sample, AA5A, was found to be discordant and was not included in the calculation of the isochron. This sample is discussed separately.

The isochron calculations yield an age of 2.55 b.y. ± 0.09 and an initial Sr^{87}/Sr^{86} ratio of 0.7065 ± 0.0016. These results are in accordance with the hypothesis advanced by Anhaeusser et al (1967) that the Mpageni is a postorogenic granite, unrelated to the migmatite.

Geochemical data on the Nelspruit migmatite are not available but assuming an average Rb content of 38 ppm. and a Sr content of 36 ppm. (as shown by X-ray fluorescence and isotope dilution analyses from the present investigation) the Sr^{87}/Sr^{86} ratio in the Nelspruit material during a period of time equal to approximately 450 m.y. would increase to roughly 0.712 which is much higher than the initial ratio found for the Mpageni granite. It is therefore possible that the Mpageni derived from the migmatite if Sr with a low Sr^{87}/Sr^{86} ratio was introduced in the postorogenic phase.

If it is assumed that the Sr with low Sr^{87}/Sr^{86} ratio was supplied by differentiation of the mantle and that this ratio was close to 0.701 (the lowest terrestrial Sr^{87}/Sr^{86} recorded - Allsopp, 1965; McElhinny, 1966) it is estimated that more than half the Sr contained in the Mpageni granite would be of mantle origin and that therefore the Sr content in the granite should be higher than that in the migmatite. However, from the samples analyzed it seems that the average Sr content in the granite is lower than that in the migmatite, contrary to the hypothesis that the Mpageni derives from the same source as the migmatite, unless the granite was generated by a process of partial fusion.

The above reasoning is oversimplified but it could approximate real conditions in a thin and more primitive earth's crust such as the one existing 2500 - 3000 m.y. ago.

The apparent mineral ages:

A few separated mineral fractions from the Mpageni samples were analyzed. The apparent ages obtained are in every case lower than the total rock ages, probably indicating loss of radiogenic Sr from the phases analyzed (see table 11 and figure 19).

This might imply a post-Mpageni metamorphic event; the existence of a younger event was also suggested by the Nelspruit separated mineral ages but the origin and the extent of this are not known since no major post-Mpageni granite emplacement has been identified in this region.

Dykes of various ages have been described (Visser et al., 1956; Anhaeusser et al, 1967). It is possible that one or more of these dyke intrusions promoted redistribution of radiogenic Sr in the area. However, all the mineral ages calculated using Sr^{87}/Sr^{86} initial ratio of 0.706 differ from the Mpageni age by less than 200 m.y. Hurley et al. (1963) have suggested that discordant mineral ages might in some instances be due to the cooling history of the rock and that probably solid diffusion of radiogenic Sr can continue for a period of time varying between a 100 and 200 million years after the emplacement of the rock; thus it is possible that the discordant mineral ages obtained for the Mpageni granite might be due to a prolonged cooling time.

Discussion of discordant point AA5A:

Sample AA5A does not lie on the Mpageni isochron although its mineralogical composition is close to that of the Mpageni. This sample was collected about a hundred feet away from the Mpageni-migmatite contact.

From the total rock analysis (table 12) it was found that the deviation of this sample from the corresponding Sr^{87}/Sr^{86} ratio of the Mpageni isochron was 18 times the average deviation of the other samples (table 10), and on statistical ground it is permissible to assume that the isotopic composition of this sample is significantly different from that of normal Mpageni granite and to exclude this point from the calculation of the Mpageni isochron.

The position of the discordant point above the isochron is suggestive of the incorporation of older material, that is a partially assimilated xenolith; however, the results obtained from separated minerals of the AA5A (table 12) do not seem to confirm this assumption.

The chloritised biotite apparent age, calculated using 0.706 as initial ratio, is approximately 2.95 b.y. But the K-felspar and plagioclase apparent ages are both low at 2.03 and 2.45 b.y. respectively and as the biotite (Lanphere et al., 1963; Moorbath, 1963; Hart, 1964) usually loses radiogenic Sr more readily than the felspars, the significance of this finding is unclear. Possibly the anomaly in the sample was generated by a very localised phenomenon (dyke emplacement or hydrothermal activity?) after emplacement of the granite.

