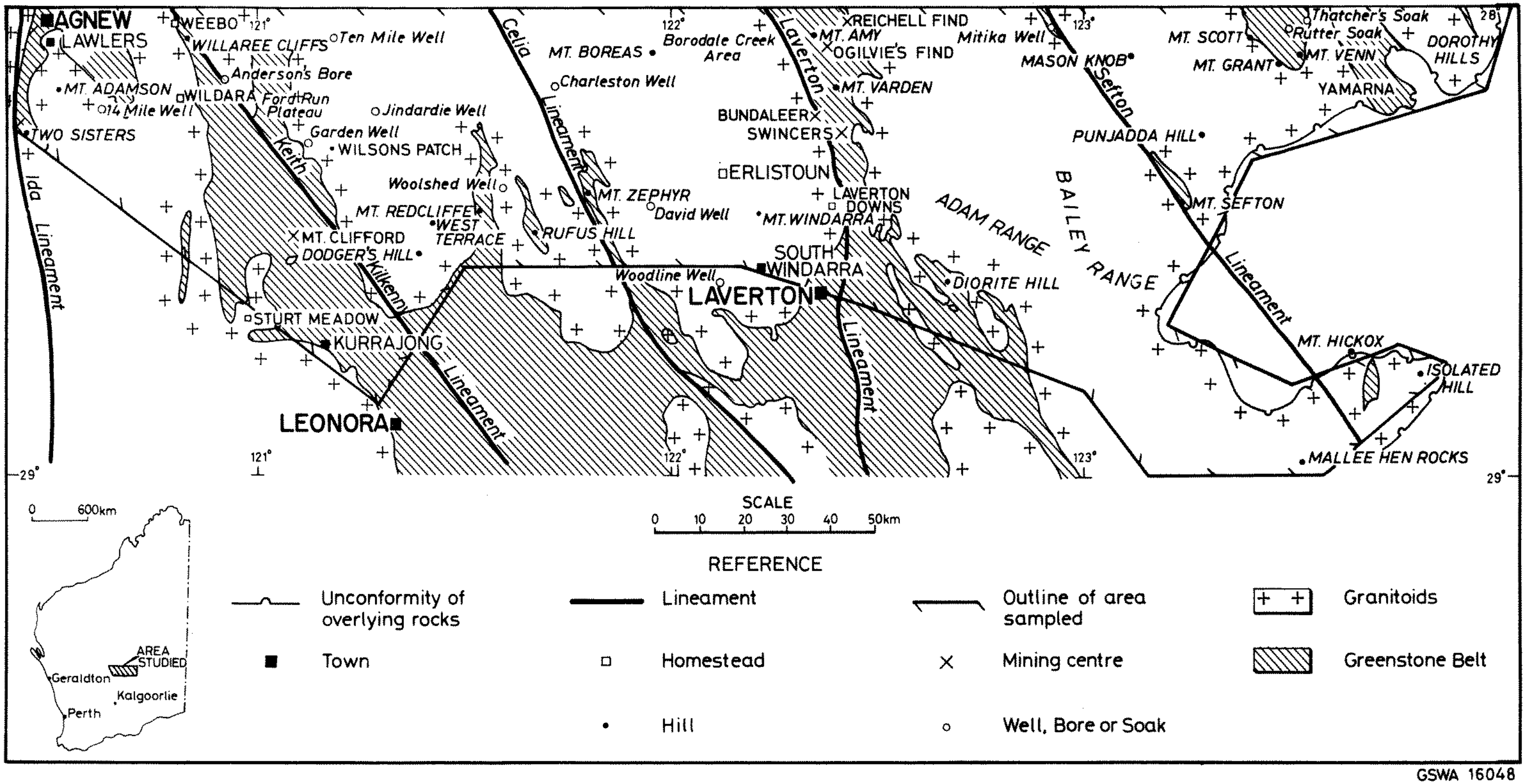

Figure 1 Sketch map of the area sampled, from the Leonora, Laverton, and Rason sheets.

Individual analyses of the different rocks grouped by localities are given in Davy (1976a, b, and c), and are not reproduced here. Summaries of the data for various rocks are given in the appendix. The data were stored on magnetic tape ; and computer-drawn histograms, means, standard deviations, correlation coefficients, and scatter plots (all based on a log-normal distribution of the elements) have been used for interpretative purposes. These print-outs are stored in the Western Australian Geological Survey files. Extensive interpretative use has also been made of cumulative frequency curves plotted on log probability paper, elemental-ratio plots, and AFM* and Na_2O-CaO-K_2O triangular diagrams. These diagrams have been included in the individual sheet reports, and are not generally reproduced in this report.

The geology of the area sampled has been described by Gower and Boegli (1973), Gower (1974), and Thom and Barnes (1974). The general picture is of large complex masses of granitoids (including both migmatite and intrusive granitoid) of various ages, separated by greenstone belts (Figure 1). The greenstone belts consist of mixtures of ultramafic, mafic, felsic-volcanic, and sedimentary rocks in varying proportions, and minor intrusions of granitoids. Several remnants of greenstone belts occur in places, within the granitoids. A layered mafic-ultramafic sill complex occurs at Mount Venn (Rason sheet). Williams (1974) divided the Eastern Goldfields Province into three subprovinces. The central (Kalgoorlie) and eastern (Laverton) subprovinces are relevant to this paper. Williams considers that a number of major linear disruption-zones (known as lineaments) run in a generally north-northwest direction through the area studied. The major lineaments recognized in the area are, from east to west:

i) Sefton,
ii) Laverton,
iii) Celia,
iv) Keith-Kilkenny, and
v) Ida.

The positions and configurations of these appear on Figure 1.

In the discussion which follows, the symbols for the various rock groups are mainly those used by the field geologists. Their designation has been changed only when later work has modified the field identification.

Samples have been given co-ordinates on the Australian Transverse Mercutor Grid (ATM), to four figures. There may be error in the fourth figure.

* AFM diagrams are plots of $Na_2O + K_2O$, MgO, and FeO^t where FeO^t is total iron expressed as FeO

The ATM Grid is divided into zones, and the co-ordinates for Leonora, Laverton, and the Western part of the Rason sheet fall in the same zone (zone 2). East of a line through Mount Venn however the base and direction of the grid is changed (zone 3), necessitating recalculation for computer manipulation of zone 3 co-ordinates in terms of those of zone 2.

Many of the samples collected retain relict igneous textures, and their composition is consistent with that of well recognized igneous rocks. Other samples have been reconstituted with loss of igneous textures, but their compositions are so little different from those of their neighbours that there is no reason to exclude them from any discussion of the results. Both types of sample have been considered as isochemical equivalents of the premetamorphic rocks.

Samples which have been recognizably affected by secondary processes have been excluded from subsequent discussion. Processes recognized have included:

i) silicification,
ii) ferruginization (lateritization),
iii) kaolinization, and
iv) carbonation.

Worden and Compston (1973) have made a study of weathering in the Dodger's Hill (Mertondale) 'granite' on the Leonora sheet. This is the only formal study of secondary surficial processes yet published for the study area.

RESULTS

ULTRAMAFIC ROCKS

Geologists who have mapped the area have divided the ultramafic rocks into the following groups, mainly on the basis of their texture and apparent primary mineralogy:

i) Aup Serpentinite after coarse-grained olivine-rich rock;
ii) Aus serpentinite after fine-grained ultramafic rock, commonly exhibiting spinifex texture;
iii) Ar altered mafic-ultramafic rocks, formerly high magnesium basalts;
iv) Ae chlorite tremolite (talc-carbonate) rocks of uncertain origin;
v) Aux pyroxenite; and
vi) Au unassigned ultramafics, including all rocks of uncertain origin whose texture has been destroyed by diagenesis or metamorphism.

Of these groups only Ar has been recognized on all three sheets, and only Ar, Ae and Au on both the Laverton and Leonora sheets. Each group is found to be chemically variable, and a range of compositions for selected rock types in selected areas is given in Table 1. A suite of previously unrecognized ultramafic rocks, probably Ae, has been identified in the Diorite Hill area (Laverton).

Table 1 shows a division into two main chemical groups: those with moderate CaO (7-15%) and MgO (10-26%); and those with low CaO (<5%) and high MgO (>26%). The first group corresponds, by and large, to the Ar, Ae, Aux, and the more magnesian tholeiites (not listed in Table 1), the second to Aus, and Aup. Overlap between groups occurs. This is not surprising when the possibilities for cumulate formation in pyroxenites (Aux), and the wide variations known within different layers or zones of high magnesium basalts (Barnes and others, 1974) are considered. Au rocks are split between the groups. Attempts have been made to further separate the ultramafic rocks using histograms and CaO-FeO^t-MgO and AFM triangular diagrams.

Separation on the basis of ratios of elements with Al_2O_3 could not be considered as alumina was not determined. It is not possible to separate high magnesium basalts from pyroxenites. This conclusion tends to support Glikson (1972) and others who argue that high magnesium basalts are the volcanic equivalents of pyroxenites.

Histograms (Figure 2) show troughs of composition in MgO (between 26 and 29%), in Ni (between 1 300 and 1 800 ppm) and in CaO (between 3 and 5%). Rocks with MgO in excess of 30%, Ni in excess of 1 800 ppm, and CaO less than 1% are all serpentinites. Most samples with MgO values of 22-29% are partly serpentinized pyroxene-rich rocks. The more highly magnesian members of the pyroxene-high-magnesium basalt sequence were also present chemically; but, below about 13% MgO, there is apparent chemical intermixing with the more magnesian members of the tholeiite sequence. There is a trough in the histograms between 12.5% and 13.5% MgO, and below this trough separation of high-magnesium basalts and pyroxenites from tholeiitic basalts and gabbros by chemistry alone is tenuous. In general the Ar, Ae, and Aux rocks contain more nickel (commonly over 400 ppm, against a maximum of about 300 ppm in tholeiites) and, on overall balance, they contain less strontium, titanium and zirconium. Chromium, potentially of value in discrimination, could not be used because of contamination from a chrome-steel grinding mill.

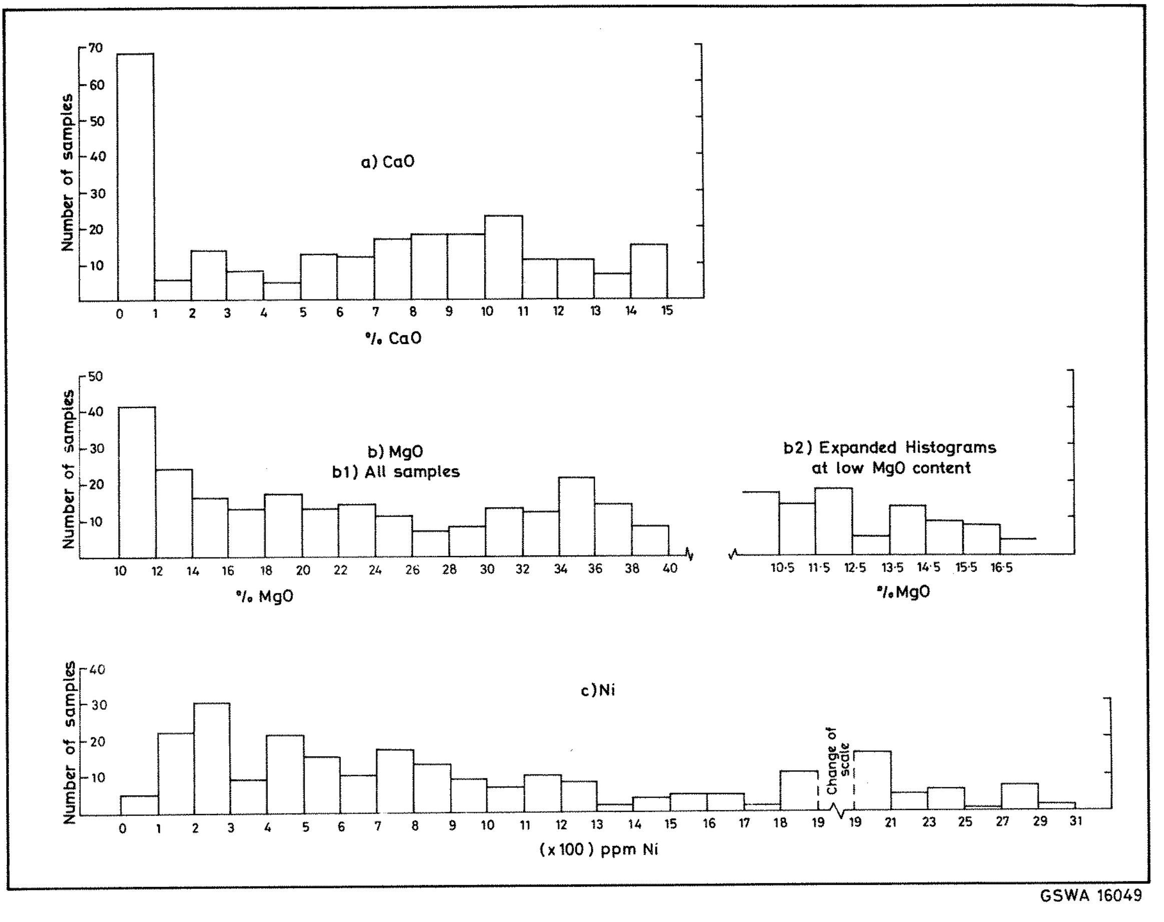

Figure 2 Histograms for the ultramafic rocks (MgO >10%).

For the most part Ae rocks have similar compositions to the high-magnesium basalts, but the original texture has been obliterated.

In general, in all the ultramafic rocks, barium, lead, rubidium, and potassium tend to be very low. Barium is commonly less than 100 ppm, and K_2O less than 0.3%. Sodium values are very low in serpentinites (<0.5%), but are higher in both pyroxenites and related rocks and in the tholeiites. Strontium tends to be higher in the Aux and Ar/Ae rocks than in the serpentinites. Silica values show a wide scatter, reflecting the original mineralogy of the rocks. TiO_2, V, and Zr all tend to be higher in the magnesian tholeiites, than in the true ultramafic rocks.

The dominant ultramafic rocks in the Lawlers-Agnew area are Au and Aux. An attempt was made to classify the Au rocks into one or more of the better recognized rock types, but they show a wide range of composition. A few Au rocks in the Lawlers Agnew area have high silica values, and are probably sediments derived from ultramafic rocks. Ultramafic sediments are known 3 kilometres northwest of the Agnew airstrip (Bunting and Williams, 1976).

In the main greenstone belt, which runs from Wildara to Leonora all ultramafic types except Ae are represented. $CaO - FeO^t - MgO$ triangular diagrams for rocks of these two areas show that there is a greater proportion of highly magnesian rocks in the main greenstone belt than in the Lawlers-Agnew belt, and that the trend from the magnesium-rich members to the calcium-iron-rich members for the two areas follows a different curve. This suggests that primary differences occur in the composition of the ultramafic rocks in the two areas, and that the rocks of the two areas have followed slightly different fractionation paths (Fig.3a, 3b). The diagrams show some degree of scatter and overlap from one rock type to another, suggesting that the divisions between the rock types are not distinct, and it is conceivable that a single continuous series is present from the most magnesian ultramafic rocks through to tholeiites. The rocks from the two areas are probably stratigraphically different, and the variation in trends may be real.

The high average MgO content of the Wildara-Kurrajong ultramafics is most significant when considered with the high degree of correlation of MgO with Ni (+0.69 Leonora sheet; + 0.76 Laverton sheet).

It has been shown empirically, as a result of exploration, that nickel ore bodies are more common in the more magnesian ultramafic rocks. If this is so (and the correlation between the two tends to support it), the Wildara-Kurrajong greenstones should be more prospective for nickel than the Lawlers-

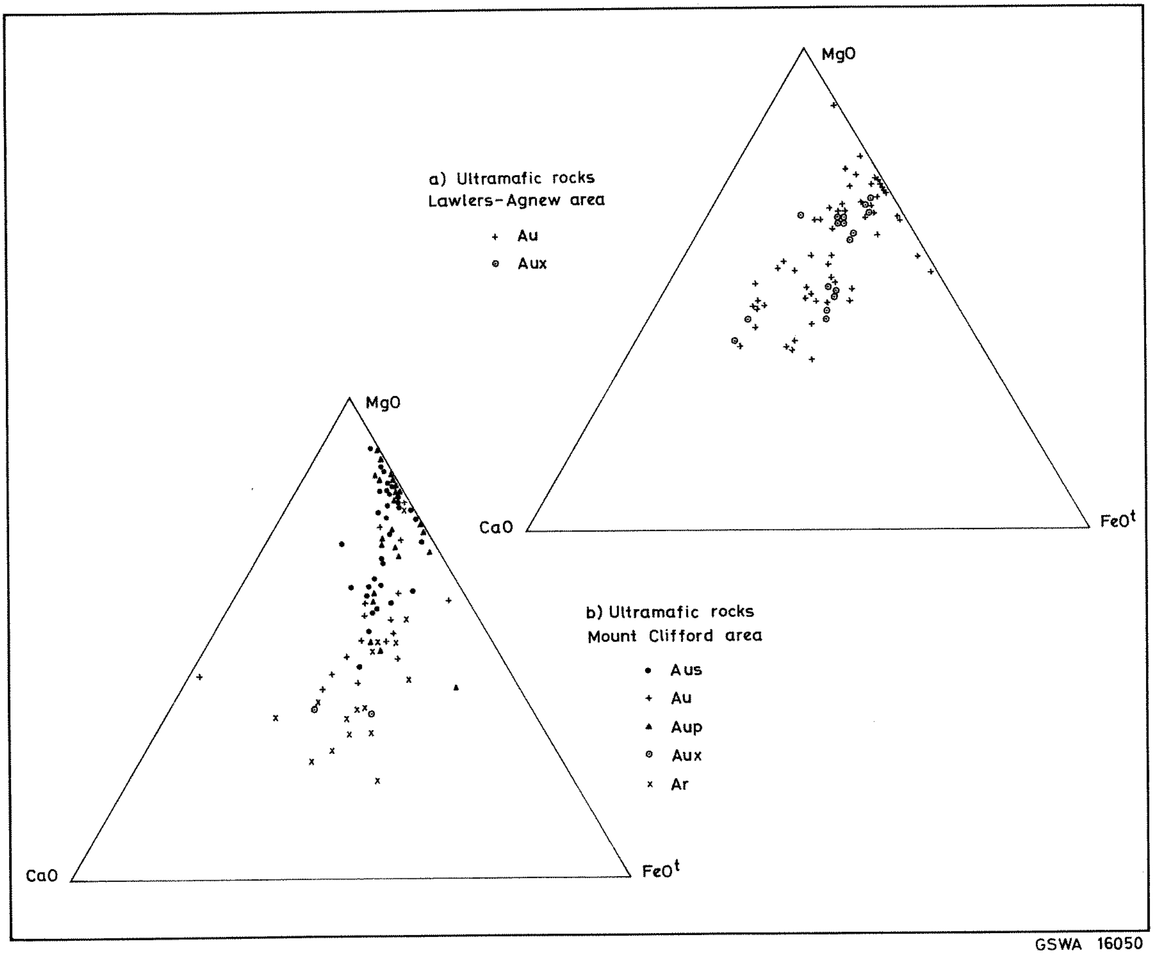

Figure 3 CaO-FeO^t-MgO diagrams for ultramafic rocks.

Agnew rocks; and in fact, the Weebo and Marriott prospects are known in the former area, whereas no significant mineralization is known in the latter.

Correlation coefficients show that copper and nickel in ultramafic rocks are not closely related (+0.05), and that the relationship between copper and magnesium oxide is even less (-0.2). The correlation of copper with calcium oxide is not high (+0.12) on the Leonora sheet, but is much higher (+0.70) on the Laverton sheet, (there are not enough ultramafic rocks on the Rason sheet for a correlation coefficient to be significant), and most of the higher values of copper in ultramafic rocks from all three sheets are found in pyroxenites and related rocks.

MAFIC ROCKS

Mafic rocks occur in all greenstone belts and as enclaves of varying size within granitoids elsewhere. In only three areas are mafic extrusive rocks geographically associated with appreciable proportions of fine-grained felsic rocks. These areas are:

i) Ford Run Plateau (Leonora sheet),

ii) Mt. Scott - Rutter Soak (Rason sheet), and

iii) Yamarna (Rason sheet).

The great majority of the mafic rocks are regionally metamorphosed basalts and dolerites (Ab and Ad respectively), their thermally metamorphosed equivalents (Ah and Am respectively), pillow basalts (Ai), and overtly carbonated basalts (Ak).

Basalts and dolerites (Ab and Ad)

The most common mafic rock is a low-potassium (0.2 - 0.3% K_2O) tholeiite, which shows little chemical variation from belt to belt. Typical results for these rocks which have all been more-or-less regionally metamorphosed, are tabulated in Table 2. The chief difference between Ab and Ad rocks from the same area is that the basaltic rocks contain slightly more alkalis, in particular sodium (Table 2). The mean values for most elements are quite similar, and the standard deviation is almost the same. Similarly, from one greenstone belt to another, (Table 3) there seem to be no major differences. However, one significant difference occurs at Diorite Hill on the Laverton sheet where the rocks contain higher MgO, and less V and Zr than comparable rocks from other parts of the region.

An attempt to identify trends along strike and as the rocks get younger, in selected areas (Agnew, Mount Clifford, Mount Varden and Laverton), has proved inconclusive, and any possible trends are small.

Mafic rocks occur at the same locality as high-magnesium basalts (e.g. at Mount Varden). These rocks are uniformly low-K tholeiites very similar to the rocks discussed above. Most of the basalts/dolerites which contain more than 0.4% K_2O belong to mafic-felsic volcanic complexes (next section). However, elevated values of K_2O are found north of Ten Mile well and east of West Terrace (both Leonora sheet). The latter rocks average 0.55% K_2O for two samples, the former 0.7% for two samples. Otherwise their chemistry is close to the low-potassium mafic rocks. One sample from West Terrace is an unaltered, pyroxene-bearing dolerite, and another is an amphibole-plagioclase rock which displays a relict igneous texture.

In all other areas, isolated samples with high K_2O values are considered, from hand specimen or thin section examination, to have been contaminated by contact with granitoids, or to have been partly sercitized.

Mafic components of the mafic-felsic associations

Mafic-felsic volcanic associations occur at Ford Run Plateau (Leonora sheet) Mount Scott-Rutter Soak (Rason sheet) and ? at Yamarna (Rason sheet).

The characteristic of the mafic rocks of these associations is that they contain more potassium than the 'low potassium' tholeiites. In the Ford Run Plateau area, the K_2O content of Ab and Ah rocks (jointly, is 0.50% and for Ad rocks is 0.45% (Table 3). Otherwise their chemistry is fairly normal for tholeiites; thus, CaO is in the range 8-13%, MgO 6-9.5%, Na_2O 1.2-2.3% and (total iron as) Fe_2O_3 8-13%.

The mafic rocks of the Mount Scott-Rutter Soak area show a distinctive geochemical trend from the southwest to the northeast, which is defined by increasing K_2O, and decreasing Fe_2O_3 and MgO (Table 2). Differences in other elements are also present. The trend is expressed lithologically by a change from dominant dolerites in the southwest to basalts in the northeast.

A 't' test was used (Davy 1976a, Appendix A1) to determine if the populations in the two areas were significantly different. The differences in Fe_2O_3 and MgO were significant at the 99% confidence level, and in Pb, Zn and Zr, at the 95% confidence level. Though the mean values for other components differ markedly, the high degree of scatter of the values indicates that the differences between the means are not significant at the 95% level. Gower and Boegli (1973, p.5), considered that the basalts had suffered surface silicification. Though no SiO_2 values have been determined on these rocks, no loss of K_2O or Na_2O is apparent, and the chemistry suggests petrogenetic change rather than surface alteration.

Yamarna lies 25-30 km east-southeast of the Mount Scott-Rutter Soak area. At Yamarna, small areas of mafic rock crop out sporadically round the perimeter of an area of felsic tuffs and agglomerates; and are, in part, separated from them by metasediments. The mafic rocks are basalts (Ab) northeast and southeast of Yamarna, but 'amphibolites' (Ah and Am) to the southwest. The basalts seem closely related to each other, and are of the low potassium (K_2O 0.2-0.3%) type unlike those of the Mount Scott-Rutter Soak group. The amphibolites are, on the whole, more potassic (up to 0.9% K_2O), and also contain more sodium (2.6 - 3.3% Na_2O), iron (12 - 12.6% Fe_2O_3), and titanium (0.9 - 1.8% TiO_2); and less magnesium (5.4 - 6.7% MgO) than the subadjacent mafic rocks.

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The analyses of the amphibolites compare quite closely with those of the basalts from Rutter Soak, yet some doubt exists about the closeness of the relationship because of the thermal metamorphism they have undergone.

The close spatial association of high-K mafic rocks with felsic volcanic rocks at Ford Run Plateau and Rutter Soak, suggests that the rocks may also be genetically related. A genetic relationship is less likely at Yamarna where thermally metamorphosed mafic rocks occur adjacent to the felsic rocks, because of the possible contamination of the mafic rocks by potassium mobilized during metamorphism.

The Mount Venn layered intrusion (Aj)

According to Gower and Boegli (1973, p.6) the Mount Venn layered intrusion is "... an arcuate, south plunging synformal structure. There is a change from dominantly ultramafic rocks at the northern end to leucogabbro at the southern end. Rhythmic layering is well developed, particularly in the central and southern parts of the body. Individual layers commonly show gravity stratification of minerals".

Forth-eight samples have been analysed. The one consistent feature of the chemistry is the low potash value of about 0.2% K_2O in all samples, only exceeded in rare contaminated rocks. Values for barium (50-200 ppm) and titanium (0.2-0.5% TiO_2) are consistently low except in marginal phases (Ba) and other isolated samples (TiO_2). Most rubidium values are less than 10 ppm; chromium and nickel are also low. A nickel value as low as 4 ppm occurs in one marginal sample. The low titanium values distinguish this rock type from the more common tholeiites, which contain approximately twice as much.

Three of the 48 samples are substantially serpentinized; these three contain 25-26% MgO, and low to moderate CaO (3.9-7.1%). They contain relatively low Cr (<1400 ppm) and Ni (<680 ppm), and are derived from pyroxene-rich rocks rather than from peridotite. The MgO content varies from 23% to 2.0%, and only minor gaps in the progression occur, for example between 18.6% and 15.3% MgO. The highly magnesian samples contain least CaO, though, except for the highly serpentinized rocks the lowest value of CaO is 7.7%. There is normally between 10 and 14.5% CaO. The iron content is low compared with the more common basalts and dolerites, and only nine of the samples have total iron (as Fe_2O_3) exceeding 10%. Most of the remainder are in the range 4 - 8%, Fe_2O_3. Sodium, too, is lower than in the low-K basalts/dolerites.

Trace elements, though commonly low, show a wide scatter of values, and the standard deviation often exceeds their mean values by over 100%.

It is not possible to identify any fractionation trends with certainty. The chemistry does not suggest restriction of more magnesian rocks to the basal zone (somewhat contrary to Gower and Boegli, 1973), and an AFM diagram (Fig.4) shows indications of several nebulous fractionation trends. One possible explanation may be the presence of two or more magma stems.

