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GEOCHRONOLOGY OF SYNTECTONIC GRANITES FROM CENTRAL ZAMBIA : LUSAKA GRANITE AND GRANITE NE OF RUFUNSA (*)

by

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RESUME.- L'âge Pb/U de zircons du granite de Lusaka est 863 m.a. Il caractérise une phase de déformation F2. Au nord-est de Rufunsa, un granite intrusif dans le "Complexe de base" a pour âge Pb/U sur zircon, 945 m.a. alors qu'un porphyre associé à ce granite a un âge de 973 m.a. La mise en place de ces roches intrusives est liée à un épisode de déformation qui a été suivi jusque dans la région de Lusaka où il correspond à la plus ancienne déformation des roches de cette région (F1).

Dans cette dernière région, la phase F3 (Lufilienne tardive) s'est produite avant 550 m.a. (isochrone secondaire Rb/Sr). La remontée post-lufilienne, telle qu'elle peut être déduite de l'age Rb/Sr de biotites, s'est produite en même temps dans les régions de Lusaka et de Rufunsa.

ABSTRACT.- The Pb/U age of zircons from the Lusaka Granite is 863 m.y. It characterizes an F_2 phase of deformation. North-east of Rufunsa, a granite intrusive into the Basement Complex has a zircon age of 945 m.y. while the indicated age of a porphyry, related to this granite is 973 m.y. The intrusion of these rocks is linked to an episode of deformation which has been traced into the Lusaka area where it corresponds to the earliest deformation of the country rocks (F_1).

In the Lusaka area, the F_3 (late Lufilian) phase occurred before 550 m.y. (Rb/Sr secondary isochron). Post-Lufilian uplift, as traced by the Rb/Sr age of biotites, occurred in the Lusaka and Rufunsa areas at the same time.

I.- GEOLOGY

This paper describes geochronological data from the Lusaka Granite which is intruded into allegedly Katanga metasediments north-west of Lusaka (15° 18'S ; 28°10'E) and from granite and associated porphyry intruded in metasediments of the Basement Complex north- east of Rufunsa (15°01'S ; 29°44'E and 15°02'S ; 29°44'E respectively).

The Lusaka Granite is a boss of adamellite elongated and marginally foliated parallel to the trend of the enclosing country rocks (THIEME, 1968). The surrounding metasediments are usually referred to the Katanga System although this view has been questioned by de SWARDT and SIMPSON (1972). Structural studies in adjacent areas (MATHESON and NEWMAN, 1966 ; BARR, 1968) have demonstrated three successive epidoses of deformation in these rocks. The F_1 and F_2 folds are coaxial and parallel to the trend of the Lufilian area ; F_1 folds appear to have been initially overturned or recumbent while F_2 folds are typically upright and symmetrical. The last structures recognised (F_3) are open folds on north-east trending axes (MATHESON and NEWMAN, 1966).

Because F_1 and F_2 fabrics in the country rocks frequently have a common orientation, it is not in general possible to refer the fabric in the granite to either episode of deformation. However, at its western extremity, the granite is involved in an upright symmetrical fold figured by SIMPSON and DRYSDALL (1963, Plate 10), which has the characteristics of an F_2 fold. Further-

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more, metadolerite dykes and stocks which are abundant in the country rocks of the Lusaka area and can be shown to have been intruded in the interval between F_1 and F_2 deformation further east, are absent from the Lusaka Granite. Taken together, these lines of evidence strongly suggest that the granite was intruded late within the deformation sequence of the Lusaka area, probably synchronously with F_2 deformation.

