# K/Pb FRACTIONATION TRENDS

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# ABSTRACT

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by

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The examination of element pairs as petrogenic indicators has been the prime interest of many geochemists in recent years. The literature suggests that the element pair, K/Pb, also has the potential for being such an indicator, but has not been given full attention due to its random chalcophile and lithophile characteristics.

This paper investigates the K/Pb ratio in various rock types. The data from 338 igneous and 493 metamorphic rocks was researched from the literature and statistically examined. Lead is the decay product of three radioactive isotopes, $U^{238}$, $U^{235}$, $Th^{232}$. In this study of common lead concentrations it was necessary to mathematically seperate the radioactively decayed lead from the reported lead values. Through the use of a correction equation, it was found that the addition of radiogenic lead, to the common lead concentrations, has a minimal effect on the overall K/Pb correlations. The correlations for nearly all the rock types examined varied widely and were relatively poor.

A plot of the igneous averages showed a positive K/Pb trend. The metamorphic averages were made obscure by large standard deviations. Individual rock trends were examined by least squares regression on those suites found significant at a 95% confidence level. The overall K/Pb data suggests a depletion of lead in the upper crust and mantle and an enrichment in the lower crust.

In conclusion, the poor correlations of the K/Pb data found in this paper and elsewhere, demands a detailed examination of the multiphases of lead. For example, very little research has been done on the gaseous and liquid phases of lead in geological environments.

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BY

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# INTRODUCTION

A literature search for investigations reporting lead analyses for major rock types has revealed that lead isotope analyses, rather than analyses for common lead,* are most often recorded. This lack of common lead concentration data, especially for igneous and metamorphic rocks, has been noted by Zartman and Wasserburg (1969), Doe and Tilling (1967), Shaw (1972), Viswanathan (1972a) and Rhodes (1969).

Successful studies by Shaw (1968), and Lewis and Spooner (1973), of coherent element pairs, like K/Rb in igneous and metamorphic rocks, has provoked interest in other elements that show close geochemical coherence. Common lead has been recognized as a potential petrogenic indicator. Within crystal chemical considerations lead is thought to closely follow potassium in behavior and isomorphically replaces potassium in K-rich minerals (Wedephol, 1956; Goldschmidt, 1937; Stavrov, 1971; Zlobin, et al., 1965). Some investigations, especially those on K-feldspar rich rocks, indicate a fractionation between K and Pb while other investigators report contradictions between their K-Pb data and crystal chemical theory. For example Heier (1962, p. 441) could only call his K-Pb data "confusing", and others denote K-Pb as a vexing problem (Heier, 1960; Taylor, et al., 1960; Howe, 1955).

*Common lead, $Pb^{204}$, is lead obtained from non-radioactive lead minerals such as galena, cerussite, wulfenite, and from rock forming minerals which accept lead into their structures, such as, potash feldspars, muscovite, biotite, etc.

In natural systems, radiogenic leads, $Pb^{206}$, $Pb^{207}$ and $Pb^{208}$ are formed from parent $U^{235}$, $U^{232}$ and $Th^{238}$ respectively. Common lead, $Pb^{204}$, can be distinguished from radiogenic leads only by mass spectroscopy; other techniques yield total lead. Therefore, data which report total lead must be corrected to common lead if hypotheses concerning the distribution of lead in time and space are to be meaningful. Since the concentration of radiogenic lead increases as a function of time, the age of the rock as well as the U, Th and total lead concentrations must be known before corrections can be applied. The problem is further complicated by the fact that lead has a complex geochemical behavior because of its chalcophile and lithophile characteristics. These factors partially explain why the distribution of lead has not been an overly active area of geochemical research.

## STATEMENT OF PROBLEM

A compilation of K-Pb concentrations in 338 igneous and 493 metamorphic rocks was researched from the literature. Only data compared with certified standards or reporting a sufficient number of replicate samples were utilized. Other trace elements, in particular, Rb, Th, U and age of the rock, if reported, were also compiled and incorporated into a correction equation for the accumulation of radiogenic lead.

Correlation matrices of data from differing rock types were arranged to examine the K-Pb fractionation problem. Least squares analyses was used to determine the predictive equation for the K versus Pb concentration in each rock type and other statistical tests were used to evaluate K-Pb relationships.

# CRYSTAL CHEMISTRY

The close geochemical association of K and Pb has been predicted by many crystal chemists and geochemists, however, only a few investigations have dealt with variations of lead and potassium in rocks. A study by Sandell and Goldich (1943) reveals a large amount of scatter of their K-Pb igneous rock data (Figure 1). Sandell and Goldich suggested that more research was necessary before valid conclusions concerning K-Pb interactions could be made.

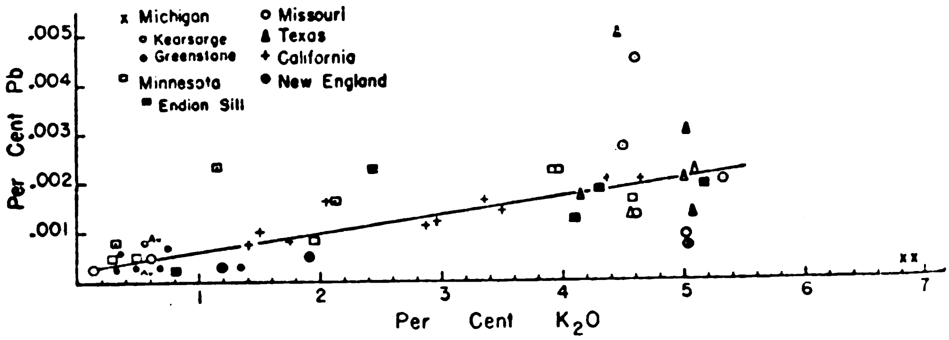



Figure 1

Figures 2 and 3 are the igneous and metamorphic scattergrams for the data researched from the literature. The simple statistics

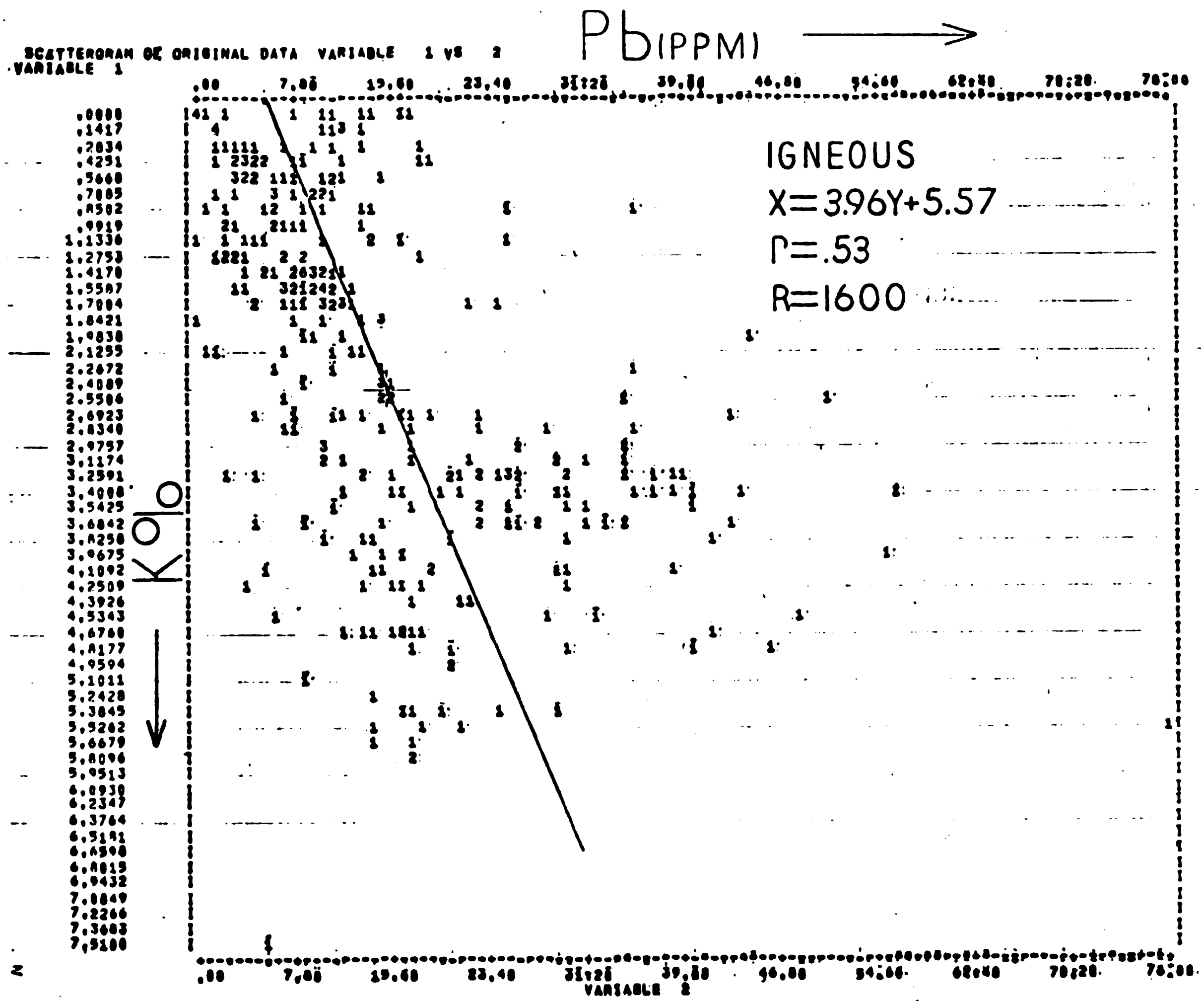



Figure 2

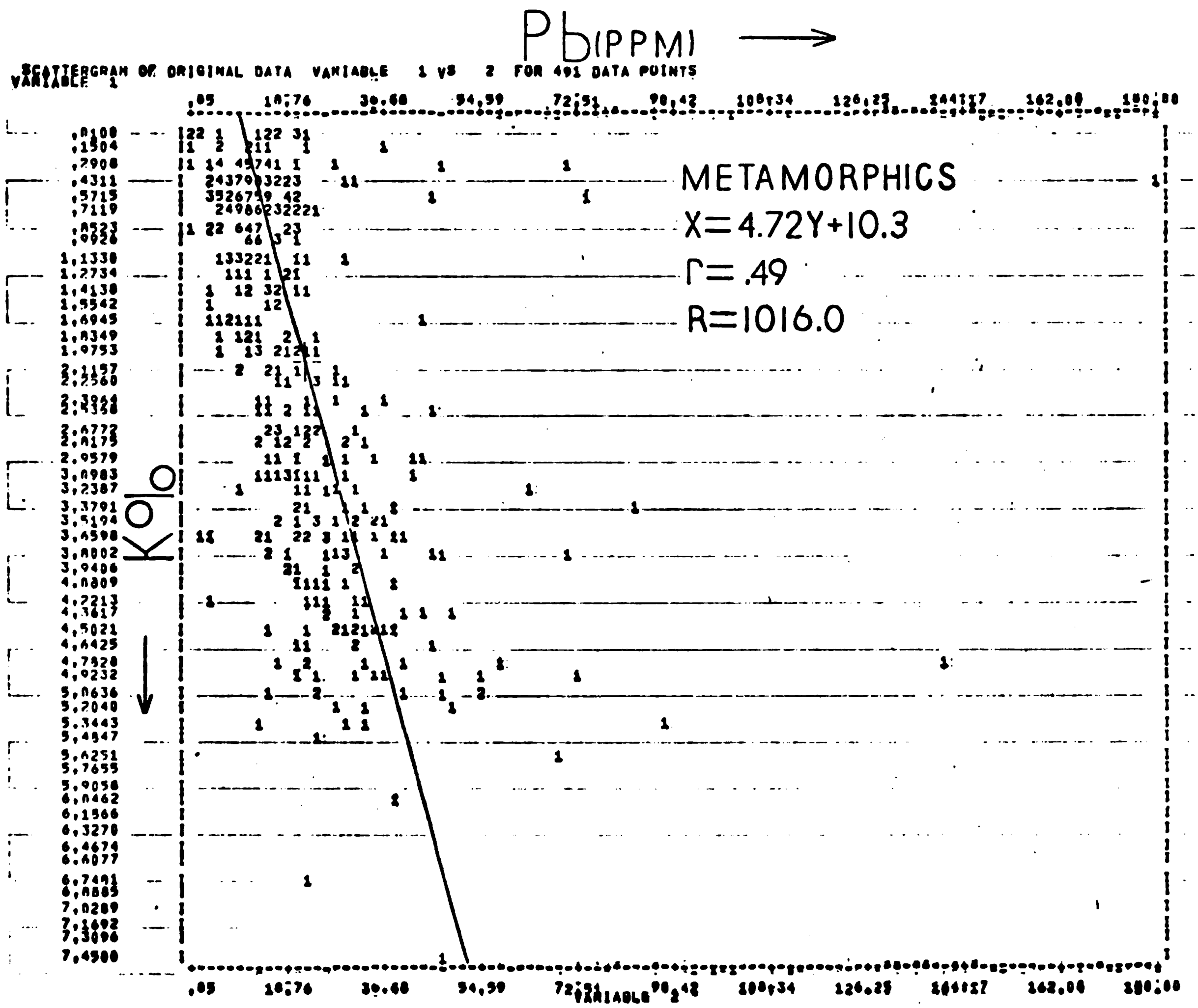

Pb(PPM)
SCATTERGRAM OF ORIGINAL DATA VARIABLE 1 VS 2 FOR 491 DATA POINTS
METAMORPHICS
X=4.72Y+10.3
r=.49
R=1016.0

Figure 3

Table 1

<u>Metamorphics</u> K%

| | | | | | |
|---|---|---|---|---|---|
| MEAN | 2.00 | STD ERROR | .073 | STD DEV | 1.62 |
| VARIANCE | 2.59 | KURTOSIS | -.69 | SKEWNESS | .70 |
| RANGE | 7.45 | MINIMUM | 0 | MAXIMUM | 7.45 |

<u>Metamorphics</u> Pb(ppm)

| | | | | | |
|---|---|---|---|---|---|
| MEAN | 19.88 | STD ERROR | .69 | STD DEV | 15.43 |
| VARIANCE | 237.99 | KURTOSIS | 31.98 | SKEWNESS | 4.22 |
| RANGE | 180.0 | MINIMUM | 0 | MAXIMUM | 180.0 |

<u>Igneous</u> K%

| | | | | | |
|---|---|---|---|---|---|
| MEAN | 2.45 | STD ERROR | .084 | STD DEV | 1.54 |
| VARIANCE | 2.36 | KURTOSIS | -.71 | SKEWNESS | .35 |
| RANGE | 7.51 | MINIMUM | .004 | MAXIMUM | 7.51 |

<u>Igneous</u> Pb(ppm)

| | | | | | |
|---|---|---|---|---|---|
| MEAN | 15.33 | STD ERROR | .62 | STD DEV | 11.35 |
| VARIANCE | 128.73 | KURTOSIS | 3.08 | SKEWNESS | 1.46 |
| RANGE | 78.0 | MINIMUM | 0 | MAXIMUM | 78.0 |

are compiled in Table 1. The range for lead in the igneous data is 78 ppm while that for the metamorphics is 180 ppm. Both plots have correlation coefficients of .55 and .49 respectively and scatter increases with increasing potassium.

It has been common practice among geochemists to arrange their data in order of increasing ionic radii since Goldschmidt recognized ionic size as a prime factor controlling the distribution of some elements in mineral lattices (Table 2). With reference to Table 2, some of the following diadochic substitutions have been reported.

Table 2

| | | | | | |
|---|---|---|---|---|---|
| $Cs^{+}$ | 1.67 | $Ba^{2+}$ | 1.35 | $Sr^{2+}$ | 1.18 |
| $Rb^{+}$ | 1.47 | $K^{+}$ | 1.33 | $Ca^{2+}$ | 1.02 |
| $Tl^{+}$ | 1.47 | $Pb^{2+}$ | 1.20 | $Na^{+}$ | 0.97 |

Lead and strontium replace $Ca^{2+}$ in calcium minerals and monoclinic pyroxenes (Rankama and Sahama, 1950). Most often lead is present in silicate minerals as a potassium-type trace cation. Potassium rich minerals, particularly potassium feldspars accept lead into their lattice. Several studies show that lead is enriched in late formed potassium minerals such as pegmatitic potassium feldspars (Wedepohl, 1956; Heier and Taylor, 1959). Lead, therefore, violates Goldschmidt's "capture" principle as there is a lack of Pb - enrichment in early formed K-minerals. Siedner (1965) explains this reverse in enrichment by Ringwood's (1955) rules: whenever diadochy in a crystal is possible between two elements, the element with the smaller electronegativity is preferentially incorporated ($Pb^{2+}$ = 1.60, $K^{1+}$ = .80).

In the orthoclase structure potassium cations are distributed directly among the rings of the Si-Al tetrahedra that are united into chains, and there exists a possibility of compensation of a large bivalent cation ($Pb^{2+}$) by a pair of Al-tetrahedra in the $[Si_2Al_2O_8]^{-2}$ framework (Byelov, 1953). The network of $SiO_4$ and $AlO_4$ tetrahedra is elastic to some degree and can adjust itself to different sizes of cations. Natural potash feldspars can be isomorphic mixtures of $KAlSi_3O_8$ and $PbAl_2Si_2O_8$.

Natural lead feldspars have never been found, however, research has shown that they may be produced artificially (Sorrell, 1962). Sorrell found high reactivities at low temperatures for artificially produced Pb-feldspars and suggested that lead in potassium feldspars may be more common than realized. Potassium feldspars, progressively enriched with lead, are found in close proximity of lead ore bodies (Cuturic, et al., 1968; Slawson and Nackowski, 1959; Doe and Hart, 1963).

The parameters governing the partitioning of lead between coexisting potash feldspars and plagioclase is unknown (Doe and Tilling, 1967). The average partitioning factor ($C^{Pb}_{K\text{-}Feldspar}$ / $C^{Pb}_{Plagioclase}$) where "C" is the concentration of lead in parts per million, is reported as less than one by some (Heier, 1960; Howie, 1955; Barth, 1967), while Doe and Tilling (1967), report a partitioning factor with a range of 2 to 4.5. Table 3 lists the major minerals allowing lead substitution, and their concentrations. A partitioning factor of 2.4 was determined between the K-feldspar and plagioclase. This factor is only a approximation since some of the analyses in Table 3 are not from coexisting minerals. A factor of 2.4 suggests that lead is more receptive in the K-feldspar structure.

Table 3

| | Potassium Feldspar Pb(ppm) | (Author,#) | Plagioclase Pb(ppm) | (Author,#) | Biotite Pb(ppm) | (Author,#) | Horneblende Pb(ppm) | Author,#) |
|---|---|---|---|---|---|---|---|---|
| GRANITES | 56.0 | (3,3) | 25.0 | (3.3) | 10.0 | (3,3) | 34.0 | (3,3) |
| " | 37.0 | (4,6) | 11.0 | (4,6) | 48.0 | (8,2) | | |
| " | 29.0 | (1,31) | | | 36.0 | (7,1) | | |
| " | 67.0 | (2,56) | | | | | | |
| DIORITE | | | 15.0 | (7,1) | 9.0 | (7&3,2) | 16.0 | (7&3,2) |
| SYENITE | 50.0 | (6,1) | | | 22.0 | (6,1) | | |
| GRANODIORITE | 28.0 | (5,2) | 15.0 | (7,1) | | | | |
| ALASKITE | 45.0 | (4,1) | 19.0 | (4,1) | | | | |
| GNEISS | 33.0 | (1&4,4) | 15.0 | (4,1) | | | | |
| PEGMATITE | 37.0 | (1,4) | 46.0 | (4,1) | | | | |
| " | 114.0 | (4,1) | | | | | | |
| AVERAGE | 49.6ppm | | 20.9ppm | | 25.0ppm | | | |

$$C^{Pb}_{K\text{-}Feldspar} / C^{Pb}_{Plagioclase} = 49.6ppm/20.9ppm = 2.4 \text{ part. factor}$$

1. Zartman, Wasserburg (1969)
2. Rhodes (1969)
3. Fershater, et al., (1969)
4. Doe, Tilling (1967)
5. Cuturic, et al., (1968)
6. Zhirov, Chernyshev (1959)
7. Rabinovich, et al., (1959)
8. Viswanathan (1972)

Diadochic substitution of lead for potassium can occur in the potassium interlayer position of biotite. For each lead captured, an additional aluminum must be admitted to the biotite tetrahedral layer to compensate for the charge difference. Zlobin and Gorshkova (1961) noted this aluminum replacement and concluded that lead is admitted into the biotite structure only with some difficulty. Parry and Nackowski (1963) studied biotites in monzonites and found increased concentrations of lead in biotite samples taken progressively away from lead ore bodies. They suggest solutions and leaching could be responsible for the negative correlation in their data. Viswanathan (1972) found a positive correlation of lead with potassium in biotites from the Canadian Shield. Stavrov (1971) did not consider biotites as major lead carriers in his analyses of granites.

Table 3 shows a wide range of lead concentrations in biotites and hornblende. Moorbath, Welke and Gale (1969) noted minimal lead concentrations in hornblendes and pyroxenes of metamorphosed suites.

Radioactive minerals are also important, as they contain sites for lead produced through radioactive decay. These minerals can contain anomalous lead. Zircon, allanite, and sphene commonly contain radiogenic lead, derived from U and Th disintegration. It can be expected therefore, that diorites and granodiorites, those rocks containing a high proportion of accessory minerals will contain anomalous leads whereas, gabbros, basalts and granites should contain higher amounts of common lead. The mode of bonding of radiogenic lead in these accessory minerals is unknown, but Boyle (1959) reports that lattice vacancies can be produced through radiation and may provide lead sites. Doe (1967) suggested that radiogenic lead is probably not found in the same lattice positions as common lead. Table 4 shows the high radioactivity of accessory minerals, zircons,

Table 4

| [1] | PbO(ppm) | α/mg/sec |
|---|---|---|
| GRANITE | 18.0 | .9 |
| PLAGIOCLASE | 15.0 | .3 |
| QUARTZ | 5.0 | .2 |
| BIOTITE | 32.0 | .4 |
| HORNEBLENDE | 12.0 | .8 |
| APATITE | 5.0 | 56.0 |
| ZIRCON | 40.0 | 400.0 |
| SPHENE | 36.0 | 260.0 |

| [2] | Total Pb(ppm) | $Pb_{206}$ |
|---|---|---|
| ZIRCON | 461.0 | 34.2 |
| SPHENE 1 | 113.0 | 39.9 |
| ACID WASH SPHENE 1 | 222.0 | 44.5 |
| SPHENE | 240.0 | 68.4 |
| MAGNETITE | 1.4 | .33 |
| APATITE | 136.0 | 34.5 |
| QUARTZ | 5.5 | 1.36 |
| PLAGIOCLASE | 3.8 | .94 |
| PERTHITE | 9.5 | 2.35 |

[1] Larsen et al.(1952)

[2] Tilton,Patterson(1955)

sphene and apatite as found in some granites. There is a large concentration of $Pb^{206}$ in the acid wash from sphene 1, which suggests this isotope is loosely bound in the lattice. Picciotto (1950) found radioactive elements present in mineral interstices and intracrystalline fractures of some granites.