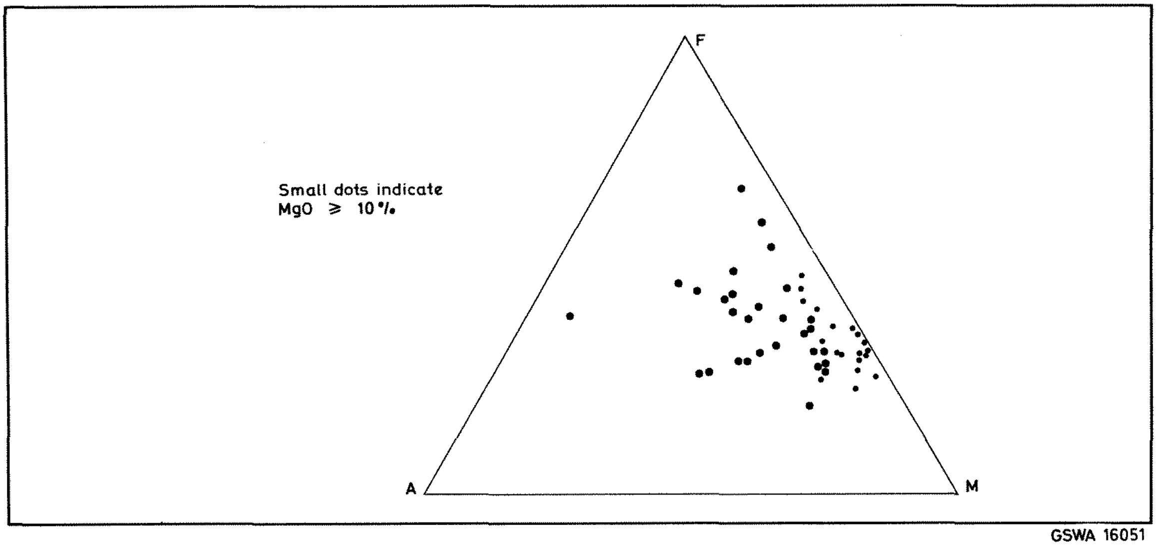

Figure 4 AFM diagram for the layered intrusion of Mount Venn.

This body contains minor copper mineralization and one nickel value over 1 000 ppm. The highest copper reported (0.34%) occurs in a tremolite-brittle mica-chlorite rock. This rock contains no sulphide, and it is considered that copper is present within the lattice of either, or both, the phyllosilicates. Chalcopyrite has been identified elsewhere in this rock.

Amphibolites (Ah and Am)

Fine and coarse-grained amphibolites (Ah and Am respectively) are found in all greenstone areas. In addition, rafts of similar material occur within the main granitoid masses. These amphibolites are considered to be thermally metamorphosed basalts and dolerites, in contrast to the regionally metamorphosed Ab and Ad rocks. The major element chemistry of all these bodies is basic (<55% SiO_2) in character, but the present composition of some of the bodies differs sharply in some elements from both low-K and high-K basalts and dolerites (Table 2). In general, the larger bodies retain the chemical characteristics of the supposed parent mafic rocks, but many of the smaller ones differ in some way. Some of these rocks have subsequently been tentatively identified as sediments on the basis of their field relationships and/or their textural properties.

Examples of possible sedimentary amphibolites include Ah rocks at Dorothy Hills (Rason sheet), at Thatchers Soak (Rason sheet) and Am rocks in the Lawlers-Agnew area (Leonora sheet). These rocks exhibit some chemical differences from the low-K igneous mafic rocks. The Am rocks from Lawlers-Agnew have higher SiO_2 (56%), and lower copper (28 ppm) and nickel (34 ppm), than normal basalts. The trace-element contents of some of the Ah rocks at Dorothy Hills are low (Ni 28 ppm, Zn 43 ppm, and Cu 12 ppm); whereas Ba (1327 ppm), K_2O (0.4%), Pb (15 ppm), and Zr (150 ppm) are all high. These rocks contrast with other similar rocks from the same area whose composition is indistinguishable from normal low-K basalts.

Many other Ah and Am rocks have the composition of low-K tholeiites, but in others there are significantly higher values of barium, potassium, and, possibly, silica compared with the low-K mafics. It is hard to determine which elements, if any, have been lost. Magnesium may be slightly lower, but was not shown to be statistically different when subjected to a 't' test. The potassium content varies from 0.4% K_2O (Mount Zephyr, Windarra, and Redcliffe; all on the Laverton sheet) to 2.3% K_2O (Woolshed well, Laverton sheet); and the degree of increase in K_2O seems to vary with the size of the mafic bodies and their degree of enclosure by granitic rocks. (The Am rock at Woolshed well consists of a small raft of mafic rock totally enclosed by porphyritic adamellite). The origins of these rocks are not clear; contamination of a mafic magma by adjacent felsic material is a possibility.

East of Wildara (Leonora sheet), two samples of Ah in close juxtaposition are very different in composition; one sample is very rich in actinolite-hornblende, containing 17.2% Fe_2O_3 compared with the more normal 9.9% Fe_2O_3 of the other. In contrast MgO is 5.2% when iron is high, 12.4% when iron is 'low'. Thin-section examination, however, suggests that both these samples were basalts.

Isolated ultramafic rocks, possibly once high magnesium basalts, also occur with Ah rocks. An example of this comes from the Ah of the Lawlers area where the high MgO value (22%) of one sample attracts immediate attention.

Pillow Basalts (Ai)

Rocks considered to be pillow basalts have been collected from the Leonora area; and from Diorite Hill, Mount Varden, and Laverton on the Laverton sheet. The rocks are fine grained, amphibolitic in hand specimen, and show no significant difference in composition from low potassium basalts (Table 2). There is no enhancement of sodium.

Carbonated Basalts (Ak)

Rocks of this type were collected from west of Mount Amy and southwest of Mount Varden on the Laverton sheet. The alkali content of the rocks near Mount Amy (0.3% K_2O and 2.9% Na_2O) is rather higher than the average for the low potassium basalts, but the difference is not considered significant; and analyses of both outcrops of this rock show no difference from the normal low-K basalts (Table 2). These rocks were not sectioned but the samples did not react with 1:1 hydrochloric acid.

Carbonated rocks undoubtedly occur within many of the mafic suites. All rocks with CaO in excess of 15%, and most with CaO over 13% contain some carbonate. In addition, a number of dolomite-rich rocks were also identified. Samples which are badly carbonated have been excluded from all summary tables. However, examination of the composition of rocks which have up to 5% calcite in thin section showed that the analyses of these rocks (which did not include CO_2) cannot be categorically separated from analyses of non-carbonated mafic rocks. In comparison with established non-carbonated rocks, there appears to have been some loss of iron, sodium, and, possibly, magnesium during these early stages of carbonation. In the absence of total petrographic knowledge ofthe mafic rocks, all analyses, except those from grossly altered samples, have been included in each appropriate category.

VOLCANOGENIC AND FINE-GRAINED FELSIC ROCKS

The nomenclature used by the field geologists for fine grained felsic rocks is as follows:

Al - acid lavas, rhyolite, dacite, and fine grained tuff lavas;

Ap - porphyritic, intrusive, hypabyssal, mainly dyke, rocks; and

Ax - pyroclastics: tuffs, agglomerate, breccias.

Extensive outcrops of lavas and pyroclastics occur at Ford Run Plateau (Leonora sheet) and in the Rutter Soak and Yamarna areas (Rason sheet). In the two former areas, the felsic rocks occur in close proximity to, or interbedded with mafic rocks. The relationship of mafic to felsic rocks is, as indicated earlier, less clear at Yamarna.

Ford Run Plateau

In the Ford Run Plateau area, both Ap and Al rocks have been sampled (Table 4; and Davy, 1976c) together with a few variants of unknown origin. Unlike most dykes, Ap rocks from this area are adamellitic, highly siliceous, and not soda rich.

In this area, rocks may be post-metamorphic in contrast with other more sodic dykes. Volcanic rocks in this general area are found in two main outcrop zones. Towards Wilsons Patch Al rocks are similar to the porphyries, but further north at Ford Run Plateau itself, the rock is dacitic. Apart from higher values of Sr, TiO_2, and ?V, the Al rocks of the Wilsons Patch sub-area are closely similar to the Ap rocks which suggests that the dykes may be feeders for the extrusive rocks.

These rocks in turn show a family resemblance in their chemistry to nearby biotite 'granite' (Agb), suggesting that this rock might be a high level intrusion.

The acid volcanics of the Ford Run Plateau area and associated mafic rocks are plotted on an AFM diagram (Fig.5a). This diagram shows an apparent calc-alkaline trend according to the separation curve of calc-alkaline rocks from tholeiites of Kuno (1968). A gap caused by the virtual absence of intermediate rocks, is present on this diagram.

Rutter Soak and Yamarna

In contrast, at Rutter Soak and Yamarna, the Ap rocks are not similar in composition to the volcanic and pyroclastic rocks. The Ap rocks are characterized by high absolute amounts of Na_2O and Sr, and by a high Na_2O/K_2O ratio (>1.5). They contain relatively high CaO (3.5-4.5%) and MgO (2.5%).

At both Rutter Soak and Yamarna, the pyroclastic rocks can be divided into medium-grained and fine-grained rocks (Davy, 1976a). The coarser rocks appear more like granodiorites commonly with a gneissic texture. Fine-grained rocks include even-grained lavas, porphyritic lavas, and thinly bedded types of probable tuffaceous nature.

Ax or Al rocks at Rutter Soak are heterogeneous, and vary from ultra-potassic (9.9% K_2O) to dacitic (6.5% Na_2O), and include a substantial number of intermediate rocks of andesitic composition (Table 4, column 2). The majority of samples, however, are dacitic with 1-3% K_2O and 3-5.5% Na_2O. In these volcanic rocks iron, calcium, and magnesium vary from less than 1% to 8.5% CaO, 5.8% MgO, and 19.9% Fe_2O_3. The lavas are particularly low in potassium (0.1-2.6% K_2O), and are all sodic dacites or andesites.

By contrast, the Yamarna rocks, 25-30 km to the southeast, form a remarkably compact composition group for rocks described as 'tuffs, agglomerates and breccias'. The rocks are again dacites and subordinate rhyodacites, having

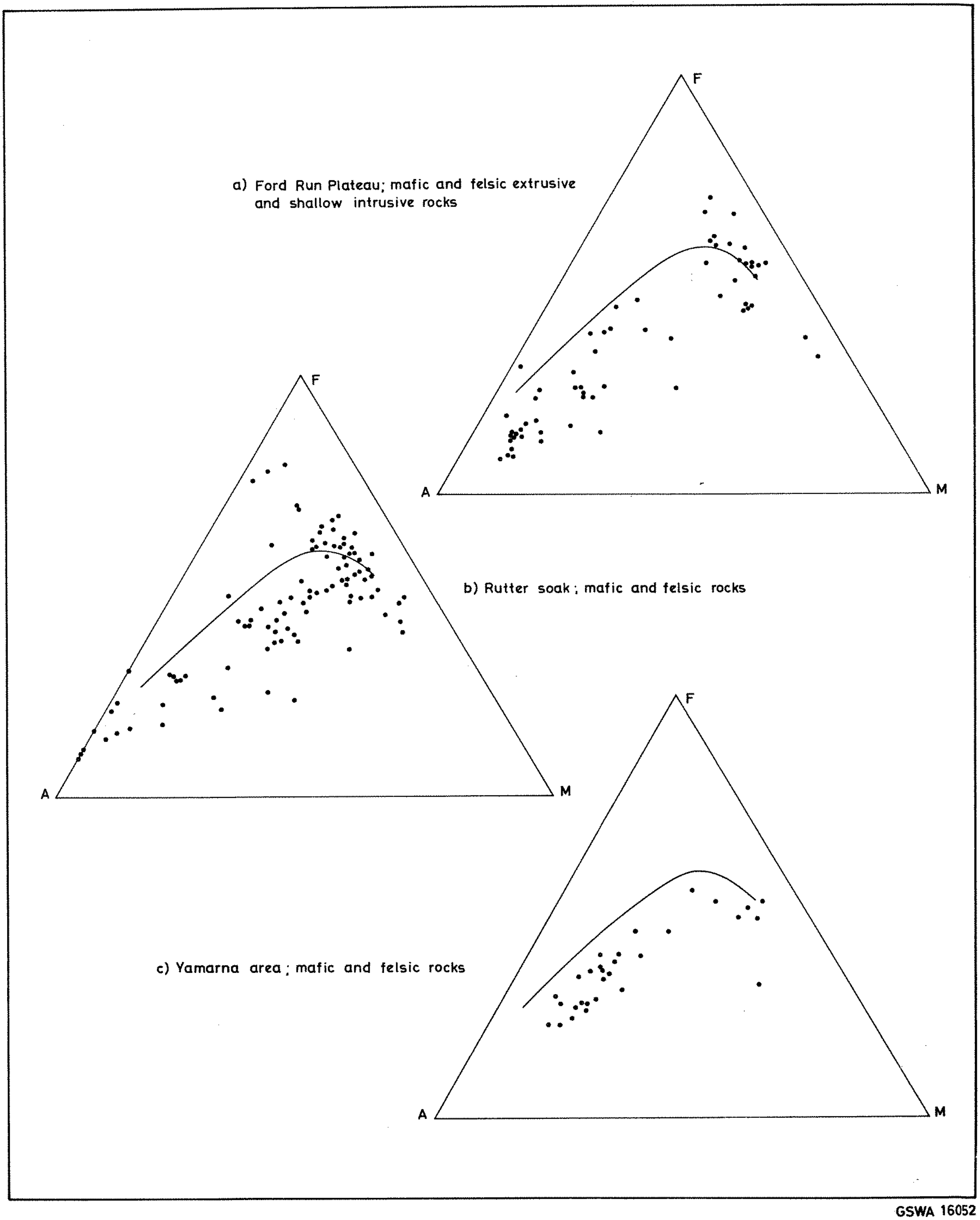

Figure 5 AFM diagrams.

K_2O in the range 1-4% and Na_2O 2.5-5.5%. Potassium, iron, and magnesium appear to be enriched in the coarser rocks; and sodium, strontium, and calcium in the finer grained rocks. In general the rocks are characterized by high Sr ($\bar{x}$ = 645 ppm, absolute maximum = 1 263 ppm) and low Rb. A few samples have a total alkali content of about 5%, and it is possible that minor silicification of these rocks has taken place. Unlike the Rutter Soak area, there are few intermediate members.

Compared with the Rutter Soak rocks, the Yamarna rocks contain very much more strontium; they also contain more calcium, iron, magnesium, and nickel; and less zirconium. AFM diagrams have been prepared for both the Rutter Soak and the Yamarna rocks (Fig.5b, c). The curve for the Rutter Soak samples shows a wide scatter but follows an overall calc-alkaline trend. The Yamarna rocks show less scatter, but also fit a calc-alkaline trend although it is not continuous, and there are fewer mafic rocks.

Fine-grained felsic rocks from other areas

Isolated examples of felsic rocks, mainly dykes and lavas, occur sporadically through the greenstone belts from Leonora to Agnew, from Laverton to Mount Varden, and in the Rufus Hill-Mount Redcliffe-Mount Zephyr area on the Laverton sheet, and in the greenstone of the northeast corner of the same sheet. The fine-grained rocks of the Mount Varden area also have calc-alkaline affinities.

The great majority of these felsic rocks are dacites or tonalitic dacites, with rare intermediate (andesitic) and ultrapotassic types. Most dacites are porphyritic; these rocks contain 5-9% Na_2O; K_2O is commonly less than 2%; CaO is commonly less than 1%; and MgO is in the range 1-3%. Full details are given in Davy (1976b, c). A few rocks (e.g. at Mount Redcliffe and Mount Varden) are rhyodacites with a K_2O content of 3.3-5.1% and a Na_2O content of 3.7-5.1%, but the rare high-potassium samples are of interest. These rocks, which have K_2O in excess of 7%, are considered to have been vitric tuffs. Potassium has probably accumulated during diagenesis of these samples, through an intermediate stage of montmorillonite or illite growth (Grim and others, 1954; Bowie and others, 1966), with metamorphism producing the present crystalline state. Both felsic and mafic suites contain a small number of samples of intermediate composition. These are characterized by SiO_2 values ranging between 55 and 65%. Some are derived from the basalts by addition of silica and soda, and by reduction in CaO, MgO and Fe_2O_3. They are distinguished from secondarily silicified samples by an increase of sodium, in contrast with sodium loss in silicified rocks. These rocks probably represent differentiated residues of the mafic series, but it is considered unlikely that the main outcrops of acid/felsic rocks, which occur within mafic rocks in the greenstone belts, have been derived in this manner.

The intermediate rocks that occur with the felsic volcanics have high soda (2.7-8.2% Na_2O) and moderate iron (5-8% Fe_2O_3) overlapping in composition the derivatives of the mafic rocks. They are distinguishable from the mafic rocks by their porphyritic texture as distinct from the generally uniform texture of intermediate members of mafic suites.

GRANITOIDS

The granitoids of the area sampled fall into several easily recognizable types in the field:

- Agm, Agn - migmatite and gneiss,
- Agg - sheared granite,
- Agp - porphyritic microgranite - microgranodiorite,
- Age - even-grained adamellite,
- Agb - biotite granite-granodiorite-adamellite, and
- Agl - porphyritic granodiorite-adamellite.

Of these, the Agp has the smallest distribution occurring only on the Laverton and Celia Lineaments. It is recognized that the migmatite gneiss and the 'sheared granites' may include some reconstituted sediments.

The overwhelming majority of granitic rocks are granodiorites and adamellites. A few outcrops of tonalite and granite occur. A single sample of syenitic rock occurs within Age of Charleston well on the Laverton sheet. An outstanding feature of the granitoids is the consistently high Na_2O content. This is rarely less than 3.5%, is commonly between 4 and 6%, and, on occasions, reaches 7.5%.

The chemistry has confirmed the coherence of most of the groupings used by the mapping geologists; however, the textural terms used by these geologists are not reflected by simple chemical groupings, as each type mapped contains a large spread of granodiorite and adamellite. Agb, in particular, has been used as an omnibus term (Table 5).

As expected, the chemistry has confirmed the mixed nature of migmatite and gneiss (Agm, Agn) and sheared granites (Agg), although the metasedimentary nature has not been geochemically substantiated. The few isotopic data fall into the range of 2480 $\pm$ 30 m.y. (Mount Boreas) to 2615 $\pm$ 25 m.y. (Borodale Creek)(J.C. Roddick, quoted by Gower 1974) with no regional younging.

Emplacement sequences

A sequence of granitoid emplacement has been postulated by geologists working in the area: it commences with primitive pre- or early tectonic granitoids (now strongly sheared and foliated) which were intruded before metamorphism; syntectonic granitoids (now weakly foliated) which developed toward the close of the main metamorphic phase; and late tectonic granitoids (essentially non foliated) intruded after the main metamorphic events had finished. In terms of the rock groupings used in the field, the first type would include Agg and Agp, the second Age and some Agb, and the last Agl and some Agb.

Some chemical development has also been postulated as complementary to the historical sequence, with a tendency to pass from granodiorites to adamellites (from soda rich to 'potassium-rich' rocks). This simple hypothesis holds true in many places, but is not universal. Thus, the main batholith of Agl, intruded (on field evidence) into Age and Agb rocks in the zone immediately west of the Celia lineament, is less potassic and more sodic than the rocks it intrudes.

By the same hypothesis the Agp at Erlistoun and the Agp west of Laverton Downs (both Laverton sheet) should both be primitive highly sodic rocks. Indeed the rock west of Laverton Downs is highly sodic and low in potassium (5.1% Na_2O; 1.8% K_2O). However the rock at Erlistoun is adamellitic (4.8% Na_2O; 4.9% K_2O), and an isolated sample from an outcrop west of Windarra is granitic (3.3% Na_2O; 7.4% K_2O).

What can be seen in a few places is a family relationship with evolution of differing groups along parallel lines. In the Erlistoun area cited above, Agp is intruded by Agb. West of Laverton Downs the Agp occurs with Agb (relationships not fully established), and is intruded by a featureless even-grained granite. In the latter area there is an apparent chemical evolution towards more potassic rocks. In the former a similar trend shows in rubidium and lead values.

	Erlistoun		Southwest of Laverton Downs		
	Agp	Agb	Agp	Agb	Ag(e)
CaO%	0.4	0.8	1.6	1.9	1.4
Fe_2O_3%	1.0	1.2	2.6	2.5	1.3
K_2O%	4.9	4.8	1.8	2.2	2.7
Na_2O%	4.8	4.6	5.1	5.0	3.3
Pb ppm	21	44	12	11	23
Rb ppm	107	278	59	52	251

It seems clear that the primary magma of the two areas was quite different but that similar fractionation patterns were developed. Since the rocks have different ages a cyclic pattern of intrusion and evolution may be postulated.

A similar type of evolutionary trend is supported at Mount Adamson where a stock of 'granite' intrudes foliated granodiorite that has lower values of Ba, Fe_2O_3, K_2O, MgO, Rb, Zn and Zr compared with the intruding rock.

Regional variations

The granitoids show a regional pattern of variation. This has been the subject of a separate paper (Davy 1976d) and is summarized as follows. When the granitoids are grouped within interlineament zones, there is a steady fall of MgO from west to east and a corresponding rise of K_2O. The latter element reaches a maximum in the Sefton-Laverton interlineament zone but starts to fall east of the Sefton lineament. A table, modified from Table 1 of Davy (1976d), is reproduced below.

Interlineament zone	(1)	(2)	(3)	(4)	(5)	(6)
			K_2O%		MgO%	
East of Sefton	58	15	4.4	4.2	0.27	0.25
Sefton-Laverton	71	23	4.9	5.0	0.51	0.58
Laverton-Celia	58	15	3.5	3.3	1.2	1.3
Celia-Keith-Kilkenny	53	12	3.2	3.5	1.5	1.4
Keith-Kilkenny-Ida	8	4	2.3	2.0	1.8	2.0

(1) Number of samples (n)
(2) Number of groups of samples (t)
(3) Overall mean K_2O
(4) Mean of group means K_2O
(5) Overall mean MgO
(6) Mean of group means MgO

Granitoids within the Keith-Kilkenny greenstone belt (n = 15 : t = 7) fall into the sequence as far as K_2O is concerned (2.5%, 2.2% respectively) and, are similar for MgO (1.7%, 2.4%) though the situation for MgO is complicated by one small dioritic outcrop (Agg) which contains 6.5% MgO. This intermediate rock should possibly not have been included as a granitoid, in which case the values would be K_2O 2.6%; 2.5% : MgO 1.5%; 1.9%. These granitoids may, in any case, not be a normal part of the regional pattern as contamination from the enveloping greenstone, suspected elsewhere, is possible.

In the regional context rubidium follows potassium; and nickel and vanadium, follow magnesium.

Some systematic chemical variation has also been established internally within the interlineament zones. Plots for individual elements in granitoids have been presented in Davy (1976b, c) for Laverton and Leonora. These plots have revealed some features of note but, except in one instance noted below, show no regular zonation.

'Zonation' occurs between the Laverton and Celia lineaments. The Mount Boreas adamellite has been established by age dating as younger than granodiorite at Borodale Creek (see p.15).

From the chemistry, particularly of K_2O, it appears that the Mount Boreas rocks extend south as one large complex batholith to include the Agp and Agb rocks of the Erlistoun area (Davy 1976b, fig.2e). Separating these rocks from the greenstones of the lineament zones is an envelope of the older rock groups. Of these two zones, the older is sodic and granodioritic in composition, the younger is potassic and adamellitic. The same is shown antipathetically in the distribution of CaO (Davy 1976b, Fig.2b).

The 'biotite granite' (Agb) between the Keith-Kilkenny Lineament and the Mount Redcliffe greenstone belt is also a mixture of at least three rock types. Near Dogers Hill (Leonora sheet), west of Mertondale, the rock is a true adamellite with subequal proportions of Na_2O and K_2O. East of Wilson's Patch is a discrete body of granodiorite which is characterized by high Sr (860 ppm), low SiO_2 (68%), and Na_2O well in excess of K_2O. Elsewhere, this granitoid varies considerably, but is mainly granodiorite. A greater field discrimination of the granitoid type Agb is desirable.

Agg near Isolated Hill on the Rason sheet has been resolved into a granodiorite and an adamellite phase on the basis of the chemistry.

One further feature of note is the possible penetration of magnesium from the greenstones of the Laverton greenstone belt into the granitic rocks lying immediately east. Though the zone between the Laverton and Sefton Lineaments is inherently low in MgO ($\bar{x}$ = 0.51%), most samples which exceed this value lie within 5-10 km of the Laverton-Mount Varden greenstones. These high magnesium values show no negative correlation with potassium along this zone. Indeed, if anything, potassium, lead and rubidium are all higher in this zone. The rock is called Agb and, in outcrops further east, the same rock type contains negligible MgO; and lower K_2O, Pb, and Rb. This rather unusual chemistry may be due to contamination of the marginal phase of a single granitoid body by the adjacent greenstones, or it may indicate that the Agb should be divided into two or more separate bodies.

Trace-element ratios

Low K/Rb and high Rb/Sr ratios are considered to demonstrate the existence of fractionated rocks, (Stavrov, 1971; and Groves, 1972). Most K/Rb ratios exceed 200, with only isolated samples, not necessarily representative of either the rock type or even a localized outcrop, lower than this value. The chief rock types of regional importance, having K/Rb less than 200, are Agb southwest of Erlistoun (143, four samples), the Mount Boreas adamellite (131, four samples), Agg rocks on the Sefton Lineament (100, three samples), and the Age in the Mount Venn general area (149, six samples). The Agg on the Sefton Lineament is the only strongly foliated granite with a "young" signature.

Rubidium and strontium values are also low, both in the absolute amount of rubidium and in the Rb/Sr ratio. The Rb values in the adamellite are 100-300 ppm, and less than 100 ppm in granodiorite. Strontium values can be high in some rocks; values exceed 500 ppm (mainly, but not always, in the more sodic rocks). For most granitoids the Rb/Sr ratio is 0.1-0.2. Values over unity are rare. Most rocks with high Rb/Sr ratios are those with low K/Rb, but this does not necessarily follow. For instance the Mount Boreas adamellite has a K/Rb ratio of 131 but a Rb/Sr ratio of 0.63. Conversely the mineralized adamellite at Dodgers Hill (Leonora sheet) has a mean K/Rb ratio of 222 with a Rb/Sr ratio of 3.5.

The only fine-grained felsic rock to conform to this grouping is an Ap rock from Mount Varden whose value is K/Rb 127; Rb/Sr 12.1. Several other individual fine grained rocks have a K/Rb ratio of less than 200 but for none of these does the Rb/Sr ratio exceed unity.

The concepts of using K/Rb and Rb/Sr ratios as absolute indices of fractionation may need revision in view of the relatively high proportion of 'primitive' rocks included in the above list. They may, however, indicate fractionation trends within a single rock group.

Rocks with both low K/Rb and high Rb/Sr ratios are as follows.

Location		Number of samples	Ratio	
			K/Rb	Rb/Sr
Leonora	Agb, Jindardie well	2	98	4
	Agg, Andersons bore	1	88	33
Laverton	Agb, southwest of Erlistoun	4	143	1.4
	Agn, east of Reichell Find	1	195	2.5
	Agg, Sefton Lineament	3	100	5.6
	Agg, northwest of Diorite Hill	1	115	14.5
	Agg, northeast of Swincers	1	149	2.2
Rason	Age, Mount Venn area	6	149	1.3

Plots of K vs Rb; each of K/Rb vs K_2O and Rb; Rb vs Sr; Rb/Sr vs each of K_2O, Na_2O and CaO have been drawn for the various rocks but most groups display a wide scatter. However, the rocks noted earlier as displaying fractionation trends between the Laverton and Celia Lineaments do display linear trends for K/Rb vs Rb plots (Fig.6a), and so do the Bailey Range, rocks (Age) when Rb/Sr is plotted against K_2O (Fig.6b). *Further work is needed to establish the* nature and significance of trends both in, and between, the various rock groups.