The granite intrusive into the metasediments of the Basement Complex north-east of Rufunsa lies in the core of a major antiform. The main deformation fabric in the enveloping rocks passes to the north-west and south-east of the intrusion and appears to be bowed out around it (BARR, 1974, pp. 38/39). Both these lines of evidence suggest that the granite was emplaced before, or early within the main deformation episode of the enveloping metaschists. However, the fabric associated with this episode passes into the granite. At the margin, which is locally discordant, it is expressed as discrete zones of shearing and cataclasis cutting across unfoliated granite but towards the core, it passes into regions of more general foliation. The granite also contains numerous inclusions of country rock in which the main deformation fabric is strongly expressed. It is concluded that the intrusion and solidification of the granite continued during the development of the structures of this episode, i.e. that the granite was synkinematic. The textures, fabric and field relations of the closely associated porphyry bodies lead to a similar conclusion.

The folds and fabrics with which the intrusion of the granite and porphyry are linked have been traced continuously to the west where they appear to correspond to the first deformation (F_1) of the allegedly Katangan rocks around Lusaka.

II.- PETROGRAPHY

The Lusaka Granite "is composed principally of microcline, plagioclase, quartz and biotite. Grain-size ranges from 0.5 to 8 mm, and microcline always exceeds the plagioclase in amount. Accessory minerals include epidote, magnetite, muscovite, apatite, sphene and zircon". The microcline is sometimes perthitic (THIEME, 1968).

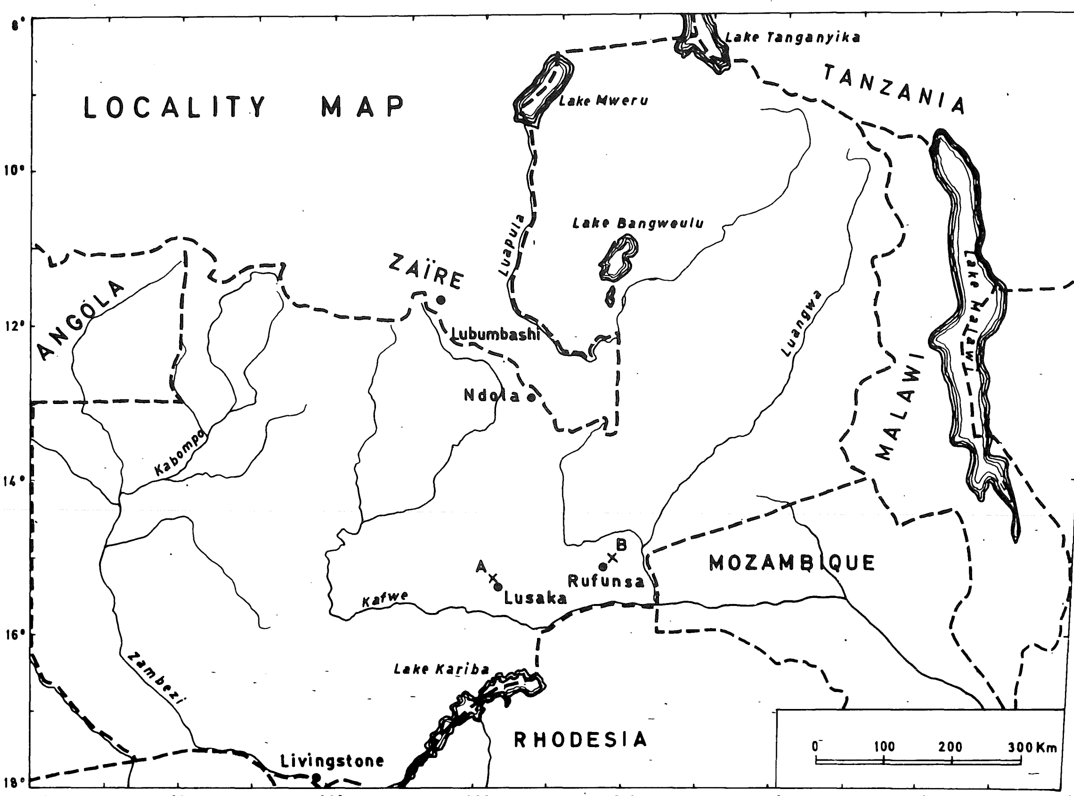

FIGURE 1.- Locality map

The granite intrusive into the Mpanshya Group is a medium to coarse-grained homogenous biotite-granite. It is composed of microcline – microperthite, oligoclase, quartz and biotite. Accessory minerals include sphene, apatite, epidote and chlorite pseudomorphing biotite. Allanite, zircon, monazite, garnet and muscovite associated with the plagioclase also are present (BARR, 1974).