## RADIOGENIC LEAD CORRECTION

Examination of common lead concentrations demands a knowledge of the initial amount of common lead introduced into the rock at its time of crystallization. A sample of ordinary lead can be considered a mixture of common and radiogenic lead. The radiogenically derived lead is composed of equal amounts of thorium lead and $U^{238}$, $U^{235}$ derived lead. Any additional amount of lead accumulated through radioactive decay in a sample must be corrected by subtraction from the ordinary lead content. In general, radiogenic lead enrichment is a function of time, however, the growth curve is not well known. U-Pb and Th-Pb isotope determination requires a primary lead correction through the use of mass spectrometry. The nature of the data in this paper does not make it possible to make common lead corrections through isotopic determinations. Rather corrections can be made if a series of critical factors are known; concentrations of Pb, Th and U and age of the rock.

Uranium$^{235}$, Uranium$^{238}$ and Thorium$^{232}$ will, through complex transformations, decay to $Pb^{206}$, $Pb^{207}$ and $Pb^{208}$ respectively (Table 5).

TABLE 5

| | | | |
|---|---|---|---|
| $Th^{232}$ | $\lambda = .499 \times 10^{-10} yr^{-1}$ | $Pb^{208}$ | + 6He + E |
| $U^{235}$ | $\lambda = .972 \times 10^{-10} yr^{-1}$ | $Pb^{207}$ | + 7He + E |
| $U^{238}$ | $\lambda = 1.54 \times 10^{-10} yr^{-1}$ | $Pb^{206}$ | + 8He + E |
| $Pb^{204}$ | unchanged | $Pb^{204}$ | |

Each parent nuclei produces an unstable nucleus that decays to a final stable isotope. Lambda ( $\lambda$ ) is the probability of decay governed by each nucleus. Common lead ($Pb^{204}$) is known to exist as a stable isotope and is not a product of radioactive decay and therefore, unchanged through time.

The relationship between the number of parent atoms and their decay rate is:

$$^{d}/_{dt}\ (N) = -\ \lambda N \tag{1}$$

where N is the number of the parent atoms at time t and $\lambda$ is again the decay constant for that particular isotope. Integration of Equation 1 gives:

$$N = N_o e^{-\lambda t} \tag{2}$$

where N is now the number of parent atoms which were remaining after time t, and $N_o$ is the initial number of parent atoms at time zero. The decay of $U^{238}$ to $Pb^{206}$ can be expressed as follows:

$$\frac{dU^{238}}{dt} = -\lambda_{238} (U^{238})_i = - \frac{d\ Pb^{206}}{dt} \qquad (3)$$

or

$$\frac{d\ Pb^{206}}{dt} = + \lambda_{238} (U^{238})_i \qquad (4)$$

The amount of $Pb^{206}$ atoms produced after a time t is:

$$Pb^{206} = \int_o^t \frac{d\ Pb^{206}}{dt}\, dt = \lambda_{238} \int_o^t U_i^{238}\, dt \qquad (5)$$

It is seen from equation 2 that:

$$Up^{238} = U_i^{238} e^{-\lambda t} \qquad (6)$$

and $$U_i^{238} = U_p^{238} e^{\lambda t} \qquad (7)$$

Substitution of equation 7 into equation 5 gives:

$$Pb^{206} = \lambda_{238} \int_o^t U_p^{238} e^{\lambda t} \qquad (8)$$

$$= \lambda_{238} U_p^{238} \left[\frac{1}{\lambda_{238}} (e^{\lambda 238t} - 1)\right] \qquad (9)$$

$$= U_p^{238} (e^{\lambda 238t} - 1)* \qquad (10)$$

The decay equation of $Pb^{207}$ and $Pb^{208}$ is constructed in a similar manner giving,

$$Pb^{207} = U^{235} (e^{\lambda 235t} - 1) \qquad (11)$$

$$Pb^{208} = Th^{232} (e^{\lambda 232t} - 1) \qquad (12)$$

*$(e^{\lambda t}-1)$ values are reported in Tables 1.6; 1.7; 1.8; by Russell and Farqhaur (1960).

Summing equations 10, 11 and 12 gives the amount of radiogenic lead added in a rock sample formed at time t.

$$\Sigma Pb_{RADIO} = U_p^{238}\ (e^{\lambda 238t}-1) + U_p^{235}\ (e^{\lambda 235t}-1) + Th^{232}\ (e^{\lambda 232t}-1) \qquad (13)$$

Dividing equation 13 by total lead ($Pb_{tot}$) and multiplying by 100 yields the percent of radiogenically derived lead.

$$\frac{\Sigma Pb_{RAD}}{Pb_{tot}} = \frac{Pb^{204}}{Pb_{tot}} \left( \frac{Up^{238}}{Pb^{204}} (e^{\lambda 238t}-1) + \frac{Up^{235}}{Pb^{204}} (e^{\lambda 235t}-1) + \frac{Th^{232}}{Pb^{204}} (e^{\lambda 232t}-1) \right) \qquad (14)$$

where

$$\frac{U^{238}}{Pb^{204}} = \frac{U}{Pb} \times \frac{Pb^{\dagger}}{Pb^{204}} \times \frac{U^{238\dagger}}{U} = \frac{U}{Pb} \times 67.5675 \times .9927 \qquad (15)$$

$$\frac{U^{235}}{Pb^{204}} = \frac{U}{Pb} \times \frac{Pb}{Pb^{204}} \times \frac{U^{235\dagger}}{U} = \frac{U}{Pb} \times 67.5675 \times .0072 \qquad (16)$$

$$\frac{Th}{Pb^{204}} = \frac{U}{Pb} \times \frac{Th}{U} \times \frac{Pb}{Pb^{204}} = \frac{U}{Pb} \times \frac{Th}{U} \times 67.5675 \qquad (17)$$

Uranium, thorium and lead concentrations are in parts per million. Finally, simple manipulation yields the radiogenic lead correction equation.

$$\text{Reported Lead}_{(ppm)} - \left(\frac{\Sigma Pb_{RAD}}{Pb_{tot}} \times (\text{Reported Lead}_{(ppm)})\right) = Pb_{original(ppm)} \qquad (18)$$

Equation 18 has an error of approximately 4 percent with the premise that the bulk of the radiogenic lead produced is thru the decay of $U^{238}$. This is a good assumption since $U^{238}$ has a crustal abundance of 99.127%[†]

[†]U.S.A.E.C. Chart of Nuclides (1968).

A Fortran IV computer program was written to facilitate in correcting the available lead data. Only data reporting concentrations (ppm) of Pb, U and Th and age could be used in the correction equation (EQ. 14 and 18). A listing of the individual corrected and uncorrected lead values is found in Appendix 1. As expected, the older, more uranium rich rocks give larger lead corrections (Table 6). The standard deviations (σ) show a general decrease, which suggests that the corrected values reduces scatter. One value,

TABLE 6

| Rock Type(#) | Uncorrected | | Corrected | | Radiogenic |
|---|---|---|---|---|---|
| | $\overline{Pb}$(ppm) | σ | $\overline{Pb}$(ppm) | σ | $\overline{Pb}$(ppm) |
| ANDESITES(17) | 4.77 | 2.91 | 4.75 | 2.89 | .02 |
| ANORTHOSITES(7) | 9.77 | 9.24 | 9.60 | 8.86 | .17 |
| GRANITES(13) | 28.71 | 8.50 | 28.10 | 7.74 | .61 |
| BASALTS(22) | 4.78 | 3.68 | 3.89 | 5.00 | 1.09 |
| GRANULITES(77) | 26.26 | 12.10 | 25.17 | 12.25 | 1.09 |
| AMPHIBOLITES(56) | 28.15 | 14.85 | 26.88 | 14.39 | 1.27 |

from a granulite (Heier and Thorensen, 1971), had an overcorrected negative value (-22 ppm) and was discarded.

Ninety-one igneous and one hundred seventy two metamorphic corrected values were incorporated into the total data available in an attempt to reduce the amount of scatter in the raw data. The K:Pb correlation matrix (Table 7) shows a relative consistency of correlations in the igneous data, even with the addition of the corrected values. The corrected metamorphic rocks decrease in correlation (r).

Table 7

| Rock Type(#) | (r) Uncorrected LogK/LogPb | (r) Corrected LogK/LogPb |
|---|---|---|
| IGNEOUS(91) | .76 | .77 |
| TOTAL IGNEOUS(338) | .47 | .48 |
| METAMORPHICS(172) | .81 | .76 |
| TOTAL METAMORPHICS(493) | .52 | .47 |
| ALL DATA(831) | .44 | .43 |

Table 7 suggests that the addition of anomalous lead caused by radioactive decay, is so minimal that this addition has only a small or insignificant effect on the overall K/Pb correlation.

The corrected rock types in Table 7 give very high correlations. The data was collected from authors that analyzed their rock samples from specific geographic locations, for example, Heier and Thoresen, (1970), and not geographically dispersed.

## K/Pb RELATIONSHIPS

The co-existing potassium - lead values were first examined assuming a linear relationship. The coefficients, $b_0$ (intercept) and $b_1$ (slope), of the linear predictive equation:

$$\hat{Y}_{Pb} = b_0 + b_1 X_K \qquad (1)$$

were found by regression analysis. The nineteen rock suites presented represent data from 338 igneous rocks and 481 metamorphic rocks. Only chemical data which satisfied the following prerequisites were used: (1) the analyses were compared to certified standards, and

(2) the authors performed a sufficient number of replicate determinations to report the precision of their analytical method. If the mean and frequency do not coincide, the data is skewed. Table 8 lists kurtosis and skewness for the arithmetic and lognormal K:Pb data. Metamorphic K and Pb values show a high tendency for lognormality with a negative skewness. In the igneous data, potassium shows arithmetic normality while that for lead suggests a lognormal distribution. Miller and Goldberg (1955) also noted that potassium was arithmetically normal. Their lead data was lognormal. Ahrens (1954) found both potassium and lead had lognormal distributions.

It is interesting to note that all the lognormal data is negatively skewed, the igneous more negatively skewed than the metamorphics. Zhirov and Chernyshev (1959) suggested that the igneous lognormal distribution of the elements characterizes the primary content of the magma. Any addition to that content would skew a lognormal distribution. If this is the case, the igneous and metamorphic data suggests contamination of Pb and possibly K from other sources.

Many investigators have reported that elements (in particular trace elements) have a lognormal distribution. In effect the log of the variables should give a higher correlation coefficient than arithmetic values of the same variables. Mixed mode (arithmetic-log) and common mode (log-log or arithmetic-arithmetic) correlations are reported in Table 9. These variables are also compared to the ratio value R, where $R = 10{,}000\ \overline{K} / \overline{Pb}$. The correlation coefficients in Table 9 indicate considerable variations between mixed and common mode correlations. For example, diorites and anorthosites consistently

Table 8

| Metamorphics | KURTOSIS | SKEWNESS |
|---|---|---|
| K% | -.70 | .71 |
| LogK | 1.46 | -.88 |
| Pb(ppm) | 31.98 | 4.22 |
| LogPb | 3.13 | -.69 |
| **Igneous** | | |
| K% | -.71 | .35 |
| LogK | 6.09 | -1.96 |
| Pb(ppm) | 3.08 | 1.46 |
| LogPb | 2.49 | -1.04 |

Table 9

| Igneous | (r) K/Pb | (r) K/LogPb | (r) LogK/Pb | (r) LogK/LogPb | (r) Pb/R* | (r) K/R* | (r) LogK/R* |
|---|---|---|---|---|---|---|---|
| GRANITE | .10 | .19 | .17 | .29 | -.60 | .34 | .25 |
| ULTRABASIC | -.33 | -.22 | -.02 | .15 | -.44 | .90 | .47 |
| ANDESITE | .38 | .31 | .32 | .28 | -.55 | .23 | .28 |
| DIORITE | .43 | .44 | .41 | .42 | -.05 | -.89 | -.03 |
| DACITE | .37 | .16 | .38 | .17 | -.34 | .44 | .41 |
| MIGMATITE | .04 | .15 | -.04 | .03 | -.47 | .54 | .62 |
| BASALT | .33 | .43 | .34 | .42 | -.38 | .30 | .35 |
| ANORTHOSITE | .97 | .88 | .96 | .89 | .40 | .61 | .61 |
| **Metamorphics** | | | | | | | |
| SCHIST | .58 | .56 | .55 | .46 | .14 | .84 | .82 |
| AMPHIBOLITE | .77 | .83 | .69 | .88 | .06 | .61 | .66 |
| GRANULITE | .58 | .65 | .59 | .68 | -.35 | .31 | .31 |
| SLATE | -.05 | -.21 | -.06 | -.20 | -.58 | .40 | .37 |
| GNEISS | .50 | .41 | .45 | .41 | -.20 | .47 | .46 |

* $R = 10{,}000(\overline{K}/\overline{Pb})$

gave similar correlation coefficients for all modes presented, whereas granites gave a wide range of values. The log values log K/logPb gave the most consistent positive correlations. Since the ratio of the log values is most generally reported in the literature, this precedent will be followed.

The statistical F test was used on the data to compare the variance of the two populations. For the F test to be valid, the data must represent random samples from a normally distributed population. The data used in this study satisfies normality (it is nearly lognormal) and randomly sampled from the literature. The null hypothesis was proposed that no differences exist between the two variances to be compared, i.e., $H_o:\sigma_1^2 = \sigma_2^2$. The test ratio of the two variances was computed according to the relationship $F = \sigma_1^2 / \sigma_2^2$ where $\sigma$ is the standard deviation and $\sigma^2$ is the variance. The calculated F value was then compared with the corresponding value in F distribution tables (Table - S, Rohlf and Sokal, 1969) at the 95% confidence limit and appropriate degrees of freedom. The choice of a 95% confidence level is satisfactory for most geological problems (Kauffman, 1969) and will be used in this study.

If the calculated F was less than the F distribution value found in the tables, there was no significant difference between the variances at a 95% confidence level. One could not therefore, reject the null hypothesis. If the calculated F was greater than the F distribution value found in the tables at 95% confidence level, then the ratio of the variances is larger than would be due to chance, and variations are considered to be caused by some outside influence and not chance alone.

Regression analysis was used to examine data and draw meaningful conclusions about dependency relationships of potassium and lead. Nineteen rock suites were analyzed.

All regression studies require that one variable takes fixed values subject to minimal error. It is a problem fitting regressions when errors of measurement are present in one or both of the variables. Geochemical data commonly has errors in one or more variables. Shaw (1968) partially avoided this problem by calculating both regressions, y on x and x on y and averaged the final slopes.

In itself, the question of which regression line is more appropriate is meaningless as it stands. Before it can be answered, we must determine; (1) how the (x,y) values were obtained and (2) the purpose of the regression (Winsor, 1946). In this study the pairs of K and Pb values (y,x) were obtained (1) as a random sample from the general population. It is then possible to estimate the constants of the (y,x) distribution; (2) it is desirable to present a relation to estimate in the future, the value of lead (x), given a future measurement of potassium (y). Consideration of 1 and 2 statistically allows the validity of the regression of x on y $(x|y)$ and is uneffected by the fact that positive errors of measurement are involved. Tables 10 and 11 are the ANOVA statistics for the logarithmic and arithmetic data.

Regression lines $(x|y)$ were drawn on log scale for twelve igneous and seven metamorphic rock suites (Figures 4 and 5). All suites, excluding diorites, exhibit subparallel behavior and steep to vertical slopes. The means and standard deviations for these regression lines are plotted in Figures 6 and 7. The igneous rocks

| | No. | K $\bar{y}$ | Pb $\bar{x}$ | Rs* d.f. | Re* d.f. | Re M.S. S.S. | Rs S.S. | Rs M.S. | F | Sig. | r | Regression line $b_1$ | $b_0$ | $\overline{K}/\overline{Pb}$*10000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Gneiss(arith.)** | 245 | 1.20 | 14.39 | 1 | 243 | 3977.92 | 12126.22 | 49.90 | 79.71 | 1.00* | .50 | 3.78 | 9.81 | 833.91 |
| **(log.)** | | -.04 | 1.10 | | | 2.29 | 11.28 | .05 | 49.44 | 1.00* | .41 | .32 | 1.11 | |
| **Granulite** | 76 | 3.51 | 25.30 | 1 | 74 | 3862.55 | 7457.01 | 100.77 | 38.33 | 1.00* | .58 | 5.19 | 7.08 | 1387.35 |
| | | .49 | 1.35 | | | 1.62 | 1.89 | .03 | 63.32 | 1.00* | .68 | .65 | 1.03 | |
| **Amphibolite** | 56 | 3.20 | 25.83 | 1 | 54 | 7072.76 | 4613.79 | 85.44 | 82.78 | 1.00* | .78 | 6.74 | 4.26 | 1238.86 |
| | | .32 | 1.29 | | | 6.46 | 1.92 | .04 | 181.55 | 1.00* | .88 | .56 | 1.12 | |
| **Schist** | 27 | 1.16 | 23.00 | 1 | 25 | 1102.78 | 2133.22 | 85.33 | 12.92 | .99* | .58 | 4.75 | 17.51 | 504.34 |
| | | -.41 | 1.32 | | | .20 | .73 | .03 | 6.72 | .98* | .46 | .12 | 1.37 | |
| **Slate** | 40 | 2.86 | 21.28 | 1 | 38 | 4.81 | 1943.17 | 51.14 | .09 | .24 | .05 | -.61 | 23.03 | 1343.98 |
| | | .44 | 1.29 | | | .05 | 1.17 | .03 | 1.52 | .78 | .20 | -.37 | 1.47 | |
| **Meta-Gabbro** | 8 | 1.54 | 9.74 | 1 | 6 | 29.26 | 121.45 | 20.24 | 1.45 | .73 | .44 | 2.33 | 6.16 | 1588.11 |
| | | | | | | .02 | .28 | .05 | .47 | .48 | .27 | .26 | .91 | |
| **Pyribolite** | 9 | .49 | 9.33 | 1 | 7 | 10.19 | 81.80 | 11.69 | .87 | .62 | .33 | -5.88 | 12.24 | 525.19 |
| | | -.34 | .93 | | | .04 | .28 | .04 | .99 | .65 | .35 | -.35 | .81 | |
| **Significant Metamorphics** | 408 | 1.90 | 18.49 | 1 | 406 | 25140.87 | 29451.94 | 72.54 | 346.57 | 1.00* | .68 | 4.85 | 9.27 | 1027.58 |
| | | .09 | 1.18 | | | 10.82 | 24.90 | .06 | 176.37 | 1.00* | .55 | .35 | 1.15 | |

* **Significant at the 95% confidence level**

**Rs* Residual**
**Re* Regression**

Metamorphic

ANOVA

Table 10

| | No. | K $\bar{y}$ | Pb $\bar{x}$ | Rs* d.f. | Re* d.f. | Re M.S. S.S. | Rs S.S. | Rs M.S. | F | Sig. | r | Regression line $b_1$ | $b_0$ | $\overline{K}/\overline{Pb}$*10000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anorthosite (arith.) | 7 | 1.22 | 9.60 | 1 | 5 | 439.25 | 31.92 | 6.39 | 68.79 | 1.00* | .97 | 5.33 | 3.07 | 1270.83 |
| (log.) | | -.08 | .88 | | | .41 | .10 | .02 | 19.11 | .99* | .89 | .76 | .94 | |
| Andesite | 69 | 1.34 | 7.74 | 1 | 67 | 195.46 | 1154.33 | 17.23 | 11.35 | .99* | .38 | 3.63 | 2.87 | 1731.26 |
| | | .09 | .83 | | | .29 | 3.51 | .05 | 5.59 | .98* | .28 | .38 | .79 | |
| Basalt | 41 | 1.04 | 7.08 | 1 | 39 | 149.24 | 1240.19 | 31.79 | 4.69 | .96* | .33 | 2.26 | 4.74 | 1468.92 |
| | | -.14 | .69 | | | 1.13 | 5.25 | .13 | 8.38 | .99* | .42 | 1.06 | .87 | |
| Diorite | 33 | 3.08 | 26.39 | 1 | 31 | 562.72 | 2427.16 | 78.30 | 7.18 | .98* | .43 | 9.43 | -2.70 | 1167.10 |
| | | .48 | 1.39 | | | .20 | .90 | .03 | 6.77 | .98* | .42 | 1.06 | .87 | |
| Granite | 75 | 3.98 | 22.16 | 1 | 73 | 153.56 | 9540.13 | 4651.18 | .83 | .63 | .11 | 1.17 | 17.49 | 1796.02 |
| | | .57 | 1.26 | | | .54 | 5.79 | .08 | 6.86 | .99* | .29 | .46 | .99 | |
| Dacite | 31 | 2.00 | 10.72 | 1 | 29 | 84.69 | 530.27 | 18.29 | 4.63 | .96* | .37 | 2.88 | 4.95 | 1865.67 |
| | | .29 | .98 | | | .06 | 1.83 | .06 | .91 | .65 | .17 | .39 | .87 | |
| Ultrabasic | 16 | .33 | 9.08 | 1 | 14 | 55.96 | 449.18 | 32.08 | 1.74 | .79 | .33 | -3.65 | 10.29 | 364.54 |
| | | -.91 | .75 | | | .12 | 5.39 | .38 | .32 | .65 | .15 | .13 | .87 | |
| Syenite | 8 | 3.76 | 23.13 | 1 | 6 | 14.31 | 914.57 | 152.43 | .09 | .23 | .12 | -2.31 | 31.81 | 1625.59 |
| | | .57 | 1.31 | | | .00 | 3.25 | .11 | .04 | .15 | .08 | -.26 | 1.46 | |
| Migmatite | 30 | 2.86 | 41.97 | 1 | 28 | 91.15 | 43399.82 | 1549.99 | .06 | .19 | .05 | .86 | 39.52 | 681.43 |
| | | .29 | 1.49 | | | .00 | 3.25 | .12 | .04 | .17 | .04 | .03 | 1.48 | |
| Granofels | 10 | .82 | 13.50 | 1 | 8 | 7.93 | 206.57 | 25.82 | .30 | .41 | .19 | 1.78 | 12.04 | 607.41 |
| | | -.16 | 1.07 | | | .07 | .66 | .08 | .88 | .63 | .32 | .33 | 1.13 | |
| Adamellite | 10 | 3.46 | 31.80 | 1 | 8 | 26.55 | 481.05 | 60.13 | .44 | .48 | .23 | 5.89 | 11.43 | 1088.05 |
| | | .53 | 1.49 | | | .00 | .09 | .01 | .24 | .36 | .17 | .49 | .74 | |
| Mangerite | 36 | 3.83 | 16.73 | 1 | 34 | 6.51 | 1706.27 | 50.18 | .13 | .28 | .06 | -.44 | 18.43 | 2289.30 |
| | | .57 | 1.20 | | | .00 | .79 | .02 | .24 | .37 | .08 | -.10 | 1.25 | |
| Significant Igneous | 222 | 2.43 | 15.26 | 1 | 220 | 11553.09 | 22522.37 | 102.37 | 112.85 | 1.00 | .58 | 4.62 | 4.05 | 1592.39 |
| | | | | | | 15.40 | 18.34 | .08 | 184.71 | 1.00 | .68 | .72 | .84 | |