An attempt was made to use K/Ba ratios on a similar basis. However, barium has proved to be most erratic in its distribution, both within a single rock type and from one specimen to another. By and large, barium values increase from west to east; but, though there is a reasonable correlation with K_2O (+0.4), and the highest values are found in the more potassic rocks, this

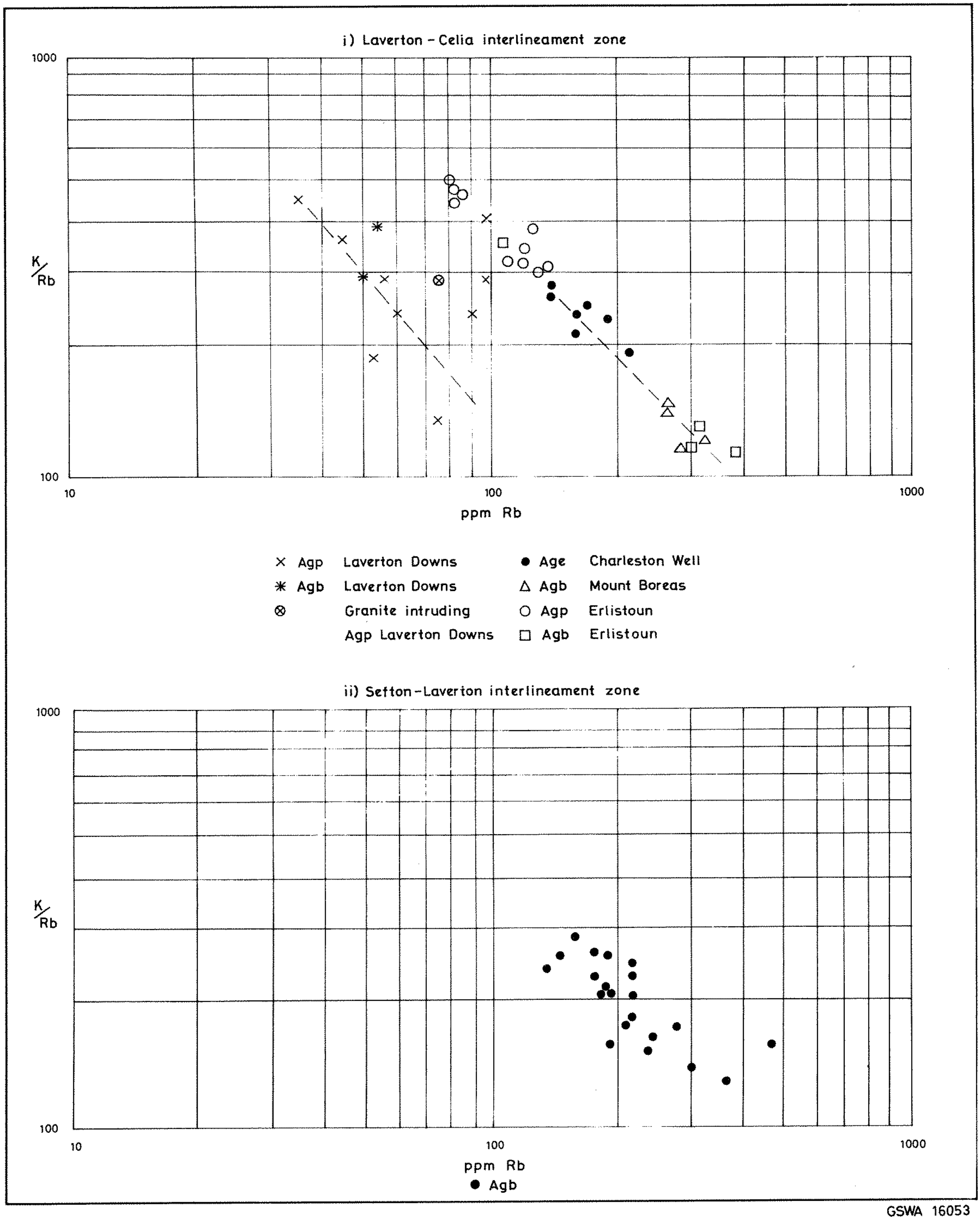

Figure 6a Ratio diagrams.

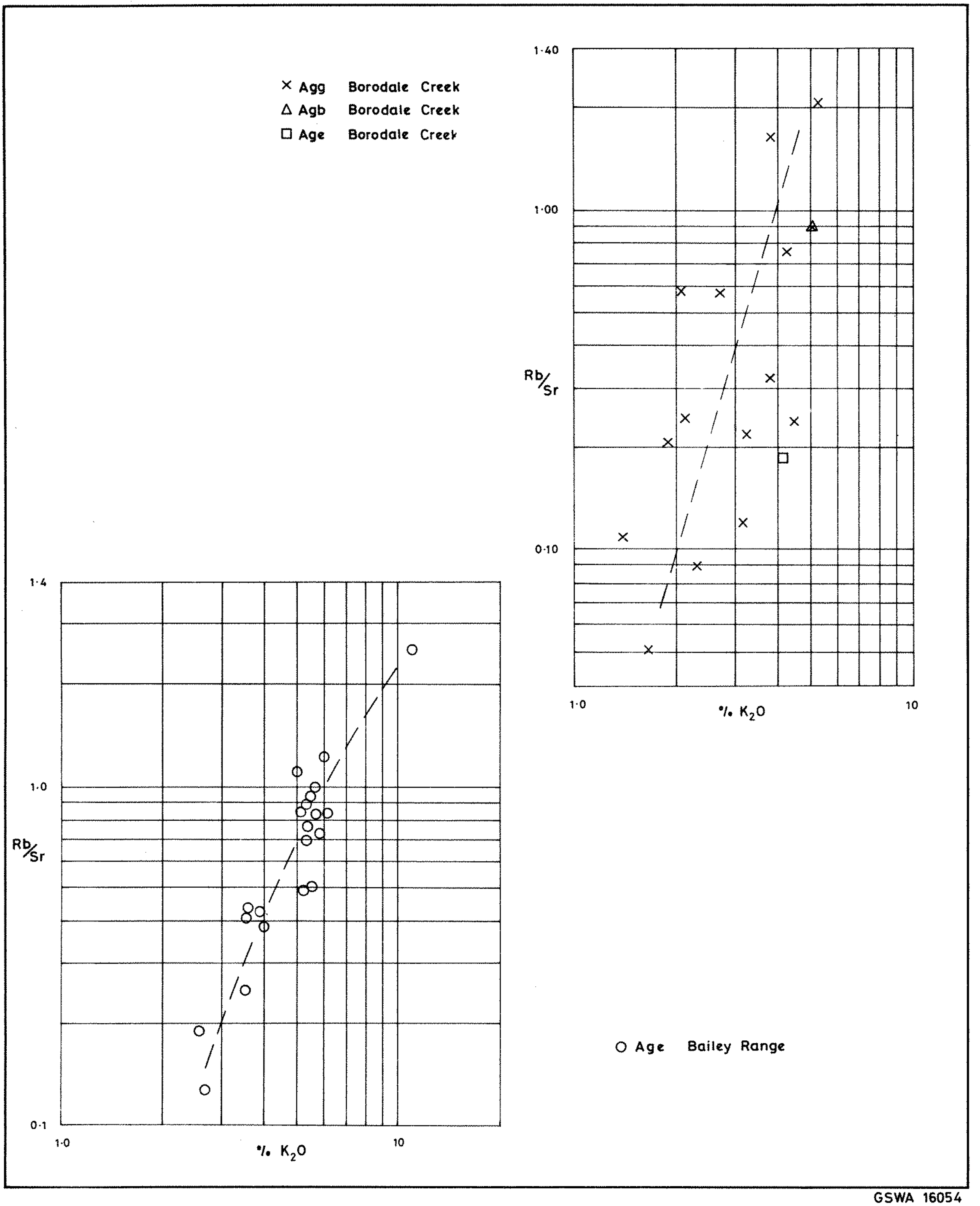

Figure 6b Ratio diagrams.

relationship does not hold in detail. The standard deviation for barium is commonly 50-100% of its mean value even within the one rock group. All plots which have involved K and Ba have given a wide scatter and are not reproduced.

Relationships of granitoids and fine-grained felsic rocks

Comparison between these rocks is only possible on geographic grounds.

The volcanic and subvolcanic rocks of the calc-alkaline associations show some resemblance to nearby granitoids. In the Mount Venn-Rutter Soak area the coarse Ax rocks show some chemical similarity to Agb which crops out around the perimeter of the felsic-mafic rocks. The Agb contains more Na and Rb less Ba, Cu, Ni, and V. In the Yamarna area the granitoid which most closely compares with the volcanics is Agg southwest of Yamarna. The granitoid contains more potash, and is lower in base metals, but both groups contain conspicuously high Sr.

Granitoids in the Ford Run Plateau area have already been noted as similar in composition to Ap and Al rocks. In this area fine and coarse-grained rocks occur in the same outcrops. The granitoids are themselves heterogeneous. Rhyolitic Al most closely resembles Agb at Garden well; dacitic Al and the Ap rocks compare well with varieties of Agb from the Ford Run Plateau area.

Elsewhere isolated fine-grained rocks have compositions close to nearby granitoids, and an equal number appear to have no relationships.

In the Keith-Kilkenny greenstone belt both granitoids and fine-grained rocks are highly sodic and low in potassium, but differ in calcium, iron, magnesium, and many trace elements.

At each of the Mount Redcliffe, Rufus Hill, and the Mount Varden areas, at least one fine-grained specimen has an essentially similar granitoid counterpart, but elements such as strontium tend to differ. Apart from certain dyke rocks which are similar to nearby Agp west of Laverton Downs, the fine grained rocks of the Mount Varden-Laverton area show little compositional similarity with nearby granites. One reason for this difference, compared with the Keith-Kilkenny belt, is the lack of granitic plutons cropping out and sampled within the greenstones.

The physical separation of fine-grained felsics and granitoids is commonly 2-10 km. Though genetic relationships are possible, they cannot be determined solely from the chemistry.

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METASEDIMENTS

Metasediments have been sampled from several widely separated localities. Rock types sampled have included cherts, schists, and conglomerates. Clasts in the conglomerates consist of igneous rocks of all types, from ultramafic to felsic, together with chert.

The main purpose of analysis was to determine the presence or absence of anomalous base-metal values, but the coverage was inadequate for a true picture of the sediments. Anomalous samples are discussed later.

COMPARISON WITH OTHER PUBLISHED DATA

ULTRAMAFIC ROCKS

Comparison has been made difficult by inadequate sampling; in many cases, examination of the collecting geologists field note book has shown that no effort was made to obtain samples which might be truly representative of the rocks as a whole. Papers by Williams (1972) and Barnes and others (1974) highlight the variations possible within one unit of an intrusive ultramafic or within one flow of an extrusive equivalent.

In this study Al_2O_3 was not determined and Ca/Al ratios cannot be used for comparative purposes.

Metaperidotites and serpentinites have relatively low MgO/FeO^t ratios (1.5-4). Some have high Na/K ratios, though as serpentinization nears completion, Na and K both tend to disappear completely. The scatter of MgO/FeO^t is higher than the range suggested by Glikson (1972) for Archaean metaperidotites.

As far as can be determined the high-magnesium basalts and other fine-grained ultramafic rocks have compositions similar to comparable rocks from South Africa (Viljoen and Viljoen, 1971) and Canada (Brooks and Hart, 1972) as well as from further south of the Yilgarn block of Western Australia (Lewis and Williams, 1973; and Williams, 1972). In Viljoen and Viljoen's terms, most of the high magnesium basalts from the Leonora-Laverton area would be called basaltic komatiites, the quench-textured more peridotitic rocks would be peridotitic komatiites. McCall and Leishman (1971) and Glikson (1972) consider that tremolite-chlorite rocks and amphibole rich assemblages high in Mg (high magnesium basalts) are extrusive and/or shallow intrusive equivalents of pyroxenites.

MAFIC ROCKS

The mafic rocks of this area form two well defined groups (Table 3), namely low potassium tholeiites of widespread occurrence, and higher potassium rocks of restricted occurrence. Table 6 shows a comparison of the low potassium rocks with other basaltic rocks from Western Australia reported in Hallberg (1972), Hallberg and Williams (1972), and Hallberg and others (1976).

The main differences shown by the present work, compared with that of the above authors, is that mean values of Na_2O, Cu, Ni, and V are all substantially lower (by a factor of at least 20%) whilst Ba and Sr are higher. K_2O is higher, on average, than for the dolerites described in Hallberg (1972). These may represent subtle but real chemical variations of what at first sight appears to have been a very uniform low-K tholeiite magma.

Table 7 affords a comparison of the low-K Western Australia dolerites and basalts with published data for similar rocks from India, South Africa, and Canada; and with the averages for various types of tholeiitic and calc-alkaline rocks classified by origin. The overall similarity of the analyses from the present study is immediately apparent, especially for the major elements.

In the present study, the normal cut-off for SiO_2 for basic rocks has been taken as 55% (Dictionary of Geological Terms, Dolphin Books, A.G.I. 1957) though in practice, most are below 54%.

Wilson and others (1965) however, distinguish in name between a group of basalts with SiO_2 content 49.83%, and a group of andesites with SiO_2 content of 51.83%. Essentially the analyses for these groups are the same except that the soda content is appreciably higher in the andesites (3.40%) than in the basalts (2.02%). Though the potassium values are higher in the andesites (0.29% K_2O) than in basalts (0.23% K_2O), both are low when considered in conjunction with other published analyses of basalts. In the present report both groups would be called basalts. Miyashiro (1975) would apparently call the andesites of Wilson and others' basalts, but he puts an upper limit for the SiO_2 content of basalts as 52.5%.

The low-K content is the one consistent feature which links the rocks from the four continents. Other elements show more variation. The overall low Na_2O content of this group of Western Australian rocks is distinctive, though not far below the Na_2O content of Canadian Keewatin basalts (Wilson and others, 1965).

The K_2O values are lower than those cited for 'basic' rocks by Manson (1967, p.222ff).

Wilson and others (1965) consider the rocks they studied to have been partly sub-aerial and partly submarine and, as the lavas are interspersed with sediments, to have formed in shallow water relatively close to a continental shoreline.

The analyses have the closest, major element similarities to oceanic or abyssal tholeiites (Engel and others, 1965; Cann, 1971) and to island arc tholeiites (Jakes and White, 1971).

The Western Australian rocks contain more iron than island-arc tholeiites, and less sodium and potassium. On the other hand the Western Australian rocks contain the same potassium and iron, but lower sodium and titanium than the oceanic tholeiites cited.

Comparative studies of trace elements are given in Table 7 and additional values of Rb, Sr and Ba are listed below.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
K %	0.18	0.22	0.18	0.21	0.12	0.22	0.5	1.4
Rb ppm	7	9	4.7	6	1.1	3.2	5	33
Sr ppm	135	127	146	175	136	250	200	815
Ba ppm	215	194	63	70	11	1-0	75	498

Explanation:
(1) Low-K dolerites (this study)
(2) Low-K basalts (this study)
(3) Vermillion greenstones, Minnesota (John and others, 1973)
(4) Canadian Archaean Basalts, a composite of 70 samples from Noranda, Kirkland Lake, and Michipicotin greenstone belts (Hart and others, 1970)
(5) Ocean floor basalts (Hart and others, 1970)
(6) Low-K island arc (Hart and others, 1970)
(7) Island arc (Jakes and White, 1972)
(8) Oceanic alkali basalts (Engel and others, 1965).

Once again there is no exact comparison with either oceanic or with island-arc tholeiites. As far as can be determined, copper, ?nickel, lead, strontium, an zinc are all quite similar to the deep oceanic rocks. However, nickel, barium and rubidium are too high, whereas vanadium and zirconium are too low. Though the barium and rubidium (as well as the potassium) content of island-arc tholeiites is higher than in oceanic tholeiites, both barium and rubidium in the Leonora-Rason area are still higher. The vanadium of the Western Australian rocks is very close to the figure given for island arc rocks by Jakes and White (1971).

Hart and others (1970) suggest that ocean floor and island-arc tholeiites are related, and further suggest that high Rb and Ba (and Pb) imply contamination by sediments.

It seems possible, therefore, but it is by no means proven, that the Leonora-Rason basalts and dolerites can be considered to be either oceanic or island arc tholeiites, partly contaminated by incorporation of sedimentary material into the magma.

If the latter has occurred, the rocks are likely, in the terms of Hart an others, to be basalts from the oceanic side of island arc trenches. Further speculation is unwarranted.

The basalts and dolerites of the Ford Run Plateau area, and the Mount Scott-Rutter Soak area are of the higher potassium type. Table 8 compares the composition of these rocks with other published figures. Data on comparable Archaean rocks are apparently not extensive. In general terms, these rocks, though containing higher amounts of potassium than the low-K tholeiites have a composition close in other respects to the low-K type tholeiite. The AFM diagrams, however (Figs.4a-c) relate these rocks (and the Yamarna rocks) to calc-alkaline trends, and the felsic volcanic and subvolcanic rocks associated with them are more clearly calc-alkaline.

One unusual feature of these mafic rocks is the high but very erratic concentration of barium. The mean value for Ford Run Plateau mafics is over 300 ppm, in the Mount Scott-Rutter Soak area it is over 400 ppm. Most low-K basalts (including both oceanic and island-arc types) have Ba contents less than 100 ppm, whereas values in this study are 3-4 times higher. The reported values are also 3 times the barium content expected in calc-alkaline basalts (Jakes and White, 1972).

Element-ratio studies

K/Rb, K/Ba and Rb/Sr studies have been made of the Leonora-Rason mafic rocks. Results are presented in Table 9. Areas with fewer than 5 samples have been omitted.

K/Ba ratios. There are no consistent patterns for K/Ba, and no difference is evident between "high"-K and low-K types. The values range from 5.4 to 22. These compare with values for continental tholeiites (Antarctica) of 27 and for continental alkali basalts (Antarctica and New Zealand) of 23 (Gunn, 1965).

Values of 24.4 and 95 have been calculated for Archaean metabasalts from Timmins-Noranda and oceanic tholeiites respectively (Table 7), and of 30 for Canadian Archaean basalts described by Hart and others (1970). The K/Ba ratio obtained in this study is evidently low compared with results obtained elsewhere.

Rb/Sr ratios. Rubidum-strontium ratios are below 0.13. High ratios (0.06-0.12) occur in the greenstones west of the Keith-Kilkenny Lineament, but further eastward, the range is 0.03-0.05 for groupings of 7 or more samples. The more highly potassic mafic-rocks range from 0.07-0.10.

Hallberg and Williams (1972) give the ratio as 0.09 for 337 basalts from the southern part of the Yilgarn block (the Eastern Goldfields), Hart and others (1970) 0.03 for Canadian Archaean basalts. Cann (1970) shows that the ratio for recent ocean floor basalts varies from 0.04 in the Gulf of Aden to 0.13 in the Palmer Ridge of the North Atlantic. Island-arc tholeiites average 0.03 (Jakes and White, 1972).

K/Rb ratios. K/Rb ratios are also distinctively low west of the Keith-Kilkenny lineament. Values in this region range from 187 to 259 in comparison with areas further east where the range is 259-498, and most below 400. A direct comparison between greenstone belts is afforded by comparing the Mount Clifford area (Keith-Kilkenny) with the Mount Varden area (Laverton). In the former area K/Rb ratios for Ab and Ad are 214 and 187 for 49 and 29 samples respectively; in the latter area the figures are 385 and 415 for 45 and 31 samples respectively.

Opinion is somewhat divided about the significance of these ratios, though much has been written about them.

Some reported K/Rb ratios

Rock type	Place	K/Rb	Author
'Lowish'-K tholeiites (K <2%)	Hawaii	512	Lessing and others 1963
Oceanfloor tholeiites	Various	<2000	Erlank and Hofmeyr 1966
Bushveld complex	South Africa	<1000	Erlank and Hofmeyr 1966
Karroo dolerites	South Africa	383- 609	Erlank and Hofmeyr 1966
Continental tholeiites	Antarctica	237	Gunn 1965
Alkali basalts	Antarctica and New Zealand	335	Gunn 1965
Dolerites	Tasmania	188- 222	Erlank and Hofmeyr 1966
Island arc tholeiites	New Britain	440-1160	Lowder and Carmichael 1970
Island arc tholeiites	South Sandwich	450	Jakes and White 1970
Island arc tholeiites	Fiji	1070	Jakes and White 1970
Calcalkaline rocks from island arcs	Fiji	310- 565	Jakes and White 1970
	New Zealand	250- 470	Jakes and White 1970
	Solomon Islands	335- 420	Jakes and White 1970
Ocean floor basalts	Midocean Ridges	328- 350 (-930)	Cann 1970
Deep ocean tholeiites		1440	Engel and others 1965
Olivine tholeiites		278	Jamieson and Clarke 1970
Olivine basalts (picrites)	Baffin Island	446	Jamieson and Clarke 1970
All mafic rocks except oceanic tholeiites, pegmatites		230	Shaw 1968
Oceanic tholeiites		>500 (to 3000)	Shaw 1968
Pegmatites		<150	Shaw 1968
Vermillion greenstone belt	Minnesota	580	Jahn and others 1973
Eastern Goldfields tholeiites	Western Australia	430	Hallberg and Williams 1972

The mean values in this report are 261 and 249 for low-K Ad and Ab respec tively, and 201 and 323 for the various higher potassium groups. These ratios are close to Shaw's (1968), value of 230 for all mafic rocks excluding oceanic tholeiites.

The ratios are lower than other Western Australian tholeiite (Hallberg an Williams 1972), though it is the low ratio of rocks from the Keith-Kilkenny greenstones which cause the overall ratio to be so far below that found by Hallberg and Williams.

Differences between the Keith-Kilkenny (including the Lawlers-Agnew rocks) and the Laverton greenstones may be explained if these rocks belong to different mafic cycles (Williams, 1974).

THE MOUNT VENN LAYERED INTRUSION

No acceptable average composition can be derived for the Mount Venn layered intrusion, and the main point of comparison with other similar sills is through the AFM diagram (Fig.4). This diagram shows a wide scatter, with a number of poorly developed fractionation trends.

Comparison of this diagram with those of McCall (1973, p.246, 247) shows the Mount Venn sill to have little or no resemblance with the Golden Mile Dolerite or with the Mount Singleton rocks. There is a closer correspondence with the Mission Sill and the Yilmia Sill(s).

The Mount Venn gabbro 'scatter' on the AFM diagram overlies the mafic end of the equivalent plot for the Binneringie Dyke (McCall and Peers, 1971, p. 1250), though ultramafic members are absent from that body. The Jimberlana dyke rocks (McCall and Peers, 1971, p.1251) also approximate at their mafic/ ultramafic ends to the Mount Venn values. The scatter shown by the Mount Venn intrusion suggests a major difference of behaviour compared with the Skaergaard Intrusion, the Dillsburg Sill, and Hawaiian dolerites (McCall and Peers, 1971 p.1251), and with the Bushveld complex (Coertze,1969).

The Mount Venn rocks are apparently different from the Western Australian sills described by Williams and Hallberg (1973), in that little or no peridotite is present, and the main ultramafic rock is ?ortho-pyroxenite. However, peridotitic rocks may be present at Mount Venn, but not exposed at the surface. The Mount Venn complex also differs in that clear-cut zonation into an upper mafic zone and a lower ultramafic zone is not apparent.

ACID AND INTERMEDIATE ROCKS

Granitoids

O'Beirne (1968) discussed, for the most part, porphyritic fine-grained felsic rocks from parts of the Kalgoorlie general area. He also referred to granitoids, dividing them into three main groups:

i) external granitoids (between the greenstone belts),
ii) internal granitoids (within the greenstone belts), and
iii) 'sodic granites', related to sodic porphyries (within the greenstone belts).

The external granitoids of O'Beirne include gneisses and migmatites, and are characterized by high soda content but are unrelated to the 'sodic granites.' The internal granitoids are potassic (adamellitic) in character. O'Beirne gives no analyses of external granites.

A feature of O'Beirnes' sodic granites is their high strontium value (658-1312 ppm for granitoids) and low rubidium content (16-90 ppm). Rb/Sr ratios of these granitoids and their related porphyries are commonly below 0.2 In the internal granites, on the contrary, strontium is commonly below 200 ppm and rubidium over 150 ppm (up to about 450 ppm). Rb/Sr ratios for these rocks are in the range 0.6-5. O'Beirne's conclusions are limited by the relatively small number of granitoids determined.

This report has shown that such a characterization is over simplified, and that the terms 'internal' and 'external' granitoids need amended definitions. Granitoids between the greenstone belts are composed of a variety of granodiorite to adamellitic rocks, with a much wider range of analyses than O'Beirne found.

The rocks most closely comparable in composition with the 'sodic granites' of O'Beirne with their high Sr values, are biotite granites (Agb) east of Wilsons Patch and at Garden well, and the outer part of the Age south of Lawlers on the Leonora sheet. Other similar isolated samples on the Laverton sheet occur near Rufus Hill (Agl), at David well (Agn), in the southeast part of the sheet (Age), north of Mount Redcliffe (Age) and at Dwyn well (Agg). (In some of these rocks the Rb content exceeds 100 ppm, but does not exceed 200 ppm). On the Rason sheet similar rocks include Agb at Mallee Hen Rocks, Agg southwest of Yamarna, Agl southwest of Yamarna, and, possibly, the Agm in the northwest corner of the sheet. Comparable fine-grained felsic rocks occur at the main felsic volcanic centres - at Yamarna (Rason sheet), Ford Run Plateau (Leonora sheet) and near Rutter Soak (Rason sheet) in order of similarity. Many other of the widely dispersed fine-grained felsic rocks are similar to O'Beirne's sodic porphyries in having low rubidium and a high Na/K ratio, but differ in having only moderate Sr values (usually in the range 100-400 ppm). An exception occurs at Mount Redcliffe where one dyke rock contains 94 ppm Rb and 1140 ppm Sr.

O'Beirne identified a small group of extrusive, porphyritic rhyolites. Apparent analogues of these rocks have been found at a number of sites in the area under study (Mount Clifford, the Ford Run Plateau in the greenstone belt southeast of Agnew, and in the Mount Varden area).

Over the years Glikson has written extensively about the rocks of the Yilgarn block (e.g. Glikson 1971, 1972, Glikson and Sheraton 1972; and Glikson and Lambert 1976). In these papers, Glikson and his co-authors discuss variations of composition with time, and in their later papers, attempt correlations over large tracts of country. In his 1971 paper, Glikson compares the SiO_2, Na_2O, K_2O, Rb and Sr, Cr, and Ni of various Western Australian granitoids and porphyries (his own work together with data from O'Beirne (1968)) with similar granitic rocks from Transvaal, South Africa, and with world averages as given by Nockolds (1954) and Taylor (1965). Comparable analyses are found in the granitoids and fine-grained felsic rocks in the Leonora-Rason area.

According to Glikson and Sheraton (1972), intrusive granitoids can be classed in a time sequence corresponding to various stages in the development and disappearance of geosynclines. They attempted to do this for Western Australian granitoids, and compared their findings with Archaean felsic rocks of Canada and Scotland, and with average figures for granite compiled by Turekian and Wedepohl (1961), as well as Nockolds (1954), and Taylor (1965). Glikson and Sheraton used the same analyses as Glikson (1971) but expanded the treatment to cover all analysed elements.

One general feature of Western Australian granitoids stands out. Compared with the suggested averages of Turekian and Wedepohl (1961) no major outcrop of Western Australian granitic rocks so far examined whether potassic or sodic, can be considered as 'high calcium' granite, though isolated samples do approach this rock type.

Glikson and Sheraton group analyses known to them into three main groups: pregeosynclinal, syngeosynclinal and Late Kinematic (approximately equivalent to what are now called early tectonic, syntectonic, and post tectonic respectively) and supplement their discussion with age data provided chiefly by Turek (1964). Glikson and Sheraton (1972) have postulated trends of increasing K_2O values and diminishing Na_2O values progressively over a period of time with granitoid emplacement. Key features of their discussion are overall low Ba values, a trend to markedly increasing Rb as K_2O increases (lowering the K/Rb ratio), and high absolute Sr values in syngeosynclinal rocks. Rb/Sr ratios are very low except in late kinematic rocks. Other points noted are an increase of copper temporarily towards late kinematic rocks and the high overall content of nickel compared with Taylor's (1965) figures. Vanadium and zirconium were measured in pregeosynclinal rocks only.