The porphyry is made up of a fine-grained granular aggregate of alkali feldspar, quartz, biotite, muscovite, and epidote and accessory apatite, sphene, zircon and calcite. Set in this matrix are rounded quartz and subhedral feldspar phenocrysts.

III.- AGE DATA AND RESULTS

THE LUSAKA GRANITE.

Former radiometric age studies on the Lusaka Granite carried out at the Institute of Geological Sciences (London), failed to produce a definitive age of this rock. An adopted age of 732 m.y. (here recalculated to 774 m.y. using λ^{87} Rb = $1.39.10^{-11}.y^{-1}$) was suggested (SNELLING, JOHNSON, DRYSDALL, 1974, pp. 25 & 28).

New analyses were performed at the Belgian Centre for Geochronology (Brussels-Tervuren). U/Pb analyses on four zircon fractions from specimen R.G. 71.532 and Rb/Sr analyses of four whole rock samples (R.G. 71.532, 71.533, 71.535 and 71.536) and on mineral fractions of R.G. 71.533 are listed respectively in Tables 1 and 2a. Former data, analysed at I.G.S. are listed in Tables 2b and 3.

U/Pb METHOD (TABLE 1).

The four zircon fractions plot on the Concordia graph (WETHERILL, 1956) on a chord which cuts the Concordia curve at 863 m.y. (upper intercept) and 35 m.y. (lower intercept) (Fig. 2). These figures indicate a continuous lead loss from the time of cristallization given by the upper intercept (TILTON, 1968 ; WASSERBURG, 1963). The chord is therefore only an approximation to a continuous lead loss curve. The true age of the zircon may thus be slightly older than 863 m.y.

Direct observation under the microscope yields no indication that inherited zircons are present. This is in agreement with the excellent alignement of the four zircon fractions.

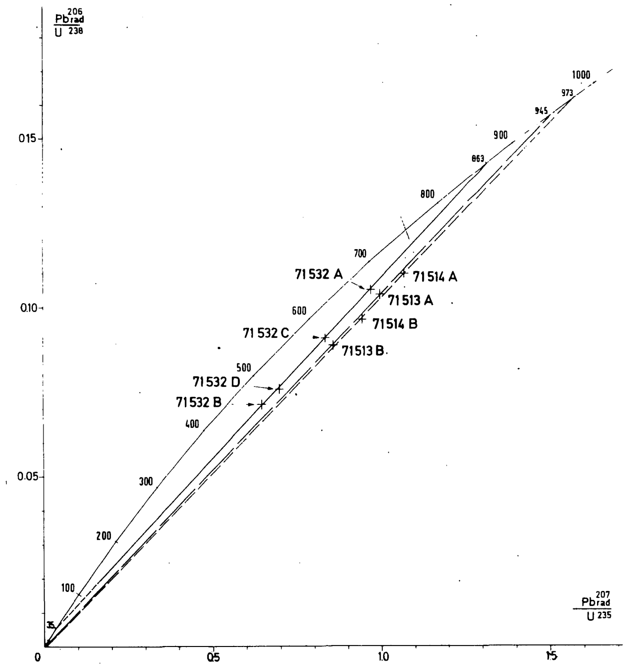

FIGURE 2.- Concordia graph : zircons - Lusaka Granite : 71.532 A, B, C & D : Granite in Mpanshya Group : 71.513 A & B ; Porphyry in Mpanshya Group : 71.514 A & B.

Rb/Sr METHOD (TABLE 2a).