*Significant at the 95% confidence level

Rs* Residual
Re* Regression

Igneous

ANOVA

Table 11

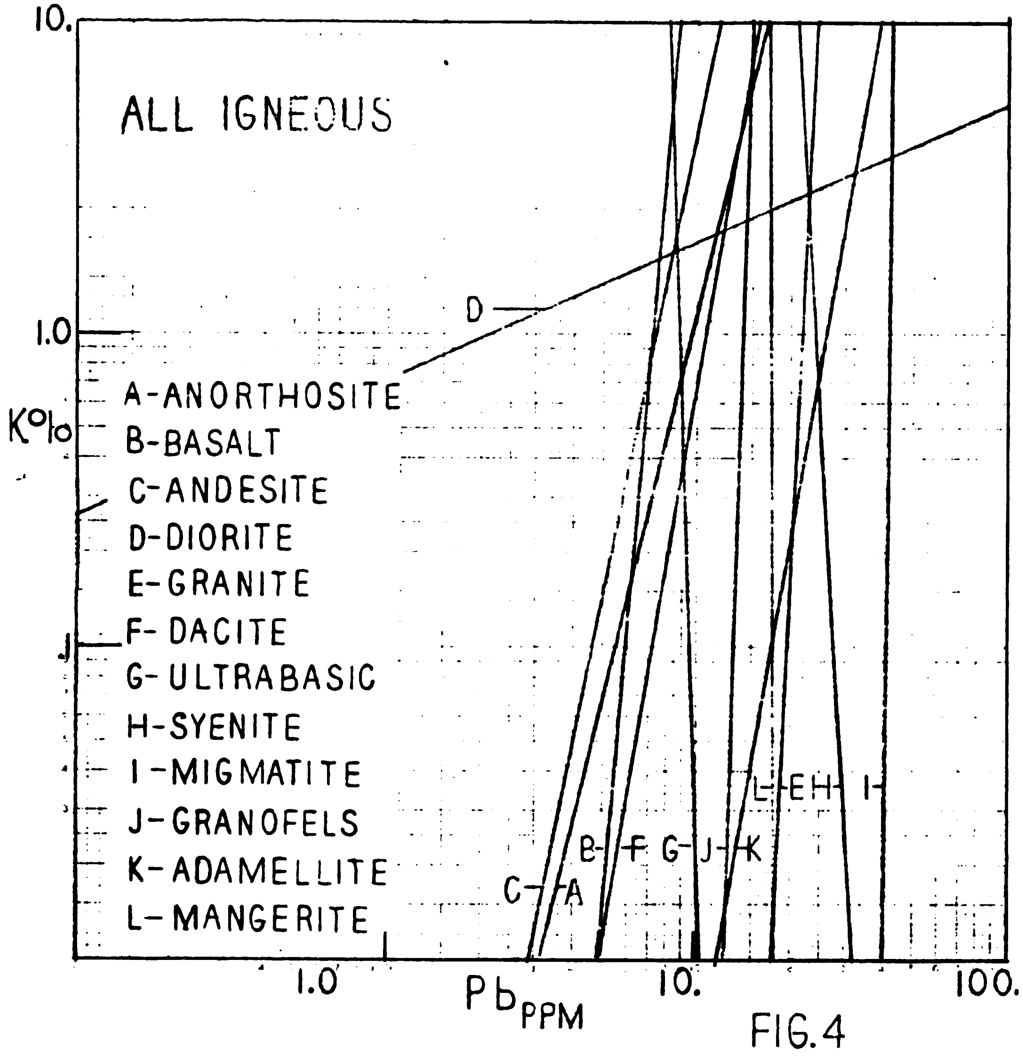

ALL IGNEOUS
10.
1.0
K%
A-ANORTHOSITE
B-BASALT
C-ANDESITE
D-DIORITE
E-GRANITE
F-DACITE
G-ULTRABASIC
H-SYENITE
I-MIGMATITE
J-GRANOFELS
K-ADAMELLITE
L-MANGERITE
D
C
A
B
F
G
J
K
L
E
H
I
1.0
10.
100.
Pb PPM
FIG.4

Figure 4.

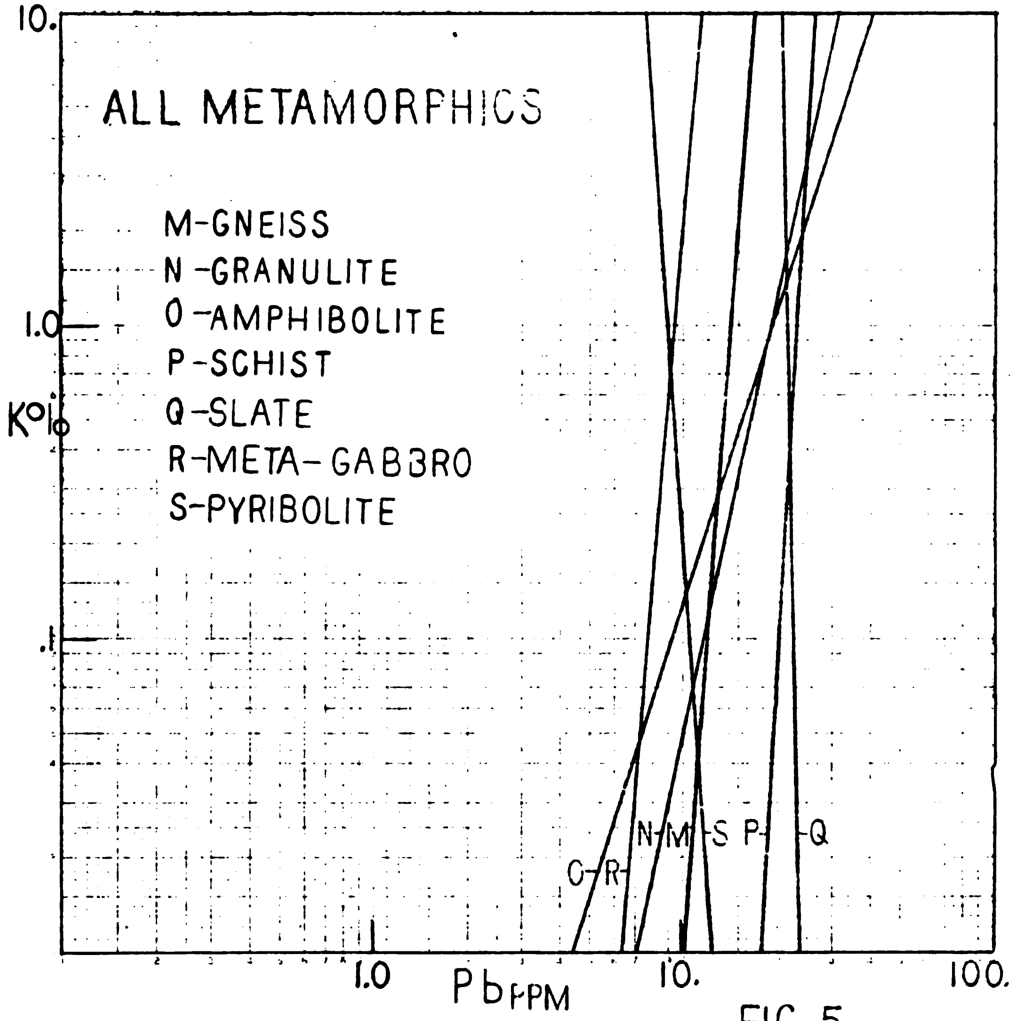



FIG. 5

**Figure 5.**

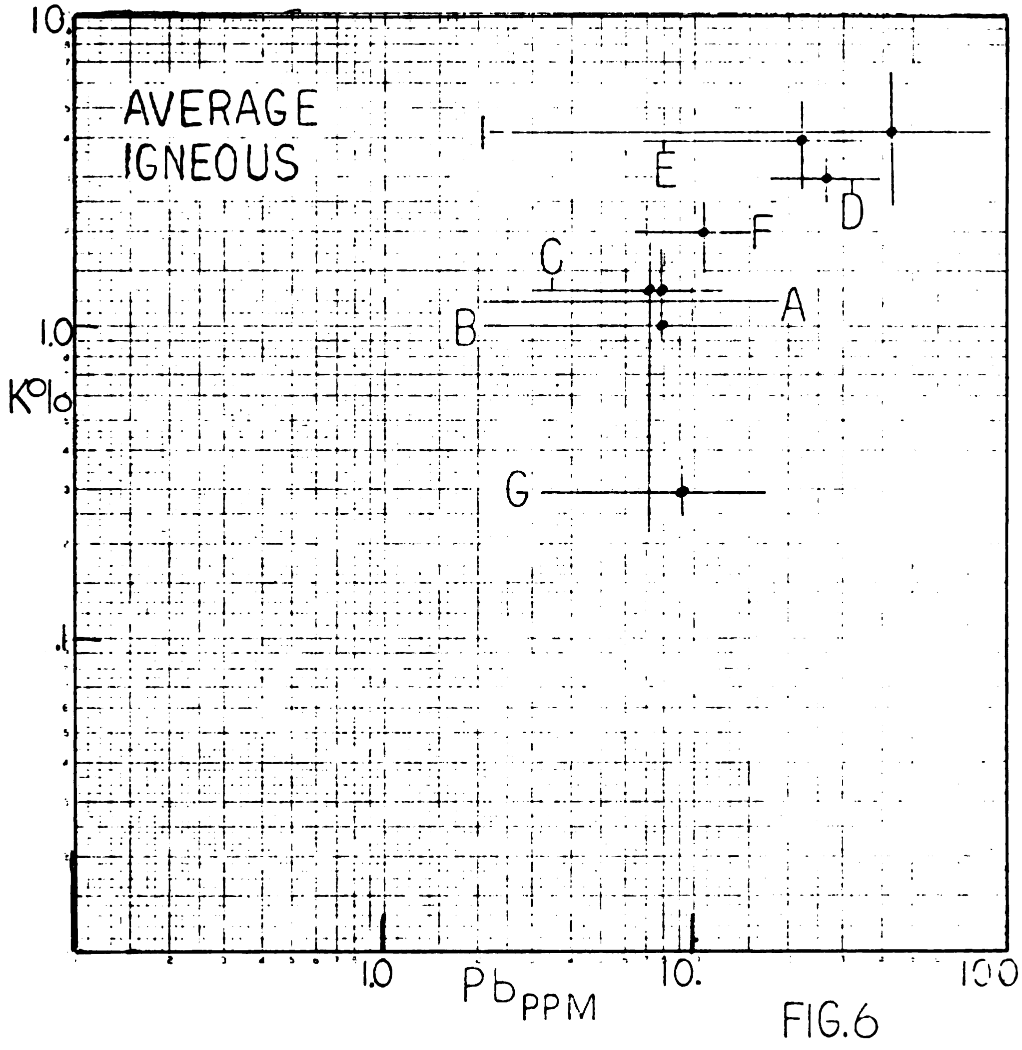



Figure 6.

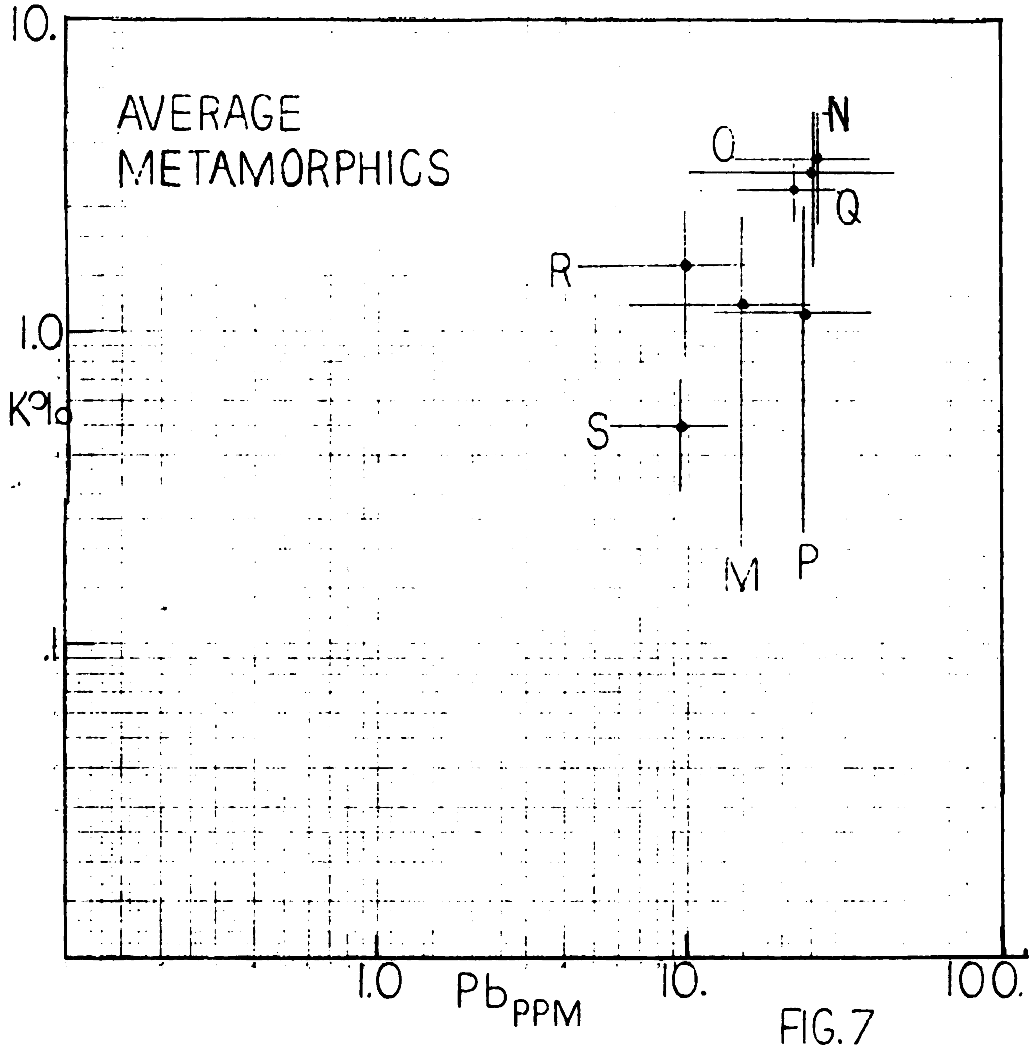


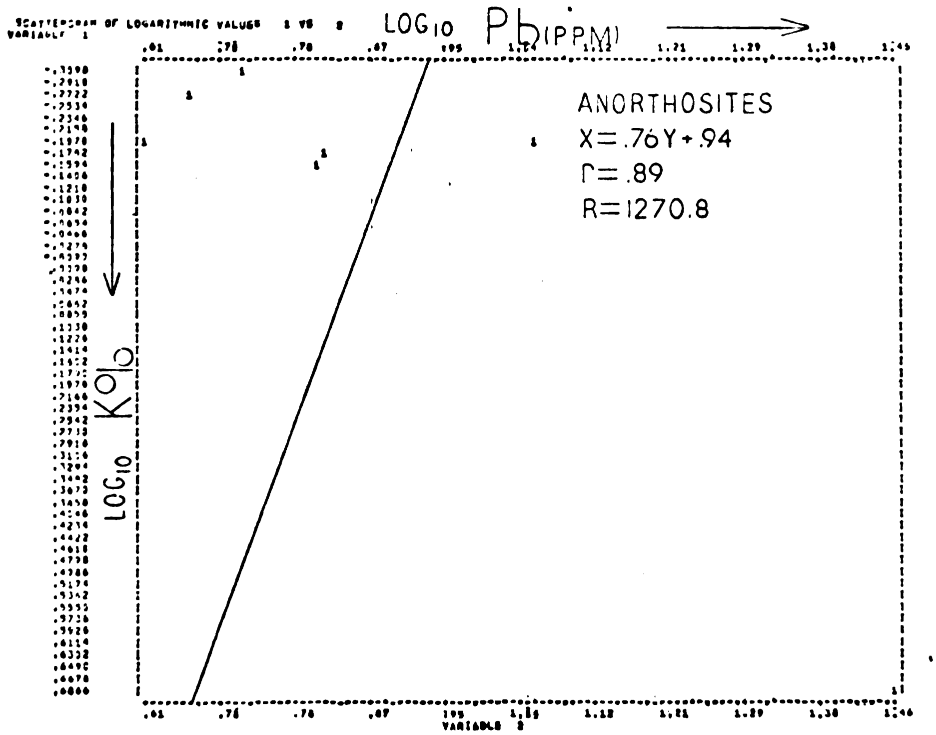

**Figure 7.**

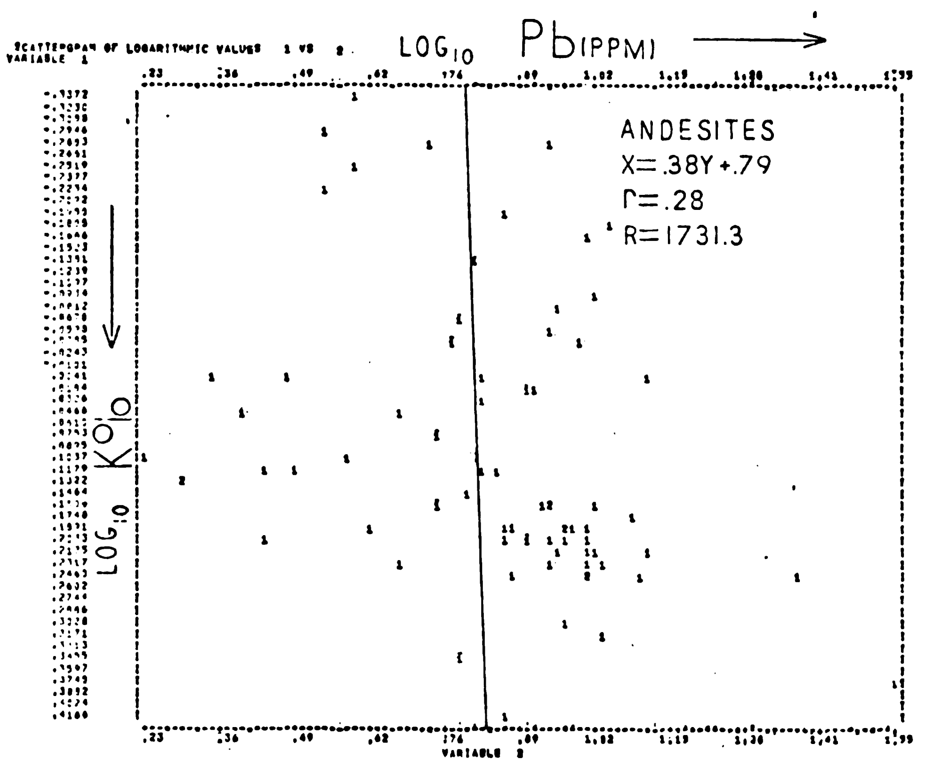
contain large standard deviations but show a definite K/Pb trend. The potassium deficient ultrabasics have the lowest lead concentrations, while the potassium rich migmatites and granites contain the largest concentrations of lead.

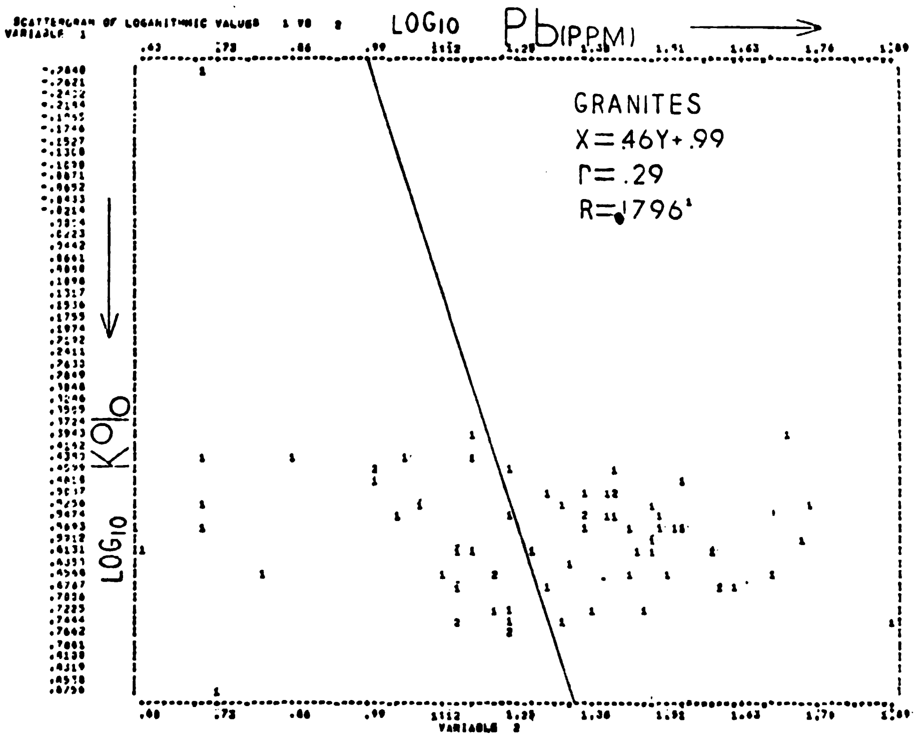
The plot of the metamorphic averages and standard deviations does not present a clear picture (Figure 7). The high temperature and pressure suites have the highest lead and potassium concentrations but the large standard deviations make conclusions difficult. It is interesting to note however, that the standard deviations for the metamorphics is largest in the potassium range while the larger standard deviations for the igneous rocks is found in the lead range. This suggests that lead is much more variable in the igneous rock suites.