This classification into pregeosynclinal, syngeosynclinal and late kinematic time groups was discussed for the Leonora to Rason area earlier, where it was suggested that the concept was somewhat simplistic. Some comparison can be made with Glikson and Sheraton, however, if it is postulated that more than one geosynclinal or major tectonic event has occurred. That there are significant time breaks in granitoid intrusion, together with cyclicity in evolution, is recognized by Glikson (Glikson, 1972; Glikson and Lambert, 1976) though nowhere does he make explicit the possibilities of a recurrent cyclic pattern of intrusion.

Other writers (Krupicka, 1975), by implication at least, allow for possible cyclicity. Krupicka petrographically identified K-rich gneisses (Amitsoq gneiss) in Greenland and K-rich pebbles in the Moodies Group of the Barberton Mountain land of South Africa.

Evidence for two major phases of intrusion, each with a similar evolutionary trend occurs, as discussed earlier, in the zone between the Laverton and Celia Lineaments where parallel patterns of development occur in 'older' and 'younger' granitoids. In this area both outcrops of Agp may represent a pretectonic rock stage and the later Agb a late syntectonic or even late tectonic stage. No other areas studied show as clearly, this two-stage sequence of events, but further evidence may be found when more detailed mapping is completed.

It is difficult, therefore, to compare analyses of rocks from Rason-Leonora with the data of Glikson for rocks from the Coolgardie and Kalgoorlie areas. Glikson presents too few analyses for comparisons to be very meaningful. It can be said, however, that barium is much more variable, and commonly higher than the figures presented in Glikson and Sheraton (1972). Nickel is confirmed as being tolerably high within most groups often exceeding 20 ppm. As in Glikson's studies, there are trends to increasing K_2O and Rb in the area studied in the regions where evolutionary trends are recognized. For the most part, Rb/Sr ratios are quite low though rarely as low as in Glikson's and Sheraton's pregeosynclinal or syngeosynclinal rocks.

As a comparison with other parts of the Yilgarn Block, analyses of granitoids from the Cue 1:250 000 sheet area may be used. Fifty-four complete silicate analyses of samples representative of the various rock types from the Poona-Dalgaranga batholith have been made. (W.A. Government Chemical Laboratories, unpublished data.) The chief features to emerge from these rocks are the preponderance of adamellites compared with granodiorites, the virtual absence of tonalites, and the relatively high Rb/Sr ratio which commonly exceeds unity (P. Muhling, pers. comm.). Rocks from this batholith have been dated at 2605 ± 51 m.y. for the outer granitoids and 2590 ± 23 m.y. for the granitoids of the core (Muhling and de Laeter, 1971), so that they are approximately equivalent in age to the rocks of the Leonora-Rason area, in particular, to the granodioritic Agg of Borodale Creek, (Laverton sheet) and the Agg of Isolated Hill (Rason sheet) which is given as 2592 ± 25 m.y. in Gower and Boegli (1971).

The Cue rocks show trends similar to the Leonora-Rason area, and the Rb/Sr increases as the rocks get younger. None of the Cue rocks show particularly high values of Sr (a maximum of 600 ppm Sr), contrasting with Leonora-Rason where porphyries reach 1200 ppm Sr and granitoids 900 ppm Sr. In contrast with the Leonora-Rason rocks, the Poona-Dalgaranga Rb values extend up to 560-600 ppm, a concentration reached by only one sample of the granitoids from the first named area.

The inference from this comparison is that there are wide compositional variations within the granitoid terrain of the Yilgarn, and that regional syntheses derived from isolated case studies are untenable.

Just as the two separate intrusive sequences have been recognized between the Laverton and Celia lineaments, so it is interesting to note that a similar overall pattern of events has been found in the Barberton area of South Africa (Viljoen and Viljoen, 1969). The oldest rocks are biotite or hornblende-bearing tonalite. These are followed, in order, by migmatites, uniform (homogeneous) granites, and, finally, by younger granites. The rocks get progressively richer in K_2O relative to Na_2O from the tonalite to the homogeneous granite. Rubidium sequentially increases while strontium decreases. The normal K/Rb range is 120-480, and Viljoen and Viljoen consider the rock fractionated when K/Rb falls below 225. Viljoen and Viljoen relate the younger granites to a separate, later event, and note that, for given Sr values in these rocks, the Rb content is appreciably higher. This feature is also shown between the Laverton and Celia Lineaments where the younger adamellites have a Rb/Sr ratio of 0.63-1.4 compared with a ratio of 0.13 in the older granodiorites. In both rock groups comparable Sr figures can be found. In each case the younger adamellite has the higher Rb content.

Attempts have been made to compare the Yilgarn Block with the Pilbara Block (Glikson and Lambert 1976), but the geology and geochemistry of the post tectonic granitoids of the area studied for this report compared with post tectonic granitoids of the Pilbara (Hickman and Lipple, 1975) are so different that comparisons between the two areas are unwarranted.

Fine-grained felsic rocks

The compositions of porphyritic rocks from Mount Zephyr, Mount Varden and Dorothy Hills resemble those of sodic felsic porphyries reported by Muhling and Low (1973) from the southern part of the Yalgoo 1:250 000 sheet, though the Yalgoo rocks contain less strontium. Analyses of two 'andesites' from the Yalgoo sheet resemble those for isolated similar rocks from Mount Clifford, Ford Run Plateau and Mount Varden.

Archaean volcanic rocks have been dated at 2635 $\pm$ 80 m.y. at Marda 120 km due north of Southern Cross (Hallberg and others, 1976). The rocks are andesites, dacites, rhyolite porphyries (dykes) and rhyolite ignimbrites. A similar, mainly andesitic, suite has been identified at Polelle, south of Meekatharra (Hallberg and others, in press).

The rhyolites of Marda loosely resemble rhyodacites from the Ford Run Plateau area. The Ford Run plateau rocks contain more calcium, magnesium, nickel, iron and vanadium, though values for rubidium, sodium, potassium, strontium, and zirconium are similar. Soda-rich dacites of the Ford Run Plateau area are not reproduced at Marda. On the other hand, Marda-type andesites have not been confirmed in the Ford Run Plateau area.

The intermediate lavas and pyroclasts at Rutter Soak more closely resembl the andesites of Marda. They have similar sodium, potassium, barium, rubidiur strontium, iron and magnesium contents, but there are variations in other elements. The more acid members at Mount Scott-Rutter Soak and Yamarna are not directly comparable to the rhyolites of Marda.

The major-element chemistry of the Polelle andesites also resembles that of intermediate rocks in the Mount Scott-Rutter Soak area, though barium is lower; and copper, nickel, and strontium are all higher.

The dacites from Polelle do not resemble the acid rocks of either Rutter Soak or Yamarna (except for strontium which is close to that in the Yamarna rocks). Compared with these rocks the Polelle rocks contain less potassium anc more calcium.

The felsic rocks from the three main centres show little resemblance to island arc or calc-alkaline dacites suggested by Jakes and White (1972) excep for the dacitic rocks of Wilsons Patch (Ford Run Plateau).

Condie and Harrison (1976) compare analyses of 'modern' rhyolites and dacites with the Archaean Midlands Belt of Rhodesia and with Archaean felsic volcanics of the Canadian Shield (Baragar and Goodwin, 1969). The Wilsons Patch dacites are very different in composition from modern dacites cited by Condie and Harrison, especially on their low iron and calcium content.

Correspondence of Ford Run Plateau and Rutter Soak rhyolites with 'modern' rhyolites (Condie and Harrison,ibid, 262) is closer but not exact.

Salic volcanic rocks reported by Baragar and Goodwin (1969) as part of their paper on andesites of the Canadian Shield are Na-rhyolite or dacite. As such, their major element chemistry compares favourably with the dacitic rocks at Ford Run Plateau, though calcium, iron, magnesium and titanium are all lower in the Ford Run Plateau area. Of the trace elements, barium and strontium are higher in the Ford Run Plateau, though calcium, iron, magnesium and titanium are all lower in the Ford Run Plateau area. Of the trace elements barium and strontium are higher in the Ford Run Plateau, copper, vanadium, and zinc are lower. There are wide differences between the Canadian figures, and the Rutters Soak, and the Yamarna rocks.

The Western Australian rocks are all more potassic than the intermediate-felsic rocks described by Jahn and others (1973) from the Vermilion greenstone belt, Minnesota.

Differences in composition from area to area are not unexpected and reflect fundamental differences in the nature of the parental magma, its degree of contamination and its mode of evolution.

ECONOMIC CONSIDERATIONS

The purposes of this project included:

i) the use of rock geochemistry as a prospecting tool, and
ii) the provision of data for the determination of possible metallogenic provinces.

This section is devoted to an examination of these two items.

METALLOGENIC PROVINCE

The term metallogenic province normally refers to a region with several mines/prospects of the same metal, or to a region which possesses markedly higher background abundances of the ore elements.

The Keith-Kilkenny greenstone belt is part of that belt of greenstones which runs from Widgiemooltha to Wiluna in what Williams (1974) called the Kalgoorlie subprovince of the Eastern Goldfields. Several nickel deposits are known along this line including Kambalda to the south, and Mount Keith and Perseverance to the north. This zone of greenstones crops out on the Leonora sheet and contains the nickel prospects of Weebo in the north (Willaree Cliffs area) and Marriott (near Mount Clifford). Mineralization has been detected in the Mount Clifford area in this study but not at Willaree Cliffs. Analyses for this greenstone belt do not particularly suggest a metallogenic province. The ultramafic rocks of this belt are dominantly peridotitic serpentinites having high magnesium values; nickel, showing a high correlation with magnesium, also appears generally higher in the ultramafic rocks of this zone than elsewhere. The dolerites of this zone contain rather more magnesium and nickel than the associated basalts and more than both dolerites and basalts of nearby greenstone belts.

The Keith-Kilkenny zone, therefore, only shows metallogenic province characteristics in the proportion of highly magnesian ultramafic rocks, and in the presence of slight enhancements of both magnesium and nickel in associated dolerites.

The isolated deposits of Windarra and Woodline Well in no way suggest widespread mineralized provinces. No other zones which could be considered as metallogenic (sub)provinces have been identified.

KNOWN PROSPECTS AND SHOWINGS

The economic potential of the region can be assessed by considering the distribution of rock types known as favourable host rocks for certain types of mineralization, or by considering the distribution of anomalous amounts of individual metals. The former estimate relies on the presence of known showings or on patterns of behaviour known from elsewhere.

In the area studied the following prospects are known.

i) Nickel
- a) Windarra
- b) South Windarra
- c) Woodline Well
- d) Weebo
- e) Marriott

ii) Copper
- a) Mount Venn

b) Dorothy Hills (with lead)
c) Mitika Well (Sefton Lineament, Laverton sheet)
d) Swincers
e) Bundaleer

iii) Lead a) Wilsons Patch

Additional mineralization consists of gold in many places, tungsten at Ogilvies Find, and molybdenum at Dodgers Hill.

Of these prospects/mines indications of their existence have been revealed at Windarra and Marriott (nickel), Mount Venn, Mitika Well, Swincers and Bundaleer (copper). Mitika Well is shown not by its copper values but by anomalous zinc. In addition the tungsten prospect of Ogilvies Find has been found anomalous in copper and zinc. Several prospects were not identified by this project (South Windarra, at least, did not crop out in its natural state).

The rock types hosting these prospects are:

i) highly magnesian ultramafic rocks (nickel),
ii) layered gabbro (copper),
iii) shear zones at margins of dolerites/basalts (copper),
iv) acid volcanics (copper) and related rocks (tungsten), and
v) granite (molybdenum, lead).

ANOMALIES OF METAL DISTRIBUTION

Additional prospective rock types may be suggested by examination of anomalies of the various ore metals. Anomalous values have been determined for the various elements following examination of cumulative frequency probability curves and scatter diagrams. The first tool emphasizes populations with unusually hgih values, the second shows where elements are unexpectedly high in relation to associated elements. No fixed proportion of anomalous samples is suggested by the probability curves but breaks of slope occurring at between 93% and 98% of the total populations suggest thresholds for anomalies.

General threshold values

The rocks were split into three groups for the Leonora and Laverton sheets as follows: felsic, mafic, and ultramafic. As there were relatively few ultramafic rocks collected from the Rason sheet only two groupings were used: i) felsic, and ii) mafic and ultramafic.

Threshold values in ppm obtained from frequency distribution curves are as follows.

Sheet / Element	Leonora	Laverton	Rason
		Felsic rocks	
Cu	40	35	(a) 50
Pb	40	60	50
U	5	5	5
Zn	65	120	50
		Mafic rocks	
Cu	140	140	(b)350
Pb	50	10	(b) 20
V	340	350	(b)250
Zn	250	125	(b)125
		Ultramafic rocks	
Cu	200	140	
Ni	2750	2000	(c)300
Pb	50	10	
Zn	250	90	

(a) few anomalous samples found

(b) includes ultramafic rocks

(c) includes mafic rocks.

The threshold for Cu, Ni, and Zn in ultramafic rocks is higher on the Leonora sheet than on the Laverton sheet suggesting a wider scatter of values in ultramafics on that sheet. Zinc has a higher threshold in the Leonora mafic rocks compared with Laverton ones but reference to Table 3 shows the mean values to be similar for both sheets. The high threshold for copper on the Rason sheet is caused by the presence of a wide scatter of values both in the Mount Venn gabbro and in the dolerites/basalts of Mount Scott-Rutter Soak.

Nickel

Nickel values over 0.2% only occur in the Laverton greenstone belt at Mount Varden, the Keith-Kilkenny greenstones, and at Mount Windarra. The highest values of nickel obtained from fresh rocks have been 0.62% in an Aus rock from Mount Clifford and 0.83% from Mount Windarra. The maximum in the Mount Varden greenstones is 0.28%. On the basis of frequency and absolute value of anomalous samples; the most promising prospecting area appears to be the ultramafic rocks of the Mount Clifford-Kurrajong subzone. Most nickel deposits contain minor amounts of copper, but only at Mount Clifford and Windarra were samples collected containing both anomalous copper and nickel.

Copper

Copper is spread more widely. The highest values reported are from felsic volcanics at Bundaleer (0.69%), gabbro at Mount Venn (0.34%), dolerite/basalt at Rutter Soak (0.32%), and serpentinite east of Wildara (0.11%).

Other values of copper over 500 ppm occur in amphibolite at Two Sisters, in gossanous serpentinite at Mount Clifford, associated with high lead (0.12%), in a ?sediment derived partly from ultramafic rocks near Lawlers; in a mineralized acid-intermediate lava at Mount Clifford; and in the dolerites/basalts between Mount Scott and Rutter Soak.

Samples with lower, but still interesting, values include: cherts east of Wildara (200-500 ppm); schists both east of Wildara and near Mount Clifford (100-200 ppm) associated with elevated lead and zinc; mafic rocks in the Mount Varden area (particularly near the Ogilvies Find prospect; where copper occurs in basalts near their sheared margin against acid volcanics); a pebble of felsic ?volcanic rock from a conglomerate at Mount Zephyr (170 ppm); and an altered felsic volcanic rock from Yamarna.

In the ultramafic rocks, except where copper occurs with nickel, the higher values (>200 ppm Cu) are found in pyroxenite (Aux) and gabbro-norite-pyroxenite at Mount Venn.

No granitic rocks show any sign of anomalous copper.

Zinc

Zinc occurs associated with copper in the schists noted above, in acid volcanics, at Bundaleer, and at Mitika Well.

The highest values of zinc, occur in two samples of ultramafic rock from the Mount Clifford area (>0.1%), and in samples of mafic and ultramafic rock from the Mount Varden area (to 630 ppm).

In felsic rocks, the highest values of zinc occur with copper in acid volcanics, at Bundaleer (360 and 720 ppm), and in 'granite' at Fourteen Mile well (Leonora sheet) where the value in one specimen is 320 ppm.

Lead

There are no true anomalous lead values except for the single sample of ?sediment near Lawlers, noted earlier; this rock contains 0.12% Pb and 670 ppm Cu. All other high lead values occur in the uranium bearing granitoids and the lead may be derived from the decay of uranium. The Age of Bailey Range (Laverton and Rason sheets) contains the highest overall lead values.

Uranium

Most granitic and fine-grained felsic rocks are low in uranium. About half the samples contain less than 1 ppm. The limits of normal background are about 5 ppm, though, any rocks which average more than 2 ppm should be considered anomalous. The most fractionated granitoids (K/Rb <200) contain the most uranium; these rocks are mainly the adamellitic granitoids.

The highest value of uranium is 98 ppm from Mount Adamson area, Leonora sheet. This rock, the Bailey Range adamellite, and the Mount Boreas adamellite appear to have the best prospects for the discovery of primary uranium mineralization, though they are not considered to be prospective for mineable uranium.

Th/U (unpublished) ratios are higher than is expected compared with figures from other parts of the world, suggesting that much of the near surface uranium may have been leached. Secondary uranium is known from the calcrete drainages south and east of Mount Venn, and the catchment systems which drain the 'hot' granitoids must be considered as possible prospecting areas.

Other elements

Barium and strontium reach quite high values (up to 0.47% and 0.13% respectively) particularly in the Mount Scott-Rutter Soak and Yamarna areas.

Though primary deposits are unlikely it is possible, by analogy with conditions in South Australia, for playa lakes and saline drainages downstream from Mount Venn to be enriched in these elements.

Fluorine was not sought but fluorite has been observed in thin sections of the Mount Boreas, Bailey Range and Mount Scott-Thatchers Soak adamellites. These rocks are worthy of further investigation for commonly related ore elements such as lithium, niobium-tantalum, tin, tungsten, and molybdenum. Isolated high values of vanadium in mafic rocks, and titanium and zirconium in silcretes (up to 17.4% TiO_2 in one silcrete (Leonora sheet)) are not considered of economic interest.

OTHER PROSPECTIVE AREAS

The calc-alkaline felsic-mafic associations may be added as areas suitable for further exploration. The Canadian Geological Survey (Hutchinson and others, 1971; Ridley, 1973) has formulated an "exhalite concept" in association with this type of volcanic-sedimentary complex. Dolerites and basalts, particularly of the Mount Scott-Rutter Soak area, contain enough copper for there to be possibilities of small mineralized showings; but the greatest potential appears to be in the possibilities of vent sulphide deposits, or related exhalative sulphides, associated with sediments and felsic members of these rocks. Such exhalative deposits are commonly relatable to chert which is present at both Ford Run Plateau and Mount Scott, and to compound piles of felsic and mafic rocks. Lack of mafic rock at Yamarna may downgrade this area as a prospect.

Prospecting the felsic volcanic and sedimentary sequences in these areas is likely to be made more difficult because of the highly weathered and leached state of many of the rocks.

DISCUSSION

The project was undertaken because of a lack of geochemical data on a 1:250 000 sheet scale, and prime aim, was to establish if bedrock geochemical sampling would be useful to field geologists, and to determine the constraints on its usefulness.

This study has assisted in regional mapping:

i) by confirming or refuting the field geologists classification,
ii) by identifying rock groups not detected as distinctive in the field,
iii) by separating classified rocks into valid subgroups (e.g. the low-K tholeiites and the 'calc-alkaline' group),
iv) by suggesting relationships between rocks of different types,
v) by providing figures for comparison with data obtained from other areas, and
vi) by suggesting areas where natural contamination of rock types has occurred.

In many cases the chemical data by themselves help to provide a classification of the rocks, but in other cases the chemistry offers no information about the origin of rocks. For instance the chemistry does not resolve the question of the pre-metamorphic precursors of Ah and Am rocks, or the differences between high-magnesium basalts and olivine basalts or picrites. In these cases the chemistry needs to be supplemented by field relationships, hand specimen, and thin section examinations.

The present project has helped the definition of parameters for using bedrock geochemistry as a prospecting tool, for the definition of metallogenic provinces and in defining regional trends.

Coverage is believed to be adequate, if not ideal, for defining regional trends in granitoids (Davy, 1976d). The number of samples analysed may be reduced by bulking samples from various rock types at each outcrop in proportion to the amount of each rock type exposed, however such bulking would cause loss of information about the degree of variation within the rock types.

Neither the degree of mapping, the quality of sampling, nor the frequency of sampling appears adequate in determining variations on a local scale, particularly in the compound piles of mafic and ultramafic rocks. Extra care is needed for the sampling of ultramafic rocks to ensure that the sample collected is representative of the unit as a whole, so that comparisons between neighbouring units become possible.

The present system is adequate for establishing the general geochemical parameters of the various rocks and for estimating whether a geochemical or metallogenic province is present.

The problem of whether the present system has provided adequate samples for regional prospecting is less easy of solution. Some areas have been extensively sampled. For instance 48 samples were taken from the Mount Venn intrusion, exposed over 20 km^2. The remaining rocks from the Mount Venn area (Mounts Scott and Grant-Rutter Soak) have also been quite closely sampled. (126 samples from 100-150 km^2.). The remainder of the Rason sheet has been sampled at an equivalent rate of one sample per 35-40 km^2. Since however outcrop is only of the order of 5-10% of the total area, the samples have been taken at the equivalent of 1 per 2-4 km^2 of rock. Though migmatitic rocks crop out in the southwest portion of the sheet many outcrops are unavailable for silicate analysis because of the severe surface alteration.

The Laverton sheet, with some exceptions, has been better served. At least one specimen has been taken from most outcrops though one or two larger areas were omitted. Collection in the Leonora sheet concentrated on the greenstone belts to the exclusion of much of the 'granite'.

The original anticipated coverage was an average of 1 sample per square mile (one sample per 2.5 km^2) i.e. approximately 600 samples per complete sheet.

The patchy distribution of the collected samples has allowed comparison of the effectiveness of the sampling for prospecting purposes. It was noted earlier that not all prospects were identified. It is worth examining how many samples were needed to establish those that were found.

In the Mount Venn gabbro four samples out of 48 were above threshold for copper, two of these samples being distinctly high (>1000 ppm) with the other two conceivable as being at the upper end of normality.

In the adjacent 'calc-alkaline' complex five out of 65 mafic rocks contained 'anomalous' copper (above 200 ppm) including three above 350 ppm. In the intermediate and felsic rocks two out of 57 samples contained over 50 ppm Cu with a maximum of 95 ppm Cu.

In the Mount Clifford-Kurrajong greenstone belt nickel mineralization was indicated directly by one sample, which contained 0.57% Ni together with 700 ppm Cu, out of 65 ultramafic rocks. In addition, two samples showed anomalous zinc concentrations (one with copper), and one other sample contained anomalous copper. In the same area two samples of mafic rocks, out of 88 analysed, were weakly anomalous in copper with a maximum of 180 ppm against a threshold of 140 ppm. One curious silicified sample contained 470 ppm Ni. There were no zinc anomalies.

The Bundaleer copper prospect with surface showings of copper was recognized in the only two samples selected at this site.

It seems clear that if localized mineralization is to be recognized, collection, particularly in the greenstone belts, should be at very close intervals, especially in areas of rapidly changing lithologies or sequences.

For general characterization of rock groups the wider spacing of one sample per 3-5 km^2 appears satisfactory except when there are rapidly changing lithologies or sequences. In these circumstances an average of at least one sample per km^2 is desirable.

Ultimately a choice has to be made between the purpose of the exercise, the economics of carrying it out, the confidence desired from the results - and the availability of suitable rock.

On the whole it is considered that this type of exercise, using bedrock geochemistry, is best suited for providing basic data on the composition of rocks for assisting mapping geologists, for establishing provinces of high chemical background, and for establishing the presence or absence of regional trends: it is less suitable for direct prospecting purposes.

CONCLUSIONS

The purpose of the project was to determine if this type of bedrock sampling and analysis was of direct use in:

i) assisting mapping,
ii) exploration for economic minerals,
iii) determining the presence or absence of metallogenic provinces, and
iv) determining the presence or absence of regional geochemical trends.

The major conclusion is that the method, as practised, has some failings, particularly as a direct reconnaissance exploration tool; but that it has been and will be of considerable value in assisting in the classification and history of the rocks, and in delineating regional trends.

Several previously unrecorded areas have been identified as worthy of further exploration (as noted later), but this must be offset against the fact that only seven out of eleven known prospects/deposits have been identified. Of these two have only been identified by indicator elements.

Its success lies in the fact that useful geochemical information has been obtained which has largely confirmed divisions mapped by regional geologists, and which has highlighted differences between some groups not readily recognizable in the field. In addition, regional trends in granitoids, and localized trends in one of the 'calcalkaline' mafic-felsic complexes

(Mount Scott-Rutter Soak) have been recognized. No province or rock group containing above regional geochemical background values has been identified.

There have been sampling and analytical deficiencies in this project which can be rectified in any subsequent exercise.

A general conclusion is that field mapping coupled with judicious geochemical sampling can contribute more to an understanding of the geology and geological history of an area than either technique alone.

GEOLOGICAL CONCLUSIONS

More detailed geological conclusions are listed as follows.

1) This study has delineated ultramafic rocks at Diorite Hill (Laverton sheet) not identified during mapping. It has allowed separation of biotite 'granite' (Agb) on the eastern part of the Leonora sheet into at least three separate units, and Agg at Isolated Hill (Rason sheet) into two units.

2) As a result of field observations, chemical and microscope determinations, some amphibolites in the Dorothy Hills (Rason sheet) Mount Varden (Laverton sheet) Wildara and Lawlers-Agnew areas (Leonora sheet) are considered to be metasediments, though this could not be determined from chemistry alone. Some apparent ultramafic rocks (Au) near Agnew may also be sediments.

3) Serpentinites and partly serpentinized rocks are recognizable from their chemistry, but it has not proved possible to separate, on chemical grounds alone, high-magnesium basalts from pyroxenites. It is also difficult to separate chemically the lower magnesium members of the high-magnesium basalt series from the more magnesian members of the tholeiite series though the high-magnesium basalts normally appear to contain rather more nickel (>400 ppm) and, possibly, chromium.

4) Comparison of the bulk composition of ultramafic rock units has proved impossible because of inadequate sampling though the division into high magnesium types (>26% MgO) and low magnesium types (<26% MgO) is readily detectable. However, the trend displayed by ultramafic rocks in the Willaree Cliffs-Kurrajong area when values are plotted on a $CaO-MgO-FeO^t$ triangular diagram, shows a different trend with a marked displacement towards MgO from that displayed by ultramafic rocks in the Lawlers-Agnew

area. If the ultramafic rocks as groups are related, separate evolutionary patterns apply in the two areas.

5) Chemical analysis has demonstrated the presence of two main types of mafic rocks, a low-K tholeiite and a 'high'-K tholeiite. A more magnesian variant of the low-K tholeiite occurs locally at Diorite Hill (Laverton sheet).

6) The low-K tholeiite conforms in its overall composition to recent island-arc and deep-oceanic tholeiites, possibly from the oceanic side of island arcs, however the high barium and strontium figures suggest some contamination of the magma by sedimentary material.

7) Differences of K/Rb and Rb/Sr ratios for different greenstone belts suggest that parts of different cycles of greenstone formation may be present.

8) The low-K tholeiites are similar in composition to equivalent rocks from the Kalgoorlke-Coolgardie-Widgiemooltha area, except that Na_2O, Cu, Ni and V are all lower in the Rason-Leonora area compared with rocks further south. Potash is marginally higher.

9) No major fractionation trends have been established for the low-K tholeiites; however, incipient fractionation may have occurred between dolerites and basalts in some greenstone areas. Minor fluctuations along strike are also present but their significance has not been established.

10) The Mount Venn layered sill is derived from a magma which differs from that of the low-K tholeiites, though the potassium content is equally low. The principal difference lies in the very low TiO_2 content which is about half that of the low-K tholeiites. No clear fractionation trends are shown. Copper occurs in sulphides and, probably, concealed in the lattice of phyllosilicates. The Mount Venn rocks are similar in composition to the Mission Sill and the more mafic varieties of the Yilmia Sills. The Mount Venn sill has chemical affinities with the Binneringie and Jimberlana dyke rocks.