Whereas the London results indicated that most of the analysed specimens had not remained closed systems (SNELLING, JOHNSON & DRYSDALL, 1974, p. 26), three (n° R.G. 71.533, 71.535, 71.536) of the four whole rock specimens analysed in Belgium fulfill this fundamental condition and define a line indicating (1) an age of 800 ± 35 m.y. with an initial ratio of 0.7058 ± 0.0040.

If all older whole rock data (Table 2b) are plotted on the same graph it is seen that the representative points of two specimens (61/27 & 66/127) fall on this line (Fig. 3). The resultant five point isochron has the following characteristics : age : 807 ± 20 m.y. ; initial ratio : 0.7050 ± 0.0030.

The scatter of the representative points of the four rocks analysed in London may be due to the fact that the samples were extremely small (SNELLING, personal communication). It is therefore to be expected that some of them have not remained closed systems and have behaved in the same way as minerals (see section IV) ; radiogenic strontium has migrated from one small portion of rock to another.

(1) These ages have veen calculated following York (1966). The errors indicated are at the 2 σ level.

TABLE 1.- U/Pb analytical data on zircon.

Rock ; number ; fraction		ppm		Isotopic composition of Pb				Apparent ages (m.y.)		
		Total Pb	Radio-genic Pb	204	206	207	208	207/206	206/238	207/235
Lusaka Granite										
71.532 A	850	98.16	93.74	0.060	79.887	6.220	13.833	852 ± 16	653 ± 13 (1) (0.1055)	699 ± 18 (1) (0.9739)
71.522 B	1684	135	126	0.091	78.456	6.486	14.967	820 ± 16	449 ± 9 (0.0715)	514 ± 15 (0.6498)
71.532 C	1017	99.7	96.9	0.037	80.743	5.919	13.300	842 ± 5	567 ± 11 (0.0911)	626 ± 11 (0.8370)
71.532 D	1310	107.3	104.3	0.037	80.579	5.929	13.455	850 ± 10	477 ± 9 (0.0760)	546 ± 11 (0.7010)
Granite in Mpanshya										
71.513 A	316	41	35	0.191	72.513	7.797	19.450	933 ± 10	645 ± 13 (0.1041)	713 ± 14 (0.9989)
71.513 B	603.8	68.75	58.24	0.205	71.009	7.953	20.833	958 ± 10	553 ± 11 (0.0888)	640 ± 14 (0.8617)
Porphyry in Mpanshya										
71.514 A	275.7	36.14	32.48	0.136	74.815	7.251	17.798	969 ± 14	680 ± 14 (0.1100)	750 ± 20 (1.0731)
71.514 B	404.5	51.06	42.26	0.231	70.232	8.318	21.218	978 ± 17	600 ± 12 (0.0966)	685 ± 18 (0.9467)

Correction Lead 1 18.6 15.7 38.9

$\lambda 238$ U = 1.537 = 10^{-10} .y^{-1} ; $\lambda 235$ U = 9.72 = 10^{-10} . $^{-1}$; N238/N235 = 137.8

(1) atomic ratios are given in brackets.

TABLE 2a.- New Rb/Sr analytical data.

N°	Rock, mineral number	Rb ppm	Sr ppm	$^{87}Sr/^{86}Sr$	$^{87}Rb/^{86}Sr$ ± 2 %	Rb & Sr concentration by
1	Lusaka Granite					
	71.532 W.R.	242	51.1	0.8421 ± 0.0002	13.8852	X-ray fluor
2	71.533 W.R.	230	87.9	0.7910 ± 0.0002	7.6296	"
3	71.535 W.R.	254	63.4	0.8380 ± 0.0007	11.743	"
4	71.536 W.R.	282	63.0	0.8519 ± 0.0002	13.145	"
5	71.533 P1+K.F.	311	129	0.7863 ± 0.0008	7.0486	Isotopic dil.
6	71.533 Bi	686	9.17	2.636 ± 0.002	257.73	X-ray fluor
7	71.533 Pl	92.5	87.9	0.7558 ± 0.006	3.0600	Isotopic dil.
	Gran. in Mpanshya Gp					
8	71.513 W.R.	246	84.3	0.8218 ± 0.0004	8.5393	X-ray fluor
9	71.513 K.F.	396	88.9	0.8560 ± 0.0006	13.084	"
10	71.513 Bi	1316	8.32	5.626 ± 0.0040	678.42	Isotopic dil.
	Porphyry					
11	71.514 W.R.	142	91.5	0.7692 ± 0.0002	4.5176	X-ray fluor

X-ray fluorescence analyses by M. DELVIGNE and F. DUREZ (M.R.A.C.)