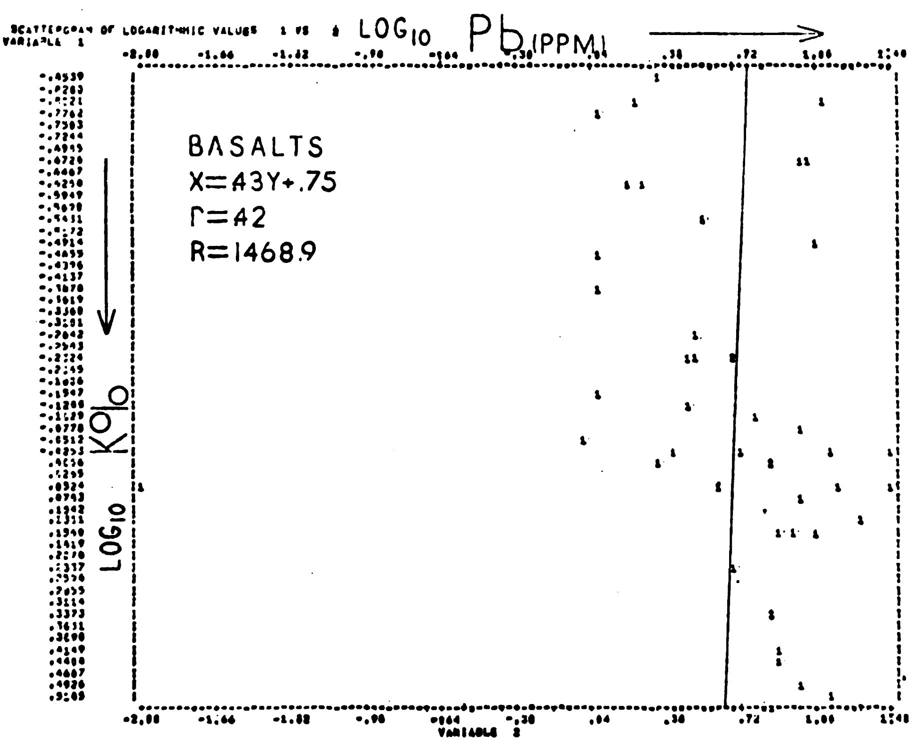
The F statistic was calculated to select the suites most significant at the 95% level. Nine suites were obtained, four metamorphic and five igneous rocks. The appropriate summary statistics are found in the ANOVA Tables 10 and 11.

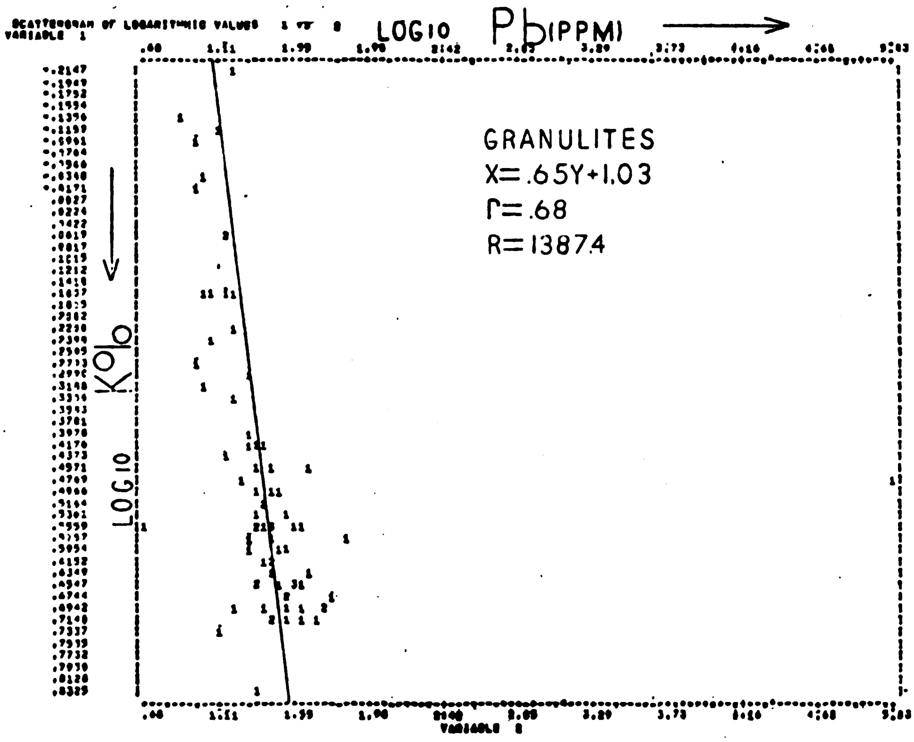
The regression lines for these significant rocks were replotted on scattergrams on log scale, and examined (Pages 28-31). The t statistic was used to determine whether the lead and potassium vary significantly between suites. The ratio of the difference between the two slopes to its standard error was compared against a t statistic. The hypothesis, that the slope of one regression line $b_1$ is significantly different from the slope of another regression line $b_2$, was examined. Rock types that visually appeared parallel (Figures 4 and 5) were statistically compared, i.e., granite vs. basalt; andesite vs. anorthosites, etc. Appropriate statistics are

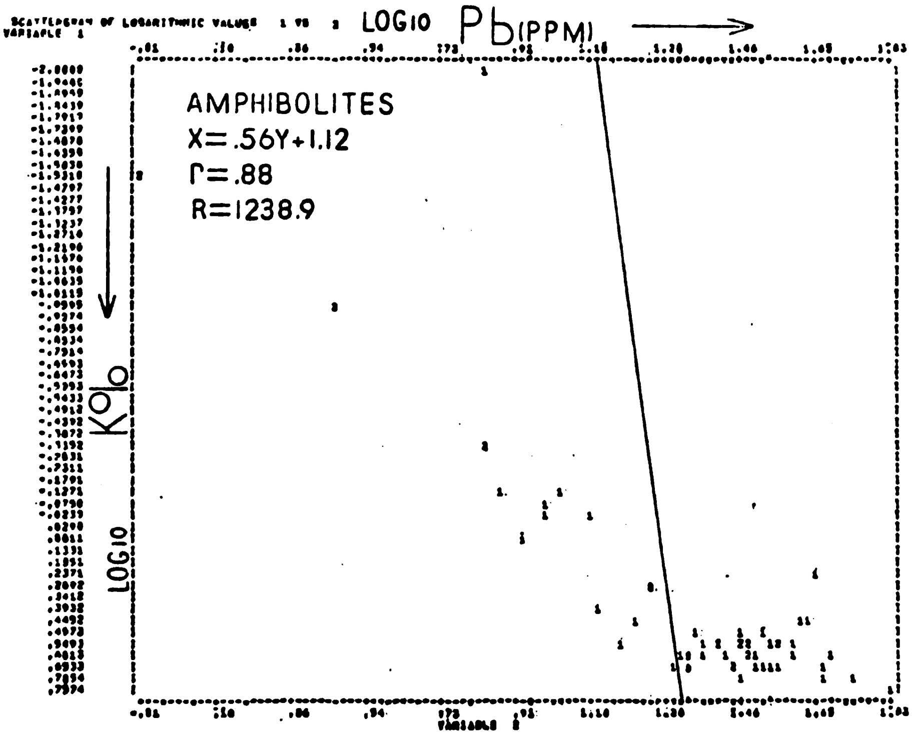

SCATTERGRAM OF LOGARITHMIC VALUES 1 VS 2
VARIABLE 1
LOG10 Pb(PPM)
ANORTHOSITES
X=.76Y+.94
r=.89
R=1270.8
LOG10 K%
VARIABLE 2

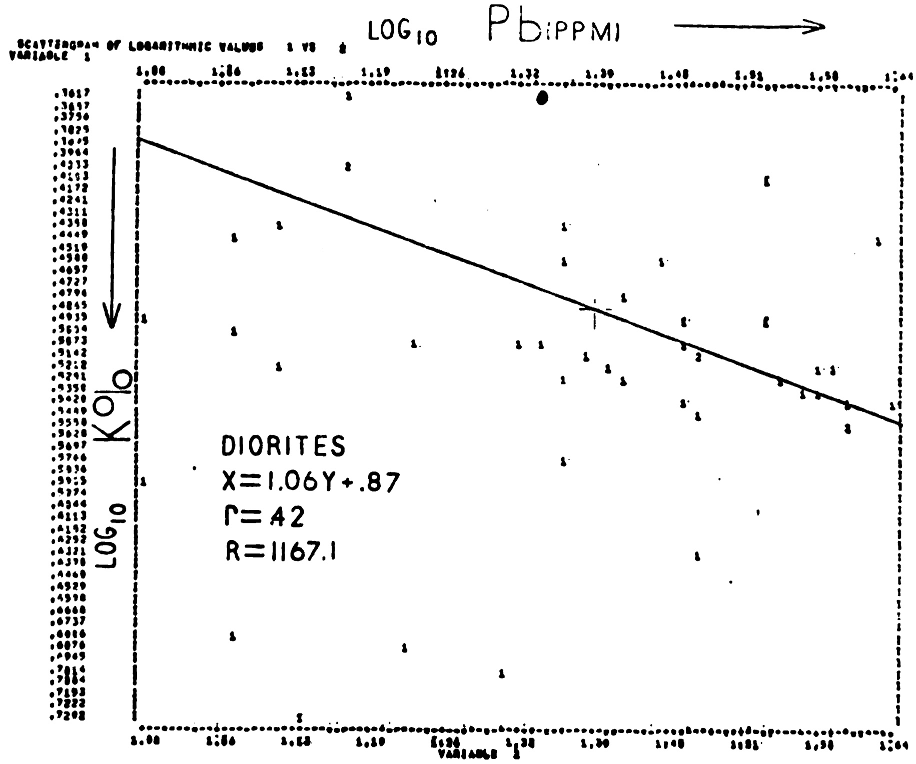

SCATTERGRAM OF LOGARITHMIC VALUES 1 VS 2
VARIABLE 1
LOG10 Pb(PPM)
ANDESITES
X=.38Y+.79
r=.28
R=1731.3
LOG10 K%
VARIABLE 2

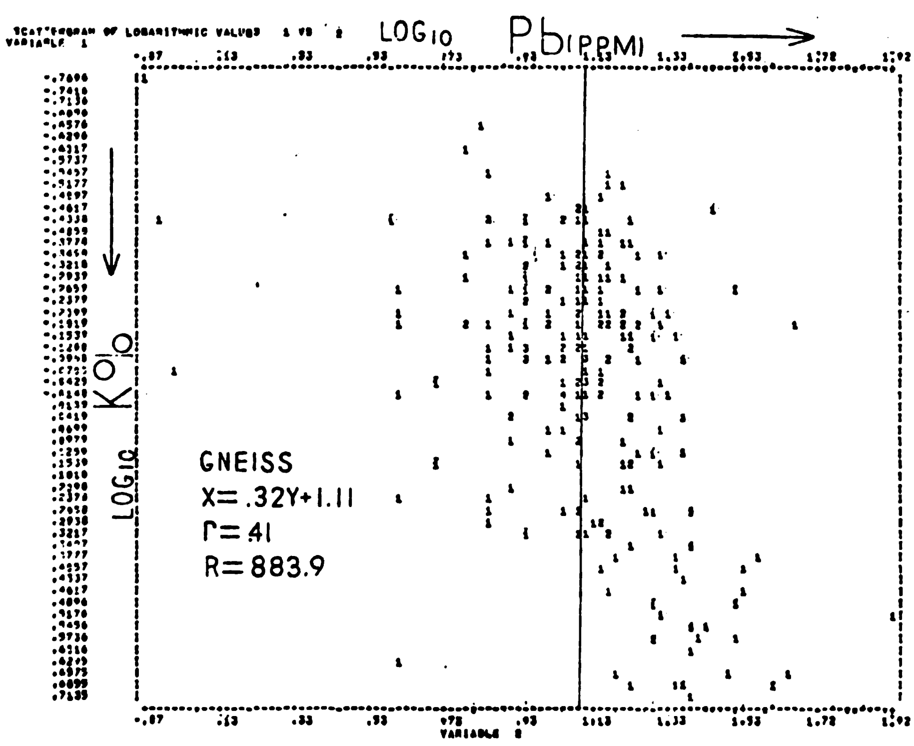

LOG10 Pb(PPM)
GRANITES
X=.46Y+.99
r=.29
R=.1796
LOG10 K%

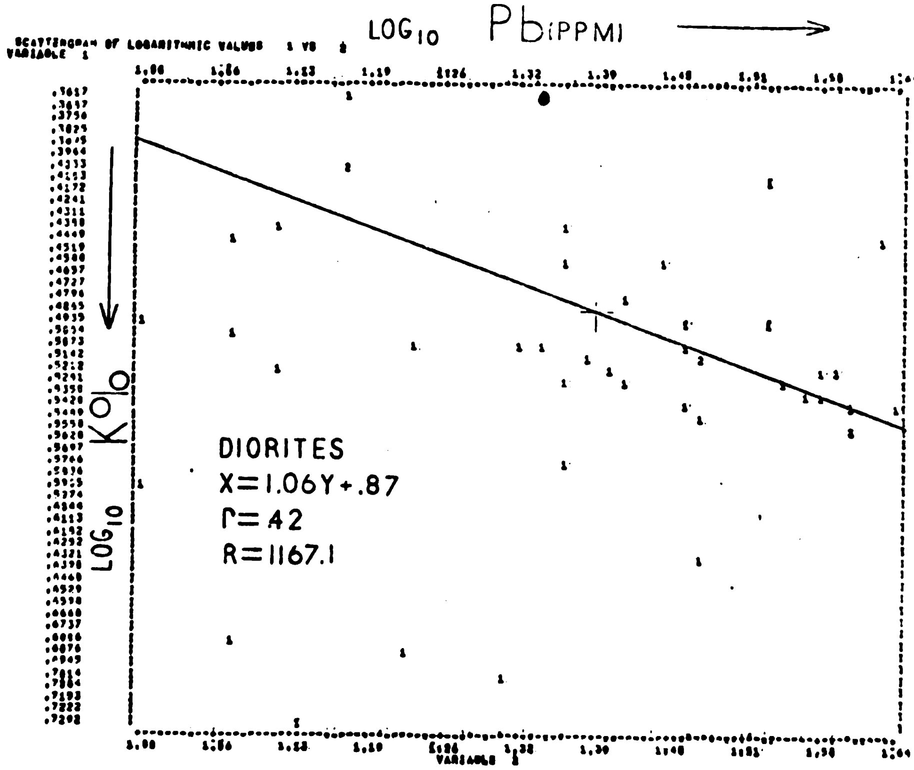

LOG10 Pb(PPM)
BASALTS
X=.43Y+.75
r=.42
R=1468.9
LOG10 K%

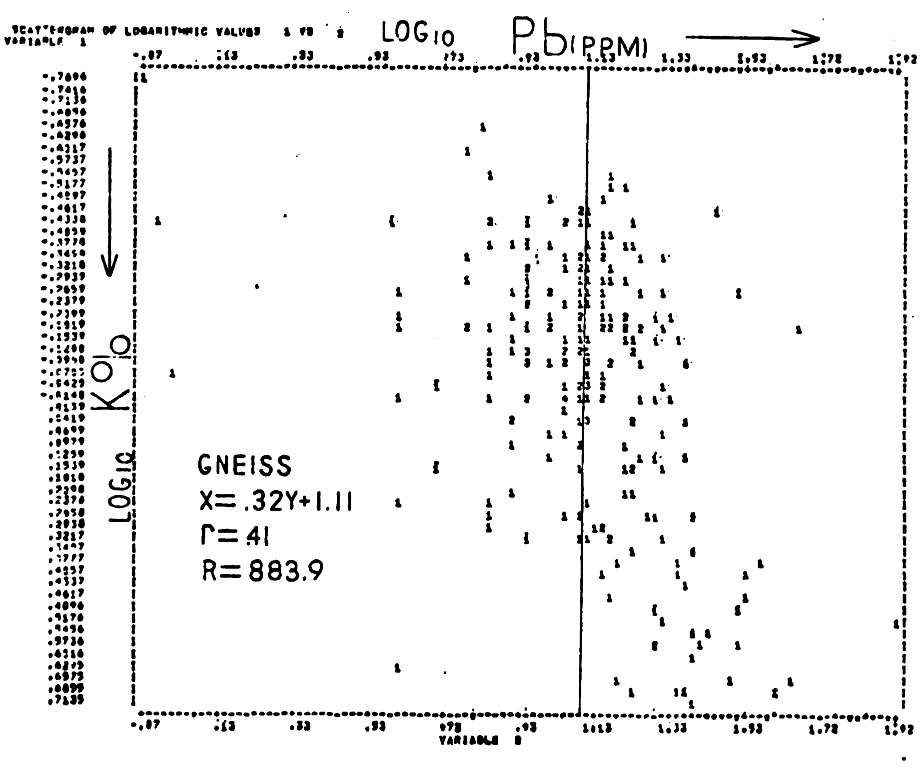

LOG10 Pb(PPM)
LOG10 K%
GRANULITES
X=.65Y+1.03
r=.68
R=1387.4


LOG10 Pb(PPM)
LOG10 K%
AMPHIBOLITES
X=.56Y+1.12
r=.88
R=1238.9


LOG10 Pb(PPM)
LOG10 K%
DIORITES
X=1.06Y+.87
r=42
R=1167.1


LOG10 Pb(PPM)
LOG10 K%
GNEISS
X=.32Y+1.11
r=41
R=883.9


LOG10 Pb(PPM)
LOG10 K%
DIORITES
X=1.06Y+.87
r=.42
R=1167.1


LOG10 Pb(PPM)
LOG10 K%
GNEISS
X=.32Y+1.11
r=.41
R=883.9

found in Appendix 2. Of the six groups examined, the slopes of two groups were not significantly different at a 95% confidence level, i.e., the andesites-gneisses and andesites-basalts. It is doubtful though, that the K/Pb environment of the andesites could be related to two distinctly different rock types (gneiss-basalt). The other groups examined had significantly different slopes.

Finally, a single regression line was drawn for an average of all the significant igneous as well as for the significant metamorphic rocks. The significant igneous and metamorphic regression lines are drawn in Figure 8. The igneous trend (R=1529.4) contains a larger range of lead values, but a smaller Pb average than the metamorphic trend (R=1027.6).

Statistical analysis of the K/Pb data has led to the following conclusions:

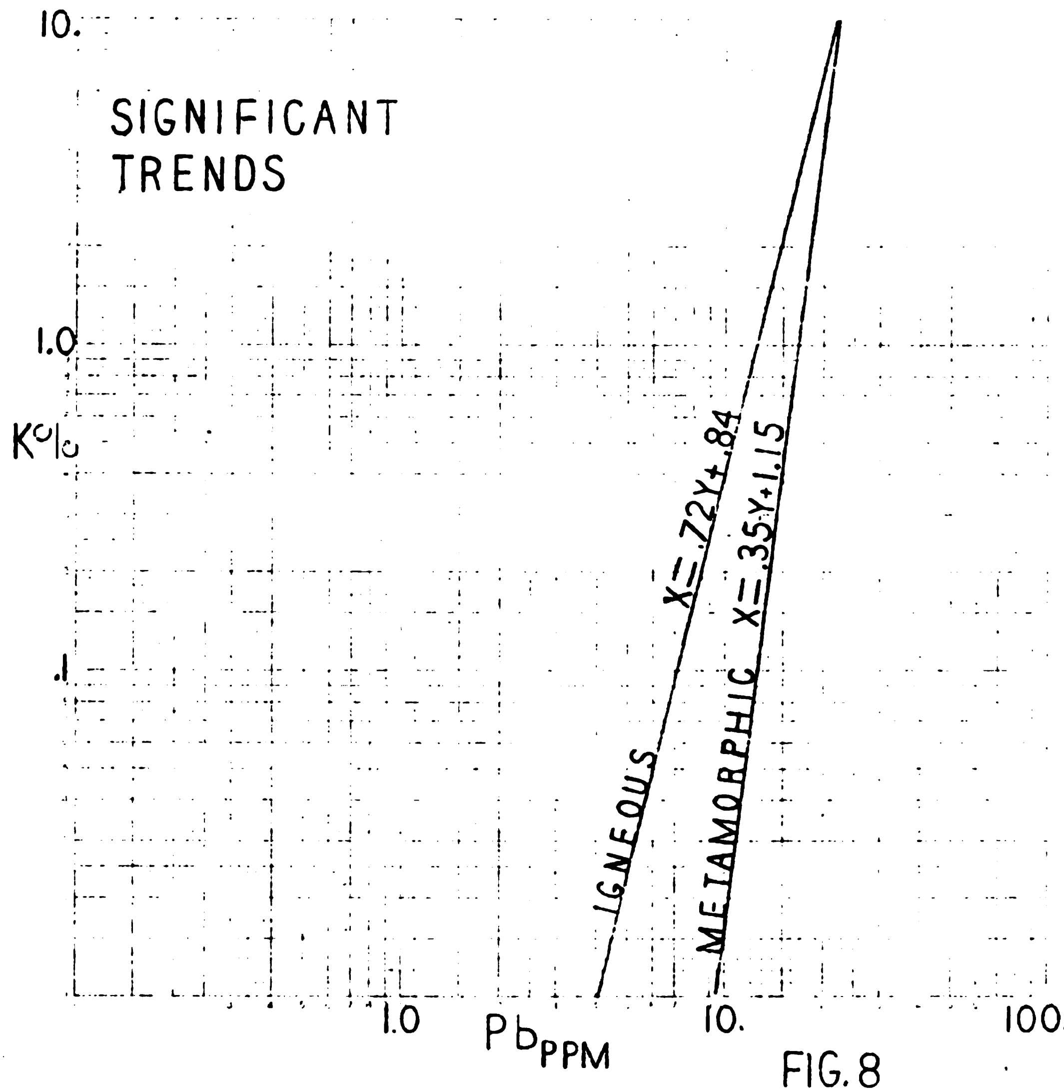
(a) most K/Pb correlations for the 19 igneous and metamorphic suites were poor;

(b) lead was found lognormal while potassium appears to be more arithmetically than lognormally distributed;

(c) of all the possible variables the log K/ log Pb correlation was chosen to best represent the data;

(d) of the 19 suites, 5 igneous and 4 metamorphic rocks were found significant at the 95% confidence level;

(e) of those accepted as significant, the andesite-basalt regression lines were parallel as were the andesite-gneiss regression lines;



SIGNIFICANT TRENDS
10.
1.0
K%
.1
1.0
10.
100.
Pb PPM
IGNEOUS X=.72Y+.84
METAMORPHIC X=.35Y+1.15
FIG. 8


Figure 8.