More detailed work on a larger number of samples combined with detailed mapping of the area could possibly explain this discordance.

5. SUMMARY AND CONCLUSIONS

Absolute ages of 2.55 ± 0.09 b.y. and 2.99 ± 0.07 b.y. were obtained for the Mpageni granite and the Nelspruit migmatite respectively using the Rb-Sr total rock method. A few separated mineral apparent ages were calculated and found to be discordant. For the Nelspruit migmatite a preliminary investigation of the "contact phase", "basic behinds" and two pegmatites was carried out. The anomalous sample AA5A of a rock phase in the Mpageni granite was studied in detail.

From the above work it was found that the Nelspruit migmatite, although a chemically heterogeneous rock, contains isotopically homogeneous strontium over a distance of at least 15 miles, and it is proposed that this is a result of deep burial of the original rocks under uniform conditions. The initial Sr^{87}/Sr^{86} ratio of 0.7052 ± 0.001 of the migmatite indicates that the strontium in the earth crust was already differentiated from that contained in the mantle 3 billion years ago.

It was also found that the age of the Nelspruit migmatite coincides with the age of 3.0 b.y. found by Allsopp et al.(1967) for the deposition of Fig Tree shales in the outer portion of the metamorphic aureole of the migmatite, and it is proposed that the homogenization of the strontium in the shales was caused by the same regional event that formed the migmatite, or by contact metamorphism.

Furthermore, the apparent separated mineral ages probably reflect a period of metamorphism at the time of emplacement of the Mpageni granite. At least some of the pegmatites were formed at the same time as the migmatite although a later date of pegmatite intrusion is possible.

A difference in Rb/Sr composition between the contact phase and the migmatite, possibly related to the difference in composition of the felspars as found by Anhaeusser (1965), was found.

The investigation of the "basic hinds" showed differences in apparent ages between the felsic, mafic and biotite-enriched portions. This might be due to migration of radiogenic strontium from the basic rim towards the mafic portions of the rock.

The finding that the Mpageni granite has remained a closed chemical system since 2.55 $\pm$ 0.090 b.y. ago with an initial Sr^{87}/Sr^{86} ratio of 0.7065 $\pm$ 0.0016, supports the classification of the Mpageni as a postorogenic intrusive, unrelated to migmatite emplacement. The initial ratio of the Mpageni granite suggests that it does not derive from total fusion of Nelspruit migmatite materials.

The separated minerals apparent ages of the Mpageni granite may indicate the action of a younger metamorphic event; however; they might also be caused by a long cooling period of the granite.

Sample AA5A shows anomalous Sr composition with both total rock and chloritised biotite apparent ages higher than Mpageni age, and K-felspar and oligoclase lower than the corresponding apparent ages from minerals of other samples. The reason for this is unclear.

In the near future natural strontium samples will be measured on a more precise mass spectrometer. The expected greater precision of results may bring out more subtle differences between samples and yield interesting results. The regressions will then be calculated and errors will be estimated with York's method (1966) by means of a computer.

EIMER AND AMEND STANDARD

TABLE - 2

(a) B.P.I. Results:

DATE	Sr^{87}/Sr^{86} normalized	Sr^{87}/Sr^{86} measured	Sr^{88}/Sr^{86} measured	BY
May 1965	0.7087	0.7130	8.476	HLA
Aug 1966	0.7093	0.7227	8.692	ADG
Nov 1966	0.7086	0.7134	8.487	RD
Apr 1967	0.7075	0.7143	8.536	HLA

(b) Means of Measurements from Investigations in Different Laboratories:

REFERENCE	Sr^{87}/Sr^{86} means normalized	DESCRIPTION OF INSTRUMENTS
B.P.I.	0.70852	See description - Chap.III
Manton (1967) (unpub. Ph.D. thesis)	0.708[illegible]	12" 68° triple filament magnetic switching - 10 analyses.
McDougall & Compston (1965)	0.7082	6" 90° voltage switching mass spectrometer.
Powell & Delong (1966)	0.7078 ± .00035	6" 90° double filament source - 8 analyses
Moorbath & Walker (1965)	0.7076 ± .0010	6" 90° AEI MS2 single Ta filament - 8 analyses
Moorbath & Bell (1965)	0.7092 ± .0009	12" 90° EEI MS5 single Ta filament - 11 analyses

EIMER AND AMEND STANDARD

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NELSPRUIT MIGMATITE - TABLE 3

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} Atomic	Sr^{87}/Sr^{86} Atomic	
KPLWR α	32.898	30.430	1.068	0.754	
KPLWR β	33.436	30.781	1.07+	0.751	1
KPBWR α	26.598	33.297	0.789	0.742	
KPBWR β	26.290	33.830	0.768	0.737	2
VCWR β	31.231	34.790	0.887	0.744	
VCWR δ	31.850	35.541	0.885	0.741	3
OG38AWR δ	38.535	27.140	1.405	0.759	
OG38AWR ε	38.561	26.839	1.419	0.763	4
OG38CWR δ	42.351	38.512	1.087	0.749	
OG38CWR ε	42.240	38.311	1.090	0.749	5
OG38DWR β	32.550	39.670	0.811	0.739	
OG38DWR γ	32.901	39.338	0.826	0.740	6
NW5WR α	37.448	75.418	0.491	0.721	
NW5WR β	37.291	77.363	0.476	0.726	7
B134DWR α	56.799	44.720	1.255	0.757	
B134DWR β	58.157	44.459	1.293	0.760	8
B134I α	20.073	42.700	0.464	0.726	9
AA7WR α	37.025	16.270	2.248	0.804	
AA7WR β	39.892	17.840	2.210	0.804	10
AA13IWR α	72.672	18.278	3.929	0.868	11
AA13MWR α	27.713	88.330	0.3100	0.715	
AA13MWR β	27.913	86.745	0.3180	0.718	12
AA19WR α	54.827	14.101	3.842	0.869	13
AA15FWR α	30.855	20.610	1.479	0.770	14
AA13GWR α	49.281	31.677	1.537	0.778	15
	50.119	30.910	1.602	0.777	

NELSPRUIT MIGMATITE

DIFFERENCES BETWEEN MEASURED AND CALCULATED

Sr^{87}/Sr^{86} RATIOS

TABLE - 4

SAMPLE	MEASURED	CALCULATED	DIFFERENCE
KPL	0.7525	0.750664	0.001836
KPB	0.7395	0.738243	0.001257
VC	0.7426	0.742811	0.000211
OG38A	0.7629	0.764660	0.001760
OG38C	0.7492	0.751398	0.002198
OG38D	0.7393	0.739949	0.000649
NW5	0.7226	0.725731	0.003131
B134D	0.7585	0.759281	0.000781
B134L	0.7260	0.724897	0.001103
AA7	0.8040	0.799821	0.004179
AA13 G	0.7770	0.773205	0.003795
AA13I	0.8680	0.871986	0.003986
AA13M	0.7165	0.718529	0.002029
AA19	0.8690	0.86829	0.00071
AA15F	0.7700	0.767984	0.002016

THE CONTACT PHASE - TABLE 5

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)	Approx. ages Billion years (in. ratio 0.705)
AA10WR α	90.011	8.102	109.80	5.236	2.92
AA10WR β	88.469	7.780	112.37	5.410	2.97
AA11WR α	71.862	8.569	8.287	1.051	2.94
AA11WR β	72.5486	8.688	8.253	1.069	3.00
AA12WR α	52.024	5.966	8.616	1.074	3.02
AA12WR γ	50.316	5.869	8.471	1.081	3.12

NELSPRUIT MIGMATITE SEPARATED MINERALS - TABLE [illegible]