11) The 'high'-K tholeiites are geographically associated with felsic lavas, pyroclastics, and hypabyssal intrusives. AFM plots of these rocks show them to follow a calc-alkaline fractionation/differentiation trend. The three areas where these calc-alkaline, mafic-felsic associations have been identified are Ford Run Plateau (Leonora sheet), Mount Scott-Rutter Soak

(Rason sheet) and Yamarna (Rason sheet). Felsic rocks with calc-alkaline affinities also occur in the Mount Varden (Laverton sheet) area.

The dominant felsic rocks at both Rutter Soak and Yamarna are pyroclastic in origin, and at Ford Run Plateau, volcanic. Rocks of intermediate composition occur with some frequency in the Mount Scott-Rutter Soak area, but are virtually absent elsewhere. Rhyodacites are common at Ford Run Plateau, but dacites are more common at both Yamarna and Rutter Soak.

12) Other fine grained, mainly porphyritic, felsic rocks occur sporadically through the area. Most of these rocks are soda rich, however, a few rhyodacite and even rhyolitic rocks are known. Ultra-potassic rocks may be diagenetically altered tuffs.

13) Granitoids of intermediate composition are almost absent. Isolated samples of syenite (Charleston well, Laverton sheet) and diorite (Mount Clifford, Leonora sheet) have been analysed.

14) Granitoids are universally soda rich with a minimum of about 3.5% Na_2O and a maximum of about 7% Na_2O. Most are granodiorites or adamellites. There are few tonalites and rare true granites. The granitoids are all low in calcium (maximum ca 3.2% CaO).

15) More than one cycle of granitic intrusion has been determined. Within an older cycle, there is increase of potassium as the rocks become younger. Within one younger cycle (between the Celia and Laverton Lineaments) the same trend to increasing potassium is suggested. The first formed members of this younger sequence are more potassic than the last members of the early sequence.

16) The granitoids show regional trends in interlineament zones (Davy, 1976d). Magnesium, nickel, and vanadium decrease from west to east. Potassium and rubidium increase from west to east reaching a maximum between the Laverton and Sefton Lineaments.

17) There is no general chemical progression from early tectonic rocks (such as Agg, Agp), through syntectonic rocks (Age, Agb) to post tectonic rocks (Agl) though definite trends may apply within localized groups.

18) The greater number of granitoids are primitive in nature with high K/Rb values (>200) and low Rb/Sr ratios (less than unity). Fractionated

granites with K/Rb <200 are represented by the Age of Bailey Range, the Age in the vicinity of the Mount Scott-Mount Venn area (both Rason sheet) and Agb of Mount Boreas (Laverton sheet). These rocks have enhanced values of uranium, and fluorite is a common accessory.

19) A number of fine-grained felsic rocks have similar compositions to nearby granitoids. Genetic relationships are possible between these groups particularly at Ford Run Plateau where the fine and coarse rocks crop out together. Elsewhere geographic separation hinders interpretation of the relationships. Other fine-grained rocks, both intrusive and extrusive, have no compositional counterparts in the granitoids analysed.

20) Inter-regional comparisons can be misleading because of problems of generalizing from too little data. However, the ultramafic rocks, the low-K tholeiites, and the granitoids, at least, find counterparts in rocks of Archaean age in South Africa, Canada/USA and India. There are localized regional differences.

AREAS OF POTENTIAL FOR PROSPECTING

On the basis of presently known mineralization, and the distribution of anomalous values, it is concluded that the following areas are possible sites of mineralization, and worthy of additional prospecting:

i) The serpentinites and other ultramafic magnesium rich rocks of the Keith-Kilkenny greenstone belt (Ni),

ii) The calc-alkaline mafic-felsic complexes of Ford Run Plateau*, Mount Scott-Rutter Soak, and Yamarna (Cu, Zn), in particular the Mount Scott-Rutter Soak area.

iii) The mafic, felsic, and sedimentary rocks of the Mount Varden area of the Laverton greenstone belt (Cu-Zn),

iv) The Mount Venn layered sill (Cu),

*Since this paper was written significant copper-zinc mineralization has been reported from the Ford Run Plateau area.

v) The fractionated granitoids, especially the Mount Boreas and Bailey Range adamellites (U-F - and related metals),

vi) Calcrete zones draining uraniferous granitoids, in particular the drainage downstream from the Mount Grant (Rason sheet) area, and those basins draining the Mount Boreas and Bailey Range rocks.

ACKNOWLEDGEMENTS

This project was undertaken by R.H.A. Cochrane formerly of the W.A. Geological Survey. Mr. Cochrane was responsible for the selection of samples, the choice of elements for analysis and the general analytical methods. Collecting geologists were Messrs R. Barnes, C. Gower, R. Thom all formerly of the W.A. Geological Survey. Analyses were carried out by Messrs N. Marsh and A. Thomas of the W.A. Government Chemical Laboratories, the last named also carrying out all computer manipulations.

TABLE 1. Ranges of values to typical ultramafic rocks of the various groups. Examples taken from specific areas.

Rock Type	Ar	Ar	Ar	Ae	Ae	Aup	Aus	Aus	Au	Au	Au	Aux
Sheet	Leonora	Laverton	Rason	Leonora	Laverton	Leonora	Leonora	Leonora	Leonora	Leonora	Laverton	Leonora
Locality	Agnew	Mt Varden	Mt Sefton	Mt Clifford	Mt Varden	Wildara	Wildara	Mt Clifford	Agnew	Mt Clifford	Mt Varden	Agnew
No. of Samples	2	8	2	2	4	1	13	17	25	8	18	4
Ba	70–95	26–290	58–2867	68–404	19–80	64	4–358	0–784	12–212	17–192	0–1006	38–315
CaO	10.4–14.9	5.0–10.1	2.8–10.0	8.5–9.5	1.1–10.6	2.8	0.1–9.1	0.1–9.9	0.3–14.3	0.1–0.5	0.1–14.1	7.4–14.7
Cr	1206–1427	1533–2662	1425–2910	537–2128	1238–3280	2056	1970–4854	681–5678	512–7093	1544–1.27%	873–5527	291–3093
Cu	59–67	14–109	13–64	56–58	30–110	10	0–1148	0–261	0–82	10–59	0–234	28–223
Fe_2O_3	7.7–14.0	9.9–13.2	8.4–12.5	11.2–11.6	9.3–12.7	11.4	7.1–14.9	4.4–144	7.3–15.0	10.3–14.2	7.8–15.8	6.6–14.7
K_2O	0.2	0.1–0.2	0.1	0.1–0.8	0.1	0	0–0.1	0–0.2	0–0.4	0–0.1	0–0.6	0.1–0.3
MgO	11.8–13.9	12.1–21.2	11.1–19.7	10.1–15.4	12.0–27.3	34.4	22.7–37.5	13.9–36.6	13.9–36.9	15.0–42.4	12.1–43.6	12.7–22.9
Na_2O	0.8–1.1	0.1–1.4	0–0.6	0.7–1.5	0–1.2	0	0–1.1	0–4.0	0–1.1	0–1.6	0–1.7	0–1.3
Ni	227–391	433–749	1001–1035	97–520	366–901	1012	848–2453	373–6186	249–2029	372–2175	191–2831	246–1022
Pb	5–81	0–8	2–7	4–7	0	0	0–9	0–34	0–19	0–16	0–8	0–6
Rb	5–12	3–7	0	5–31	1–9	4	0–7	2–8	0–14	2–10	0–18	0–10
SiO_2	47.0–50.0	42.3–53.9		48.1–48.8	43.8–50.1	42.0	41.0–45.7	30.9–56.6	38.1–58.8	41.6–47.3	28.2–51.0	44.2–54.7
Sr	43–75	15–154	13–43	40–183	4–100	30	0–51	2–85	3–129	2–55	0–224	7–170
TiO_2	0.4–0.6	0.4–0.6	0.1–0.3	0.5–0.6	0.3–0.6	0.2	0.1–0.5	0.1–0.6	0.1–0.7	0.2–0.7	0–1.2	0.2–0.9
V	186–211	148–189	73–170	170–173	139–248	91	73–173	47–188	49–219	74–182	14–263	109–217
Zn	62–206	56–81	75–197	89–109	60–125	62	45–161	35–2220	30–249	53–104	32–94	43–249
Zr	24–35	16–36	0–18	45–62	13–48	9	4–32	5–104	6–50	7–82	0–56	9–39

TABLE 2. Examples of typical mafic rocks

Rock Type	Ad	Ad	Ab	Ab	Ah	Ah	Ah	Am	Am	Ai	Ak
Locality	Lawlers-Agnew	Mt Scott	Mt Varden	Rutter Soak	Karara	Mt Redcliffe	Mitika Well	Diorite Hill southeast	Woolshed Well	Mt Varden	Mt Varden
Sheet	Leonora	Rason	Laverton	Rason	Laverton	Laverton	Laverton	Laverton	Laverton	Laverton	Laverton
No. of Samples	41	10	45	14	4	14	2	9	4	8	3
CaO	$10.8^{1.8}$	$9.8^{1.1}$	$10.2^{2.0}$	$10.0^{2.2}$	$9.7^{0.8}$	$10.7^{1.8}$	6.4	$10.1^{2.1}$	$7.0^{2.9}$	$11.1^{1.5}$	12.4
Fe_2O_3	$11.9^{3.2}$	$13.4^{3.0}$	$13.4^{2.6}$	$7.8^{4.4}$	$11.7^{2.1}$	$12.8^{2.5}$	11.7	$14.1^{2.9}$	$5.8^{2.7}$	$12.7^{1.5}$	11.9
K_2O	$0.25^{0.11}$	$0.55^{0.22}$	$0.23^{0.10}$	$0.70^{0.32}$	$0.23^{0.05}$	$0.37^{0.22}$	1.8	$0.14^{0.07}$	$2.3^{1.6}$	$0.25^{0.11}$	0.17
MgO	$7.6^{2.9}$	$7.1^{2.0}$	$6.2^{2.0}$	$4.5^{1.8}$	$6.8^{0.8}$	$5.9^{1.5}$	4.4	$6.5^{1.6}$	$6.4^{3.0}$	$5.2^{1.0}$	6.6
Na_2O	$1.8^{0.7}$	$2.3^{0.9}$	$2.2^{0.9}$	$2.1^{1.0}$	$2.4^{0.4}$	$1.9^{0.7}$	4.0	$2.0^{1.4}$	$3.4^{1.5}$	$1.6^{0.6}$	1.9
SiO_2	$52.2^{3.9}$		$49.7^{2.7}$		$52.9^{2.0}$	$51.5^{2.8}$	52.9	$52.9^{2.7}$	$59.4^{6.6}$	$50.2^{1.4}$	50.8
TiO_2	$1.0^{0.5}$	$1.1^{0.5}$	$1.3^{0.6}$	$0.9^{0.5}$	$1.4^{0.3}$	$0.9^{0.1}$	2.6	$1.3^{0.5}$	$0.5^{0.2}$	$1.2^{0.2}$	1.0
Ba	172^{172}	441^{231}	229^{192}	428^{265}	504^{220}	178^{123}	1293	546^{595}	1055^{358}	297^{245}	433
Cu	63^{49}	92^{84}	83^{28}	60^{76}	43^{22}	43^{24}	41	67^{34}	34^{18}	103^{79}	107
Ni	116^{71}	131^{76}	107^{64}	105^{68}	130^{22}	126^{136}	52	72^{20}	86^{38}	102^{18}	116
Pb	3^{3}	6^{3}	2^{3}	15^{13}	3^{4}	3^{4}	0	2^{3}	12^{11}	1^{2}	3
Rb	8^{6}	25^{24}	5^{5}	18^{11}	8^{6}	8^{6}	37	3^{3}	53^{51}	6^{5}	2
Sr	120^{58}	308^{144}	138^{59}	269^{169}	106^{21}	139^{78}	265	161^{164}	682^{254}	112^{29}	147
V	232^{118}	264^{202}	309^{105}	156^{90}	344^{32}	253^{27}	240	348^{93}	85^{80}	303^{41}	251
Zn	101^{78}	97^{23}	90^{25}	73^{22}	96^{13}	98^{21}	141	93^{15}	71^{17}	102^{15}	84
Zr	85^{47}	84^{53}	86^{48}	121^{25}	70^{3}	64^{16}	338	74^{27}	105^{26}	74^{16}	56
	Low K	'High' K	Low K	'High' K	Low K		?contam-inated		?contam-inated	Low K	Low K

Oxides in percentage; trace elements in ppm.

Superscripts indicate standard deviation (4 or more samples).

TABLE 3. Comparison of mean values of tholeiitic rocks grouped by greenstone belt.

Greenstone belt	Agnew		Keith–Kilkenny		Redcliffe–Rufus		Mt Zephyr		Laverton		Diorite Hill		Sefton Lineament		All samples		Ford Run Plateau		Mt Scott–Rutter Soak	
Sheet	Leonora		Leonora		Laverton		Laverton		Laverton		Laverton		Laverton and Rason				Leonora		Rason	
Rock Type	Ab	Ad	Ad	Ab	Ad	Ab	Ad	Ab	Ad	Ab	Ad	Ab	Ad	Ab	Ad	Ab	Ad	Ab	Ad	Ab
No. of Samples	25	46	33	74	5	13	7	10	37	61	7	4	8	6	143	193	14	14	48	14
CaO	12.1	11.0	11.1	10.8	12.0	10.7	11.2	11.5	10.3	10.4	13.1	12.6	12.4	11.8	11.1	10.9	10.9	8.9	10.3	10.0
Fe_2O_3	11.8	11.6	10.9	11.7	10.9	12.5	13.0	12.8	12.8	13.2	10.1	10.9	10.9	12.2	11.7	12.3	11.8	12.6	10.2	7.8
K_2O	0.26	0.24	0.26	0.32	0.20	0.22	0.19	0.27	0.20	0.23	0.17	0.13	0.17	0.25	0.22	0.27	0.45	0.40	0.58	0.70
MgO	7.9	7.6	8.7	7.4	7.0	6.3	5.3	5.7	7.0	6.4	10.0	8.2	8.0	8.3	7.7	7.0	8.2	6.4	7.9	4.5
Na_2O	1.4	1.8	1.8	1.6	1.2	1.7	1.4	1.5	2.0	2.0	1.2	1.3	1.4	1.9	1.8	1.7	1.7	2.3	2.1	2.1
SiO_2	51.6	51.8	50.4	51.3	50.4	50.9	49.2	49.4	49.2	49.7	49.6	48.7	(c)48.9	(d)49.9	50.4	50.6	50.0	51.9		
TiO_2	0.9	1.0	0.8	1.0	0.8	1.0	1.1	1.0	1.1	1.2	0.5	0.6	0.7	0.9	0.9	1.0	0.7	1.1	1.2	0.9
Ba	130	164	287	209	427	253	183	178	244	199	83	129	87	176	215	194	313	333	462	428
Cu	57	65	77	80	56	57	74	68	81	(b)78	69	82	86	57	73	74	79	80	80	60
Ni	114	122	151	123	100	97	117	124	99	115	148	151	153	168	125	120	116	95	119	105
Pb	4	(a)3	4	5	0	1	0	1	1	2	0	3	5	1	2	3	6	5	9	15
Rb	10	8	11	13	15	5	5	6	4	5	6	3	5	9	7	9	16	13	24	18
Sr	107	119	148	127	151	131	99	134	142	136	218	148	97	90	135	127	153	133	239	269
V	239	226	217	237	238	257	291	270	272	296	172	199	235	250	237	259	210	236	258	156
Zn	93	97	78	91	73	85	94	90	97	(b)89	73	73	71	92	89	90	90	83	97	73
Zr	63	81	55	70	53	69	72	65	77	80	20	29	57	61	68	71	82	89	82	121

Oxides in percentages; trace elements in ppm; a–45 samples; b–60 samples; C–2 samples; d–4 samples.

TABLE 4. Comparison of selected fine–grained felsic rocks

	Ax/Al		Ax	Ap	Al	Ap	Ax	Al	?	Ap
Locality	Rutter Soak		Yamarna	Ford Run Plateau		Leonora	Ford Run Plateau	Laverton	Mt Zephyr	Mt Varden
Sheet	Rason		Rason	Leonora		Leonora	Leonora	Laverton	Laverton	Laverton
No. of Samples	Medium Grain 17	Fine Grain 22	25	4	20	1	1	1	2	4
CaO	$1.5^{1.2}$	5.7^{18}	$2.5^{1.4}$	$0.3^{0.1}$	$0.8^{0.8}$	0.3	0.2	0.1	1.9	$1.3^{0.3}$
Fe_2O_3	$2.0^{0.8}$	$7.6^{4.8}$	$4.5^{1.5}$	$1.8^{0.7}$	$2.8^{1.2}$	1.0	1.8	3.4	2.5	$2.2^{0.5}$
K_2O	$3.3^{2.3}$	$1.7^{2.2}$	$2.3^{0.7}$	$3.6^{1.0}$	$3.3^{1.5}$	0.1	9.7	2.5	1.7	$2.0^{0.3}$
MgO	$0.6^{0.5}$	$3.4^{1.4}$	$2.2^{0.8}$	$1.0^{0.2}$	$1.9^{1.2}$	1.2	1.1	1.2	1.6	$1.8^{0.4}$
Na_2O	$3.4^{1.7}$	$3.8^{1.5}$	$4.2^{1.1}$	$3.9^{0.7}$	$4.1^{2.2}$	9.9	0.4	2.9	5.5	$5.3^{0.5}$
SiO_2				$75.3^{3.0}$	$71.0^{5.0}$	69.9	74.2	73.4	69.3	$69.4^{1.1}$
TiO_2	$0.4^{0.2}$	$0.8^{0.5}$	$0.5^{0.2}$	$0.1^{0.1}$	$0.3^{0.1}$	0.2	0.2	0.2	0.4	$0.4^{0.1}$
Ba	1522^{1018}	790^{649}	1527^{947}	1082^{345}	1429^{1043}	23	1240	489	760	619^{76}
Cu	26^{23}	20^{14}	23^{23}	12^{8}	24^{21}	11	74	9	79	5^{3}
Ni	25^{12}	51^{47}	44^{16}	20^{5}	30^{23}	51	19	22	57	23^{4}
Pb	19^{8}	13^{8}	24^{13}	5^{2}	19^{11}	9	8	18	5	10^{3}
Rb	81^{67}	39^{39}	69^{23}	103^{42}	91^{44}	5	165	89	68	54^{8}
Sr	209^{171}	230^{180}	646^{220}	63^{28}	409^{409}	173	34	54	333	313^{189}
U	1^{1}	1^{2}	1^{1}	1	1	1	1	1	1	1
V	39^{31}	95^{36}	73^{24}	7^{3}	38^{25}	10	16	18	37	29^{15}
Zn	36^{25}	74^{39}	73^{27}	22^{5}	57^{40}	15	11	32	54	54^{14}
Zr	152^{46}	150^{80}	117	252^{80}	193^{106}	79	137	190	126	129^{37}
K/Ba	18	18	13	28	19	36	65	42	19	27
K/Rb	338	392	277	290	301	166	488	233	207	307
Rb/Sr	0.39	0.17	0.11	1.6	0.22	0.03	4.9	1.7	0.20	0.17

Oxides in percentages; trace elements in ppm. Superscripts indicate standard deviations (four or more samples).

TABLE 5. Comparison of coarse-grained felsic rocks, examples to show typical compositions

Type	Agm	Agn	Agn	Agg	Agg	Agp	Agp	Age	Age	Agb	Agb	Agl	Agl
Locality	N.W.	David Well	Bailey Range	Isolated Hill	Erlistoun	Laverton Downs		Lawlers		Garden Well	N.E. of Mt Varden	Woolshed Well	Dorothy Hills
Sheet	Rason	Laverton	Laverton	Rason		Laverton		Leonora	Rason	Leonora	Laverton	Laverton	Rason
No. of Samples	1	1	5	4	5	10	7	2	6	10	6	5	4
CaO	2.3	2.6	$0.9^{0.6}$	$0.8^{0.3}$	$2.7^{0.4}$	$0.4^{0.3}$	$1.6^{0.5}$	2.3	$0.8^{0.3}$	$1.3^{1.0}$	$1.2^{0.5}$	$1.3^{0.5}$	$1.3^{0.7}$
Fe_2O_3	2.3	0.9	$1.7^{0.8}$	$1.1^{0.2}$	$3.0^{0.8}$	$1.0^{0.2}$	$2.6^{0.6}$	1.7	$1.8^{0.2}$	$3.0^{1.6}$	$2.1^{0.8}$	$1.4^{0.5}$	$2.6^{1.9}$
K_2O	2.7	1.0	$4.9^{1.1}$	$4.6^{0.4}$	$2.1^{0.5}$	$4.9^{0.8}$	$1.8^{0.5}$	1.4	$5.3^{0.1}$	$2.6^{1.5}$	$5.3^{0.5}$	$3.4^{0.7}$	$2.5^{1.0}$
MgO	0.9	0.9	$0.1^{0.1}$	$0.1^{0.1}$	$1.0^{0.6}$	$0.9^{0.1}$	$1.5^{0.3}$	1.1	$0.1^{0.1}$	$1.4^{0.5}$	$1.5^{0.3}$	$1.3^{0.2}$	0^{0}
Na_2O	5.4	6.5	$4.0^{0.6}$	$3.7^{0.4}$	$4.6^{0.6}$	$4.8^{0.6}$	$5.1^{0.5}$	5.5	$3.8^{0.2}$	$4.2^{0.9}$	$3.8^{0.3}$	$5.2^{0.8}$	$4.7^{0.6}$
SiO_2	N.D.	71.2	$72.6^{0.8}$	N.D.	N.D.	$72.7^{1.0}$	$69.2^{1.7}$	70.7	N.D.	$72.2^{3.3}$	$71.0^{2.8}$	$72.3^{2.2}$	N.D.
TiO_2	0.4	0.1	$0.2^{0.1}$	$0.1^{0.1}$	$0.4^{0.2}$	$0.1^{1.0}$	$0.3^{0.1}$	0.3	$0.3^{0.1}$	$0.3^{0.2}$	$0.4^{0.2}$	$0.1^{0.1}$	$0.4^{0.1}$
Ba	1032	1613	1452^{654}	706^{437}	883^{288}	1323^{398}	686^{214}	482	1068^{147}	631^{177}	1298^{206}	818^{554}	967^{428}
Cu	13	11	9^{4}	11^{8}	4^{5}	8^{4}	10^{9}	17	12^{10}	13^{6}	12^{4}	11^{8}	5^{6}
Ni	22	17	15^{1}	38^{41}	19^{8}	17^{3}	21^{6}	29	17^{4}	19^{5}	20^{6}	21^{5}	11^{4}
Pb	30	8	35^{25}	40^{9}	16^{4}	21	12^{7}	26	39^{5}	9^{5}	31^{9}	24^{9}	14^{6}
Rb	171	19	146^{28}	192^{90}	81^{22}	107^{22}	59^{19}	51	295^{50}	76^{59}	182^{25}	94^{25}	78^{32}
Sr	706	595	274^{44}	146^{94}	490^{187}	249^{203}	340^{82}	444	226^{35}	128^{93}	315^{84}	475^{250}	203^{165}
U	1	1	2	4^{2}	2^{1}	<1	<1	5	2^{1}	<1	1^{1}	<1	<1
V	32	12	10^{6}	7^{5}	33^{16}	10^{5}	42^{11}	18	15^{4}	21^{14}	25^{12}	17^{4}	11^{7}
Zn	66	5	37^{20}	24^{4}	65^{13}	9^{7}	43^{17}	32	51^{20}	39^{27}	50^{26}	31^{15}	66^{62}
Zr	147	66	123^{68}	72^{13}	159^{39}	58^{14}	147^{8}	93	196^{17}	215^{77}	180^{145}	74^{13}	262^{84}
K/Ba	22	5.1	27	54	20	31	22	24	41	34	34	34	21
K/Rb	131	437	278	199	215	380	253	228	149	284	242	300	266
Rb/Sr	0.24	0.03	0.53	1.3	0.17	0.43	0.17	0.11	1.3	0.59	0.58	0.20	0.38

Oxides in percentages: trace elements in ppm. Superscripts indicate standard deviations (four or more samples). N.D. = Not determined.

TABLE 6. Comparison of representative mafic rocks from the present study compared with other published analyses from Western Australia

Group	(1)	(2)	(3)	(4)	(5)	(6)
No. of Samples	143	193	123	84	337	8
SiO_2	50.4	50.6	51.4	50.8	51.3	52.2
Al_2O_3			14.8	14.5	14.8	14.1
Fe_2O_3	[a]10.5	[a]11.1	[a]10.4	[a]11.7	[a]10.5	2.4
FeO						7.9
MgO	7.7	7.0	6.7	6.9	6.7	7.3
CaO	11.1	10.9	10.7	9.9	10.8	10.1
Na_2O	1.8	1.7	2.7	2.7	2.7	2.1
K_2O	0.22	0.27	0.18	0.25	0.18	0.10
H_2O						2.5
CO_2						0.3
TiO_2	0.9	1.0	0.92	1.16	0.96	0.65
P_2O_5						0.08
MnO						0.17
Ba	215	194				30
Cr			395	314	367	181
Cu	73	74	98	111	107	96
Ni	125	120	161	145	170	102
Pb	2	3				
Rb	7	9	9	9	9	3
Sr	135	127	105	91	105	79
V	237	259	320	307	320	269
Zn	89	90	112	107		83
Zr	68	71	60	54	61	40

Oxides in percentage; elements in ppm.

(1) Average of 143 low–K dolerites from the Leonora, Laverton and Rason sheets (this study).

(2) Average of 193 low–K basalts from the Leonora, Laverton and Rason sheets (this study).

(3) Average values 123 basalts, Coolgardie – Norseman area. Hallberg (1972).

(4) Average values 84 dolerites/gabbros. Coolgardie – Norseman area. Hallberg (1972).

(5) Average tholeiitic basalt. Eastern Goldfields, W.A. Hallberg & Williams (1972).

(6) Average basalt in association with Marda Complex. Hallberg and others 1976.

a – Total iron as FeO

TABLE 7. Comparison of low–K tholeiites of the studied area with other published analyses

Group	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
No. of Samples	143	193	5	4	53	20	82	10					
%													
SiO_2	50.4	50.6	52.70	52.13	49.83	51.83	49.0	49.9	49.6	51.6	50.6	51.1	47.0
Al_2O_3			13.13	13.33	14.64	14.53	14.8	17.2	16.0	15.9	16.3	16.2	15.8
Fe_2O_3			1.20	2.24	3.03	2.96	2.36	2.0				3.1	3.3
FeO	10.5^+	11.1^+	9.16	9.94	8.77	8.46	8.20	6.9	11.5^+	9.5^+	8.4^+	7.6	7.9
MgO	7.7	7.0	7.98	6.35	7.36	6.22	6.36	7.2	7.8	6.7	9.0	6.2	7.1
CaO	11.1	10.9	10.70	8.98	10.46	8.42	9.75	11.8	11.3	11.7	9.5	9.9	10.1
Na_2O	1.8	1.7	2.38	2.97	2.02	3.40	2.07	2.7	2.8	2.4	2.9	2.5	3.2
K_2O	0.22	0.27	0.16	0.26	0.23	0.29	0.25	0.16	0.22	0.44	1.07	0.7	1.4
H_2O				2.08	1.81	1.56	3.52			0.45	0.81	0.7	1.0
CO2					0.33	0.29	0.85						
TiO_2	0.9	1.0	0.40	1.09	0.94	1.11	1.09	1.51	1.43	0.80	1.05	1.6	2.5
P_2O_5			0.77		0.19	0.22	0.11		0.14	0.11	0.21	0.22	0.5
MnO			0.13	0.21	0.21	0.18	0.19	0.17				0.17	0.2
ppm													
Ba	215	194					85	14				244	444
Cr				300			175	297	200–400	50	40	160	168
Cu	73	74	99				115	77				123	108
Ni	125	120	112	850			85	97	30–200	30	25	85	98
Pb	2	3					2.4						
Rb	7	9						1	0.2–5	5	10	17	41
Sr	135	127					124	130	70–150	200	330	450	774
V	237	259	159				362			270	255	251	236
Zn	89	90					99						
Zr	68	71	110				103	95		70	100	108	138

(1) Average values dolerites, this study
(2) Average values basalts, this study
(3) Orthoamphibolites, Chitaldrug amphibolite belt, India, *Satyanarayana and others (1974).*
(4) Metabasalts. L. Onverwacht Series, Transvaal. Viljoen and Viljoen, (1969).
(5) Average Canadian Keewatin Archaean basalts, Wilson and others (1965).
(6) Average Canadian Keewatin Archaean andes–ites, Wilson and others (1965).
(7) Metabasalts from Timmins–Noranda, Canada. Baragar and Goodwin (1969).
(8) *Oceanic tholeiites. Engel and others (1965).*
(9) Abyssal tholeiites. Data cited in Hallberg and Williams (1972, p. 197)
(10) Island arc tholeiites. Jakes and White (1971)
(11) Island arc calc-alkaline rocks. Jakes and White (1971).
(12) All tholeiitic basalts, Manson (1967). T.E. from Prinz (1967).
(13) All alkali basalts, Manson (1967). T.E. from Prinz (1967).