(f) the regression line best fitting the metamorphic data can be expressed as:

$$_{ppm}\text{Pb} = 4.85\ (\text{K\%}) + 9.27$$

$$\log\ _{ppm}\text{Pb} = .35\ \log\ (\text{K\%}) = 1.15$$

(g) the regression line best fitting the igneous data can be expressed as:

$$_{ppm}\text{Pb} = 4.62\ (\text{K\%}) + 4.05$$

$$\log\ _{ppm}\text{Pb} = .73\ \log\ (\text{K\%}) + .841$$

## Pb AND K/Pb TRENDS

The lead concentrations and R values are inconsistent with published values. R values in the andesites have a wide range, 1530 - 1720; the basalts (including tholietes) range from 1000 to 8333; granites, with an average lead concentration of 20 ppm has an R range of 1670 to 1995 (Table 12).

Wedepohl (1956) reported average Pb contents of basic, granodiorite and granitic rocks as 6, 15 and 20 ppm respectively. He used standards G-1 and W-1 and reported lead values at 26 and 6 ppm. Recent results on G-1 and W-1 reported in Stevens, et al., (1960) and Fleischer and Stevens (1962) indicate 49 ppm and 8 ppm, respectively for those standards (Flanagan, (1973) reports 48 and 7.8 ppm Pb). Any report using Wedepohl's (1956) data would therefore, have lead concentrations reported too low. Using Steven's analyses, Kolbe and Taylor (1966) reported 30 ppm Pb for seventeen samples of porphyritic Cape granites. This paper reports an average of 22 ppm lead for 75 granite samples. The wide ranges (Table 12)

TABLE 12

| Rock Type(Author) | Pb(ppm) | K% | R |
|---|---|---|---|
| GRANITE(1) | 20.0 | 3.34 | 1670 |
| " (3) | 19.0 | 3.79 | 1995 |
| " (2) | 20.0 | | |
| " (6) | 20.0 | | |
| " (10) | 22.0 | 3.98 | 1796 |
| " (11) | 19.0 | | |
| BASALT(1) | 8.0 | .83 | 1040 |
| " (3) | 6.0 | 5.00 | 8333 |
| " (3) | 1.0 | .10 | 1000 |
| " (2) | 5.0 | | |
| " (6) | 6.0 | | |
| " (10) | 7.08 | 1.04 | 1469 |
| " (11) | 6.0 | | |
| ANDESITE(1) | 15.0 | 2.30 | 1530 |
| " (6) | 10.0 | | |
| " (10) | 7.74 | 1.34 | 1731 |
| DACITE(6) | 10.0 | | |
| (10) | 10.7 | | |
| ULTRABASIC(6) | 3.0 | | |
| (10) | 9.1 | | |
| (11) | 6.0 | | |
| DUNITE(3) | .03 | .01 | 3333 |
| GRANODIORITE(11) | 15.0 | | |
| SIAL CRUST(8) | 11.5 | 1.65 | 1434 |
| CRUST(7) | 10.2 | | |
| UPPER CONTINENTAL CRUST(9) | 15.0 | 2.60 | 1730 |
| LOWER CONTINENTAL CRUST(9) | 20.0 | 2.00 | 1000 |
| MANTLE(9) | .05 | .005 | 1000 |
| MANTLE(8) | .27 | .04 | 1482 |
| UPPER MANTLE(7) | .24 | | |
| CORE(9) | .10 | $2.5x10^{-5}$ | 25 |
| CHRONDRITE(9) | .18 | .084 | 4600 |
| " (4) | .15 | .08 | 5333 |
| IRON METEORITE(5) | .224 | | |
| " | .099 | | |
| " | .098 | | |
| TROILITE(4) | 3.88 | | |
| " | 5.68 | | |

1. Vinogradov(1956)
2. Taylor(1969)
3. Turekian,Wedephol(1961)
4. Mason(1962)
5. Marshall,Feitknecht(1964)
6. Wedephol(1956)
7. Armstrong,Hein(1973)
8. Armstrong(1968)
9. Shaw(1972)
10. This paper
11. Hurley,et al.,(1962)

and low correlations (Tables 10 and 11) of the igneous data questions the significance of K/Pb fractionation in igneous rocks.

Comparative literature for the K-Pb metamorphic data is lacking. Similar to the igneous data, the increase in lead is generally correlative with an increase in potassium. It is of interest to note that the high grade metamorphics contain high concentrations of potassium and lead. Doe and Hart (1963) and Doe, Tilton and Hopson (1965), reported that lead may enter K feldspars that are subject to metamorphism. The R values for the granulites and amphibolites are 1388 and 1238 respectively. The large standard deviations found in these two suites makes any conclusions on their possible K/Pb fractionations obscure. Lambert and Heier (1968) found a lead depletion in granulites as opposed to amphibolites, as was found in this paper, but the variability of their K/Pb ratios placed doubt on the significance of the lead loss.

Shaw (1972) reports an R ratio of 1730 for rocks of the upper crust. An average of granites, granodiorites and diorites from this study gives a much lower value of 1482. Representative rocks from the lower crust (basalts, granulites, amphibolites) average 1365. Shaw (1972) reported a value of 1000 for lower crustal rocks. The ratios reported here and in Shaw (1972) suggests a depletion of Pb in the upper crust. Wedepohl (1974, written commun.) suggests a depletion of Pb in the lower crust. Armstrong (1968) and Shaw (1972) show a depletion of Pb in the mantle and core. This is supported by Jamieson and Clarke (1970) who report that lead is probably rejected from the zone of magma generation of the upper mantle. Primitive iron and chrondritic meteorites have concentrations of .098 - .18 ppm lead. Fish, et al., (1960) surmise that depletion in chrondrites could result from the fractionation of Pb S in the parent asteroid.

DISCUSSION

Analysis of the lead-potassium data reported here reveals that an increase of potassium is not a linear concomitant increase of lead in either metamorphic or igneous rocks.

Since the work of Goldschmidt (1954) the prevailing explanation in minerals has been that the size and charge of the ions and the nature and strength of the bonds govern the behavior of trace elements during magmatic and metamorphic fractionation (Taylor and Heier, 1960). Lead should therefore be concentrated in the early formed K-feldspars of granodiorite - dioritic melts and their concentration decrease as fractionation proceeds. This phenomenon is not observed in this paper. Granitic melts, such as migmatites, contain a high concentration of lead (42 ppm average). Cuturic et al., (1968) found that later formed K-feldspars in the Dinarids area were enriched in lead. Gavrilin, et al., (1972), Cuturic et al., (1968), Parry and Nackowski (1963), Kolbe and Taylor (1966) concluded that their lead data was affected by the loss or gain of lead through hydrothermal fluids, either by the formation of a fluid phase or by the formation of a gaseous phase. Jagitsch and Perlstrom (1946) claim to have evidence for diffusion of less highly charged ionic groups such as $P_2O_5$, PbO or ZnO. Doe and Hart (1963) report that lead can be exchanged between mineral fractions at temperatures estimated by Hart, et al., (1968) to be $400^{o}$ - $450^{o}$ C. Richards (1971) suggested that leached aqueous solutions could be the immediate source of some lead ore bodies. Drury (1971) found high lead concentrations in granitic veins of Coll and Tire. Galena was not found in polished sections even though galena was mined in the Coll area. Doe and Hart (1963) noted that lead in their mineral fractions was located on intergranular surfaces. DeVore (1955) observed that important amounts of trace elements do not occupy regular lattice sites but, through adsorption, occur on growth surfaces, imperfections, dislocations and various interfaces within the crystal.

## CONCLUSION AND SUMMARY

The concensus that the K/Pb problem, reported by several authors, as "vexing" seems justifiable. The generally accepted empirical rules of Goldschmidt (1937), and modified by Ringwood (1955) and Ahrens (1964) governing element distribution in geological processes does not fully encompass the geochemical properties of lead. The existing rules do not describe the possible coexisting lead phases and probable competition between elements during fractionation. These conditions may cause the magnitude and direction of fractionation of potassium and lead to reverse in different chemical systems. For example, Shrivastava and Proctor (1962) and Putman and Burnham (1963) found high concentrations of lead (155 ppm) in the mafic minerals of some plutonic rocks. Putnam and Burnham (1963) discussed the difficulties of empirically determining whether K-feldspar in equilibrium with granitic magma will have a higher lead content than that in equilibrium with a granodioritic magma. Viswanathan (1972) in his studies of lead in granitic rocks suggested that lead in granitic rocks and minerals was useful in interpreting problems of granite petrogenesis. His examination of Ca/Pb, Sr/Pb, K/Pb and

Ba/Pb ratios in biotites proved to be instrumental as petrogenetic tracers. His conclusions should be tested elsewhere.

The K/Pb whole rock data analyzed here was an attempt to understand the geochemical behavior of lead in various igneous and metamorphic rocks. The correlation coefficients for those two major groups were .53 and .49 respectively, scatter was evident with an increase in potassium and lead. The appropriate data was corrected for anomalous radiogenic lead in an attempt to improve the correlation coefficients. It was found that the addition of radiogenic lead produces a minimal effect on K/Pb geochemical coherence. Statistical analysis of individual rock types reveals a general increase of lead with potassium but not in a normal gabbro through granite magmatic trend. Large standard deviations within the igneous and metamorphic trends render conclusions awkward. The general trend found was for an enrichment of lead in the lower crust (R=1365) while the upper crust (R=1482) was depleted in lead.

# APPENDIX 1

## Corrected and uncorrected K/Pb ratios

## APPENDIX 1

### Abbreviations and Definitions

ADAMELLITE - quartz monzonite

GRANOFELS - medium - to coarse - grained granoblastic metamorphic rock

MANGERITE - monzonite

PYRIBOLITE - mnemonic term igneous rock pyroxene + amphibole

ABIOTIGNEISS - acid biotite gneiss

BBIOTIGNEISS - basic biotite gneiss

AHORNGNEISS - acid hornblende gneiss

BHORNGNEISS - basic hornblende gneiss

PYROXGNEISS - pyroxene gneiss

AHORBIOGNEISS - acid hornblende gneiss

BHORBIOGNEISS - basic hornblende gneiss

QGARGNEISS - quartz garnet gneiss

GRAN (A) - granulite acid

GRAN (SA) - granulite sub-acid

GRAN (INT) - granulite intermediate

AMPFGNEISS - amphibolite gneiss

AMPHIB (A) - acid amphbolite

AMPHIB (B) - basic amphbolite

AMPHIB (SA) - sub-acid

AMPHIB (INT) - intermediate

ERRATA - change Heier Thor (1970) to Heier Thor (1971)

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| GRANITE | LAMBERT HEIER | 1968 | 1.667857E+03 | 1.708868E+03 | 2.470899E+02 | 2.805139E+04 | 2.141328E+02 | 1.310000E+02 |
| GRANITE | LAMBERT HEIER | 1968 | 1.434375E+03 | 1.438159E+03 | 3.614173E+02 | 2.832244E+03 | 2.178649E+02 | 1.300000E+01 |
| GRANITE | LAMBERT HEIER | 1968 | 2.018182E+03 | 2.056134E+03 | 3.217391E+02 | 1.554054E+04 | 6.756757E+02 | 2.300000E+01 |
| GRANITE | LAMBERT HEIER | 1968 | 1.133333E+03 | 1.148372E+03 | 2.412903E+02 | 1.149733E+04 | 3.208556E+03 | 3.583333E+00 |
| GRANITE | LAMBERT HEIER | 1968 | 1.261503E+03 | .0 | 8.225000E+01 | .0 | .0 | .0 |
| GRANITE | LAMBERT HEIER | 1968 | 1.154639E+03 | 1.168497E+03 | 3.225225E+02 | 1.592179E+04 | 1.117318E+03 | 1.425000E+01 |
| GRANITE | LAMBERT HEIER | 1968 | 1.212500E+03 | 1.227849E+03 | 2.155556E+02 | 1.587629E+04 | 1.237113E+03 | 1.283333E+01 |
| GRANITE | LAMBERT HEIER | 1968 | 1.076087E+03 | 1.196737E+03 | 1.486486E+02 | 1.579798E+05 | 7.272727E+03 | 2.172222E+01 |
| GRANITE | LAMBERT HEIER | 1968 | 1.458621E+03 | 1.470889E+03 | 2.627329E+02 | 7.092199E+03 | 1.182033E+03 | 6.000000E+00 |
| GRANITE | LAMBERT HEIER | 1968 | 1.265385E+03 | 1.273358E+03 | 3.916667E+02 | 5.471125E+03 | 1.215805E+03 | 4.500000E+00 |
| GRANITE | HENGE | 1969 | 2.475424E+03 | 2.481116E+03 | 2.826531E+02 | 2.353791E+04 | 4.223827E+03 | 5.572650E+00 |
| GRANITE | LAMBERT HEIER | 1968 | 1.434783E+03 | 1.443747E+03 | 2.229730E+02 | 6.363636E+03 | 6.060606E+02 | 1.050000E+01 |
| GRANITE | LAMBERT HEIER | 1968 | 1.165385E+03 | 1.175628E+03 | 2.779817E+02 | 8.910891E+03 | 1.650165E+03 | 5.400000E+00 |
| GRANITE | HEIER THOR | 1970 | 1.390741E+04 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | HEIER THOR | 1970 | 7.107692E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | HEIER THOR | 1970 | 1.070000E+04 | .0 | .0 | .0 | .0 | .0 |
| OBSIDIAN | NOCKOLDS | 1954 | 1.400000E+03 | .0 | .0 | .0 | .0 | .0 |
| RHYOLITE | ZEIG PICHLER | 1967 | 7.272727E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | ZLOBIN | 1965 | 1.111765E+03 | .0 | .0 | .0 | .0 | .0 |
| RHYOLITE | ZEIG PICHLER | 1967 | 6.250000E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | HEIER THOR | 1970 | 2.330000E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | ZLOBIN | 1965 | 1.334880E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | ZLOBIN | 1965 | 8.870588E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | HEIER THOR | 1970 | 3.931507E+03 | .0 | .0 | .0 | .0 | .0 |
| RHYOLITE | ZEIG PICHLER | 1967 | 5.098039E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANITE | TUREKIAN | 1961 | 1.666667E+03 | .0 | 2.272727E+02 | 3.400000E+04 | 1.200000E+04 | 2.833333E+00 |
| GRANITES | FLANAGAN | 1973 | 9.479167E+02 | .0 | 2.968182E+02 | 1.098901E+05 | 7.472527E+03 | 1.470588E+01 |
| GRANITE | ZHIROV | 1962 | 2.937500E+03 | .0 | 1.793741E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.615385E+03 | .0 | 2.373098E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 2.937500E+03 | .0 | 2.043478E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.428571E+03 | .0 | 2.400000E+02 | .0 | .0 | .0 |
| PHONOLITE | OVERSBY | 1971 | 2.887574E+03 | .0 | 2.666667E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 2.500000E+03 | .0 | 2.272727E+02 | .0 | .0 | .0 |
| PHONOLITE | OVERSBY | 1971 | 2.463415E+03 | .0 | 3.176101E+02 | .0 | .0 | .0 |
| PHONOLITE | OVERSBY | 1971 | 3.912409E+03 | .0 | 3.028249E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.375000E+03 | .0 | 2.000000E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 2.250000E+03 | .0 | 3.000000E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.176471E+03 | .0 | 2.347826E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 1.896552E+03 | .0 | 3.437500E+02 | .0 | .0 | .0 |
| GRANITES | DRURY | 1973 | 7.128205E+02 | .0 | 2.673077E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 3.978571E+03 | .0 | 4.843478E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 2.666667E+03 | .0 | 2.074074E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 4.071429E+03 | .0 | 1.965517E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.411765E+03 | .0 | 3.411765E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.470588E+03 | .0 | 2.809524E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.470588E+03 | .0 | 2.809524E+02 | .0 | .0 | .0 |
| GRANITE | TUREKIAN | 1961 | 2.210526E+03 | .0 | 2.470588E+02 | 4.047619E+04 | 7.142857E+03 | 5.666667E+00 |
| GRANITE | ZHIROV | 1962 | 3.000000E+03 | .0 | 2.000000E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 2.800000E+03 | .0 | 2.100000E+02 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| GRANITES | FLANAGAN | 1973 | 1.092105E+03 | .0 | 1.514599E+02 | 1.493976E+05 | 3.373494E+04 | 4.428571E+00 |
| GRANITES | FLANAGAN | 1973 | 1.310000E+03 | .0 | 1.572000E+02 | 8.909952E+04 | 1.781170E+04 | 5.000000E+00 |
| GRANITE | ZHIROV | 1962 | 7.600000E+03 | .0 | 2.903077E+02 | .0 | .0 | .0 |
| RHYOLITE | GUNN HOOSER | 1971 | 1.397059E+03 | .0 | 1.696429E+02 | .0 | .0 | .0 |
| GRANITES | FLANAGAN | 1973 | 1.198718E+03 | .0 | 2.226190E+02 | 6.470588E+04 | 5.347594E+03 | 1.210000E+01 |
| PITCHSTONE | GIBSON | 1972 | 1.613043E+03 | .0 | 2.653000E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 1.419231E+03 | .0 | 2.838462E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 3.327273E+03 | .0 | 2.928000E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 1.586957E+03 | .0 | 2.281250E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 2.141176E+03 | .0 | 3.033333E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 1.428000E+03 | .0 | 2.856000E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 1.552174E+03 | .0 | 3.400000E+02 | .0 | .0 | .0 |
| PITCHSTONE | GIBSON | 1972 | 1.676190E+03 | .0 | 3.352381E+02 | .0 | .0 | .0 |
| GRANITE | TAYLOR | 1966 | 1.156667E+03 | .0 | 2.393103E+02 | 4.899135E+04 | 1.383285E+04 | 3.541667E+00 |
| GRANITE | ZHIROV | 1962 | 6.800000E+03 | .0 | 1.545455E+02 | .0 | .0 | .0 |
| FELSIC | VINOGRADOV | 1962 | 1.670000E+03 | .0 | 1.670000E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.100000E+03 | .0 | 2.214286E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 1.764706E+03 | .0 | 2.000000E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.000000E+03 | .0 | 2.500000E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 3.000000E+03 | .0 | 2.500000E+02 | .0 | .0 | .0 |
| RHYOLITE | GUNN HOOSER | 1971 | 1.913333E+03 | .0 | 2.521368E+02 | .0 | .0 | .0 |
| GRANITE | ZHIROV | 1962 | 5.600000E+03 | .0 | 2.800000E+02 | .0 | .0 | .0 |
| BASALT | JAKES | 1970 | 4.681818E+03 | .0 | 4.681818E+02 | 1.359223E+04 | 2.815534E+03 | 4.827586 |
| GRANITES | DRURY | 1973 | 2.714286E+02 | .0 | 3.392857E+02 | .0 | .0 | .0 |
| PEGMATOID | LAMBERT HEIER | 1968 | 1.040000E+03 | .0 | 1.733333E+03 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.000000E+03 | .0 | 4.139265E+02 | .0 | .0 | .0 |
| ANDESITE | FLANAGAN | 1973 | 6.837607E+02 | .0 | 3.582090E+02 | 2.670933E+04 | 7.833333E+03 | 3.409574E+00 |
| ANDESITE | GUNN HOOSER | 1971 | 2.172043E+03 | .0 | 2.837079E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.440000E+03 | .0 | .0 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.620370E+03 | .0 | 3.038194E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.988372E+03 | .0 | 2.845238E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.320312E+03 | .0 | 2.928943E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.835165E+03 | .0 | 3.686534E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.755319E+03 | .0 | 3.416149E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.012500E+03 | .0 | 3.432836E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.594059E+03 | .0 | 3.026316E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.236111E+03 | .0 | 2.780656E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.148649E+03 | .0 | 4.453782E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.818182E+03 | .0 | 3.326403E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.136986E+03 | .0 | 2.694301E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.529412E+03 | .0 | 3.369330E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.648936E+03 | .0 | 3.391685E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.614583E+03 | .0 | 2.902622E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.648936E+03 | .0 | 3.391685E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.559322E+03 | .0 | 3.552124E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 9.292929E+02 | .0 | 1.789883E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.250000E+03 | .0 | 3.886010E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.701149E+03 | .0 | 3.303571E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOUSER | 1971 | 1.681818E+03 | .0 | .0 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.750000E+03 | .0 | .0 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| ANDESITE | NOCKOLDS | 1954 | 1.800000E+03 | .0 | .0 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.417476E+03 | .0 | 3.153348E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.285714E+03 | .0 | .0 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.914286E+03 | .0 | 4.379085E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 2.395833E+03 | .0 | 5.066079E+02 | .0 | .0 | .0 |
| ANDESITE | GUNN HOOSER | 1971 | 1.636364E+03 | .0 | 3.927293E+02 | .0 | .0 | .0 |
| ANDESITE | TAYLOR | 1966 | 1.280488E+03 | .0 | 2.386364E+02 | 4.476190E+04 | 1.333333E+04 | 3.357143E+00 |
| ANDESITE | TAYLOR | 1966 | 7.923077E+02 | .0 | 3.322581E+02 | 1.947573E+04 | 3.883495E+03 | 5.000000E+00 |
| ANDESITE | GUNN HOOSER | 1971 | 1.426230E+03 | .0 | 3.000000E+02 | .0 | .0 | .0 |
| ANDESITE | TAYLOR | 1966 | 1.140625E+03 | .0 | 4.294118E+02 | 2.191781E+04 | 7.935205E+03 | 2.758621E+00 |
| ANDESITE | TAYLOR | 1966 | 6.181818E+02 | .0 | 4.000000E+02 | 2.205882E+04 | 7.352941E+03 | 3.000000E+00 |
| ANDESITE | TAYLOR | 1966 | 1.742857E+03 | .0 | 4.692308E+02 | 1.803279E+04 | 7.540984E+03 | 2.391304E+00 |
| ANDESITE | TAYLOR | 1966 | 1.457143E+03 | .0 | 2.684211E+02 | 2.000000E+04 | 1.901961E+04 | 1.051546E+00 |
| ANDESITE | HEDGE | 1969 | 3.562500E+03 | 3.581785E+03 | 2.164557E+02 | 3.309942E+04 | 8.536012E+03 | 3.878712E+00 |
| ANDESITE | TAYLOR ET AL. | 1969 | 4.785714E+03 | 4.789785E+03 | 5.153846E+02 | 7.482587E+03 | 2.089552E+03 | 3.571429E+00 |
| ANDESITE | TAYLOR ET AL. | 1969 | 3.830000E+03 | 3.807991E+03 | 3.304348E+02 | 1.754386E+04 | 8.333333E+03 | 2.105263E+00 |
| ANDESITE | HEDGE | 1969 | 6.098964E+02 | 6.104725E+02 | 2.789474E+02 | 3.228415E+04 | 9.245283E+03 | 3.486798E+00 |
| ANDESITE | HEDGE | 1969 | 1.606805E+03 | 1.614972E+03 | 1.954023E+02 | 6.858424E+04 | 1.768235E+04 | 3.835526E+00 |
| ANDESITE | TAYLOR ET AL. | 1969 | 9.000000E+03 | 9.012856E+03 | 5.600000E+02 | 1.600000E+04 | 3.428571E+03 | 2.916667E+00 |
| ANDESITE | TAYLOR ET AL. | 1969 | 7.529412E+03 | 7.546913E+03 | 5.333333E+02 | 1.015625E+04 | 4.531250E+03 | 2.241379E+00 |
| ANDESITE | TAYLOR ET AL. | 1969 | 3.625000E+03 | 3.632903E+03 | 2.965909E+02 | 2.107280E+04 | 8.429119E+03 | 2.500000E+00 |
| ANDESITE | TAYLOR ET AL. | 1969 | 5.714286E+03 | 5.725186E+03 | 4.571429E+02 | 1.187500E+04 | 4.625000E+03 | 2.567568E+00 |
| DACITE | GUNN HOOSER | 1971 | 1.244444E+03 | .0 | 6.059594E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.632533E+03 | .0 | 2.404814E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 2.987052E+03 | .0 | 7.750000E+02 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/RB)X10000 | CORRECTED (K/RB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| DACITE | GUNN HOOSER | 1971 | 2.115044E+03 | .0 | 3.583208E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.716535E+03 | .0 | .0 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 2.348315E+03 | .0 | 3.921201E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.711864E+03 | .0 | 3.284553E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | .0 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.290541E+03 | .0 | 3.368607E+02 | .0 | .0 | .0 |
| RHYODACITE | HEDGE | 1969 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DACITE | HEDGE | 1969 | 8.264840E+02 | 8.278121E+02 | 2.784615E+02 | 3.834254E+04 | 1.228519E+04 | [illegible] |
| DACITE | GUNN HOOSER | 1971 | 1.890990E+03 | .0 | 2.724638E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | .0 | .0 | 3.132328E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 2.308642E+03 | .0 | 3.521657E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.572650E+03 | .0 | 3.168908E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.572650E+03 | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.735349E+03 | .0 | 3.498099E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 2.271605E+03 | .0 | 3.809524E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 2.081728E+03 | .0 | 3.488438E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.545455E+03 | .0 | 2.978694E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.884615E+03 | .0 | 2.893761E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.780488E+03 | .0 | 3.653000E+02 | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| DACITE | GUNN HOOSER | 1971 | 1.618279E+03 | .0 | 3.225584E+02 | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| MAFIC | VINOGRADOV | 1962 | 1.037500E+03 | .0 | 1.844444E+02 | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | 8.240000E+02 | .0 | 8.240000E+02 | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| ULTRABASIC | SHERATON | 1978 | 4.428571E+02 | .0 | 3.100000E+02 | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| ULTRABASIC | SHERATON | 1978 | 1.085900E+02 | .0 | 1.825085E+02 | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| ULTRABASIC | SHERATON | 1978 | 5.030000E+01 | .0 | 1.142857E+02 | .0 | .0 | .0 |
| ULTRABASIC | SHERATON | 1978 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| ULTRABASIC | DRURY | 1973 | 4.478598E+01 | .0 | 7.600000E+02 | .0 | .0 | .0 |
| ULTRABASIC | SHERATON | 1978 | [illegible] | .0 | [illegible] | .0 | .0 | .0 |
| ULTRAMAFIC | VINOGRADOV | 1962 | 3.000000E+03 | .0 | 1.500000E+02 | .0 | .0 | .0 |
| DUNITE | FLANAGAN | 1973 | 6.338028E+00 | .0 | 9.000000E+02 | 1.111111E+04 | 1.111111E+04 | 1.000000E+00 |
| ULTRABASIC | TUREKIAN | 1961 | 4.000000E+01 | .0 | 2.000000E+02 | 2.500000E+04 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | 1.213793E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | 8.825000E+02 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | 9.025000E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | 9.351351E+02 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | 9.105263E+02 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | 1.315385E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | [illegible] | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | 8.615385E+02 | .0 | .0 | .0 | .0 | .0 |

| | | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|---|
| GRANODIORITE | ZLOBIN | 1965 | | 8.815789E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | | 2.569231E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.332000E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.106667E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.100000E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.113793E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | | 1.900000E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.477273E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.552381E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 2.658333E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | | 9.294118E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | | 1.086207E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 3.140000E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.169231E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | | 1.035714E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.256522E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 6.581395E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | ZLOBIN | 1965 | | 2.358333E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 1.195652E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENODIORITE | ZLOBIN | 1965 | | 7.676471E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | TAYLOR | 1966 | | 1.700000E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANODIORITE | FLANAGAN | 1973 | | 1.366667E+03 | .0 | 1.768194E+02 | 4.085366E+04 | 1.006098E+04 | 4.066606E |
| GRANODIORITE | TAYLOR | 1966 | | 1.700000E+03 | .0 | 2.318182E+02 | 5.490196E+04 | 1.568627E+04 | 3.500000E |
| DIORITE | ZLOBIN | 1965 | | 7.416667E+02 | .0 | .0 | .0 | .0 | .0 |
| DIORITE | ZLOBIN | 1965 | | 1.740000E+03 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 8.342857E+02 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 1.035484E+03 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 1.645000E+03 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 9.852941E+02 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 1.356000E+03 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 9.162162E+02 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 1.374074E+03 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 8.790698E+02 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 9.341463E+02 | .0 | .0 | .0 | .0 | .0 |
| ADAMELLITE | ZLOBIN | 1965 | | 1.480000E+03 | .0 | .0 | .0 | .0 | .0 |
| SYENITE | TUREKIAN | 1961 | | 4.000000E+03 | .0 | 4.363636E+02 | 2.708333E+04 | 6.250000E+03 | 4.333333E+00 |
| SYENITE | FLANAGAN | 1973 | 1 | 2.115385E+03 | .0 | 5.000000E+01 | 3.636364E+03 | 8.181818E+03 | 4.666667E+00 |
| GRANOSYENITE | ZLOBIN | 1965 | | 1.478261E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANOSYENITE | ZLOBIN | 1965 | | 1.183333E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANOSYENITE | ZLOBIN | 1965 | | 8.022727E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANOSYENITE | ZLOBIN | 1965 | | 1.643478E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANOSYENITE | ZLOBIN | 1965 | | 5.950000E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANOSYENITE | ZLOBIN | 1965 | | 1.440000E+03 | .0 | .0 | .0 | .0 | .0 |
| BASALT | FLANAGAN | 1973 | | 8.011364E+02 | .0 | 3.025751E+02 | 4.255319E+04 | 1.234043E+04 | 3.448276E+00 |
| BASALT | TUREKIAN | 1961 | | 1.383333E+03 | .0 | 2.766667E+02 | 4.819277E+04 | 1.204819E+04 | 4.000000E+00 |
| BASALT | TAYLOR | 1966 | | 1.180000E+03 | .0 | 3.470588E+02 | 5.084746E+04 | 1.694915E+04 | 3.000000E+00 |
| BASALT | TAYLOR | 1966 | | 1.180000E+03 | .0 | 2.269231E+02 | 3.728914E+04 | 1.016949E+04 | 3.666667E+00 |
| THOBASALT | JAKES | 1970 | | 3.583333E+03 | .0 | 1.075000E+02 | 7.209302E+03 | 7.906977E+03 | 9.117647E-01 |
| NORITE | FLANAGAN | 1973 | | 2.200000E+02 | .0 | 2.444444E+02 | 2.272727E+04 | 2.272727E+04 | 1.000000E+00 |
| OLIVGABBRO | SHERATON | 1970 | | 2.075472E+02 | .0 | 7.333333E+02 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| BASALT | FLANAGAN | 1973 | 1.333333E+02 | .0 | 1.333333E+02 | 1.875000E+05 | 6.250000E+04 | 3.000000E+00 |
| BASALT | GUNN MOOSER | 1971 | 1.906250E+03 | .0 | 3.805350E+02 | .0 | .0 | .0 |
| BASALT | GILL | 1970 | 3.220000E+03 | 3.220213E+03 | 4.293333E+02 | 3.478261E+03 | 1.490683E+03 | 2.333333E+00 |
| BASALT | GILL | 1970 | 2.538462E+03 | 2.538645E+03 | 1.764706E+02 | 4.818182E+03 | 2.060606E+03 | 2.338235E+00 |
| BASALT | GILL | 1970 | 1.659091E+03 | 1.659182E+03 | 2.433333E+02 | 5.410959E+03 | 2.465753E+03 | 2.194444E+00 |
| BASALT | FLANAGAN | 1973 | 8.357143E+02 | .0 | 2.853659E+02 | 8.034188E+04 | 1.538462E+04 | 5.222222E+00 |
| BASALT | GUNN MOOSER | 1971 | .0 | .0 | 2.157598E+02 | .0 | .0 | .0 |
| OLIV BASALT | GUNN MOOSER | 1971 | 2.875000E+03 | .0 | 6.497175E+02 | .0 | .0 | .0 |
| GABBRO | HEDGE | 1969 | 1.849057E+03 | 1.851237E+03 | 3.379310E+02 | 1.469388E+04 | 3.367347E+03 | 4.363636E+00 |
| BASALT | GILL | 1970 | 1.263158E+03 | 1.263618E+03 | 1.142857E+03 | 7.083333E+03 | 5.000000E+03 | 1.416667E+00 |
| BASALT | GILL | 1970 | 3.587500E+03 | 3.587788E+03 | 4.484375E+02 | 2.961672E+03 | 1.881533E+03 | 1.574074E+00 |
| THOLEITE | GILL | 1970 | 1.500000E+03 | 1.500649E+03 | 1.142857E+03 | 7.083333E+03 | 5.000000E+03 | 1.416667E+00 |
| THOLEITE | GILL | 1970 | 9.000000E+03 | 9.009051E+03 | 1.011236E+03 | 1.111111E+03 | 2.444444E+03 | 4.545455E-01 |
| THOLEITE | GILL | 1970 | 6.166667E+03 | 6.170805E+03 | 1.088235E+03 | 1.351351E+03 | 2.297297E+03 | 5.882353E-01 |
| THOLEITE | GILL | 1970 | 2.916667E+03 | 2.920918E+03 | 8.750000E+02 | 8.857143E+03 | 9.714286E+03 | 9.117647E-01 |
| THOLEITE | GILL | 1970 | 3.000000E+02 | 3.000260E+02 | 1.100000E+03 | 6.666667E+03 | 5.151515E+03 | 1.294118E+00 |
| THOLEITE | GILL | 1970 | 1.687500E+03 | 1.687777E+03 | 5.869565E+02 | 1.851852E+03 | 1.851852E+03 | 1.000000E+00 |
| BASALT | GILL | 1970 | 1.416667E+03 | 1.418024E+03 | 1.062500E+03 | 1.117647E+04 | 1.058824E+04 | 1.055556E+00 |
| BASALT | GILL | 1970 | 2.033333E+03 | 2.034402E+03 | 1.297872E+03 | 1.229508E+04 | 2.622951E+03 | 4.687500E+00 |
| BASALT | GILL | 1970 | 8.529412E+02 | 8.531595E+02 | 5.918367E+02 | 3.448276E+03 | 5.172414E+03 | 6.666667E-01 |
| BASALT | GILL | 1970 | 3.443038E+03 | 3.443172E+03 | 4.857143E+02 | 4.779412E+03 | 2.058824E+03 | 2.321429E+00 |
| BASALT | GILL | 1970 | 2.566667E+03 | 2.568095E+03 | 9.746835E+02 | 7.792208E+03 | 2.987013E+03 | 2.608696E+00 |
| BASALT | GILL | 1970 | 9.411765E+02 | 9.416450E+02 | 1.000000E+03 | 1.125000E+04 | 7.500000E+03 | 1.500000E+00 |
| BASALT | HEDGE | 1969 | 6.392694E+02 | 6.396318E+02 | 8.750000E+02 | 1.714286E+04 | 5.714286E+03 | 3.000000E+00 |
| BASALT | HEDGE | 1969 | 3.800000E+03 | 3.812252E+03 | 3.275862E+02 | 1.831579E+04 | 4.842105E+03 | 3.782609E+00 |
| BASALT | GILL | 1970 | 2.026667E+03 | 2.026838E+03 | 6.909091E+02 | 8.092105E+03 | 2.697368E+03 | 3.000000E+00 |
| BASALT | GILL | 1970 | 3.591837E+03 | 3.592037E+03 | 4.756757E+02 | 2.954545E+03 | 1.022727E+03 | 2.888889E+00 |
| BASALT | GILL | 1970 | 3.214286E+03 | 3.214582E+03 | 7.500000E+02 | 4.533333E+03 | 2.177778E+03 | 2.081633E+00 |
| NORITE | ZLOBIN | 1965 | 1.471429E+03 | .0 | .0 | .0 | .0 | .0 |
| NORITE | ZLOBIN | 1965 | 1.200000E+03 | .0 | .0 | .0 | .0 | .0 |
| NORITE | ZLOBIN | 1965 | 4.680000E+02 | .0 | .0 | .0 | .0 | .0 |
| NORITE | ZLOBIN | 1965 | 7.384615E+02 | .0 | .0 | .0 | .0 | .0 |
| GABBRO | ZLOBIN | 1965 | 1.309091E+03 | .0 | .0 | .0 | .0 | .0 |
| GABBRO | ZLOBIN | 1965 | 3.800000E+02 | .0 | .0 | .0 | .0 | .0 |
| GABBRO | ZLOBIN | 1965 | 8.500000E+02 | .0 | .0 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 1.306667E+03 | .0 | 3.438596E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 8.928571E+02 | .0 | 8.333333E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 7.625000E+02 | .0 | 7.176471E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 6.214286E+02 | .0 | 8.700000E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 8.333333E+02 | .0 | 1.500000E+03 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 4.266667E+02 | .0 | 1.280000E+03 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 2.421053E+02 | .0 | 6.571429E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 2.692308E+02 | .0 | 5.000000E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 1.750000E+03 | .0 | 3.181818E+02 | .0 | .0 | .0 |
| GRANOFELSES | DRURY | 1973 | 1.833333E+02 | .0 | 4.714286E+02 | .0 | .0 | .0 |
| ANORTHOS | LAMBERT HEIER | 1968 | 1.620000E+03 | 1.678882E+03 | 2.113043E+02 | 3.662551E+04 | 1.646091E+03 | 2.225000E+01 |
| XNORTHOSITE | HEIER THOR | 1970 | 1.046154E+03 | .0 | 2.266667E+03 | .0 | .0 | .0 |
| ANORTHOSITE | HEIER THOR | 1970 | 1.560976E+03 | .0 | 2.133333E+03 | .0 | .0 | .0 |
| ANORTHOSITE | HEIER THOR | 1970 | 5.565217E+02 | 5.625686E+02 | 1.600000E+03 | 6.250000E+03 | 1.562500E+03 | 4.000000E+00 |
| ANORTHOSITE | HEIER THOR | 1970 | 1.173913E+03 | .0 | 1.800000E+03 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| ANORTHOSITE | HEIER THOR | 1970 | 9.245283E+02 | .0 | 2.450000E+03 | .0 | .0 | .0 |
| ANORTHOSITE | HEIER THOR | 1970 | 1.125000E+03 | .0 | 2.400000E+03 | .0 | .0 | .0 |
| MANGERITE | HEIER THOR | 1970 | 4.617117E+02 | 4.704911E+02 | 5.394737E+02 | 8.292683E+03 | 4.390244E+03 | 1.888889E+00 |
| MANGERITE | HEIER THOR | 1970 | 1.808290E+03 | 1.849179E+03 | 5.629032E+02 | 8.595989E+02 | 1.719198E+03 | 5.000000E-01 |
| MANGERITE | HEIER THOR | 1970 | 2.661017E+03 | 2.706252E+03 | 9.812500E+02 | 1.486208E+03 | 6.369427E+02 | 2.333333E+00 |
| MANGERITE | HEIER THOR | 1970 | 1.786207E+03 | 1.821956E+03 | 4.625000E+02 | 7.722008E+02 | 1.544402E+03 | 5.000000E-01 |
| MANGERITE | HEIER THOR | 1970 | 7.155172E+03 | 7.272561E+03 | 1.660000E+03 | 4.819277E+02 | 2.409639E+02 | 2.000000E+00 |
| MANGERITE | HEIER THOR | 1970 | 1.786207E+03 | 1.821956E+03 | 4.625000E+02 | 7.722008E+02 | 1.544402E+03 | 5.000000E-01 |
| MANGERITE | HEIER THOR | 1970 | 2.733333E+03 | 2.756045E+03 | 1.078947E+03 | 9.756098E+02 | 2.439024E+02 | 4.000000E+00 |
| MANGERITE | HEIER THOR | 1970 | 2.121795E+03 | 2.150172E+03 | 6.895833E+02 | 3.021148E+02 | 9.063444E+02 | 3.333333E-01 |
| MANGERITE | HEIER THOR | 1970 | 3.125000E+03 | .0 | 1.481481E+03 | .0 | 5.000000E+02 | .0 |
| MANGERITE | HEIER THOR | 1970 | 1.670886E+03 | 1.720218E+03 | 5.280000E+02 | 3.409091E+03 | 1.893939E+03 | 1.800000E+00 |
| MANGERITE | HEIER THOR | 1970 | 2.715190E+03 | 2.741845E+03 | 1.046341E+03 | 1.398601E+03 | 2.331002E+02 | 6.000000E+00 |
| MANGERITE | HEIER THOR | 1970 | 2.212903E+03 | 2.228519E+03 | 1.106452E+03 | 8.746356E+02 | 2.915452E+02 | 3.000000E+00 |
| MANGERITE | HEIER THOR | 1970 | 1.157767E+03 | .0 | 8.084746E+02 | .0 | 6.289308E+02 | .0 |
| MANGERITE | HEIER THOR | 1970 | 2.633136E+03 | 2.679465E+03 | 6.953125E+02 | 2.471910E+03 | 4.494382E+02 | 5.500000E+00 |
| MANGERITE | HEIER THOR | 1970 | 2.597561E+03 | 2.650217E+03 | 8.875000E+02 | 2.112676E+03 | 7.042254E+02 | 3.000000E+00 |
| MANGERITE | HEIER THOR | 1970 | 1.283784E+03 | 1.306939E+03 | 6.551724E+02 | 4.736842E+03 | 1.052632E+03 | 4.500000E+00 |
| MANGERITE | HEIER THOR | 1970 | 3.364341E+03 | .0 | 9.644444E+02 | 9.216590E+02 | .0 | .0 |
| MANGERITE | HEIER THOR | 1970 | 1.610294E+03 | 1.684014E+03 | 3.421875E+02 | 4.566210E+03 | 3.196347E+03 | 1.428571E |
| MANGERITE | HEIER THOR | 1970 | 2.183575E+03 | 2.201897E+03 | 8.370370E+02 | 6.637168E+02 | 4.424779E+02 | 1.500000E |
| MANGERITE | HEIER THOR | 1970 | 2.288043E+03 | 2.331698E+03 | 8.096154E+02 | 1.425178E+03 | 9.501188E+02 | 1.500000E |
| MANGERITE | HEIER THOR | 1970 | 2.393443E+03 | .0 | 6.843750E+02 | .0 | .0 | .0 |
| MANGERITE | HEIER THOR | 1970 | 2.513333E+03 | 2.536774E+03 | 7.540000E+02 | 1.326260E+03 | 2.652520E+02 | 5.000000E |
| MANGERITE | HEIER THOR | 1970 | 2.114458E+03 | 2.201868E+03 | 4.558442E+02 | 2.849003E+03 | 2.279202E+03 | 1.250000E |
| MANGERITE | HEIER THOR | 1970 | 1.694118E+03 | 1.716046E+03 | 1.200000E+03 | 2.083333E+03 | 6.944444E+02 | 3.000000E |
| MANGERITE | HEIER THOR | 1970 | 1.627451E+03 | 1.649649E+03 | 5.187500E+02 | 4.016064E+02 | 1.204819E+03 | 3.333333E-01 |
| PETROMANGE | HEIER THOR | 1970 | 2.530864E+03 | 2.654797E+03 | 4.659091E+02 | 1.951220E+03 | 2.439024E+03 | 8.000000E-01 |
| RETROMANGE | HEIER THOR | 1970 | 3.117978E+03 | 3.345260E+03 | 5.186916E+02 | 3.063063E+03 | 2.702703E+03 | 1.133333E+00 |
| MANGERITE | HEIER THOR | 1970 | 2.396040E+03 | 2.455201E+03 | 6.285714E+02 | 1.446281E+03 | 1.239669E+03 | 1.166667E+00 |
| PETROMANGE | HEIER THOR | 1970 | 2.824742E+03 | 2.929389E+03 | 7.116883E+02 | 4.562044E+03 | 9.124088E+02 | 5.000000E+00 |
| MANGERITE | HEIER THOR | 1970 | 3.051948E+03 | 3.080403E+03 | 9.791667E+02 | 2.127660E+02 | 4.255319E+02 | 5.000000E-01 |
| MANGERITE | HEIER THOR | 1970 | 2.731429E+03 | 2.796052E+03 | 8.385965E+02 | 2.092050E+03 | 8.368201E+02 | 2.500000E+00 |
| MANGERITE | HEIER THOR | 1970 | 5.897727E+03 | .0 | 1.297500E+03 | 3.853565E+02 | .0 | .0 |
| RETROMANGE | HEIER THOR | 1970 | 4.464286E+03 | .0 | 7.653061E+02 | 2.666667E+02 | .0 | .0 |
| RETROMANGE | HEIER THOR | 1970 | 1.413613E+03 | 1.451749E+03 | 6.750000E+02 | 2.962963E+03 | 2.222222E+03 | 1.333333E+00 |
| PETROMANGE | HEIER THOR | 1970 | 2.830682E+03 | 3.039285E+03 | 3.437500E+02 | 6.233766E+03 | 2.337662E+03 | 2.666667E+00 |
| PETROMANGE | HEIER THOR | 1970 | 2.821429E+03 | .0 | 1.316667E+03 | .0 | 2.531646E+02 | .0 |
| MIGMATITES | DRURY | 1973 | 8.255319E+02 | .0 | 2.042105E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.585106E+03 | .0 | 2.223881E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 6.090909E+02 | .0 | 3.329193E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.624242E+03 | .0 | 4.743363E+02 | .0 | .0 | .0 |
| MIGMATITE | ZHIROV | 1962 | 2.642857E+03 | .0 | 2.055556E+02 | .0 | .0 | .0 |
| ANATEXITE | ZHIROV | 1962 | 2.133333E+03 | .0 | 2.133333E+02 | .0 | .0 | .0 |
| MIGMATITE | ZHIROV | 1962 | 2.375000E+03 | .0 | 2.111111E+02 | .0 | .0 | .0 |
| ANATEXITE | ZHIROV | 1962 | 2.222222E+03 | .0 | 2.857143E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 3.055556E+01 | .0 | 2.391304E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 3.446809E+02 | .0 | 3.115385E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 4.952381E+02 | .0 | 3.250000E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 4.476190E+02 | .0 | 2.473684E+02 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| MIGMATITES | DRURY | 1973 | 4.157895E+02 | .0 | 9.875000E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 2.785714E+02 | .0 | 9.750000E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 2.215385E+03 | .0 | 6.127660E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 5.744444E+03 | .0 | 3.008929E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.014286E+03 | .0 | 4.733333E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 3.523810E+02 | .0 | 1.761905E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 2.333333E+03 | .0 | 3.636364E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 8.714286E+02 | .0 | 4.135593E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.551724E+02 | .0 | 3.461538E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 3.900000E+02 | .0 | 2.543478E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.085714E+03 | .0 | 1.890547E+02 | .0 | .0 | .0 |
| PYROLITES | DRURY | 1973 | 1.575000E+03 | .0 | 9.000000E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 2.076923E+02 | .0 | 4.500000E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 6.372727E+02 | .0 | 1.168333E+03 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 6.545455E+02 | .0 | 6.545455E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 1.583333E+02 | .0 | 3.166667E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 4.058333E+02 | .0 | 8.116667E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 7.750000E+02 | .0 | 4.428571E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 5.777778E+02 | .0 | 5.666667E+02 | .0 | .0 | .0 |
| PYRIBOLITES | DRURY | 1973 | 1.217500E+03 | .0 | 6.957143E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 8.750000E+01 | .0 | 3.000000E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 5.915493E+01 | .0 | 4.666667E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 6.780822E+02 | .0 | 4.583383E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 9.066667E+01 | .0 | 2.266667E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 5.666667E+02 | .0 | 3.805970E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.076316E+03 | .0 | 2.222826E+02 | .0 | .0 | .0 |
| MIGMATITES | DRURY | 1973 | 1.566667E+03 | .0 | 2.424603E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.357143E+02 | .0 | 9.400000E+02 | .0 | .0 | .0 |
| AHORNGNEISS | SHERATON | 1970 | 4.357143E+02 | .0 | 4.357143E+02 | .0 | .0 | .0 |
| AHORNGNEISS | SHERATON | 1970 | 7.230769E+02 | .0 | 7.230769E+02 | .0 | .0 | .0 |
| AHORNGNEISS | SHERATON | 1970 | 6.700000E+02 | .0 | 8.375000E+02 | .0 | .0 | .0 |
| AHORNGNEISS | SHERATON | 1970 | 5.600000E+02 | .0 | 4.000000E+02 | .0 | .0 | .0 |
| AHORNGNEISS | SHERATON | 1970 | 1.425000E+03 | .0 | 9.500000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.810811E+02 | .0 | 2.625000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.153846E+02 | .0 | 1.350000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.230769E+02 | .0 | 1.375000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 1.637500E+03 | .0 | 8.733333E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.466667E+02 | .0 | 1.300000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.600000E+02 | .0 | 1.150000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.461538E+02 | .0 | 1.160000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.300000E+02 | .0 | 1.300000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 9.000000E+02 | .0 | 8.100000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 8.125000E+02 | .0 | 1.083333E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 1.371429E+03 | .0 | 1.500000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 1.425000E+03 | .0 | 9.500000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 1.250000E+02 | .0 | 3.500000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 9.000000E+02 | .0 | 1.200000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.111111E+02 | .0 | 5.090909E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 5.105263E+02 | .0 | 8.083333E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.736842E+02 | .0 | 8.875000E+02 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| ABIOTIGNEISS | SHERATON | 1970 | 8.700000E+03 | .0 | 7.000001E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 9.000000E+02 | .0 | 7.000000E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.650000E+03 | .0 | 6.388889E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 4.437500E+02 | .0 | 2.388889E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.250000E+02 | .0 | 8.666667E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 2.733333E+02 | .0 | 5.857143E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 4.888889E+02 | .0 | 1.466667E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 9.222222E+02 | .0 | 1.600000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.545455E+02 | .0 | 1.300000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 4.666667E+02 | .0 | 1.400000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 6.250000E+02 | .0 | 1.071429E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.058333E+03 | .0 | 1.154545E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 5.416667E+02 | .0 | 1.625000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.307692E+02 | .0 | 3.909091E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.461538E+02 | .0 | 1.125000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 7.230769E+02 | .0 | 1.175000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.846154E+02 | .0 | 1.000000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 2.692308E+02 | .0 | 1.166667E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 6.857143E+02 | .0 | 1.920000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.266667E+02 | .0 | 1.633333E+03 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.615385E+03 | .0 | 4.117647E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.763636E+03 | .0 | 6.818182E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.353846E+03 | .0 | 7.333333E+02 | .0 | .0 | .0 |
| GNEISS | ZHIROV | 1962 | 2.444444E+03 | .0 | 1.157895E+02 | .0 | .0 | .0 |
| GNEISS | ZHIROV | 1962 | 2.125000E+03 | .0 | 1.416667E+02 | .0 | .0 | .0 |
| GNEISS | ZHIROV | 1962 | 2.571429E+03 | .0 | 1.800000E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.471429E+03 | .0 | 6.437500E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.466667E+03 | .0 | 8.148148E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.480000E+03 | .0 | 8.538462E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 8.187500E+02 | .0 | 8.187500E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.376471E+03 | .0 | 1.017391E+03 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.326316E+03 | .0 | 1.026316E+03 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.663158E+03 | .0 | 5.862264E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 9.666667E+02 | .0 | 5.948718E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.226087E+03 | .0 | 5.529412E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 8.939394E+02 | .0 | 4.659375E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.407143E+03 | .0 | 1.158824E+03 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 9.784736E+02 | .0 | 1.037500E+03 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 8.900000E+02 | .0 | 8.600000E+02 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 1.958333E+03 | .0 | 5.702703E+02 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 1.842857E+03 | .0 | 5.863636E+02 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 1.180000E+03 | .0 | 5.900000E+02 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 1.208333E+03 | .0 | 7.250000E+02 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 5.000000E+02 | .0 | 7.187500E+02 | .0 | .0 | .0 |
| GNEISS | DRURY | 1973 | 1.750000E+03 | .0 | 7.500000E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.315789E+02 | .0 | 1.575000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 7.105263E+02 | .0 | 1.500000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.071429E+02 | .0 | 8.142857E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.857143E+02 | .0 | 9.714286E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 2.357143E+02 | .0 | 8.250000E+02 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| BHORBIOGNEISS | SHERATON | 1970 | 7.357143E+02 | .0 | 7.923077E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 6.214286E+02 | .0 | 7.250000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.083333E+02 | .0 | 1.225000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.916667E+02 | .0 | 1.175000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 2.916667E+02 | .0 | 5.833333E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 1.066667E+03 | .0 | 9.142857E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.916667E+02 | .0 | 7.833333E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 7.583333E+02 | .0 | 1.820000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.454545E+02 | .0 | 9.800000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 6.700000E+02 | .0 | 8.375000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 5.600000E+02 | .0 | 4.900000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 8.100000E+02 | .0 | 1.157143E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 8.823529E+02 | .0 | 6.818182E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 9.090909E+02 | .0 | 3.703704E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 5.444444E+02 | .0 | 1.225000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 9.444444E+02 | .0 | 1.214286E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 2.066667E+02 | .0 | 1.550000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 3.095238E+02 | .0 | 1.625000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.750000E+02 | .0 | 7.916667E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 7.150000E+02 | .0 | 8.937500E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.100000E+03 | .0 | 6.111111E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 3.400000E+02 | .0 | 2.266667E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 6.173913E+02 | .0 | 9.466667E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 2.350000E+02 | .0 | 5.875000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.250000E+02 | .0 | 6.250000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 2.294118E+02 | .0 | 2.785714E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.611111E+02 | .0 | 1.627451E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 9.272727E+02 | .0 | 9.272727E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.588235E+02 | .0 | 6.500000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 1.037500E+03 | .0 | 4.256410E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.312500E+02 | .0 | 6.900000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.937500E+02 | .0 | 3.150000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 2.800000E+02 | .0 | 1.120000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 7.444444E+02 | .0 | 1.340000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.000000E+02 | .0 | 6.750000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.777778E+02 | .0 | 1.016667E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.583333E+02 | .0 | 6.076923E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.000000E+02 | .0 | 6.000000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 7.846154E+02 | .0 | 1.133333E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 3.545455E+02 | .0 | 6.500000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 9.272727E+02 | .0 | 6.800000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 7.666667E+02 | .0 | 9.200000E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.375000E+03 | .0 | 1.375000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 4.350000E+03 | .0 | 9.157895E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.550000E+03 | .0 | 6.200000E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 2.900000E+03 | .0 | 9.666667E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.414286E+03 | .0 | 1.414286E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 4.333333E+02 | .0 | 5.200000E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.116667E+03 | .0 | 5.153846E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 8.833333E+02 | .0 | 2.650000E+03 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| PYROXGNEISS | SHERATON | 1970 | 9.714286E+02 | .0 | 8.500000E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 5.428571E+02 | .0 | 1.266667E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 4.285714E+02 | .0 | 1.500000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 6.222222E+02 | .0 | 2.600000E+03 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 1.077778E+03 | .0 | 6.062500E+02 | .0 | .0 | .0 |
| PYROXGNEISS | SHERATON | 1970 | 8.333333E+02 | .0 | 1.071429E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.318182E+02 | .0 | 1.216667E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 3.722222E+02 | .0 | 8.375000E+02 | .0 | .0 | .0 |
| QGARGNEISS | SHERATON | 1970 | 5.533333E+02 | .0 | 3.478333E+02 | .0 | .0 | .0 |
| QGARGNEISS | SHERATON | 1970 | 6.647059E+02 | .0 | 3.645161E+02 | .0 | .0 | .0 |
| QGARGNEISS | SHERATON | 1970 | 7.750000E+02 | .0 | 2.952381E+02 | .0 | .0 | .0 |
| QGARGNEISS | SHERATON | 1970 | 1.055556E+03 | .0 | 3.518519E+02 | .0 | .0 | .0 |
| QGARGNEISS | SHERATON | 1970 | 1.456522E+03 | .0 | 2.913043E+02 | .0 | .0 | .0 |
| QGARGNEISS | SHERATON | 1970 | 4.130952E+02 | .0 | 4.753425E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 1.227273E+03 | .0 | 6.136364E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 2.857143E+03 | .0 | 6.451613E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 2.425000E+03 | .0 | 1.940000E+03 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 5.428571E+02 | .0 | 5.428571E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 7.000000E+02 | .0 | 8.000000E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 5.333333E+02 | .0 | 9.600000E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 6.400000E+02 | .0 | 9.142857E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 3.166667E+02 | .0 | 7.600000E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 1.933333E+02 | .0 | 7.250000E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 1.937500E+02 | .0 | 7.750000E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 2.588235E+02 | .0 | 6.285714E+02 | .0 | .0 | .0 |
| BHORGNEISS | SHERATON | 1970 | 4.272727E+02 | .0 | 9.400000E+02 | .0 | .0 | .0 |
| GNEISS | ZHIROV | 1962 | 2.882353E+03 | .0 | 3.062500E+02 | .0 | .0 | .0 |
| GNEISS | SHERATON | 1970 | 2.785714E+03 | .0 | 8.863636E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.857143E+02 | .0 | 8.500000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.619048E+02 | .0 | 6.062500E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 1.750000E+02 | .0 | 1.120000E+03 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 4.250000E+02 | .0 | 8.500000E+02 | .0 | .0 | .0 |
| BHORBIOGNEISS | SHERATON | 1970 | 7.363636E+02 | .0 | 8.100000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 1.880000E+03 | .0 | 9.400000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 1.133333E+03 | .0 | 1.360000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 1.157143E+03 | .0 | 9.000000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.142857E+03 | .0 | 1.433333E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 1.228571E+03 | .0 | 1.720000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 8.555556E+02 | .0 | 1.283333E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 4.111111E+02 | .0 | 1.233333E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 1.100000E+03 | .0 | 9.880000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 7.545455E+02 | .0 | 1.037500E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 5.545455E+02 | .0 | 6.777778E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 7.000000E+02 | .0 | 8.555556E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 8.272727E+02 | .0 | 1.011111E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 4.300000E+02 | .0 | 7.166667E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 9.545455E+02 | .0 | 9.545455E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 4.916667E+02 | .0 | 9.833333E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 8.500000E+02 | .0 | 9.272727E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 5.333333E+02 | .0 | 1.266667E+03 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| AHORBIOGNEISS | SHERATON | 1970 | 5.500000E+02 | .0 | 1.320000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 9.416667E+02 | .0 | 7.062500E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 8.333333E+02 | .0 | 1.500000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 8.538462E+02 | .0 | 4.826087E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.615385E+02 | .0 | 1.720000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.538462E+02 | .0 | 2.125000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 7.153846E+02 | .0 | 7.750000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 5.692308E+02 | .0 | 5.692308E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.307692E+02 | .0 | 8.200000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 7.357143E+02 | .0 | 5.150000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.785714E+02 | .0 | 2.375000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 2.928571E+02 | .0 | 6.833333E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 3.071429E+02 | .0 | 5.375000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.384615E+02 | .0 | 1.660000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 4.133333E+02 | .0 | 7.750000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 4.400000E+02 | .0 | 7.333333E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 5.600000E+02 | .0 | 8.400000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 3.785714E+02 | .0 | 1.060000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 3.687500E+02 | .0 | 2.150000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 3.875000E+02 | .0 | 1.550000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 5.444444E+02 | .0 | 9.800000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 2.611111E+02 | .0 | 1.175000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 6.647059E+02 | .0 | 1.132889E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 8.818182E+02 | .0 | 1.816889E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 5.916667E+02 | .0 | 5.071429E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 2.916667E+02 | .0 | 8.750000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 1.131818E+03 | .0 | 1.310526E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 3.695652E+02 | .0 | 1.214286E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 3.833333E+02 | .0 | 6.900000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 7.500000E+02 | .0 | 1.038462E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.647059E+02 | .0 | 9.875000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.235294E+02 | .0 | 6.000000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 8.764706E+02 | .0 | 6.208333E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 9.250000E+02 | .0 | 5.692308E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.312500E+02 | .0 | 4.600000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 3.357143E+02 | .0 | 7.833333E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 4.571429E+02 | .0 | 7.111111E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 9.625000E+02 | .0 | 9.625000E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 8.692308E+02 | .0 | 5.947368E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 8.846154E+02 | .0 | 6.388889E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 1.100000E+03 | .0 | 4.481481E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.545455E+02 | .0 | 1.200000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 1.360000E+03 | .0 | 2.666667E+02 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 6.555556E+02 | .0 | 1.475000E+03 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 4.000000E+02 | .0 | 9.600000E+02 | .0 | .0 | .0 |
| AHORBIOGNEISS | SHERATON | 1970 | 5.500000E+02 | .0 | 1.100000E+03 | .0 | .0 | .0 |
| ABIOTIGNEISS | SHERATON | 1970 | 3.400000E+02 | .0 | 6.800000E+02 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 3.700000E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 1.809524E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 1.250000E+01 | .0 | .0 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| SCHIST | ESSAM | 1973 | 4.500000E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 9.090909E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 3.200000E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 5.135135E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 3.913043E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 3.458333E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 5.000000E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 6.375000E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 2.588235E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 2.857143E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 4.000000E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 1.710000E+03 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 1.545455E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 3.076923E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 2.352941E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | ESSAM | 1973 | 4.941176E+01 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 9.560000E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 1.010345E+03 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 1.024138E+03 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 1.141935E+03 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 8.741935E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 8.923077E+02 | .0 | .0 | .0 | .0 | .0 |
| SCHIST | SHAW | 1956 | 5.156250E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 8.333333E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 2.437500E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.882353E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.684211E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.233333E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 2.846154E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.333333E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.900000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.700000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.600000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.500000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.722222E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.280000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 8.571429E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 9.583333E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 8.214286E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.225806E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.277778E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 8.148148E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 2.117647E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.611111E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 7.000000E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 9.090909E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 8.478261E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.043000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.526316E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 2.214286E+03 | .0 | .0 | .0 | .0 | .0 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| SLATES | BANNO CHAPPELL | 1969 | 7.931034E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.166667E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.647059E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.000000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.647059E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.000000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.588235E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.289231E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATES | BANNO CHAPPELL | 1969 | 1.125000E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATE | SHAW | 1956 | 9.563000E+02 | .0 | .0 | .0 | .0 | .0 |
| SLATE | SHAW | 1956 | 1.643750E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATE | SHAW | 1956 | 2.223077E+03 | .0 | .0 | .0 | .0 | .0 |
| SLATE | SHAW | 1956 | 1.371429E+03 | .0 | .0 | .0 | .0 | .0 |
| GNEISS | SHAW | 1956 | 7.878788E+02 | .0 | .0 | .0 | .0 | .0 |
| GNEISS | SHAW | 1956 | 1.500000E+03 | .0 | .0 | .0 | .0 | .0 |
| GNEISS | SHAW | 1956 | 1.018750E+03 | .0 | .0 | .0 | .0 | .0 |
| GRANULITES | HEIER THOR | 1970 | 6.711712E+02 | .0 | 2.980000E+02 | 3.328959E+05 | .0 | .0 |
| GRANULITES | HEIER THOR | 1970 | 1.176259E+03 | 1.200016E+03 | 8.837838E+02 | 2.140673E+03 | 2.140673E+03 | 1.000000E+00 |
| GRANULITES | HEIER THOR | 1970 | 2.037736E+03 | 2.113116E+03 | 4.075472E+02 | 1.851852E+03 | 2.314815E+03 | 8.000000E-01 |
| GRANULITES | HEIER THOR | 1970 | 1.245763E+03 | 1.279468E+03 | 8.647059E+02 | 5.442177E+03 | 2.040816E+03 | 2.666667E+00 |
| GRANULITES | HEIER THOR | 1970 | 4.067164E+03 | .0 | 7.465753E+02 | 1.284404E+03 | .0 | .0 |
| GRANULITES | HEIER THOR | 1970 | 5.939630E+02 | .0 | 9.875000E+02 | 1.265823E+03 | .0 | .0 |
| GRANULITES | HEIER THOR | 1970 | 1.878378E+03 | 1.902447E+03 | 5.245283E+02 | 1.438849E+03 | 7.194245E+02 | 2.000000E+00 |
| GRANULITES | HEIER THOR | 1970 | 8.368794E+02 | 8.543639E+02 | 7.375000E+02 | 1.271186E+04 | 8.474576E+02 | 1.500000E+01 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.107407E+03 | 1.119306E+03 | 3.215054E+02 | 8.361204E+03 | 3.010033E+03 | 2.777778E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.450000E+03 | 1.461102E+03 | 5.800000E+02 | 2.298851E+03 | 2.298851E+03 | 1.000000E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 3.812500E+02 | 3.992528E+02 | 8.714286E+02 | 1.688525E+05 | 1.603279E+04 | 9.363636E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.478261E+03 | 1.487134E+03 | 3.035714E+02 | 3.823529E+03 | 1.176471E+03 | 3.250000E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.561905E+03 | .0 | 2.523077E+02 | 2.134146E+02 | .0 | .0 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.222727E+03 | 1.225266E+03 | 3.493506E+02 | 7.434944E+02 | 7.434944E+02 | 1.000000E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.083474E+03 | 1.090026E+03 | 2.688312E+02 | 7.246377E+03 | 2.415459E+03 | 3.000000E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 7.733333E+02 | 7.791584E+02 | 3.092632E+02 | 1.293103E+04 | 1.724138E+03 | 7.500000E+00 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.200000E+03 | 1.200709E+03 | 1.472924E+02 | 1.051471E+05 | 2.696078E+03 | 3.900000E+01 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 1.836364E+03 | 2.147480E+03 | 2.269663E+02 | 1.148315E+05 | 1.138614E+04 | 1.008696E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.311765E+03 | 1.349806E+03 | 1.592857E+02 | 2.959641E+04 | 3.587444E+03 | 8.250000E+00 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.278125E+03 | 1.365500E+03 | 3.170543E+02 | 8.264059E+04 | 4.400978E+03 | 1.877778E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.025806E+03 | 1.090523E+03 | 1.756906E+02 | 9.025157E+04 | 6.603774E+03 | 1.366667E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.608696E+03 | 1.716076E+03 | 2.500000E+02 | 6.108108E+04 | 4.324324E+03 | 1.412500E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.388889E+03 | 1.455225E+03 | 2.435065E+02 | 5.493333E+04 | 2.666667E+03 | 2.060000E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.804762E+03 | 1.901819E+03 | 2.746377E+02 | 4.432718E+04 | 3.166227E+03 | 1.400000E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.707692E+03 | .0 | 4.577320E+02 | 9.009009E+02 | .0 | .0 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.507143E+03 | 1.586084E+03 | 1.661417E+02 | 5.308057E+04 | 3.317536E+03 | 1.600000E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 2.080000E+03 | .0 | 3.661972E+02 | .0 | 7.692308E+02 | .0 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.268293E+03 | 1.306399E+03 | 1.837456E+02 | 3.365385E+04 | 3.269231E+03 | 1.029412E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.263889E+03 | 1.318649E+03 | 1.872428E+02 | 5.890110E+04 | 1.538462E+03 | 3.828571E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.375758E+03 | 1.500688E+03 | 1.396923E+02 | 9.162996E+04 | 7.709251E+03 | 1.188571E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 9.733333E+02 | 1.012965E+03 | 1.921053E+02 | 7.146119E+04 | 2.054795E+03 | 3.477778E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.202632E+03 | 1.325472E+03 | 1.692593E+02 | 1.052516E+05 | 1.312910E+04 | 8.016667E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.958333E+03 | 2.162487E+03 | 2.107623E+02 | 7.510538E+04 | 5.531915E+03 | 1.357692E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.031429E+03 | 1.052765E+03 | 4.688312E+02 | 3.074792E+04 | 2.216066E+03 | 1.387500E+01 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| GRAN(A) | LAMBERT HEIER | 1968 | 1.779167E+03 | 1.889780E+03 | 2.271277E+02 | 4.730679E+04 | 4.918033E+03 | 9.619048E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.433333E+03 | 1.716487E+03 | 1.784232E+02 | 4.418605E+04 | 7.674419E+03 | 5.757576E+00 |
| GRANULITES | HEIER THOR | 1970 | 1.324675E+03 | -1.403651E+05 | 3.060000E+02 | 3.084967E+05 | 4.705882E+04 | 6.555556E+00 |
| GRANULITES | HEIER THOR | 1970 | 1.428571E+03 | 1.441423E+03 | 2.000000E+02 | 1.333333E+03 | 6.666667E+02 | 2.000000E+00 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.145161E+03 | .0 | 3.141593E+02 | 5.633803E+02 | .0 | .0 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.314286E+03 | 1.388492E+03 | 1.795122E+02 | 4.755435E+04 | 9.239130E+03 | 5.147059E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.283333E+03 | 1.367398E+03 | 3.100671E+02 | 6.969597E+04 | 6.926407E+03 | 1.006250E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.442424E+03 | 1.488001E+03 | 1.576159E+02 | 3.424370E+04 | 2.100840E+03 | 1.630000E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.054000E+03 | 1.082976E+03 | 1.959108E+02 | 4.174573E+04 | 9.277040E+03 | 1.833333E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.631250E+03 | 1.940915E+03 | 1.441989E+02 | 1.666667E+05 | 7.088123E+03 | 2.351351E+01 |
| GRANULITES | HEIER THOR | 1970 | 8.333333E+02 | 9.894553E+02 | 2.500000E+03 | 6.400000E+04 | 1.466667E+04 | 4.363636E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.590909E+03 | 1.628511E+03 | 2.979989E+02 | 1.257143E+04 | 4.571429E+03 | 2.750000E+00 |
| GRANULITES | HEIER THOR | 1970 | 8.623853E+02 | 8.823988E+02 | 4.476190E+02 | 9.510638E+03 | 3.127660E+03 | 3.000000E+00 |
| GRANULITES | HEIER THOR | 1970 | 2.857143E+03 | 3.166338E+03 | 3.820225E+02 | 9.941176E+03 | 3.529412E+03 | 2.208333E+00 |
| GRANULITES | HEIER THOR | 1970 | 8.453608E+02 | .0 | 7.454545E+02 | .0 | .0 | .0 |
| GRANULITES | HEIER THOR | 1970 | 1.959596E+03 | 2.061810E+03 | 4.850000E+02 | 1.030928E+04 | 1.546392E+03 | 6.666667E+00 |
| GRANULITES | HEIER THOR | 1970 | 7.294118E+03 | 7.816505E+03 | 6.888889E+02 | 2.688172E+03 | 8.064516E+02 | 3.333333E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.273913E+03 | 1.352876E+03 | 2.989796E+02 | 7.303754E+04 | 4.778157E+03 | 1.528571E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.433846E+03 | 1.481927E+03 | 1.705607E+03 | 4.684932E+04 | 7.671233E+03 | 6.107143E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.438462E+03 | 1.676801E+03 | 7.003745E+01 | 1.081497E+05 | 2.513369E+04 | 4.223404E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 7.950820E+02 | 8.410054E+02 | 1.776557E+02 | 1.185567E+05 | 4.536082E+03 | 2.613636E |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.180952E+03 | 1.330665E+03 | 2.058091E+02 | 1.715726E+05 | 4.233871E+03 | 4.052381E |
| GRAN(A) | LAMBERT HEIER | 1968 | 8.491525E+02 | 9.318143E+02 | 1.828467E+02 | 1.572954E+05 | 1.357285E+04 | 1.158824E |
| GRAN(A) | LAMBERT HEIER | 1968 | 2.214286E+03 | .0 | 4.043478E+02 | 2.150538E+02 | .0 | .0 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.525806E+03 | 1.532568E+03 | 1.653846E+02 | 1.268499E+03 | 1.268499E+03 | 1.000000E· |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.578125E+03 | 1.610166E+03 | 1.578125E+02 | 2.396040E+04 | 1.980198E+02 | 1.210000E+02 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.261290E+03 | 1.442740E+03 | 2.624161E+02 | 1.869309E+05 | 2.301790E+03 | 8.121111E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 9.107143E+02 | 9.392203E+02 | 1.559633E+02 | 6.039216E+04 | 1.372549E+03 | 4.400000E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.443478E+03 | 1.452497E+03 | 2.243243E+02 | 6.325301E+03 | 6.024096E+02 | 1.050000E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.112500E+03 | 1.161648E+03 | 3.000000E+02 | 7.303371E+04 | 3.745318E+02 | 1.950000E+02 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.805682E+03 | .0 | 3.935897E+02 | .0 | 9.771987E+02 | .0 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.690476E+03 | 1.698112E+03 | 3.514851E+02 | 4.225352E+03 | 2.816901E+02 | 1.500000E+01 |
| GRAN(A) | LAMBERT HEIER | 1968 | 1.229268E+03 | 2.077332E+03 | 3.130435E+02 | 6.150794E+04 | 3.769841E+04 | 1.631579E+00 |
| GRANULITES | HEIER THOR | 1970 | 3.253165E+03 | 3.312818E+03 | 4.178862E+02 | 3.891051E+02 | 7.782101E+02 | 5.000000E-01 |
| GRANULITES | HEIER THOR | 1970 | 1.101395E+03 | 1.378183E+03 | 2.419048E+02 | 7.559055E+04 | 1.181102E+03 | 6.400000E+01 |
| GRAN(INT) | LAMBERT HEIER | 1968 | 9.700000E+02 | 9.781986E+02 | 4.041667E+02 | 6.185567E+03 | 3.092784E+03 | 2.000000E+00 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 5.287671E+02 | 5.485873E+02 | 1.581967E+02 | 9.326425E+04 | 1.165803E+04 | 8.000000E+00 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.204545E+03 | 1.359083E+03 | 2.172131E+02 | 1.675472E+05 | 4.905660E+03 | 3.415385E+01 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.362963E+03 | 1.377223E+03 | 3.285714E+02 | 7.336957E+03 | 2.173913E+03 | 3.375000E+00 |
| GRAN(SA) | LAMBERT HEIER | 1968 | 1.205263E+03 | 1.209884E+03 | 2.348718E+02 | 3.930131E+03 | 6.550218E+02 | 6.000000E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 6.795455E+02 | .0 | 4.983333E+02 | 1.672241E+03 | .0 | .0 |
| GRANULITES | HEIER THOR | 1970 | 8.474576E+02 | 8.372951E+02 | 3.750000E+02 | 2.733333E+04 | 1.133333E+04 | 2.411765E+00 |
| GRAN(A) | LAMBERT HEIER | 1968 | 9.548790E+02 | 9.316406E+02 | 2.262195E+02 | 4.528302E+04 | 4.851752E+03 | 9.333333E+00 |
| GRANULITES | HEIER THOR | 1970 | 1.000000E+03 | 1.030510E+03 | 2.659794E+02 | 9.520930E+03 | 2.395210E+03 | 4.000000E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.738516E+03 | 2.235660E+03 | 2.497462E+02 | 7.591301E+04 | 2.235772E+03 | 3.390909E+01 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.410714E+03 | 1.545912E+03 | 1.673729E+03 | 4.151899E+04 | 1.265823E+03 | 3.280000E+01 |
| GNEISS | HEIER THOR | 1970 | 8.700000E+03 | 1.059750E+04 | 3.565574E+02 | 6.896552E+03 | 1.609195E+03 | 4.285714E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.738516E+03 | 2.162598E+03 | 2.497462E+02 | 7.591301E+04 | 2.235772E+03 | 3.390909E+01 |
| AMPFGNEISS | HEIER THOR | 1975 | 1.340684E+03 | 1.544631E+03 | 1.614173E+02 | 3.512195E+04 | 8.780488E+03 | 4.000000E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.527607E+03 | 1.599478E+03 | 2.263636E+02 | 1.887550E+04 | 8.032129E+02 | 2.350000E+01 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| GNEISS | HEIER THOR | 1970 | 2.436170E+03 | 2.268533E+03 | 2.544444E+02 | 2.685590E+04 | 5.240175E+03 | 5.125000E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.833333E+03 | 2.032228E+03 | 1.887255E+02 | 2.857143E+04 | 2.857143E+03 | 1.000000E+01 |
| GNEISS | HEIER THOR | 1970 | 2.027451E+03 | 2.132376E+03 | 4.103175E+02 | 7.156673E+03 | 2.127660E+03 | 3.363636E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.376307E+03 | 2.002543E+03 | 1.266026E+02 | 9.696203E+04 | 1.822785E+04 | 5.319444E+00 |
| GNEISS | HEIER THOR | 1970 | 1.698864E+03 | .0 | 5.436364E+02 | 5.896288E+04 | .0 | .0 |
| GNEISS | HEIER THOR | 1970 | 6.785714E+02 | 1.042289E+03 | 1.610169E+02 | 1.263158E+05 | 5.105263E+04 | 2.474227E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.248252E+03 | 1.325657E+03 | 2.163636E+02 | 2.268908E+04 | 3.081232E+03 | 7.363636E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.128571E+03 | 1.232146E+03 | 3.085938E+02 | 4.886076E+04 | 1.772152E+03 | 2.757143E+01 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.199507E+03 | 1.232351E+03 | 2.203620E+02 | 1.088296E+04 | 1.437372E+03 | 7.571429E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.275862E+03 | 1.529856E+03 | 8.564815E+01 | 5.621622E+04 | 1.527027E+04 | 3.473684E+00 |
| GNEISS | HEIER THOR | 1970 | 3.953488E+02 | 1.993605E+03 | .0 | 9.529412E+05 | 9.411765E+04 | 1.012500E+01 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.613548E+03 | 1.712928E+03 | 2.518519E+02 | 1.752941E+04 | 2.941176E+03 | 4.600000E+00 |
| AMPFGNEISS | HEIER THOR | 1970 | 3.382353E+02 | .0 | 2.555556E+02 | .0 | 4.347826E+03 | .0 |
| AMPFGNEISS | HEIER THOR | 1970 | 6.333333E+02 | 9.633270E+02 | 1.862745E+01 | 2.894737E+05 | 2.894737E+04 | 1.000000E+01 |
| AMPFGNEISS | HEIER THOR | 1970 | 1.256906E+03 | 1.485451E+03 | 2.993421E+02 | 4.659341E+04 | 1.120879E+04 | 4.156863E+00 |
| XVVISS | HEIER THOR | 1970 | 1.520000E+03 | 4.035220E+03 | 9.500000E+02 | 1.394737E+05 | 3.157895E+04 | 4.416667E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 9.703000E+02 | 1.008078E+03 | 2.365854E+02 | 2.268041E+04 | 1.546392E+04 | 1.466667E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 7.272727E+02 | 7.556150E+02 | 4.705882E+02 | 6.625000E+04 | 1.000000E+04 | 6.625000E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 4.000000E+02 | .0 | 6.000000E+02 | .0 | 1.666667E+04 | .0 |
| AMPHIB(INT) | LAMBERT HEIER | 1968 | 1.785714E+03 | 1.849380E+03 | 2.232143E+02 | 5.320000E+04 | 1.120000E+04 | 4.750000E+00 |
| AMPHIB(INT) | LAMBERT HEIER | 1968 | 3.977273E+02 | 3.981398E+02 | 6.034483E+03 | 1.142857E+03 | 1.142857E+03 | 1.000000E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.330303E+03 | 1.439807E+03 | 1.545775E+02 | 7.370410E+04 | 1.070615E+03 | 6.883617E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.254854E+03 | 1.277120E+03 | 2.745562E+02 | 5.818368E+03 | 6.465517E+03 | 9.000000E-01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 2.589899E+03 | 2.522811E+03 | 2.283105E+02 | 3.000000E+03 | 2.209000E+03 | 1.545455E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.082929E+03 | 1.112771E+03 | 2.723926E+02 | 3.028428E+04 | 2.629928E+03 | 1.307692E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 2.828282E+03 | 2.119905E+03 | 3.172414E+02 | 4.347826E+03 | 1.304348E+03 | 3.333333E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.868182E+03 | 1.947078E+03 | 2.431953E+02 | 5.839416E+04 | 1.216545E+03 | 4.800000E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 4.482308E+03 | 4.540682E+03 | 2.489238E+02 | 3.221402E+04 | 2.577320E+03 | 1.250000E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 6.000000E+02 | 6.271697E+02 | 1.943182E+02 | 8.298298E+04 | 1.949318E+02 | 3.230000E+02 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.030612E+03 | 1.078762E+03 | 1.498516E+02 | 6.237234E+04 | 6.930693E+03 | 8.000000E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.585517E+03 | 1.658458E+03 | 2.734940E+02 | 5.198238E+04 | 5.286344E+03 | 9.833333E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 8.666667E+02 | 8.903112E+02 | 2.909091E+02 | 7.873303E+04 | 9.049774E+03 | 8.700000E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.736000E+03 | 1.838376E+03 | 2.371585E+02 | 4.677419E+04 | 4.608295E+03 | 1.015000E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 9.742857E+02 | 1.029408E+03 | 2.583333E+02 | 7.243492E+04 | 5.278592E+03 | 1.372222E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 3.171429E+02 | 8.397193E+02 | 3.306358E+02 | 5.574476E+04 | 2.622378E+03 | 2.106667E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.681250E+03 | 1.862475E+03 | 1.532764E+02 | 8.962825E+04 | 3.903346E+03 | 2.552381E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.351351E+03 | 1.489615E+03 | 1.432665E+02 | 8.450000E+04 | 9.200000E+03 | 9.195652E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.335294E+03 | 1.413784E+03 | 1.876033E+02 | 6.288550E+04 | 5.286344E+03 | 1.191667E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.217143E+03 | 1.315619E+03 | 1.990654E+02 | 9.293775E+04 | 7.981221E+03 | 1.164786E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.026316E+03 | 1.065335E+03 | 1.859729E+02 | 4.846154E+04 | 6.410256E+03 | 7.560000E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.143333E+03 | 1.198449E+03 | 1.971264E+02 | 4.839550E+04 | 8.746356E+03 | 5.533333E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 7.404762E+02 | 7.494242E+02 | 1.896341E+02 | 7.073955E+03 | 7.073955E+03 | 1.000000E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.711765E+03 | 1.772440E+03 | 1.711765E+02 | 5.841924E+03 | 9.621993E+03 | 6.071429E-01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.079167E+03 | 1.104939E+03 | 2.072000E+02 | 3.957529E+04 | 7.722008E+02 | 5.125000E+01 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.496429E+03 | 1.900097E+03 | 1.325949E+02 | 1.785203E+05 | 2.863962E+04 | 6.233333E+00 |
| AMPHIB(A) | LAMBERT HEIER | 1968 | 1.330233E+03 | 1.395614E+03 | 1.716000E+02 | 4.708625E+04 | 6.293706E+03 | 7.481481E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 2.425000E+03 | 2.661379E+03 | 1.747748E+02 | 3.685567E+04 | 1.005155E+04 | 3.666667E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.286667E+03 | 1.343212E+03 | 1.746606E+02 | 4.067358E+04 | 6.735751E+03 | 6.038462E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.111111E+03 | 1.153902E+03 | 2.439024E+02 | 4.450000E+04 | 6.000000E+03 | 7.416667E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.111111E+03 | 1.153902E+03 | 2.433090E+01 | 4.450000E+04 | 6.000000E+03 | 7.416667E+00 |