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)	Apparent ages Billion years
KPLKF α 80% pure	87.376	35.131	2.458	0.800	2.77
KPLKF β 90% pure	87.314	36.800	2.345	0.790	2.60
KPL Bio α	146.270	11.540	12.523	1.166	2.64
KPBKF α 90% pure	75.000	33.997	2.180	0.769	2.48
KPBKF β 90% pure	73.658	34.044	2.144	0.780	2.51
VC Bio α	183.923	6.687	27.470	1.755	2.74
VCKF α 80% pure	71.323	41.510	1.698	0.773	2.87
VCKF β 90% pure	70.827	41.270	1.696	0.776	2.99

Biotite-total rock join KPL apparnt.age 2.55 Sr^{87}/Sr^{86} initial ratio 0.713

Biotite-total rock join VC apparnt.age 2.68 Sr^{87}/Sr^{86} initial ratio 0.709

PEGMATITES INTRUDING THE NELSPRUIT MIGMATITE

TABLE - 7

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)	Apparent ages Billion years (in.ratio 0.705)
AA13PWR α	78.382	4.709	16.447	1.365	2.831
AA13PWR δ	79.039	4.708	16.588	1.367	2.815
OG38BWR α	74.027	6.466	11.312	1.133	2.630
OG38BWR β	72.248	6.322	11.293	1.128	2.684
OG38GWR δ	76.350	4.2811	17.623	1.458	3.011
OG38GWR ε	73.403	4.173	17.383	1.430	2.941
OG38FWR α	50.643	3.745	13.362	1.264	2.958
OG38FWR β	50.821	3.825	13.130	1.256	2.949

THE "BASIC BEHIND" - TABLE 8

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)	Apparent ages Billion years
AA9F	25.413	44.181	0.568	0.729	2.94
AA9M	34.509	46.280	0.737	0.737	3.12
AA9BB	49.510	50.592	0.967	0.744	2.84

MPAGENI GRANITE WHOLE ROCK SAMPLES - TABLE 9

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)
B136WR β	72.800	14.244	5.016	0.887
B136WR γ	73.80[illegible]	14.334	5.088	0.888
AA2WR α	48.501	20.331	2.357	0.791
AA4AWR α	45.824	71.373	0.634	0.730
AA4AWR β	45.033	72.266	0.616	0.729
AA4BWR α	66.220	30.462	2.150	0.784
AA5BWR α	73.690	12.480	5.835	0.922
AA5BWR β	72.920	12.360	5.830	0.918

MPAGENI GRANITE - DIFFERENCES BETWEEN MEASURED AND CALCULATED Sr^{87}/Sr^{86} RATIOS

TABLE - 10

SAMPLE	MEASURED	CALCULATED	DIFFERENCE
B136	0.8875	0.88909	0.00159
AA2	0.7910	0.791687	0.000687
AA4A	0.7290	0.729089	0.000089
AA4B	0.7840	0.784133	0.000133
AA5B	0.9200	0.917316	0.002684
AA5A	0.8350	0.82578	0.00922

MPAGENI SEPARATED MINERALS - TABLE 11

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)	Apparent ages Billion years
B136KF α	156.450	19.473	7.940	0.980	2.47
AA4A Plag α	25.250	67.024	0.437	0.719	2.38
AA4AKF α	69.8862	81.960	0.842	0.735	2.39
AA4A Bio α	205.754	12.154	16.728	1.2665	2.37

MPAGENI AA5A AND SEPARATED MINERALS - TABLE 12

SAMPLE	Rb^{87} Conc.	Sr^{86} Conc.	Rb^{87}/Sr^{86} (atomic)	Sr^{87}/Sr^{86} (atomic)	Apparent ages Billion years (in.ratio 0.705)
AA5AWR α	74.289	22.149	3.300	0.836	2.79
AA5AWR β	73.197	21.950	3.295	0.834	2.76
AA5AKF α	165.536	29.090	5.624	0.901	2.03
AA5AP1 α	112.341	26.394	4.202	0.856	2.51
AA5AP1 β	112.692	26.135	4.693	0.852	2.42
AA5A Chlor.bio α	97.670	18.143	5.319	0.926	2.93
AA5A Chlor.bio β	87.7200	15.241	5.687	0.940	2.92