W. R. : whole-rock ; Pl : plagioclase ; K.F. : potash feldspar ; Bi : biotite

TABLE 2b.- Former Rb/Sr analytical data

N^o	Rock mineral number	Rb ppm	Sr ppm	$^{87}Sr/^{86}Sr$	$^{87}Rb/^{86}Sr$	Ref.
	Lusaka Granite					
12	R5;66. 127. W.R.	288	61.96	0.8577	13.46	1
13	R5;66. 128. K.F.	474.5	86.57	0.8763	16.13	1
14	R5;66. 129. Pl.	129.2	83.82	0.7962	4.50	1
15	R6;66. 126. W.R.	297.8	58.26	0.8657	15.03	1
16	R6;66. 137. K.F.	444.2	91.40	0.8648	14.08	1
17	R6;66. 125. Pl.	124.4	89.31	0.7816	4.06	1
18	R7;66. 123. W.R.	277.5	62.72	0.8644	12.99	1
19	R7;66. 122. K.F.	478.6	89.14	0.8684	15.79	1
20	R7;66. 124. Pl.	99.5	89.58	0.7619	3.23	1
21	VII. B. 10 W.R. 61.27	256.0	53.20	0.8610	13.80	2

References : 1. SNELLING, JOHNSON & DRYSDALL, 1972, p 24 ; 2. SNELLING. HAMILTON, DRYSDALL and STILLMAN, 1964.

All Rb and Sr concentration analyses by isotopic dilution.
W.R. : whole rock ; K.F. : potash feldspar ; Pl : plagioclase.

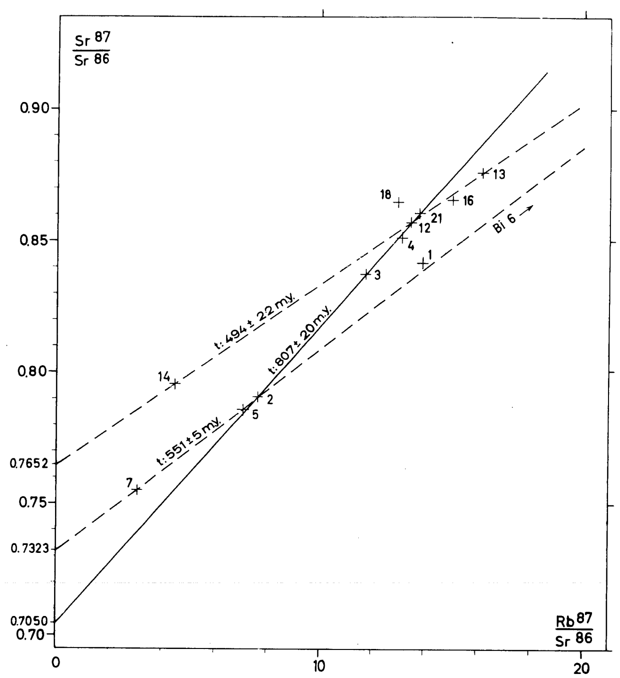

FIGURE 3.- Plot of representative points of whole rocks and minerals, Lusaka Granite (analyses 1–7 and 12–21, see tables 2a and 2b).

It is noteworthy that the only one of the specimens analysed in Brussels to have lost radiogenic strontium is number 71532 which is the most alkalic of these specimens (see Section IV).

The age of 807 ± 20 m.y. is the best Rb/Sr age for the Lusaka granite.