TABLE 8. Comparison of the high–K tholeiites with other published analyses

Group	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Location	Ford Run Plateau Dolerite Basalt		Mt Scott–Rutter Soak Dolerite Basalt		Lake of the Woods – Wabigoon greenstone belt basalts Canada	Average tholeiite basalt	Island arc tholeiite
No. of samples	14	14	48	14	134		
%							
SiO_2	50.0	51.9			50.0	50.83	51.57
Al_2O_3					14.7	14.07	15.91
Fe_2O_3					2.70	2.88	2.74
FeO	(a) 10.6	(a) 11.3	9.2	7.0	8.96	9.00	7.04
MgO	8.2	6.4	7.9	4.5	6.11	6.34	6.73
CaO	10.9	8.9	10.3	10.0	8.93	10.42	11.74
Na_2O	1.7	2.3	2.1	2.1	2.21	2.23	2.41
K_2O	0.45	0.40	0.58	0.70	0.39	0.82	0.44
H_2O					2.01	0.91	0.45
CO_2					1.81		
TiO_2	0.7	1.1	1.2	0.9	0.97	2.03	0.80
P_2O_5					0.25	0.23	0.11
MnO					0.21	0.18	0.17
Ba	313	333	462	428	122	250	75
Cu	79	80	80	60	91	100	
Ni	116	95	119	105	110	150	30
Pb	6	5	9	15	3.6	5	
Rb	16	13	24	18			5
Sr	153	133	239	269	217	465	200
V	210	236	258	156	384	250	270
Zn	90	83	97	73	89	100	
Zr	82	89	82	121	133	110	70

1 – 2 Leonora Sheet W.A. This study
3 – 4 Rason Sheet W.A. This study
5 Barragar and Goodwin. (1969)
6 Major elements Nockolds, (1954); Trace elements (7 analyses) from Barragar and Goodwin 1969.
7 Jakes and White 1972
(a) Total iron as FeO

TABLE 9. Comparison of various elemental ratios in mafic rocks in the Leonora, Laverton and Rason areas.

Rock Type	Ab				Ad			
Greenstone Group	n	K/Ba	K/Rb	Rb/Sr	n	K/Ba	K/Rb	Rb/Sr
Lawlers–Agnew	25	17	216	.09		41	15	259 .06
East of Wildara	22	15	194	0.12				
Mt Clifford	49	12	214	.09	29	7.3	187	.08
Mt Redcliffe	7	9.3	360	.04				
Rufus Hill	6	5.4	498	.02	5	3.9	111	.10
Mt Zephyr	10	13	373	.04	7	8.6	315	.05
Southwest of Laverton	10	13	277	.04	6	21	273	.06
Northeast of Laverton	6	22	259	.07				
Mt Varden	45	8.3	382	.04	31	6	415	.03
(Diorite Hill)	4	8.4	360	.02	7	17	277	.03
Mt Sefton	(a)8	14	353	.04				
East of Mt Hickox	(a)8	5.5	259	.05				
Ford Run Plateau	14	12	255	.10	14	15	233	.10
Mt Scott area					48	19	201	.10
Rutter Soak	14	14	323	.07				

(a) Dolerites and basalts not differentiated

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APPENDIX A - Analyses of granitoids grouped by interlineament zone

Inter Lineament Zone	KEITH–KILKENNY – IDA				KEITH–KILKENNY GREENSTONES						
Rock Type	Age				Age		Agb	Age	Agb		Age
Locality	Mt Adamson	Lawlers	14 Mile Well	E of Joe's Fault	E of Wildara		SE of Little Bore	Victory Well (Mt Clifford)	Leonora		Area
Coordinates	34/50	34–35/51	36/50	37/51	38–39/50	39/50	38–39/49	39–40/45–46	40/46	44/43	43/41
No. of Samples	4	2	1	1	3	1	3	3	3	1	1
CaO	$2.3^{0.5}$	2.3	3.5	2.0	0.7	6.5	1.9	2.8	0.4	0.2	2.9
Fe_2O_3	$2.7^{0.8}$	1.7	3.1	1.8	0.8	6.5	2.4	3.4	1.4	3.4	2.8
K_2O	$3.1^{0.5}$	1.4	0.2	3.1	4.4	0.2	3.6	2.6	0.3	2.4	1.9
MgO	$1.6^{0.9}$	1.1	5.6	0.6	0.4	6.5	1.6	2.8	2.3	1.5	1.9
Na_2O	$4.4^{0.4}$	5.5	5.2	4.8	4.7	7.0	4.5	4.6	7.8	8.3	5.7
SiO_2	69.0^{14}	70.7	64.2	70.4	74.2	58.1	69.2	66.8	70.9	64.2	73.9
TiO_2	$0.4^{0.1}$	0.3	0.7	0.3	0.03	0.8	0.4	0.5	0.3	0.4	0.3
Ba	1086^{577}	482	37	889	516	566	1226	(909)	90	1086	487
Cu	14^{7}	17	5	12	18	20	19	17	4	15	64
Ni	22^{8}	29	47	20	30	226	58	40	55	23	27
Pb	33^{4}	26	2	29	32	5	30	23	5	49	17
Rb	121^{19}	51	5	113	115	0	103	59	6	100	60
Sr	382^{93}	444	103	477	116	927	400	(541)	231	401	336
U	28^{47}	5	1	2	2	< 1	3	< 1	< 1	8	< 1
V	33^{11}	18	102	22	6	112	38	55	34	43	25
Zn	74^{12}	32	319	75	22	58	61	81	22	67	39
Zr	188^{31}	93	165	112	50	203	154	141	121	876	115
K/Ba	24	24	45	29	71	2.9	24	24	28	11	32
K/Rb	213	228	332	228	317	–	290	313	415	199	263
Rb/Sr	0.32	0.11	0.05	0.05	1.0	–	0.26	0.13	0.03	0.25	0.18

(a) Including 1 U value of 92 ppm; Without this $\overline{X}$ (n = 3) = 55, S = 6
Oxides in percentages; elements in ppm –
Figures given are mean values: Superscripts (for 4 or more samples) are standard deviations

APPENDIX A - cont'd

Inter Lineament Zone	CELIA–KEITH KILKENNY																	
Rock Types	Agg	Age			Agb											Agl		
Locality	Anderson's Bore	N of Mt Redcliffe	N of Mt Redcliffe	NE Monu–ment Hill	Dodgers Hill		Jindardie Well	E of Wilsons Patch	Garden Well	Garden Well	Ford Run Plateau		Smith Well	'Al' West of Ossies Well	Mt Redcliffe	Bob Well	Wool–shed Well	Rufus Hill
Coordinates E/N	39/50	45 50	46 49	48 47	Mo 44/45	other 43/50	43/50	42/49	41/48–49	41/49	40/49	40/50	39/50	39/49	45 48	45 49	46–47 48–49	47 46
No. of Samples	1	1	1	1	17	1	2	3	10	1	2	1	1	2	2	1	5	1
CaO	0.5	0.4	1.8	0.5	$0.4^{0.3}$	0.1	0.6	2.2	1.3^{10}	6.0	0.3	2.3	2.1	2.2	0.8	0.3	$1.3^{0.5}$	2.0
Fe_2O_3	1.7	0.8	2.6	0.9	$1.4^{0.9}$	1.0	0.8	2.9	$3.0^{1.6}$	9.4	1.9	2.7	2.8	3.6	1.4	0.7	$1.4^{0.5}$	2.1
K_2O	6.0	4.7	3.3	4.6	$3.4^{1.2}$	4.9	2.3	3.8	$2.6^{1.5}$	1.7	3.4	1.9	2.0	0.1	3.8	4.7	$3.4^{0.7}$	3.1
MgO	0	0.9	2.0	0.9	$1.5^{1.3}$	1.2	0.6	2.1	$1.4^{0.5}$	3.7	1.0	2.1	0.8	3.4	1.0	0.9	$1.3^{0.2}$	1.8
Na_2O	3.6	4.4	5.0	5.4	$3.7^{1.3}$	4.5	4.5	5.0	$4.2^{0.9}$	4.6	4.4	5.7	4.2	8.5	4.9	4.3	$5.2^{0.8}$	5.5
SiO_2	71.1	73.1	68.5	74.1	$74.8^{3.3}$	77.5	73.0	68.9	$72.2^{3.3}$	55.7	75.7	68.4	71.1	64.8	73.3	73.3	$72.3^{2.2}$	70.1
TiO_2	0.1	0.1	0.4	0.1	$0.1^{0.1}$	0.1	0.1	0.4	$0.3^{0.2}$	1.8	0.2	0.4	0.5	0.7	0.2	0.1	$0.1^{0.1}$	0.3
Ba	43	268	947	568	449^{185}	489	259	1167	631^{177}	1167	1213	1224	627	95	(971)	1074	818^{554}	858
Cu	5	12	31	9	23^{11}	19	6	15	13^{6}	70	6	4	12	28	8	4	11^{8}	15
Ni	16	16	34	17	(a) 50^{135}	34	17	34	19^{5}	31	17	33	29	62	18	16	21^{5}	20
Pb	109	33	21	40	19^{13}	14	25	25	9^{5}	9	8	7	29	9	9	3	24^{9}	23
Rb	568	192	120	186	127^{61}	137	194	130	76^{59}	57	87	93	71	2	111	130	94^{25}	88
Sr	17	83	734	109	36^{21}	27	49	860	128^{93}	712	66	625	383	365	282	149	475^{250}	918
U	(c) 25	< 1	2	< 1	2^{3}	1	1	1.6	< 1	< 1	< 1	1	2	< 1	2	< 1	< 1	< 1
V	6	12	42	12	8^{4}	3	9	41	21^{14}	202	14	36	47	80	12	7	17^{4}	38
Zn	39	2	49	18	23^{29}	15	16	66	39^{27}	97	29	70	73	28	24	18	31^{15}	36
Zr	308	89	123	81	(b) 157^{206}	115	53	171	215^{77}	949	144	138	180	155	79	56	74^{13}	123
K/Ba	1158	146	29	67	63	83	74	27	34	12	23	13	26	8.7	32	36	34	30
K/Rb	88	203	228	205	222	297	98	243	284	247	324	170	234	415	284	300	300	292
Rb/Sr	33.4	2.3	0.16	1.7	3.5	5.1	4.0	0.15	0.59	0.08	1.3	0.15	0.19	0.01	0.39	0.87	0.20	0.10

(a) Including 1Ni value of 574 ppm. Without this x (n=16) = 17, s = 8 ppm (b) Including 1Zr value of 956 ppm. Without this x (n=16) = 107, S = 10 ppm (c) Including 1U value of 92 ppm. Without this x (n = 3) = 5, S = 6 ppm

APPENDIX A - cont'd

Inter-Lineament Zone	Laverton Greenstone	CELIA – LAVERTON														
Rock Type	Age	Agn	Agp			GRANITE INTRUDING Agp	Agg		Agg	Agb					Age	
Locality	Greenstones	David Well	W of Laverton Downs	Erlistoun	W of Windarra	SW of Laverton Downs	Dwyer Well	Windarra	Borodale Creek	SW of Swincers	SW of Erlistoun	E of Windarra	Mt Boreas	Borodale Creek	Borodale Creek	N of Mt Zephyr
Co-ord – E	55	49	54–55	51–52	52	54	50	53	53	54	51–52	53–54	50	52	52	47
inates N	45	48	46–47	47–48	46	46	47	46	51–52	49	47	46	51–52	51	51	50
No of Samples	1	1	7	10	1	1	2	1	14	1	4	2	(a) 4	1	1	8
CaO	0.5	2.6	$1.6^{0.5}$	$0.4^{0.3}$	0.5	1.4	2.8	2.7	$1.5^{1.0}$	1.0	$0.8^{0.1}$	1.9	$1.0^{0.2}$	1.0	1.2	$0.7^{0.4}$
Fe_2O_3	1.5	0.9	$2.6^{0.6}$	$1.0^{0.2}$	0.8	1.3	1.9	2.6	$1.7^{1.0}$	1.1	$1.2^{0.3}$	2.5	$1.9^{0.6}$	2.0	1.6	$1.8^{0.6}$
K_2O	2.7	1.0	$1.8^{0.5}$	$4.9^{0.5}$	7.4	2.7	1.3	1.0	$3.0^{1.0}$	0.5	$4.8^{0.4}$	2.2	$4.5^{0.4}$	5.1	4.1	$4.8^{0.4}$
MgO	1.1	0.9	$1.5^{0.3}$	$0.9^{0.1}$	1.0	1.3	3.2	1.2	$1.2^{0.4}$	1.0	$1.0^{0.1}$	1.7	$0.3^{0.1}$	1.5	1.5	$1.2^{0.2}$
Na_2O	7.0	6.5	$5.1^{0.5}$	$4.8^{0.6}$	3.3	5.7	6.0	6.0	$5.0^{0.6}$	6.4	$4.6^{0.1}$	5.0	$4.3^{0.2}$	4.9	5.1	$4.9^{0.9}$
SiO_2	70.7	71.2	$69.2^{1.7}$	$72.7^{1.0}$	75.0	70.3	68.7	68.9	$71.8^{2.2}$	74.2	$73.2^{1.7}$	69.3	$72.7^{0.9}$	71.5	70.8	$69.8^{3.6}$
TiO_2	0.2	0.1	$0.3^{0.1}$	$0.1^{0.1}$	0	0.2	0.2	0.3	$0.2^{0.2}$	0.1	$0.2^{0.1}$	0.4	$0.2^{0.1}$	0.3	0.3	$0.3^{0.2}$
Ba	1135	1613	686^{214}	1323^{395}	491	1046	367	205	636^{337}	192	752^{289}	626	603^{253}	881	1281	1460^{735}
Cu	12	11	10^{9}	8^{4}	16	2	6	3	13^{13}	8	5^{5}	15	(b)	28	3	13^{7}
Ni	23	17	21^{6}	17^{3}	19	12	84	100	20^{7}	17	17^{2}	20	(b)	22	17	17^{2}
Pb	17	8	12^{7}	21^{11}	23	40	9	28	22^{15}	9	44^{12}	11	(b)	51	46	33^{12}
Rb	43	19	59^{19}	107^{22}	251	78	36	50	80^{47}	20	278^{118}	52	286^{31}	260	129	164^{27}
Sr	528	595	340^{82}	249^{203}	92	509	495	315	286^{198}	149	198^{48}	(400)	453	290	630	444^{256}
U	< 1	1	< 1	< 1	< 1	1	< 1	< 1	< 1	< 1	6^{7}	< 1	6^{337}	2	< 1	< 1
V	36	12	42^{11}	10^{5}	7	10	32	44	19^{16}	25	15^{4}	43	(b)	15	22	25^{11}
Zn	29	5	43^{17}	9^{7}	13	44	29	57	37^{33}	3	32^{12}	56	(b)	64	52	47^{20}
Zr	98	66	147^{8}	58^{14}	24	86	54	125	97^{60}	56	119^{55}	158	(b)	225	174	185^{194}
K/Ba	20	5.1	22	31	125	21	29	40	39	22	53	29	62	48	27	27
K/Rb	521	437	253	380	245	287	300	166	311	207	143	351	131	163	264	243
Rb/Sr	0.08	0.03	0.17	0.43	2.7	0.15	0.07	0.16	0.28	0.13	1.4	0.13	0.63	0.90	0.19	0.37

(a) Raw data from Gower, (1973), table 2. (except uranium) (b) Not determined

APPENDIX A - cont'd

Inter Lineament Zone	SEFTON LAVERTON								
Rock Type	Agl								
Locality	Breakaway Bore	NE of Laverton Downs	SE of Laverton Downs	NE of Mt Varden	NW of Adam Range	Bubbles	Bullrush Rock Hole	N of White Cliffs	Mallee Hen Rocks
Coordinates E	55	55	56	55–56	57	57	59	60	65
N	47–49	47	46	51	48	49	61	47	40
No. of Samples	7	1	1	6	1	1	4	2	2
CaO	$0.9^{0.4}$	0.1	0.8	$1.2^{0.5}$	1.6	0.3	$1.1^{0.2}$	1.4	1.6
Fe_2O_3	$1.5^{0.2}$	3.6	2.6	$2.1^{0.8}$	2.9	1.7	$1.9^{0.4}$	1.9	0.7
K_2O	$4.8^{0.3}$	9.1	5.7	$5.3^{0.5}$	5.7	5.9	$5.0^{0.4}$	5.1	3.0
MgO	$1.2^{0.2}$	1.2	0.9	$1.5^{0.3}$	0.9	0	$0.2^{0.3}$	0.4	0
Na_2O	$4.4^{0.4}$	0.1	7.5	$3.8^{0.3}$	3.6	3.7	$3.9^{0.4}$	3.9	5.5
SiO_2	$71.5^{0.8}$	72.0	67.2	$71.0^{3.8}$	68.8	72.9	$71.9^{0.6}$	71.3	59
TiO_2	$0.2^{0.1}$	0.3	0.3	$0.4^{0.2}$	0.6	0.1	$0.3^{0.2}$	0.3	0.1
Ba	852^{239}	1514	203	1298^{206}	2867	1138	1153^{289}	1423	1134
Cu	5^{4}	12	12	12^{4}	30	20	30^{31}	12	7
Ni	15^{3}	14	17	20^{6}	18	24	18^{2}	19	19
Pb	53^{30}	24	118	31^{4}	78	30	43^{9}	45	25
Rb	250^{46}	475	372	182^{25}	178	287	198^{29}	168	59
Sr	225^{83}	110	300	315^{84}	501	112	211^{93}	305	717
U	5^{5}	< 1	8	1^{1}	3	1	1^{2}	1	2
V	16^{5}	29	33	25^{12}	6	12	13^{8}	16	9
Zn	40^{12}	27	86	50^{36}	103	27	61^{15}	66	9
Zr	170^{35}	236	871	180^{145}	474	147	243^{51}	193	64
K/Ba	47	50	233	34	17	43	36	30	40
K/Rb	159	159	127	242	266	171	210	252	422
Rb/Sr	1.1	4.3	1.2	0.58	0.36	2.6	0.94	0.55	0.08

APPENDIX A - cont'd

Inter Lineament Zone	SEFTON LAVERTON												
Rock Type	Agn					Agg						Age	
Locality	Bailey Range	E of Reichell Find	SE of Sheet	SW of Bailey Range	NW of Bailey Range	Bailey Range	NE of Map	SW Diorite Hill	SE Diorite Hill	NW Diorite Hill	NE of Swincers	Bailey Range	Adam Range
Coordinates E	60–61	55	61	62–67	62	61	60	56	58	56	55	61–64	57
N	47–48	52	43	41–44	48	47	52	45	44	47	49	45–47	47
No. of Samples	5	1	1	3	1	1	3	1	3	1	1	25	1
CaO	$0.9^{0.6}$	0.9	3.1	1.5	0.2	0.4	0.6	0.4	1.8	0.1	0.5	$1.2^{0.6}$	1.5
Fe_2O_3	$1.7^{0.8}$	1.1	1.9	3.1	1.5	1.1	0.9	2.7	2.2	0.9	0.7	$1.8^{0.7}$	3.2
K_2O	$4.9^{1.1}$	5.2	1.6	4.4	5.2	6.1	3.6	3.0	4.2	4.8	6.3	$5.1^{1.5}$	6.1
MgO	$0.1^{0.1}$	1.0	0.3	0.6	0	0	0	1.2	0.5	0.7	1.0	$0.3^{0.4}$	1.2
Na_2O	$4.0^{0.6}$	4.2	6.4	4.0	4.4	3.5	5.2	6.3	3.5	4.3	3.2	$3.8^{0.7}$	3.2
SiO_2	$72.6^{0.8}$	73.1	68.1	–	–	72.3	73.7	73.6	71.4	74.0	73.7	70.7^{19}	68.1
TiO_2	$0.2^{0.1}$	0.1	0.2	0.6	0.2	0.1	0	0.2	0.3	0.1	0.1	$0.3^{0.2}$	0.7
Ba	1452^{654}	742	667	2008	1559	1362	132	254	1790	287	737	1172^{346}	3791
Cu	9^{4}	9	11	15	23	3	25	10	8	9	12	15^{10}	20
Ni	15^{1}	22	17	11	17	14	24	18	26	14	13	18^{5}	17
Pb	35^{25}	39	23	34	12	50	33	20	27	7	101	49^{43}	88
Rb	146^{28}	221	48	118	121	152	298	157	128	347	350	173^{59}	168
Sr	274^{44}	89	464	388	246	265	59	186	257	24	160	270^{158}	548
U	2	<1	1	1	2	4	3	<1	2	1	5	4^{4}	5
V	10^{6}	4	21	36	12	6	5	45	31	9	13	17^{13}	42
Zn	37^{20}	22	38	97	20	12	22	26	27	10	17	52^{28}	106
Zr	123^{65}	61	84	463	112	68	48	147	114	260	79	185^{96}	744
K/Ba	27	58	20	18	27	37	226	98	19	139	71	36	15
K/Rb	278	195	277	309	357	333	100	159	272	115	149	245	301
Rb/Sr	0.53	2.5	0.1	0.35	0.49	0.58	5.1	0.84	0.50	14.5	2.2	0.64	0.31

APPENDIX A - cont'd

Interlineament Zone	EAST OF SEFTON													
Rock Type	Agg						Agm	Agb		Age	Agl			
Locality	Isolated Hill (i)	Isolated Hill (ii)	SW Yamarna	NE Yamarna (i)	NE Yamarna (ii)	NE Dorothy Hills	NW Sheet	Punjadda Mason	Mt. Venn area	Mt. Venn area	Mt. Douglas	NE Mason Hill	SW Yamarna	Dorothy Hills
Co–ordinates E	(69)	(69)	(68)	(69)		(71)	62	62–65	66–67	66	(70)	63	(67)	(71)
N	43	43	49	52		52	52	48–52	51–52	52	44	52	49	51
No. of samples	4	5	3	1	2	1	1	21	7	6	1	1	2	1
CaO	$0.8^{0.3}$	$2.7^{0.4}$	2.8	0.7	0.3	1.1	2.3	$0.9^{0.3}$	$1.3^{0.6}$	$0.8^{0.3}$	0.4	0.9	0.8	0.5
Fe_2O_3	$1.1^{0.2}$	$3.0^{0.8}$	2.5	0.6	1.5	0.8	2.3	$1.5^{0.5}$	$2.4^{1.3}$	$1.8^{0.1}$	1.4	1.4	1.8	0.3
K_2O	$4.6^{0.4}$	$2.1^{0.5}$	3.2	6.0	3.1	3.8	2.7	$5.3^{0.6}$	$4.7^{0.7}$	$5.3^{0.1}$	5.7	5.2	5.9	4.0
MgO	$0^{0.1}$	$1.0^{0.6}$	1.0	0	0	0	0.9	$0.1^{0.1}$	$0.4^{0.4}$	$0.1^{0.1}$	0	0	0	0
Na_2O	$3.7^{0.4}$	$4.6^{0.6}$	4.3	0	5.1	5.0	5.4	$3.8^{0.6}$	$4.1^{0.5}$	$3.8^{0.2}$	3.4	3.7	4.0	4.3
SiO_2	–	–	–	–	–	–	–	(a) 79.1	–	–	–	–	–	–
TiO_2	$0.1^{0.1}$	$0.4^{0.2}$	0.3	0.1	0.2	0.1	0.4	$0.2^{0.1}$	$0.3^{0.1}$	$0.3^{0.1}$	0.1	0.2	0.3	0.4
Ba	706^{437}	883^{288}	1039	1667	337	451	1032	1079^{280}	830^{311}	1068^{147}	818	769	1150	1055
Cu	11^{8}	4^{5}	21	4	7	6	13	12^{9}	12^{12}	12^{10}	5	0	6	11
Ni	38^{41}	19^{8}	23	20	11	10	22	16^{6}	15^{5}	17^{4}	15	10	17	15
Pb	40^{9}	16^{4}	16	18	10	23	30	39^{11}	29^{12}	39^{5}	31	36	41	22
Rb	192^{90}	81^{22}	73	388	71	71	171	207^{55}	127^{58}	295^{50}	174	303	250	125
Sr	146^{94}	490^{187}	562	41	43	167	706	255^{108}	256^{158}	226^{35}	164	154	211	447
U	4^{2}	2^{1}	2	< 1	<1	1	1	2^{1}	3^{2}	2^{1}	<1	7	5	1
V	7^{5}	33^{16}	34	4	9	3	32	13^{7}	17^{10}	15^{4}	4	12	15	20
Zn	24^{4}	65^{13}	55	12	23	10	66	45^{20}	47^{17}	51^{20}	8	53	46	1
Zr	72^{13}	159^{39}	120	130	237	23	147	179^{71}	172^{110}	169^{17}	127	182	233	137
K/Ba	54	20	26	30	76	70	22	40	41	41	58	56	43	31
K/Rb	199	215	364	265	365	444	131	212	261	149	272	142	177	266
Rb/Sr	1.3	0.17	0.13	9.5	1.7	0.43	0.24	0.81	0.50	1.3	1.1	2.0	1.2	0.28

(a) 3 analyses only. Bracketed co–ordinates are in zone 3 but expressed as zone 2 equivalents.