| | | | UNCORRECTED (K/PB)X10000 | CORRECTED (K/PB)X10000 | (K/RB)X10000 | (TH/K)X10000 | (U/K)X10000 | TH/U |
|---|---|---|---|---|---|---|---|---|
| AMPHIB(B) | LAMBERT HEIER | 1968 | 4.000000E+02 | .0 | 6.000000E+02 | .0 | 1.666667E+04 | .0 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 3.000000E+02 | .0 | 3.000000E+02 | .0 | 3.333333E+04 | .0 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 6.927273E+02 | 7.234924E+03 | 1.849328E+02 | 3.654723E+04 | 5.533459E+03 | 1.303333E+01 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.326667E+03 | 1.833917E+03 | 1.957265E+02 | 5.371179E+04 | 8.733624E+03 | 6.150000E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.245161E+03 | 1.293389E+03 | 2.230588E+02 | 3.784563E+04 | 5.217617E+03 | 7.250333E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.212903E+03 | 1.244538E+03 | 2.238095E+02 | 3.085106E+04 | 2.925532E+03 | 1.054545E+01 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 9.350000E+02 | 9.550577E+02 | 3.895833E+02 | 3.743316E+04 | 1.871658E+03 | 2.000000E+01 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.440000E+03 | 1.501723E+03 | 2.181818E+02 | 4.138438E+04 | 4.166667E+03 | 9.933333E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.333333E+03 | 1.415850E+03 | 1.641026E+02 | 5.843750E+04 | 7.812500E+03 | 7.480000E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 9.810811E+02 | 1.003648E+03 | 2.372549E+02 | 3.830303E+04 | 5.856749E+03 | 7.857143E+00 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.352778E+03 | 1.449816E+03 | 1.887597E+02 | 7.125357E+04 | 4.928131E+03 | 1.445833E+01 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.270968E+03 | 1.327581E+03 | 3.078125E+02 | 5.329346E+04 | 3.553299E+03 | 1.500000E+01 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.013889E+03 | 1.062214E+03 | 2.723881E+02 | 6.876712E+04 | 5.479452E+03 | 1.255000E+01 |
| AMPHIB(SA) | LAMBERT HEIER | 1968 | 1.582143E+03 | 1.674616E+03 | 1.737255E+02 | 5.417507E+04 | 4.063205E+03 | 1.333333E+01 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 1.366667E+03 | 1.428925E+03 | 1.366667E+03 | 3.983740E+04 | 6.504065E+03 | 6.125000E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 1.000000E+03 | 1.053346E+03 | 8.888889E+02 | 6.875000E+04 | 8.750000E+03 | 7.857143E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 8.376923E+02 | 8.387238E+02 | 6.562500E+02 | 5.333333E+04 | 1.047619E+04 | 5.090909E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 1.428571E+01 | 1.467983E+01 | 1.666667E+01 | 1.600000E+06 | 6.000000E+05 | 2.666667E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 7.285714E+02 | 7.494902E+02 | 6.375000E+02 | 2.745098E+04 | 1.372549E+04 | 2.000000E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 7.428571E+02 | 7.627265E+02 | 6.500000E+02 | 1.538462E+04 | 1.538462E+04 | 1.000000E+00 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 3.000000E+02 | .0 | 3.000000E+02 | .0 | 3.333333E+04 | .0 |
| AMPHIB(B) | LAMBERT HEIER | 1968 | 9.400000E+02 | 9.669894E+02 | 1.740741E+02 | 2.127560E+04 | 1.063830E+04 | 2.000000E+00 |
| METAGABBRO | HEIER THOR | 1970 | 6.391533E+02 | .0 | 7.714286E+02 | .0 | .0 | .0 |
| METAGABBRO | HEIER THOR | 1970 | 2.088235E+03 | 2.157147E+03 | 4.671053E+02 | 4.225352E+03 | 1.408451E+03 | 3.000000E+00 |
| METAGABBRO | HEIER THOR | 1970 | 1.290909E+03 | .0 | 3.230769E+02 | .0 | 7.936508E+03 | .0 |
| METAGABBRO | HEIER THOR | 1970 | 1.229167E+03 | 1.257624E+03 | 3.371429E+02 | 5.084746E+03 | 1.694915E+03 | 3.000000E+00 |
| METAGABBRO | HEIER THOR | 1970 | 9.142857E+02 | .0 | 2.133333E+03 | .0 | .0 | .0 |
| METAGABBRO | HEIER THOR | 1970 | 1.597403E+03 | 1.864991E+03 | 1.732394E+02 | 2.195122E+04 | 8.943089E+03 | 2.454545E+00 |
| METAGABBRO | HEIER THOR | 1970 | 2.151899E+03 | 2.254488E+03 | 8.500000E+02 | 4.117647E+03 | 2.352941E+03 | 1.750000E+00 |
| METAGABBRO | HEIER THOR | 1970 | 3.230769E+03 | 4.110081E+03 | 1.473684E+02 | 2.142857E+04 | 5.357143E+03 | 4.000000E+00 |