The difference between the U/Pb (863 m.y.) and Rb/Sr (807 m.y.) results could be reduced if all limits of error were taken into account ; however these results do not necessarily indicate the same event. The former represents the age of cristallisation of the zircon and we have seen that the figure obtained cannot be too high. The latter figure is the age of the closure of the Rb/Sr system for migration of radiogenic strontium ; this is only a younger limit to the age of the rock. Reasons for considering it to be lower than the age of the rock are given in Section 4.

Two secondary isochrons on minerals have been obtained. The first (at I.G.S., London) concerns specimen R5 (whole rock, potassium feldspar and plagioclase). This yields 494 ± 22 m.y. with initial ratio 0.7652 ± 0.0037. A second mineral isochron concerns specimen R.G. 71.533 (whole rock, plagioclase and mixture of potassium feldspar and plagioclase). The result is 551 ± 5 m.y. with initial ratio 0.7323 ± 0.0004 (or, if biotite is included, 539 ± 15 m.y. with initial ratio 0.7331 ± 0.0013).

It will be shown in Section 4 that these ages most probably represent different closures of the rubidium-strontium system for radiogenic strontium migration following on the same final Lufilian event which occurred earlier than about 550 m.y.

TABLE 3.- Former K/Ar analytical data on biotite.

Specimen	I.G.S. number	K °/o	Ar^{40} ppm	Age m.y.	References
Lusaka Granite (R5)	66.25	7.51	0.543	531 ± 22	SNELLING, JOHNSON & DRYSDALL (1972 p. 25)
Lusaka Granite (R6)	66.26	7.38	0.323	531 ± 21	d°
Lusaka Granite (R7)	66.31	7.08	0.333	567 ± 23	d°
Lusaka Granite	61.11	7.60	0.339	540 ± 22	SNELLING, HAMILTON, DRYSDALL & STILLMAN, (1964, Table 2)

$$\lambda_\beta = 0.585 \times 10^{-10}\ .y^{-1}\ ;\ \lambda_\beta = 0.472 \times 10^{-10}\ .y^{-1}$$

K/Ar METHOD.

Four K/Ar analyses have been published previously (SNELLING, JOHNSON & DRYSDALL, 1972 ; SNELLING & OTHERS, 1964) and are reproduced in Table 3. They are concordant within the limits 548 ± 4 m.y..

This result corresponds to one of the secondary Rb/Sr isochrons and post-dates the final Lufilian event (see Section IV).

GRANITE AND PORPHYRY INTRUSIVE INTO THE MPANSHYA GROUP.

Two zircon fractions from specimen R.G. 71.513 (granite) and two from specimen R.G. 71.514 (porphyry) have been analysed by the U/Pb method. Both rock-types have been analysed by the Rb/Sr method, a "whole rock" determination on each and determinations on two mineral fractions of the granite.

U/Pb METHOD (TABLE 1).

The two zircon fractions from the granite (R.G. 71.513) define a chord which transects Concordia (Fig. 2) at an upper intercept of 945 m.y. and a lower intercept of zero. For the porphyry (R.G. 71.514) the two fractions indicate 973 m.y. and zero respectively.

Together, the four fractions lie on a line with an upper intercept of 995 m.y. and a lower one of 35 m.y. This line confirms that the two rocks are approximately of the same age. It is however obvious from Fig. 2 that the representative points of these zircon fractions really occur in pairs.

Rb/Sr METHOD (TABLE 2).

In view of the fact that only one "whole rock" specimen was available for each of the two rock types the Rb/Sr data do not by themselves yield definitive evidence of their age.

When taken together, the representative whole rock points yield an age indication of 934 m.y. with an initial ratio of 0.710.

There is no geological indication that the two rocks are exactly contemporaneous and, in view of the U/Pb results which indicate two distinct but not very different ages, it is unlikely that the 934 m.y. line is an "isochron".

If conventional initial ratios, lower than 0.710 are chosen, the apparent ages for each of the rocks are in the same order as the zircon U/Pb ages (Table 4).