APPENDIX B - Analyses of the felsic rocks of the mafic-felsic association

Interlineament Zone	Keith–Kilkenny–Celia					East of Sefton				
Locality	Ford Run Plateau					Mt. Venn area			Yamarna	
Co-ordinates E N	40 49–50	40 50	40–41 47–49	40 50	41 47	66 51	66 51	66 51	(69) 50	(69) 50
Types	Ap	Al	Al	?	?	Ax (cse.g.r.)	Ax (f.g.)	Ax (int.)	Ax (cse.g.)	Ax (f.g.)
No. of Samples	4	9	20	1	1	6	9	22	12	9
CaO	$0.3^{0.1}$	$1.4^{0.4}$	$0.8^{0.8}$	7.8	0.2	$1.4^{0.9}$	$1.8^{1.5}$	$5.7^{1.8}$	$1.9^{0.8}$	$2.6^{1.2}$
Fe_2O_3	$1.8^{0.7}$	$2.5^{1.3}$	$2.8^{1.2}$	6.3	1.8	$2.0^{0.7}$	$2.1^{2.0}$	$7.6^{4.8}$	$4.6^{1.0}$	$3.7^{1.2}$
K_2O	$3.6^{1.0}$	$1.9^{0.8}$	$3.3^{1.5}$	0.6	9.7	$3.6^{1.9}$	$2.7^{2.0}$	$1.6^{2.2}$	$2.6^{1.7}$	$2.1^{0.1}$
MgO	$1.0^{0.2}$	$1.0^{0.8}$	$1.9^{1.2}$	4.7	1.1	$0.8^{0.4}$	$0.4^{0.5}$	$3.4^{1.4}$	$2.2^{0.6}$	$1.7^{0.7}$
Na_2O	$3.9^{0.7}$	$5.0^{0.9}$	$4.1^{2.2}$	4.7	0.4	$2.9^{1.5}$	$3.7^{1.6}$	$3.8^{1.5}$	$3.7^{1.2}$	$4.7^{0.6}$
SiO_2	$75.3^{3.0}$	$72.0^{3.2}$	$71.0^{5.0}$	61.2	74.2	–	–	–	–	–
TiO_2	$0.1^{0.1}$	$0.3^{0.1}$	$0.3^{0.1}$	0.6	0.2	$0.4^{0.2}$	$0.3^{0.2}$	$0.8^{0.5}$	$0.5^{0.1}$	$0.5^{0.1}$
Ba	1082^{345}	1209^{852}	1492^{1043}	200	1240	1753^{1544}	1427^{696}	790^{649}	1495^{980}	1246^{468}
Cu	12^{8}	8^{7}	24^{21}	51	74	22^{16}	31^{29}	20^{14}	19^{10}	18^{10}
Ni	20^{5}	19^{9}	30^{23}	95	19	27^{11}	26^{13}	51^{47}	43^{14}	39^{9}
Pb	5^{2}	7^{6}	19^{22}	8	8	19^{5}	21^{5}	13^{8}	21^{7}	33^{16}
Rb	103^{42}	47^{16}	91^{44}	25	165	82^{17}	62^{53}	39^{39}	80^{22}	59^{21}
Sr	63^{28}	319^{231}	409^{409}	241	34	221^{220}	231^{150}	230^{100}	584^{208}	727^{255}
U	< 1	< 1	< 1	< 1	1	1^{1}	1^{0}	1^{2}	1^{1}	1^{1}
V	7^{3}	22^{15}	38^{25}	102	16	45^{33}	221^{40}	95^{36}	73^{14}	64^{23}
Zn	22^{5}	29^{21}	57^{40}	92	11	52^{31}	28^{17}	74^{39}	71^{16}	72^{37}
Zr	252^{80}	239^{135}	193^{106}	126	137	155^{32}	134^{39}	150^{80}	115^{19}	113^{20}
K/Ba	28	13	19	25	65	17	17	17	14	14
K/Rb	290	335	301	199	488	338	338	392	270	295
Rb/Sr	1.6	0.15	0.22	0.10	4.9	0.31	0.31	0.17	0.14	0.08

Oxides in percent. Elements in ppm. Superscripts indicate standard deviation.
Grid Reference in parentheses is Zone III transformed to Zone II

APPENDIX C - Analyses of other fine-grained rocks

Zone	KEITH-KILKENNY-IDA			KEITH–KILKENNY GREENSTONES					CELIA - KEITH-KILKENNY						LAVERTON-CELIA
Locality	Lawlers– Agnew			Leonora Area		Mt. Clifford Area			N. of 10 Mile Well		Mt. Redcliffe		Rufus Hills		Mt. Zephyr
Coordinates E	34	34	35	42	41	40	39-40		41		45	45	47	47	48
N	51	52	52	43	44	46	46–48		51		48	48	47	46	48
Rock Types	Al	Al	Al	Al	Ap	'Ao'/Ax	Ax/'Ap'	Ap	Ap	Ap	Ax/Al				
No. of Samples	1	1	1	1	1	1	1	3	1	1	1	1	1	1	2
CaO	0.6	2.4	0.5	0.3	0.3	0.1	0.3	2.2	6.5	7.0	5.0	1.3	8.5	1.5	1.9
Fe_2O_3	0.8	2.0	0.7	1.6	1.0	1.7	2.7	4.0	6.9	2.9	5.1	1.9	7.8	2.4	2.5
K_2O	0.2	1.3	4.5	0.9	0.1	7.6	2.0	0.3	0.8	0.2	3.3	4.9	0.2	1.8	1.7
MgO	1.3	0.5	0	1.0	1.2	2.1	1.9	3.5	4.2	0.4	4.7	1.5	5.2	1.7	1.6
Na_2O	7.3	5.8	4.6	7.7	9.9	0.3	6.2	8.2	2.9	2.5	4.0	4.8	3.6	5.0	5.5
SiO_2	71.9	69.7	73.6	71.2	69.9	73.0	67.5	62.6	62.7	75.7	62.2	70.6	55.9	69.9	69.3
TiO_2	0	0.3	0.1	0.3	0.2	0.1	0.5	0.6	0.6	0.3	0.6	0.3	0.9	0.4	0.4
Ba	91	784	69	364	23	1415	1297	332	368	137	1225	1182	397	506	760
Cu	7	11	9	54	11	9	14	15	24	25	20	8	71	18	79
Ni	18	25	18	22	51	24	31	59	66	30	65	26	65	20	57
Pb	20	15	26	9	9	18	14	10	3	2	10	19	3	0	5
Rb	23	56	166	24	5	120	132	13	26	1	94	103	6	96	68
Sr	49	389	29	365	173	53	813	439	187	114	1138	552	292	297	333
U	6	1	4	2	<1	<1	<1	<1	1	<1	2	1	<1	<1	1
V	13	32	5	24	10	9	43	74	100	30	104	30	177	40	37
Zn	4	21	15	4	15	16	54	36	65	68	63	22	76	30	54
Zr	202	104	42	197	79	115	148	165	140	87	150	99	98	139	126
K/Ba	18	14	541	21	36	45	13	7.5	18	12	22	34	4.2	15	19
K/Rb	72	193	225	311	166	526	126	191	255	1660	291	395	277	156	207
Rb/Sr	0.47	0.14	5.7	0.07	0.03	2.3	0.16	0.03	0.14	0.01	0.08	0.19	0.20	0.32	0.20

Oxides in percentage. Elements in ppm.

APPENDIX D - Analyses of mafic rocks grouped by lineament zone

Area	Lawlers – Agnew										Two Sisters	Lawlers – Agnew	
Rock Type	Ab					Ad					Ab/Ad	Am	Ah
Co-ordinates E	35	34	34	35–36	Total	35	34	34	36	Total	34	34	35–37
N	51	51	52	50–51		51	51	52	50		49	52	49–51
Number of Samples	6	6	5	8	25	7	9	12	13	41	5	5	4
CaO	$13.1^{1.6}$	$12.7^{1.2}$	$11.4^{2.3}$	$11.5^{1.8}$	$12.1^{1.9}$	$11.6^{0.8}$	$10.2^{1.8}$	$10.8^{2.0}$	$10.7^{2.0}$	$10.0^{1.8}$	$12.8^{1.8}$	$9.2^{1.6}$	$12.8^{0.8}$
Fe_2O_3	$11.4^{0.7}$	$9.8^{2.0}$	$14.1^{3.8}$	$12.2^{3.3}$	$11.8^{2.9}$	$9.9^{2.9}$	$13.4^{3.3}$	$11.5^{3.0}$	$12.2^{3.3}$	$11.9^{3.2}$	$9.0^{2.5}$	$13.5^{2.4}$	$11.2^{3.2}$
K_2O	$0.12^{0.04}$	$0.42^{0.44}$	$0.22^{0.08}$	$0.28^{0.15}$	$0.26^{0.24}$	$0.17^{0.08}$	$0.27^{0.08}$	$0.28^{0.14}$	$0.25^{0.08}$	$0.25^{0.11}$	$0.14^{0.09}$	$0.23^{0.05}$	(a) $0.7^{1.0}$
MgO	$9.3^{1.9}$	$9.3^{2.7}$	$4.8^{1.4}$	$7.7^{1.9}$	$7.9^{2.7}$	$7.5^{2.3}$	$6.7^{2.7}$	$8.3^{2.8}$	$7.5^{2.7}$	$7.6^{2.9}$	$7.7^{2.6}$	$4.2^{0.5}$	$8.4^{2.8}$
Na_2O	$0.9^{0.5}$	$1.0^{0.5}$	$1.7^{0.7}$	$1.9^{0.8}$	$1.4^{0.4}$	$2.1^{0.7}$	$1.6^{0.8}$	$1.7^{0.6}$	$1.9^{0.7}$	$1.8^{0.7}$	$1.6^{0.6}$	$2.3^{1.1}$	$1.2^{0.6}$
SiO_2	$51.1^{3.5}$	$53.4^{5.8}$	$51.4^{2.2}$	$50.7^{1.1}$	$51.6^{3.5}$	$53.5^{4.5}$	$50.7^{4.6}$	$51.9^{3.5}$	$52.8^{3.3}$	$52.2^{3.9}$	$48.7^{2.1}$	$51.6^{1.6}$	$50.1^{1.2}$
TiO_2	0.7^{0}	$0.7^{0.2}$	$1.3^{0.5}$	$1.0^{0.5}$	$0.9^{0.4}$	$0.9^{0.4}$	$1.2^{0.6}$	$0.9^{0.5}$	$0.9^{0.5}$	$1.0^{0.5}$	$0.6^{0.2}$	$1.9^{0.6}$	$0.9^{0.6}$
Ba	81^{49}	194^{198} $(122)^{102}$	91^{37}	129^{49}	130^{106}	127^{42}	192^{149}	214^{279} (143^{172})	143^{97}	172^{172}	94^{43}	114^{48}	272^{268}
Cu	48^{20}	49^{37}	66^{23}	63^{46}	57^{36}	39^{17}	55^{56}	70^{37}	74^{63}	63^{49}	83^{45}	28^{14}	37^{17}
Ni	167^{65}	103^{35}	75^{47}	107^{27}	114^{52}	112^{52}	139^{114}	125^{75}	95^{64}	116^{71}	167^{117}	34^{21}	128^{44}
Pb	2^{3}	3^{4}	9^{17}	3^{5}	4^{9}	4^{4}	13^{26} (4^{4})	2^{3}	22^{53} (1^{2})	11^{32} (3^{3})	4^{6}	1^{1}	2^{2}
Rb	3^{3}	8^{4}	5^{3}	11^{11}	10^{8}	4^{3}	8^{7}	10^{7}	6^{7}	8^{6}	12^{14}	3^{2}	(a) 31^{57}
Sr	102^{36}	100^{22}	128^{42}	103^{24}	107^{31}	118^{25}	156^{106}	117^{27}	100^{37}	120^{58}	113^{22}	106^{41}	103^{63}
V	213^{16}	219^{30}	266^{60}	257^{84}	239^{54}	219^{81}	178^{80}	225^{48}	283^{177}	232^{118}	176^{14}	229^{56}	246^{73}
Zn	87^{40}	80^{20}	108^{44}	98^{43}	93^{38}	71^{60}	147^{112}	84^{27}	100^{85}	101^{78}	66^{35}	103^{27}	77^{29}
Zr	48^{31}	50^{18}	89^{39}	68^{71}	63^{32}	91^{40}	106^{72}	72^{39}	80^{32}	85^{47}	48^{14}	132^{48}	59^{42}
K/Ba	12	18(16)	28	18	17	11	41	11(16)	15	12	12	17	21 (6.1)
K/Rb	332	436(249)	365	211	216	353	280	232	346	259	97	636	187 (830)
Rb/Sr	0.03	0.08	0.04	0.11	0.09	0.03	0.05	0.09	0.06	0.07	0.11	17	21 (6.1)

Bracketed values indicate mean values and standard deviations when one anomalous sample has been removed. Oxides in percentage : Elements in ppm.

(a) including 1 value of K_2O of 2.1%, and RB of 116 ppm. Without these $\bar{x}$ (K_2O), (n = 3) = 0.20%, S (K_2O) = 0%

$\bar{x}$ (Pb) = 2 ppm, S (Rb) = 3 ppm

APPENDIX D - cont'd

Area	KEITH – KILKENNY GREENSTONES												
Locality	Willaree Cliffs	East of Wildara								Leonora			
Type	Ab	Ab				Ad		Ah		Ab		Ad	Ah
Co–ordinates E	38	38–39	39	38–39	Total		38	38	39	43	41–42	42–43	43
N	52	50	50	50			50	50	50	41	43–44	42	41
No. of samples	1	3	16	3	22	1	1	1	1	1	2	3	2
CaO	12.4	$15.3^{1.2}$	$10.7^{1.5}$	10.5	$11.3^{2.4}$	11.7	12.5	10.1	13.9	5.6	6.9	11.1	11.6
Fe_2O_3	8.0	$9.7^{3.0}$	$10.9^{2.3}$	10.2	$10.6^{2.2}$	11.9	9.6	17.2	9.9	6.3	12.8	11.7	11.3
K_2O	0.2	0.10^{0}	$0.24^{0.11}$	1.2	$0.35^{0.37}$	1.5	0.3	0.3	0.2	1.6	0.15	0.20	0.15
MgO	7.4	$6.9^{1.1}$	$7.8^{2.5}$	8.0	$7.8^{2.5}$	10.5	11.8	5.2	12.4	11.6	6.7	8.0	9.2
Na_2O	1.0	$0.2^{0.1}$	$1.8^{0.7}$	1.5	$1.6^{0.8}$	0.8	1.4	2.1	0.7	2.5	2.7	2.3	1.7
SiO_2	55.7	$51.6^{3.6}$	$51.9^{3.6}$	51.9	$51.9^{3.2}$	50.3	48.7	48.3	52.3	54.7	52.7	50.9	48.8
TiO_2	0.7	$1.0^{0.4}$	$0.8^{0.2}$	0.7	$0.8^{0.2}$	0.7	0.6	1.5	0.5	0.4	1.4	0.8	0.7
Ba	375	227^{288}	141^{75}	397	188^{182}	402	240	171	75	402	99	214	49
Cu	24	56^{11}	84^{33}	80	80^{40}	44	64	113	64	21	49	46	45
Ni	210	117^{35}	138^{57}	134	134^{54}	160	264	103	200	278	83	143	159
Pb	0	5^{9}	4^{5}	6	4^{5}	3	0	12	0	11	4	3	1
Rb	11	2^{3}	10^{5}	60	15^{20}	40	8	7	8	48	10	6	7
Sr	142	253^{296}	101^{93}	159	130^{112}	118	102	116	92	287	103	91	58
V	233	242^{83}	226^{26}	215	227^{36}	220	198	330	190	104	332	250	238
Zn	62	70^{8}	91^{26}	87	88^{26}	69	61	111	50	61	91	85	105
Zr	45	67^{21}	51^{16}	64	55^{20}	55	53	133	35	77	102	59	46
K/Ba	4.4	3.7	14	25	15	31	10	15	22	33	12.6	3.9	25
K/Rb	151	415	199	166	194	311	311	356	207	277	124	138	178
Rb/Sr	0.08	0.01	0.10	0.38	0.12	0.34	0.08	0.06	0.09	0.17	0.10	0.07	0.12

APPENDIX D - cont'd

Area	KEITH – KILKENNY GREENSTONES											
Locality	Mt. Clifford – Kurrajong Area											
Type	Ab						Ad					
Co–ordinates E	39	40–41	39–40	39–40	40	Total	39	39	39–40	40–41	40–41	Total
N	47	46–48	46	45–46	44		47–49	47	46	46	47–48	
No. of Samples	5	14	13	11	6	49	12	1	7	3	6	29
CaO	$10.3^{0.7}$	$9.2^{1.9}$	$10.4^{2.3}$	$11.5^{1.8}$	$12.6^{1.2}$	$10.7^{2.1}$	$10.9^{2.1}$	12.2	$11.0^{2.0}$	12.5	$10.8^{1.0}$	$11.0^{1.9}$
Fe_2O_3	$13.5^{2.8}$	$12.9^{2.1}$	$12.1^{2.9}$	$11.6^{1.1}$	$10.9^{0.7}$	$12.2^{2.2}$	$11.6^{2.6}$	9.3	$10.7^{2.8}$	8.5	$11.4^{1.7}$	$10.9^{2.5}$
K_2O	$0.24^{0.06}$	$0.32^{0.20}$	$0.35^{0.29}$	$0.27^{0.23}$	$0.35^{0.40}$	$0.31^{0.25}$	$0.26^{0.09}$	0.1	$0.33^{0.26}$	0.23	$0.23^{0.14}$	$0.27^{0.16}$
MgO	$5.9^{2.0}$	$6.9^{1.4}$	$6.9^{2.4}$	$7.6^{2.5}$	$9.3^{1.2}$	$7.2^{2.2}$	$8.4^{2.0}$	12.9	$8.9^{1.2}$	9.5	$8.3^{2.3}$	$8.7^{2.1}$
Na_2O	$1.9^{0.4}$	$1.8^{0.6}$	$1.7^{1.0}$	$1.2^{0.6}$	$1.3^{0.8}$	$1.6^{0.7}$	$1.6^{1.2}$	1.6	$1.9^{0.8}$	1.3	$1.9^{0.3}$	$1.7^{0.9}$
SiO_2	$51.2^{2.9}$	$50.7^{2.9}$	$50.1^{4.3}$	$51.7^{2.5}$	$50.9^{2.8}$	$50.9^{3.2}$	$49.8^{2.7}$	50.4	$48.9^{2.3}$	56.2	$50.7^{2.5}$	$50.4^{3.3}$
TiO_2	$1.1^{0.4}$	$1.0^{0.2}$	$1.0^{0.5}$	$1.0^{0.4}$	$0.7^{0.1}$	$1.0^{0.4}$	$0.7^{0.3}$	0.4	$0.8^{0.4}$	1.0	$0.8^{0.2}$	$0.8^{0.3}$
Ba	197^{107}	263^{210}	247^{180}	174^{91}	157^{134}	219^{162}	330^{189}	133	300^{217}	496	206^{160}	308^{203}
Cu	69^{23}	101^{20}	84^{25}	76^{43}	59^{35}	83^{32}	78^{28}	52	96^{27}	91	87^{28}	81^{32}
Ni	74^{44}	86^{39}	112^{56}	161^{56}	149^{19}	116^{56}	129^{55}	138	142^{38}	295	124^{35}	148^{79}
Pb	4^{6}	6^{6}	8^{5}	4^{5}	7^{3}	6^{5}	1^{2}	9	7^{7}	7	3^{5}	4^{5}
Rb	10^{3}	12^{4}	15^{8}	10^{8}	10^{8}	12^{7}	11^{4}	4	14^{9}	13	12^{7}	12^{6}
Sr	115^{25}	141^{37}	127^{67}	102^{24}	138^{77}	126^{50}	151^{56}	112	171^{58}	134	161^{83}	155^{64}
V	258^{54}	299^{25}	232^{90}	260^{41}	220^{22}	238^{55}	224^{47}	154	205^{57}	222	206^{28}	214^{46}
Zn	102^{2}	101^{21}	86^{20}	92^{21}	80^{24}	93^{22}	84^{28}	43	78^{29}	88	77^{14}	78^{29}
Zr	86^{33}	83^{28}	78^{45}	71^{41}	55^{7}	76^{38}	53^{22}	29	55^{24}	67	58^{31}	55^{25}
K/Ba	10	10	12	13	19	12	6.5	6.2	9.1	3.9	9.3	7.3
K/Rb	199	221	194	224	290	214	196	207	196	147	159	187
Rb/Sr	0.09	0.09	0.12	0.10	0.07	0.09	0.07	0,04	0.08	0.13	0.07	0.08

APPENDIX D - cont'd

Area	KEITH – KILKENNY – CELIA INTERLINEAMENT ZONE												
Locality	Ford Run Plateau								Ten Mile Well	East of W. Terrace	Mt. Redcliffe		
Rock Type	Ad				Ab & Ah			Pd?	Ab/Ad	Ab/d	Ab	Ah	Am
Co–ordinates E N	40–46 48–49	41 48–49	40 49	Total	40 50	40–41 47–48	Total		(in N.E. Agb) 41–51	45 45	45–46 47	45–46 47–48	45–46 47–48
No. of samples	5	2	7	14	2	12	14	1	2	2	7	14	7
CaO	$10.8^{0.7}$	8.8	$11.2^{2.6}$	$10.9^{2.1}$	9.9	$8.8^{2.0}$	$8.9^{2.0}$	$10.9^{10.9}$	13.1	8.7	$10.0^{1.3}$	$10.7^{1.8}$	$10.6^{1.3}$
Fe_2O_3	$13.1^{1.6}$	12.0	$10.6^{2.7}$	$11.8^{11.8}$	10.9	$12.9^{3.2}$	$12.6^{12.6}$	15.5	8.3	12.6	$13.4^{1.3}$	$12.8^{2.5}$	$12.7^{2.4}$
K_2O	$0.40^{0.19}$	1.0	$0.32^{0.26}$	$0.45^{0.32}$	0.50	$0.38^{0.19}$	$0.40^{0.19}$	0.3	0.7	0.55	$0.26^{0.05}$	$0.37^{0.22}$	$0.53^{0.37}$
MgO	$8.1^{1.3}$	6.2	$8.5^{1.9}$	$8.2^{1.8}$	8.3	$6.1^{2.1}$	$6.4^{2.1}$	5.8	6.9	9.3	$6.2^{1.2}$	$5.9^{1.5}$	$6.1^{1.3}$
Na_2O	$1.6^{0.6}$	2.1	$1.7^{0.4}$	$1.7^{0.7}$	1.9	$2.4^{1.4}$	$2.3^{1.2}$	0.9	2.3	1.3	$1.9^{0.4}$	$1.9^{0.7}$	$1.7^{0.5}$
SiO_2	$49.1^{1.7}$	51.5	$50.8^{1.8}$	$50.0^{1.8}$	51.9	$51.9^{1.3}$	$51.9^{5.4}$	50.4	51.4	46.5	$50.0^{2.0}$	$51.5^{2.8}$	$50.2^{2.9}$
TiO_2	$0.8^{0.1}$	1.0	$0.6^{0.3}$	$0.7^{0.2}$	0.9	$1.1^{0.3}$	$1.1^{0.3}$	1.1	0.7	0.8	$1.0^{0.1}$	$0.9^{0.1}$	$0.9^{0.2}$
Ba	193^{196}	941	202^{234}	313^{351}	284	(a) 341^{371}	(b) 333^{342}	162	163	243	232^{171}	178^{123}	308^{252}
Cu	91^{50}	78	70^{21}	79^{34}	71	81^{31}	80^{29}	59	43	96	54^{26}	43^{24}	51^{12}
Ni	131^{101}	73	110^{61}	116^{74}	131	89^{34}	95^{41}	57	99	331	103^{346}	123^{136}	99^{39}
Pb	7^{4}	7	7^{7}	6^{5}	2	6^{6}	5^{6}	0	3	0	1^{3}	3^{4}	0^{0}
Rb	16^{8}	31	13^{6}	16^{9}	15	13^{5}	13^{5}	11	23	19	6^{3}	8^{6}	16^{18}
Sr	156^{84}	259	120^{39}	153^{91}	148	130^{30}	133^{37}	110	168	142	139^{68}	139^{78}	151^{81}
V	228^{50}	217	196^{57}	210^{58}	200	242^{64}	236^{62}	303	164	201	258^{53}	253^{27}	246^{56}
Zn	99^{33}	103	87^{24}	90^{28}	104	79^{33}	83^{33}	97	66	80	94^{14}	98^{21}	84^{12}
Zr	114^{100}	87	63^{22}	82^{66}	91	88^{36}	89^{37}	76	132	81	80^{25}	64^{16}	67^{14}
K/Ba	17	8.8	12	12	15	9.3	10	15	36	19	9.3	17	14
K/Rb	207	268	191	233	277	243	255	226	253	240	360	384	275
Rb/Sr	0.10	0.12	0.11	0.10	0.10	0.10	0.10	0.10	0.14	0.13	0.04	0.06	0.11

(a) Including 1 Ba value of 1445 ppm. Without this $\bar{x}$ (n=11) = 241 ppm, S = 134 ppm (b) Without the Ba value of 1445 ppm, $\bar{x}$(n=13) = 247 ppm, S = 124 ppm

APPENDIX D - cont'd

Area	KEITH–KILKENNY–CELIA INTERLINEAMENT ZONE											
Locality	Rufus Hill		Woolshed Well	Two Bills Well		Mt. Zephyr		Nambi	Valais Well	Erlistoun	Windarra	
Rock Type	Ad	Ab	Am	Ab	Ad	Ab		Ab	Ah	Ah	Ah	Am
Co–ordinates E	47	47	46	49	48	47–48	48	47	50	52	53	53
N	46	47	49	47	47–48	47–48	48	48	47	48	46	46
No. of samples	5	6	4	3	7	10	6	2	1	1		
CaO	$12.0^{1.9}$	$11.5^{1.7}$	$7.0^{2.9}$	12.0	$11.2^{1.1}$	$11.5^{1.4}$	$11.0^{2.8}$	13.9	11.4	10.3	9.2	$11.2^{0.9}$
Fe_2O_3	$10.9^{0.8}$	$11.5^{1.2}$	$5.8^{2.7}$	12.3	$13.0^{1.7}$	$12.8^{2.2}$	$10.4^{2.0}$	10.1	12.7	13.6	14.2	$11.0^{2.3}$
K_2O	$0.20^{0.10}$	$0.18^{0.08}$	$2.3^{1.6}$	0.23	$0.19^{0.11}$	$0.27^{0.15}$	$0.37^{0.28}$	0.65	0.4	1.0	0.4	$0.33^{0.21}$
MgO	$7.0^{0.8}$	$6.4^{2.0}$	$6.4^{2.0}$	6.2	$5.3^{0.9}$	$5.7^{1.0}$	$5.9^{1.4}$	5.4	4.2	6.3	9.1	$6.3^{1.6}$
Na_2O	$1.2^{0.8}$	$1.4^{1.1}$	$3.4^{1.5}$	1.5	$1.4^{0.2}$	$1.5^{0.4}$	$1.5^{1.1}$	0.8	1.4	2.1	2.9	$0.9^{0.4}$
SiO_2	50.4^{10}	$52.0^{4.0}$	$59.4^{6.6}$	49.7	$49.2^{2.4}$	$49.4^{2.2}$	$52.6^{4.9}$	50.1	50.7	48.6	48.6	$51.6^{5.5}$
TiO_2	$0.8^{0.2}$	$0.9^{0.2}$	$0.5^{0.2}$	0.9	$1.1^{0.3}$	$1.0^{0.3}$	$0.9^{0.9}$	0.7	1.0	0.8	0.9	$0.6^{0.2}$
Ba	427^{400}	277^{356}	1055^{358}	468	183^{135}	178^{129}	646^{563}	601	617	1097	123	170^{130}
Cu	56^{13}	60^{21}	34^{18}	80	74^{33}	68^{26}	51^{18}	83	38	46	91	64^{7}
Ni	100^{25}	90^{43}	86^{38}	129	117^{34}	124^{45}	169^{121}	94	97	90	171	114^{30}
Pb	0^{1}	1^{1}	12^{11}	0	0^{0}	1^{3}	2^{5}	0	3	3	6	3^{4}
Rb	15^{11}	3^{2}	53^{51}	4	5^{4}	6^{5}	9^{6}	26	4	25	12	9^{7}
Sr	151^{40}	122^{97}	682^{254}	122	99^{33}	134^{35}	178^{111}	126	129	163	113	96^{33}
V	238^{28}	256^{28}	85^{80}	256	291^{76}	270^{54}	224^{68}	215	294	242	281	191^{19}
Zn	73^{11}	75^{25}	71^{17}	93	94^{13}	90^{14}	93^{11}	69	97	100	113	73^{15}
Zr	53^{8}	57^{7}	105^{26}	57	72^{17}	65^{14}	60^{14}	55	63	41	60	49^{12}
K/Ba	3.9	5.4	18	4.1	8.6	13	4.8	9.0	5.4	7.6	27	16
K/Rb	111	498	360	477	315	373	341	207	830	332	311	304
Rb/Sr	0.10	0.02	0.08	0.03	0.05	0.04	0.05	0.21	0.03	0.15	0.12	0.09