GOOD BYE - EYE-DIOT

# APPENDIX 2

## t test for parallelism

## Appendix 2

### Comparison of Two Slopes

Basically the method is to compare the ratio, of the difference between the two slopes to its standard error, against a t variable with $(n_1 + n_2 - 4)$ degrees of freedom.

$n$ = number of samples
$b$ = slope
$C_{yy}$ = sum of squares of y
$s_1^2$ = residual sum of squares

Granite:
$n = 75$
$b_1 = 1.17$
$C_{yy} = 13546.51$
$S_1^2 = 13,392.95$

Granulite:
$n = 76$
$b_1 = 5.18$
$C_{yy} = 11319.56$
$S_1^2 = 7457.01$

Andesite:
$n = 69$
$b_1 = 3.63$
$C_{yy} = 1349.79$
$S_1^2 = 1154.34$

Schist:
$n = 27$
$b_1 = 4.75$
$C_{yy} = 3235.99$
$S_1^2 = 2133.22$

Basalt:
$n = 41$
$b_1 = 2.26$
$C_{yy} = 1389.43$
$S_1^2 = 1240.19$

Amphibolites:
$n = 56$
$b_1 = 6.73$
$C_{yy} = 11686.55$
$S_1^2 = 4613.79$

Anorthosite:
$n = 7$
$b_1 = 5.33$
$C_{yy} = 471.18$
$S_1^2 = 31.93$

Sample Calculation

Anorthosites-Andesites

$$s^2 = \frac{s_1^2 + s_1^2}{n_1 + n_2 - 4} = \frac{1381.72}{72.0} = 19.19$$

$$S_B^2 = \frac{s^2}{\epsilon_{y_1 y_2}} + \frac{s^2}{\epsilon_{y_1 y_2}} = .014 + .041 = .055$$

$$S_B = .234$$

$$t_{calc.} = \frac{3.78 - 4.75}{.145} = -7.26$$

$t_{table} = t_{.05,\ 60} = 1.98$ slopes are signf. different.

Schist-Gneiss

$$s^2 = 57.32$$

$$_B^2 = .021$$

$$S_B = .145$$

$$t_{calc.} = \frac{3.78 - 4.75}{.145} = -6.69$$

$t_{table} = t_{.05,120} = 1.98$ slopes are signf. different.

Amphibolite-Granulite

$$s^2 = 94.30$$

$$S_B^2 = .016$$

$$S_B = .127$$

$$t_{calc.} = \frac{6.73 - 5.18}{.127} = 12.20$$

$t_{table} = t_{.05,120} = 1.98$ slopes are signf. different.

Granite-Basalt

$s^2 = 133.36$

$S_B^2 = .105$

$S_B = .325$

$t_{calc.} = \frac{1.17 - 2.26}{.32} = -.3.35$

$t_{table} = t_{.05,120} = 1.98$ slopes are signf. different.

Gneiss-Andesite

$s^2 = 42.84$

$S_B^2 = .035$

$S_B = .19$

$t_{calc.} = \frac{3.63 - 3.78}{.19} = -.79$

$t_{table} = t_{.05,120} = 1.98$ slopes are not signf. different.

Andesite-Basalt

$s^2 = 22.59$

$S_B^2 = .97$

$S_B = .95$

$t_{calc.} = \frac{3.63 - 2.26}{.95} = .14$

$t_{table} = t_{.05,120} = 1.98$ slopes are not signf. different.

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