TABLE 4.- Apparent ages for granite and porphyry intrusive into the Mpanshya Group, for conventional initial ratios.

Initial ratio	Granite (71.513) age (m.y.)	Porphyry (71.514) age (m.y.)
0.709	941	950
0.708	949	966
0.707	957	982

It is seen that an initial ratio such as 0.708 yields, for each rock, apparent ages in keeping with the U/Pb results. However, it is possible that the Rb/Sr results reflect a closure for radiogenic strontium migration later than that for the lead isotopes.

Finally, a secondary three point mineral isochron (whole rock, potassium feldspar, biotite) for the granite (R.G. 71.513) yields 516 ± 13 m.y. with an initial ratio of 0.7608 ± 0.0024. This age is that of the closure of the Rb/Sr system for radiogenic strontium after a late Lufilian event (see Section 4).

IV.- GEOLOGICAL INTERPRETATION OF RESULTS.

A. AGES AND ORIGIN OF THE INTRUSIVES.

For the Lusaka Granite, the U/Pb data yield the age of crystallization of the zircons. If, despite what we have indicated in Section 3 a portion of the zircons be inherited, they yield the age of complete loss of radiogenic lead in that portion. In both cases they indicate an age of crystallization of the granite of 863 m.y. As this granite is rather alcaline ($^{87}Rb/^{86}Sr$ in the range 7.63 - 13.89) it is not surprising to find that, after crystallization of the zircons, mobility of strontium isotopes has continued for some time, homogenization occurring later, at 807 m.y. (see discussion in Section IV C). The initial ratio of the Rb/Sr isochron, 0.7050 ± 0.0030, indicates some measure of crustal history which is in keeping with the protracted mobility of radiogenic strontium between 863 m.y. and 807 m.y. In view of this and of what has been said of the zircons, there is no indication of "remobilisation and reconstitution of the basement" (THIEME, 1968).

The intrusives in the Mpanshya Group of the Basement Complex are dated respectively at 973 m.y. for the studied porphyry and at 945 m.y. for the granite. These ages are those of the zircons which are to some extent supported by the Rb/Sr data. The texture of the porphyry indicates that it was fluid and the zircon age therefore records the age of intrusion and crystallization (BARR, 1974, p. 24). The date for the granite is also the age of intrusion. The apparent initial $^{87}Sr/^{86}Sr$ ratio (0.708) suggests that these rocks have had an appreciable measure of crustal history, of which an important part was prior to the crystallization of the zircon.

B. AGE OF THE TWO EARLIEST DEFORMATIONS IN THE "KATANGAN" TIME RANGE.

The intrusions near Rufunsa are linked to the main, although not the earliest, tectonothermal event of the area (Section 1). This event is about 950 m.y. old and corresponds to the Lomamian (pre-Lufilian) orogenic phase in Zaïre (CAHEN, 1974). It is the earliest representative so far dated of a long sequence of structural and metamorphic episodes hitherto all regarded as "pan-african" which differentiate the Precambrian rocks along the borders of Zambia and Rhodesia (the Zambesi belt) from adjacent structural units.

Accepting that folds and fabrics of a single tectonic episode are broadly contemporaneous in areas about 100 km across, this is also the age of the first deformation (F_1) of the Katangan rocks of the Lusaka area. The 863 m.y. age of the Lusaka Granite is related to the F_2 phase of this area (see Section 1) ; it is, within the limits of error identical to rubidium-strontium results obtained in Central Zaïre and in the Copperbelt of Zambia and South-east Shaba. In the latter region microcline in veins near the base of the Roan Supergroup is dated at 888 ± 42 m.y.). This result has been interpreted as indicating the age of "a metamorphic environment caused by a relatively deep subsidence which can only have occurred during the early stages of the Lufilian orogeny" (CAHEN, 1974).