APPENDIX D - cont'd

Area	LAVERTON GREENSTONES											
Locality	Laverton area			'Ar' E of Laverton Downs	Tholeiite within Ar Mt. Varden	Mt. Varden	Mt Varden		Mt Varden			
Rock Type	Ad	Ab	Ab			Ai	Ak		Am			
Grid Co-ordinates E	55–56	55–56	55	55	55	54–55	53	54	53	54	55	55
N	46	46	45	47	49	49–50	51	50	52	49	50	51
No. of Samples	6	10	6	1	4	8	2	3	9	3	3	2
CaO	$10.2^{1.1}$	$11.3^{1.3}$	$10.8^{0.9}$	10.4	$10.0^{0.4}$	$11.1^{1.5}$	8.6	12.4	$10.3^{0.9}$	10.9	8.3	11.2
Fe_2O_3	$12.3^{2.6}$	$12.3^{1.4}$	$13.0^{0.8}$	12.8	$13.1^{0.5}$	$12.7^{1.5}$	12.6	11.9	$11.3^{3.2}$	10.9	17.4	13.4
K_2O	$0.23^{0.10}$	$0.20^{0.10}$	$0.25^{0.30}$	0.2	$0.30^{0.08}$	$0.25^{0.11}$	0.30	0.17	$0.27^{0.16}$	0.60	0.27	0.20
MgO	$7.7^{1.3}$	$6.6^{1.0}$	$7.8^{0.9}$	6.7	$5.2^{0.5}$	$5.2^{1.0}$	7.4	6.6	$7.6^{1.4}$	7.7	4.5	6.0
Na_2O	$1.6^{0.3}$	$1.6^{0.8}$	$1.4^{0.3}$	2.6	$1.9^{0.5}$	$1.6^{0.6}$	2.9	1.9	$2.2^{0.4}$	1.3	2.6	1.4
SiO_2	$48.6^{2.4}$	$50.7^{1.3}$	$48.1^{1.9}$	49.5	$50.1^{0.9}$	$50.2^{1.4}$	50.5	50.8	$49.9^{2.9}$	51.0	49.0	49.1
TiO_2	$0.8^{0.8}$	$1.1^{0.2}$	$0.9^{0.2}$	1.0	$1.1^{0.1}$	$1.2^{0.2}$	0.9	1.0	$0.8^{0.3}$	0.4	2.0	1.0
Ba	93^{73}	124^{59}	96^{103}	101	222^{93}	297^{245}	126	433	137^{75}	430	358	734
Cu	78^{36}	56^{21}	79^{8}	37	79^{24}	103^{79}	58	107	77^{40}	49	103	51
Ni	101^{37}	124^{16}	162^{60}	129	110^{11}	102^{18}	115	116	118^{40}	70	57	113
Pb	0^{0}	4^{5}	1^{2}	0	0^{1}	1^{2}	1	3	2^{2}	2	0	0
Rb	7^{4}	6^{4}	8^{7}	0	10^{4}	6^{5}	9	2	5^{4}	16	6	13
Sr	112^{27}	142^{77}	109^{24}	98	117^{19}	112	147	147	142^{33}	83	177	97
V	236^{55}	283^{31}	225^{26}	279	313^{8}	303^{41}	242	251	243^{56}	185	508	281
Zn	69^{15}	85^{16}	88^{11}	90	83^{9}	102^{102}	85	84	73^{21}	65	107	92
Zr	54^{13}	69^{11}	54^{5}	54	68^{7}	74^{16}	62	56	53^{17}	39	116	54
K/Ba	21	13	22	16	11	7.0	20	3.2	16	12	6.3	2.3
K/Rb	273	277	259	–	249	346	277	705	448	311	373	128
Rb/Sr	0.06	0.04	0.07	–	0.09	0.05	0.06	0.0	0.04	0.19	0.03	0.08

APPENDIX D - cont'd

Area	LAVERTON GREENSTONES											
Locality	Mt Varden						Mt Varden					
Rock Type	Ad						Ab					
Grid Co–ordinates E	55	55	54	54	53	All	55	55	54	54	53	All
N	50	49	50	51	52		50	49	50	51	52	
No. of Samples	3	3	15	8	2	31	5	11	10	9	10	45
CaO	9.8	10.5	$10.4^{1.4}$	$9.7^{0.8}$	12.1	$10.3^{1.4}$	$8.6^{2.8}$	$9.9^{1.8}$	$11.1^{2.0}$	$9.7^{1.8}$	$10.6^{1.5}$	$10.2^{2.0}$
Fe_2O_3	14.6	12.6	$12.8^{2.5}$	$13.5^{2.7}$	9.1	$12.9^{2.7}$	$15.8^{3.2}$	$13.0^{3.0}$	$12.5^{2.5}$	$14.1^{1.7}$	$13.1^{1.7}$	$13.4^{2.6}$
K_2O	0.23	0.2	$0.19^{0.05}$	$0.23^{0.09}$	0.15	$0.20^{0.10}$	$0.22^{0.11}$	$0.23^{0.13}$	$0.20^{0.10}$	$0.24^{0.07}$	$0.25^{0.12}$	$0.23^{0.16}$
MgO	5.9	7.8	$6.2^{2.1}$	$8.1^{2.9}$	7.6	$6.9^{2.4}$	$4.5^{1.0}$	$6.6^{2.8}$	$6.1^{2.3}$	$5.7^{1.4}$	$7.1^{1.1}$	$6.2^{2.0}$
Na_2O	1.8	2.2	$2.2^{0.7}$	$2.1^{0.4}$	2.4	$2.1^{0.6}$	$2.6^{1.0}$	$1.9^{1.1}$	$2.2^{1.0}$	$2.4^{1.0}$	$2.0^{0.5}$	$2.2^{0.9}$
SiO_2	48.8	49.1	$49.2^{2.3}$	$49.5^{2.9}$	50.1	$49.3^{2.2}$	$50.7^{4.2}$	$51.2^{3.1}$	$49.7^{1.5}$	$48.1^{3.0}$	$49.1^{0.4}$	$49.7^{2.7}$
TiO_2	1.7	0.9	$1.4^{0.6}$	$1.0^{0.4}$	0.8	$1.2^{0.6}$	$1.7^{0.8}$	$1.2^{0.6}$	$1.1^{0.5}$	$1.8^{0.6}$	$1.1^{0.4}$	$1.3^{0.6}$
Ba	936	163	260^{236}	130^{68}	189	278^{301}	266^{124}	269^{212}	135^{84}	245^{224}	247^{242}	229^{192}
Cu	95	62	73^{27}	96^{78}	84	81^{46}	92^{32}	79^{26}	73^{30}	85^{38}	90^{14}	93^{74} (83^{28})
Ni	86	112	89^{21}	112^{70}	125	99^{41}	72^{40}	138^{109}	102^{27}	69^{27}	130^{30}	107^{64}
Pb	0	0	2^{3}	2^{3}	1	1^{2}	0^{1}	1^{2}	2^{2}	5^{5}	0^{0}	2^{3}
Rb	8	4	4^{3}	4^{2}	4	4^{3}	6^{4}	8^{7}	3^{3}	4^{3}	6^{3}	5^{4}
Sr	153	98	172^{95}	131^{30}	108	148^{73}	130^{53}	131^{49}	111^{41}	184^{82}	134^{46}	138^{59}
V	297	270	289^{66}	272^{109}	221	279^{80}	304^{156}	309^{90}	276^{71}	399^{134}	268^{52}	309^{105}
Zn	123	74	99^{35}	120^{100} (86^{33})	61	102^{59}	112^{20}	98^{30}	79^{21}	87^{29}	83^{11}	102^{84} (90^{25})
Zr	113	58	94^{42}	63^{17}	47	81^{40}	144^{93}	79^{39}	67^{34}	98^{38}	73^{30}	86^{48}
K/Ba	2.0	10	6.1	15	6.8	6	69	7.1	12	8.1	8.4	8.3
K/Rb	239	415	394	477	311	415	304	239	553	498	346	382
Rb/Sr	0.05	0.04	0.02	0.03	0.04	0.03	0.05	0.06	0.03	0.02	0.04	0.04

Values in brackets are for samples less one anomalous value

APPENDIX D - cont'd

Area	LAVERTON – SEFTON INTERLINEAMENT								
Locality	Diorite Hill	Diorite Hill Area	Diorite Hill	SE of Diorite Hill	Diorite Hill	SE of Diorite Hill	Karara Well		Adam Range
Rock Type	Ai	Ad	Ab		Am		Ah	Am	Am
Grid Co–ordinates E	58	57–58	57–58	59	58	58	59	59	55–57
N	45	44–46	44–45	44	45	44	43	43	47–49
No. of Samples	1	7	4	1	3	9	4	2	3
CaO	13.1	$13.1^{0.1}$	$12.6^{1.3}$	12.8	13.5	$10.1^{2.1}$	$9.7^{0.8}$	10.8	11.6
Fe_2O_3	11.4	$10.1^{2.3}$	$10.9^{3.4}$	6.1	8.7	$14.1^{2.9}$	$11.7^{2.1}$	14.4	(11.0)
K_2O	0.1	$0.17^{0.16}$	$0.13^{0.10}$	0.9	0.20	$0.14^{0.07}$	$0.23^{0.05}$	0.30	0.33
MgO	8.9	$10.0^{2.0}$	$8.2^{1.2}$	3.0	6.7	$6.5^{1.6}$	$6.8^{0.8}$	7.2	8.5
Na_2O	1.0	$1.2^{0.6}$	$1.3^{0.4}$	4.0	1.7	$2.0^{1.4}$	$2.4^{0.4}$	1.6	2.0
SiO_2	46.9	$49.6^{1.7}$	$48.7^{1.4}$	55.3	49.2	$52.9^{2.7}$	$52.9^{2.0}$	49.9	50.3
TiO_2	0.5	$0.5^{0.2}$	$0.6^{0.3}$	1.3	0.5	$1.3^{0.3}$	$1.4^{0.3}$	1.1	0.9
Ba	77	83^{53}	129^{101}	846	248	546^{595}	504^{220}	134	(132)
Cu	59	69^{33}	82^{22}	51	62	67^{34}	43^{22}	99	44
Ni	126	148^{62}	151^{68}	141	191	72^{20}	130^{22}	130	98
Pb	0	0^{1}	3^{3}	7	1	2^{3}	3^{4}	1	6
Rb	5	6^{7}	3^{2}	28	9	3^{3}	8^{6}	11	11
Sr	73	218^{141}	148^{105}	292	251	161^{164}	106^{21}	97	123
V	236	172^{84}	199^{86}	162	204	348^{93}	344^{32}	300	(214)
Zn	75	73^{8}	73^{15}	138	63	93^{15}	96^{13}	97	100
Zr	11	20^{5}	29^{16}	78	19	74^{27}	70^{3}	68	101
K/Ba	1.1	17	8.4	8.8	6.7	2.1	3.8	19	21
K/Rb	166	277	360	267	184	387	239	226	249
Rb/Sr	0.07	0.03	0.02	0.10	0.04	0.02	0.08	0.11	0.09

Values in brackets are sample means minus one anomalous value.

APPENDIX D - cont'd

Area	Sefton Greenstones					East of Sefton Lineament									
Locality	Mitika Well			E of Mt Hickox	Mt Sefton	Mt Scott	Mt Scott Mt Grant	E of Mt Scott	SE of Rutter Soak	Yamarna (i)	Yamarna (ii)	Yamarna Mt Venn	Dorothy Hills (i)	Dorothy Hills (ii)	
Rock Type	Ab	Ad	Ah	Ab/Ad	Ab/Ad	Ad	Ad	Ad	Ab	Am					
Grid Co-ordinates E	60	60	60	(68)	64	66	66	66	66	(69)		(68)	(71)		62
	52	52	51--52	43	47	52	51	52	51	50		51	52		52
No of Samples	4	2	2	8	8	10	20	13	14	5	2	2	2	2	2
CaO	$12.4^{1.4}$	11.9	6.4	$11.6^{2.3}$	$12.0^{1.5}$	$9.8^{1.1}$	$10.5^{1.8}$	$10.1^{1.0}$	$10.0^{2.2}$	$10.3^{0.6}$	11.2	13.7	9.9	11.6	10.9
Fe_2O_3	$11.8^{0.7}$	12.3	11.7	$11.0^{2.3}$	$11.0^{1.6}$	$13.4^{3.0}$	$13.7^{3.1}$	$11.9^{3.0}$	$7.8^{4.4}$	$9.5^{1.7}$	12.3	4.1	8.0	11.5	13.4
K_2O	$0.28^{0.15}$	0.20	1.8	$0.25^{0.11}$	$0.17^{0.06}$	$0.55^{0.22}$	$0.50^{0.28}$	$0.62^{0.32}$	$0.70^{0.4}$	$0.28^{0.04}$	0.90	0.15	0.40	0.20	0.55
MgO	$9.2^{1.2}$	9.3	4.4	$8.7^{1.5}$	$7.4^{2.0}$	$7.1^{2.0}$	$8.1^{2.6}$	$6.5^{3.1}$	$4.5^{1.8}$	$7.9^{0.9}$	6.0	6.5	3.5	8.6	7.7
Na_2O	$2.0^{0.5}$	2.0	4.0	$2.0^{1.2}$	$1.3^{0.6}$	$2.3^{0.9}$	$2.0^{0.7}$	$2.5^{0.9}$	$2.1^{1.0}$	$2.0^{0.8}$	3.0	1.7	2.3	1.6	1.7
SiO_2	$49.9^{2.7}$	48.9	52.9	–	–	–	–	–	–	–	–	–	–	–	–
TiO_2	$0.8^{0.2}$	0.8	2.6	$0.7^{0.2}$	$0.8^{0.2}$	$1.1^{0.5}$	$1.3^{0.5}$	$1.2^{0.5}$	$0.9^{0.5}$	$0.7^{0.1}$	1.3	0.1	1.2	0.7	1.1
Ba	195^{219}	91	1293	380^{385}	99^{57}	441^{231}	429^{417}	407^{273}	428^{265}	332^{168}	556	515	1327	170	217
Cu	64^{27}	30	41	52^{33}	89^{58}	92^{84}	86^{111}	81^{77}	60^{76}	21^{21}	19^{19}	172	12	52	72
Ni	190^{43}	163	52	154^{55}	143^{49}	131^{76}	121^{67}	92^{23}	105^{68}	87^{9}	131	71	28	140	134
Pb	2^{2}	2	0	9^{7}	5^{5}	6^{3}	11^{7}	9^{6}	15^{13}	8^{7}	4	8	15	11	1
Rb	11^{2}	6	37	8^{8}	4^{3}	25^{24}	24^{18}	19^{14}	18^{11}	8^{2}	20	1	10	1	17
Sr	92^{17}	85	265	149^{75}	97^{23}	308^{144}	191^{85}	281^{96}	269^{169}	232^{39}	418	212	296	76	103
V	228^{66}	266	240	234^{162}	244^{43}	264^{402}	277^{150}	241^{184}	156^{90}	163^{55}	243	65	225	244	301
Zn	74^{18}	76	141	68^{13}	84^{30}	97^{23}	104^{26}	79^{29}	73^{22}	71^{12}	135	23	43	71	85
Zr	43^{30}	50	338	47^{19}	63^{14}	84^{53}	83^{28}	85^{28}	121^{121}	75^{6}	145	9	150	144	66
K/Ba	12	18	12	5.5	14	10	9.7	13	14	7.0	13	2.4	2.5	9.8	21
K/Rb	211	277	404	259	353	183	166	271	323	290	373	1245	332	1660	268
Rb/Sr	0.12	0.07	0.14	0.05	0.04	0.08	0.13	0.07	0.07	0.03	0.05	–	003	0.01	0.17

Oxides in percentage. Elements in ppm. Co–ordinates in brackets are Zone 3 transformed to Zone 2 values.

Area	KEITH KILKENNY GREENSTONES															
Locality	Ford Run Plateau	NW of Sturts Meadows	Mt Clifford – Kurrajong													Leonora
Rock Type	Au	?Ar	Ae	Au						Aup		Aus			Aux	Ae
Co-ordinates E	40	39	38–39	38		40–41	39	40	39	39	39–40	39–40	39–40	40	39	42
N	49–50	44	47–48	49		47–48	47	46	46	48	46–47	48	47	46	46	43
No. of Samples	2	2	2	1	1	8	1	2	2	1	21	8	17	1	1	1
CaO	5.7–11.7	10.0–10.2	8.5–9.5	1.2	19.5	0.1–10.5	0.1	0.1–5.0	6.5–6.9	7.1	0–8.2	0.2–8.4	0.1–9.9	6.0	14.3	0.3
Fe_2O_3	10.1–11.0	11.5–12.4	11.2–11.6	18.0	0.9	10.3–14.2	10.0	8.7–14.2	14.5–14.9	12.0	6.7–21.1	7.1–13.9	4.4–14.4	11.6	10.6	12.3
K_2O	0.1	0.1–0.2	0.1–0.8	0.1	1.5	0–0.1	0.1	0–0.1	0.1	0	0–1.0	0–0.1	0–0.2	0.1	0.1	0
MgO	18.2–30.3	8.9–11.6	10.1–15.4	24.0	14.8	15.0–42.4	42.8	26.2–38.8	20.9–22.6	24.9	15.3–49.7	20.1–41.4	13.8–39.6	27.0	12.8	38.1
Na_2O	0.2–0.3	0.7–1.9	0.7–1.5	0.2	0	0–1.6	0	0	0–0.4	0.2	0–2.1	0–0.2	0–4.0	0.1	1.3	0
SiO_2	44.0–48.1	43.8–45.1	48.1–48.8	46.6	39.3	41.6–47.3	43.7	43.6–43.9	42.5–43.1	46.6	24.5–48.7	40.1–49.0	30.9–56.6	45.6	50.3	41.1
TiO_2	0.4	0.5–0.6	0.5–0.6	0.5	0.2	0.2–0.7	0.2	0.2–0.7	0.5–0.6	0.3	0–0.6	0.1–0.4	0.1–0.6	0.5	0.7	0.2
Ba	49–69	133–264	68–404	19	158	17–192	21	6–33	11–60	46	0–395	0–64	0–784	134	102	21
Cr	1961–2226	369–558	537–2128	5405	61	1544–1.27%	3000	3054–4454	1151–3368	2432	784–3833	1619–2962	681–5678	2190	1420	7016
Cu	16–46	95–111	56–58	59	154	10–59	46	11–58	19–39	64	0–701	1–59	0–261	24	63	10
Ni	330–1054	261–281	97–520	5420	72	372–2175	3000	930–2182	389–710	791	496–5665	586–3547	373–6186	989	301	1015
Pb	0	6–12	4–7	0	29	0–16	1	1–6	0–3	1	0–23	0–8	0–34	6	3	0
Rb	5–8	8–9	5–31	6	57	2–10	9	2–4	2–6	6	2–30	3–11	2–8	7	5	5
Sr	7–26	90–122	40–183	20	119	2–55	1	0–87	8–31	15	0–432	0–14	2–85	66	25	0
V	124–156	144–147	170–173	106	46	74–182	71	43–185	188–199	126	7–187	55–173	47–188	144	171	97
Zn	52–59	69–73	89–109	112	571	53–104	62	61–63	78–95	66	35–1017	39–75	35–2220	73	76	94
Zr	27–38	29–31	45–62	25	56	7–82	17	11–38	29–42	12	0–93	1–33	5–104	26	67	11

Oxides in Per cent. Elements in ppm.

APPENDIX E - Analyses of non-tholeiitic ultramafic rocks group by lineament zones

	Ranges of Composition																	
Area	LAWLERS – AGNEW											KEITH KILKENNY GREENSTONES						
Rock Type	?	Ar	Ar	Au				Aus	Aux		Aux	Au		Aup	Aus	Aus	Aux	Ar
Locality	Two Sisters			Lawlers–Agnew								East of Wildara						
Coordinates E	34	35	36	34–35	34	35	35–36	35	34	35	35	38	38–39	39	38	39	38	38
N	49	52	50	52	50–51	51	51–52	52	51	52	51	49	50	49	49–50	50	50	50
No. of Samples	3	1	1	10	4	16	25	1	15	2	2	1	5	1	13	2	1	1
CaO	9.1–10.8	10.4	14.9	0.1–14.4	0–2.0	0.1–14.3	0.3–14.3	2.4	1.8–14.8	9.8–14.7	7.4–13.6	10.7	0.3–12.9	2.8	0.1–9.1	0.3–5.5	9.4	10.8
Fe_2O_3	12.0–17.0	14.0	7.7	7.2–14.4	4.8–21.2	7.9–15.7	7.3–15.0	15.2	6.7–16.4	7.1–14.7	6.6–14.5	9.5	10.5–12.3	11.4	7.1–14.9	10.6–13.3	13.3	11.8
K_2O	0.1–0.2	0.2	0.2	0–0.3	0–0.1	0–0.3	0–0.4	0.1	0–0.2	0.2–0.3	0.1–0.3	0.7	0–0.2	0	0–0.1	0 0	0.1	0.2
MgO	13.5–19.9	11.8	13.9	13.1–37.4	11.5–33.9	14.2–37.0	13.9–36.9	31.8	13.6–35.5	12.7–13.6	19.6–22.9	14.1	14.6–38.4	34.4	22.7–37.5	23.4–38.0	11.2	10.7
Na_2O	0.4–0.5	0.8	1.1	0–1.1	0–0.1	0–1.5	0–1.1	0	0–0.8	1.3	0–0.8	1.1	0–0.8	0	0–1.1	0	4.7	1.7
SiO_2	44.7–47.8	47.0	50.0	42.4–55.4	23.7–51.5	41.7–54.4	38.1–58.8	42.8	39.5–52.9	44.8–50.7	44.2–54.7	58.9	42.1–51.7	42.0	41.0–57.7	42.3–45.4	49.1	50.2
TiO_2	0.4–0.6	0.6	0.4	0–0.7	0–2.0	0.1–0.5	0.1–0.7	0.4	0.2–0.6	0.3–0.9	0.2–0.4	0.3	0.2–0.6	0.2	0.1–0.5	0.2–0.5	0.8	0.6
Ba	46–64	95	70	2–763	0–111	0–200	12–212	120	10–121	62–123	38–315	269	20–938	64	4–358	33–63	27	67
Cr	2382–2567	1427	1206	455–6414	227–3147	1654–8341	512–7093	4847	516–6019	291–465	2425–3093	1073	1036–2359	2056	1970–4854	2188–2434	748	675
Cu	38–830	67	59	2–94	0–114	0–59	0–82	0	4–66	28–223	35–60	31	9–103	10	0–1148	6–27	78	55
Ni	598–939	391	227	207–2419	514–1902	251–2205	249–2029	1493	187–1546	246–428	399–1022	262	251–2315	1012	848–2453	1677–1889	138	224
Pb	0–14	81	5	0–4	0–4	0–3	0–19	0	0–10	4–6	0	1	1–11	0	0–9	0	0	0
Rb	2–8	12	5	0–12	0–4	0–9	0–14	5	0–7	0–10	0–2	21	1–6	4	0–7	6	0	3
Sr	20–28	43	75	0–183	0–53	2–73	3–129	16	1–99	115–170	7–38	74	0–81	30	0–51	1–28	133	86
V	151–209	211	186	33–199	7–427	67–199	49–219	134	96–210	143–217	109–135	95	81–207	91	73–173	101–160	225	247
Zn	94–190	206	62	36–120	78–100	46–214	30–249	73	44–185	48–249	43–93	112	51–69	62	45–161	79–93	76	76
Zr	34–43	35	24	0–53	2–238	0–80	6–50	51	5–52	9–39	11–36	147	6–33	9	4–32	7–33	57	18

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APPENDIX E - cont'd

Area	CELIA GREEN– STONE	CELIA– LAVERTON INTER– LINEAMENT		LAVERTON GREENSTONES				LAVERTON–SEFTON INTERLINEAMENT			SEFTON	EAST OF SEFTON	EAST OF SEFTON
Locality	Mt Zephyr	Windarra	Laverton	Laverton	Mt Varden			NW of Diorite Hills	Diorite Hill	SE of Diorite Hills	Mt Sefton	N of Mt Venn	Mt Venn
Rock Type	Ar	Ae	Ae	Au	Ar	Ae	Au	Ar	Au	Au	Ar	Ar	Aj
Grid Co-ordinates E	48	53	56	53	55	54–55	53–55	56	58	58	64	66	(67)
Grid Co-ordinates N	48	46	45	45	49	49–50	48–52	47	45	44	47	52	51
No. of Samples	1	6	1	1	8	4	18	2	4	4	2	3	45
CaO	6.5	$4.7^{7.7}$	0.5	0.2	$8.1^{1.7}$	$7.1^{4.1}$	0.1–14.1	(a) 1.7	10.7^{25}	$9.5^{0.8}$	2.0–10.8	4.3–13.0	3.9–14.5
Fe_2O_3	14.3	$10.4^{2.1}$	14.2	11.3	$12.1^{1.0}$	$11.7^{1.6}$	7.8–15.8	13.2	$13.9^{2.8}$	$12.8^{1.5}$	8.4–12.5	9.3–12.6	14–19.4
K_2O	0.1	$0.02^{0.04}$	0.1	0	$0.11^{0.04}$	0.10^{0}	0–0.6	0.15	$0.18^{0.22}$	$0.23^{0.15}$	0.1	0.1–0.7	0.1–0.6
MgO	20.7	$29.5^{7.8}$	30.8	35.4	$16.8^{3.3}$	$20.0^{6.2}$	12.1–43.6	19.1	$14.2^{2.8}$	$19.5^{1.0}$	11.1–19.7	10.3–25.4	0.7–26.5
Na_2O	0	$0.1^{0.2}$	0.1	0	$0.7^{0.4}$	$0.6^{0.6}$	0–1.7	0.3	$0.5^{0.4}$	$0.6^{0.1}$	0–0.6	0.1–2.9	0.1–4.7
SiO_2	40.6	$45.0^{5.2}$	41.1	44.4	$46.2^{3.5}$	$46.6^{2.8}$	28.2–51.0	58.4	$48.2^{2.6}$	$50.8^{1.3}$			
TiO_2	0.3	$0.2^{0.2}$	0.2	0.3	$0.5^{0.1}$	$0.4^{0.1}$	0–1.2	0.3	$0.7^{0.2}$	$0.5^{0.1}$	0.1–0.3	0.3–0.4	0.1–2.0
Ba	12	36^{71}	34	72	141^{112}	56^{28}	0–1006	(a) 257	434^{758}	579^{373}	58–2867	39–140	34–686
Cu	25	75^{68}	5	0	53^{28}	64^{34}	0–234	23	69^{53}	74^{56}	13–64	9–38	3–3430
Ni	609	2514^{1694}	1282	1877	577^{110}	683^{226}	191–2831	1129	412^{206}	685^{140}	1001–1035	456–1260	4–1189
Pb	0	4^{5}	0	0	2^{3}	0	0–8	4	2^{2}	2^{2}	2–7	0–11	0–43
Rb	1	29^{61}	2	4	5^{2}	5^{4}	0–18	4	9^{11}	5^{8}	0	0–33	0–27
Sr	4	23^{31}	6	8	66^{49}	34^{46}	0–244	45	78^{81}	82^{10}	13–43	8–138	0–469
V	167	63^{56}	86	96	165^{14}	165^{24}	14–263	102	241^{60}	184^{34}	73–170	146–184	14–806
Zn	60	49^{30}	85	45	68^{11}	81^{30}	32–300	178	114^{26}	85^{6}	75–197	69–123	13–114
Zr	23	20^{25}	12	36	27^{7}	32^{14}	0–56	18	19^{7}	23^{7}	0–18	15–25	0–78
Cr	2528	2847^{832}	5288	3498	2082^{536}	2407^{874}	873–5527	5786	–	–	1425–2410	1594–2881	95–1366
K/Ba	69	4.6	24	–	6.5	15		4.9	3.4	2.9	–	–	–
K/Rb	830	5.7	415	–	183	166		311	166	322	–	–	–
Rb/Sr	0.25	1.2	0.33	0.50	0.08	0.15		0.09	0.12	0.14	–	–	–

Oxides in per cent; elements in ppm. (a) wide range. Co-ordinates in brackets are zone III given as Zone II

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