C. AGES OF LATE LUFILIAN FOLD OR METAMORPHIC PHASES.

It has recently been verified that, all other circumstances being equal, closure of the rubidium-strontium system to migration of radiogenic strontium (i.e. the threshold temperature below which isotopic mobility ceases), occurs later in the more alcaline rocks, the critical factor being the low strontium content (DELHAL *et al.*, 1971 ; CAHEN, DELHAL & LEDENT, 1976 ; see also BICKFORD and MOSE, 1975). This explains why the rather alcaline Lusaka Granite remained an open rubidium-strontium system some time after its zircon crystallized.

The same property clarifies the interpretation of the secondary (mineral) rubidium-strontium isochrons which, together with argon-potassium determinations yield younger limits to at least one late Lufilian event.

The two mineral isochrons for the Lusaka granite yield similar but slightly different results : A whole rock, potassium feldspar, plagioclase (analyses 12, 13 & 14 of table 2b) isochron (there are more mineral components in the rock and in the following one, so that the alignment of their representative points is significant) yields an age of 494 ± 22 m.y. with an initial ratio of 0.7652 ± 0.0037. This rock has $^{87}Rb/^{86}Sr$ ratio of 13.46 and a strontium content of 61.96 ppm, whereas specimen 71.533 (analyses 2, 6 & 7 of table 2a) yields 551 ± 5 m.y. with an initial ratio of 0.7323 ± 0.0004. The latter specimen has a $^{87}Rb/^{86}Sr$ ratio of 7.6296 and a strontium content of 87.9 ppm. The former system, with an appreciably lower strontium content has remained open longer than the latter.

There is thus no ground for believing that in the Lusaka Granite the 494 m.y. and 551 m.y. closures follow on different events.

Comparison between secondary isochrons for the Lusaka Granite and the granite intrusive into the Mpanshya Group can also be made ; to render the data entirely comparable, the comparison is limited to the whole-rock - biotite "isochrons" which in fact indicate the loss of radiogenic strontium in the biotite. In the Lusaka Granite (R.G. 71.533, n° 2 & 6), the age is 528 m.y. whereas for the granite intrusive into the Mpanshya Group (R.G. 71.513, n° 8 & 10) the age is 516 m.y.

This indicates that regional uplift consecutive to the final Lufilian event occurred in these two regions about 100 km apart, at approximately the same time.

In the Lusaka area, 551 m.y. is a younger limit to a late Lufilian event (probably the F_3 open folding on north-east trends) ; the potassium-argon data yield the same limit : 548 m.y.

BARR (1974) shows the last metamorphic events in the Rufunsa area to have been an amphibolite facies metamorphism associated with flat-lying folds followed by a downgrading of amphibolite facies assemblage to the quartz-albite-muscovite chlorite subfacies of the greenschist facies. Both these metamorphic events are sufficient to provoke or maintain isotopic mobility. In view of the parallelism in the uplifts of the Lusaka and Rufunsa areas, mentioned above, it may be concluded that the younger Lufilian event of the latter area occurred, as in the former, before c 550 m.y.

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VII.- APPENDIX, LOCALITIES.

Granite (R.G. 71.513) - 29°44'E - 15°01'S - Old Quarry, 5,2 km from Great East Road on track to Chief Sikebeta.

Porphyry (R.G. 71.514) - 29°44'E - 15°02'S - Small outcrop of porphyry dyke cutting limestone, 100m west of road to Chief Sirebeta, 3,5 km from Great East Road.

Lusaka Granite (R.G. 71.532) - Central unfoliated portion of the granite.

(R.G. 71.533) - Foliated margins of the granite.

(R.G. 71.535) - id.

(R.G. 71.536) - id.

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p. 50. Table 1, 6ème colonne (Isotopic compositions of Pb 206), 5ème ligne, lire : 72.563 au lieu de 72.513.
p. 50. Table 2a, 5ème colonne ($^{87}Sr/^{86}Sr$) 7ème ligne, lire : 0,7558 ± 0,0006 au lieu de 0,7558 ± 0,006.