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THE AGE OF THE VISTA ALEGRE PLUTON AND ITS BEARING ON THE REINTERPRETATION OF THE PRECAMBRIAN GEOLOGY OF NORTHERN ANGOLA [1]

by

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(3 figures and 2 tables)

RESUME.- L'âge U-Pb obtenu sur cinq fractions de zircon du pluton de Vista Alegre en Angola septentrional, soutenu par les données Rb-Sr sur roches totales, indique une mise en place il y a environ 2000 Ma. Cet âge est en contradiction avec l'âge post-Ouest Congolien, c'est-à-dire Précambrien tardif à Paléozoïque inférieur, préconisé par SCHERMERHORN (1976). Ce résultat permet de résoudre quelques-uns des problèmes qui, de longue date, se sont posés concernant la corrélation des successions précambriennes de part et d'autre de la frontière entre Bas Zaïre et Angola.

Les métasédiments dans lesquels le pluton de Vista Alegre est intrusif n'appartiennent pas au Supergroup Ouest Congolien comme suggéré auparavant mais font partie d'entités antérieures, probablement le Kimézien et peut-être le Zadinien inférieur du Bas Zaïre. Le véritable cycle Ouest Congolien débute en Angola septentrional par le dépôt de sédiments arkosiques qui correspondent à la base du Sansikwa du Bas Zaïre et remontent à quelque 1000 Ma.

ABSTRACT.- The age yielded by U-Pb analyses on five zircon fractions from the Vista Alegre Pluton of northern Angola, supported by Rb-Sr whole-rock data, indicates emplacement some 2000 Ma ago. This is in contradiction to the post-West Congo, i.e. Late Precambrian to Early Palaeozoic, age advocated by SCHERMERHORN (1976) and helps to resolve some of the long-standing problems in correlating the Precambrian geology of northern Angola with that of Lower Zaïre.

The metasediments intruded by the Vista Alegre Pluton do not belong to the West Congo Supergroup as was previously suggested but form part of pre-West Congo rock units probably correlatable with the Kimezian and possibly the Lower Zadinian of Lower Zaïre. The true West Congo cycle in northern Angola began with deposition of arkosic sediments which correspond to the basal deposits of the Sansikwa Group of Lower Zaïre at about 1000 Ma ago.

INTRODUCTION

In recent years it has become more and more evident that a misinterpretation of some aspects of the Precambrian geology of northern Angola is at the base of a long-standing disagreement between geologists who have worked south of the Lower Zaïre-Angola frontier and those active to the north of this boundary. However, reinterpretation of large tracts of the country just south of the border is possible on the basis of recent work in Lower Zaïre. This is not the case farther south, notably in the Vista Alegre area where, judging from existing maps, the geology is sufficiently different from that in Zaïre to prevent any reasonable extrapolation from the north. As this southern area plays an important part in the ideas of those geologists who explored the northwestern regions of Angola, a recourse to radiometric dating remained, in the absence of renewed detailed fieldwork, the only possibility of extending this reinterpretation southwards.

The Vista Alegre Pluton (14°45'E; 8°21'S, see fig. 1) is of particular interest in this debate since, according to SCHERMERHORN (1976), it intrudes the lower stratigraphic units of the Sansikwa Group, the basal unit of the Late Precambrian West Congo Super-

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group as defined by STANTON *et al.* (1963) (1). This interpretation was regarded as unlikely by one of us (A. K.) after fieldwork in northern Angola in 1973, and on the basis of field relationships in Lower Zaïre (LEPERSONNE, 1973), after which a considerably older age was suspected. We report here on the results of a geochronological study, using both the U-Pb and Rb-Sr methods, which proves beyond reasonable doubt that the age and stratigraphic relationships as inferred by SCHERMERHORN (1976) and STANTON *et al.* (1963) are erroneous as far as the Vista Alegre Pluton and the Sansikwa are concerned.

GEOLOGY

By 1964, a great deal of northwestern Angola had been covered by a number of geological maps, published at a scale of 1:250.000 as a result of systematic work by geologists of the Empresa do Cobre de Angola (E.C.A.) : H.R. KORPERSHOEK, L.J.G. SCHERMERHORN, W.I. STANTON. The area, just south of the frontier with Lower Zaïre to the west of 14°E was, however, less systematically surveyed and its geology is in part based on photogeological interpretation of observations by previous geologists (see KORPERSHOEK, 1964).

In this area the only major unconformity recognized by KORPERSHOEK (and his colleagues) is the one between the West Congo Supergroup (as defined in Angola) and a Basement Complex (STANTON and others, 1963; KORPERSHOEK, 1964).

The West Congo Supergroup of Angola corresponds to the West Congolian of Lower Zaïre (see LEPERSONNE, 1974; CAHEN, 1978a and b). However, in northern Angola a considerable succession of metasediments was added at the base of the Supergroup, whereas these rocks had always been considered in Zaïre to be disconformable or unconformable below the West Congolian. These units are, in Angola, ascribed to lower subdivisions of a vastly expanded Sansikwa (lowermost West Congolian), originally defined in this form in the more southerly regions not far from the Vista Alegre Pluton.

This view has not changed (SCHERMERHORN, 1976) and essentially no new field work has been carried out in this part of Angola since that of the E.C.A. geologists.

In Lower Zaïre field work had started much earlier, and is still continuing on a small scale. The field observations of SEKIRSKY, MASSAR, STEENSTRA & TACK (1958-1973), the photogeological work of LEPERSONNE, the petrographical investigations of DELHAL and the geochronological studies of CAHEN, DELHAL & LEDENT, have gradually (the successive stages of this evolution are summarily retraced in CAHEN *et al.*, 1978b) demonstrated the following sequence of events (only the more recent literature is mentioned):

1. Early Proterozoic deposition of a sequence of sedimentary and probably volcanic rocks : the Kimezian Supergroup;
2. Amphibolite facies metamorphism with migmatisation during the Tadilian orogenic event at 2088 ± 60 Ma (DELHAL & LEDENT, 1976). The foliation produced during this event generally follows NNE to ENE trends (CAHEN, 1977a and b).
3. Erosion and unconformity with overlying Zadinian observed at several places (LEPERSONNE, 1969; DELHAL & LEDENT, 1976).
4. Deposition of the lower Zadinian formations (Palabala volcanic rocks and micaschists, Matadi quartzites).
5. Diastrophism, erosion and disconformity to unconformity with Upper Zadinian observed at several places (MASSAR, unpubl.; STEENSTRA, 1973; LEPERSONNE, 1973; CAHEN, 1977a).
6. Outpouring of upper Zadinian tholeiitic lavas (TACK, 1975b) and deposition of sedimentary successions (CAHEN, 1977a).
7. Folding along axes usually trending NNE to ENE (CAHEN, 1977a), in contrast to trends in younger successions. The rocks mentioned under 8 rest on those enumerated under 6, 4 and 1.
8. Outpouring of mainly silicic lavas and formation of volcanic-detritic rocks resting on all older sequences; deposition of sedimentary sequences. These sequences belong to the Mayumbian (TACK, 1973a; 1973b; 1975; in prep.; LEPERSONNE, 1974, 1977, 1979; CAHEN, 1977a; CAHEN *et al.*, 1978b).
9. Diastrophism, including folding on at least a local scale (LEPERSONNE, 1977, 1979) and intrusion of Mativa, Kinyididi, Bata Kimenga, Yoyo and other granites (TACK, 1973a; 1973b, 1975; LEPERSONNE, 1977). The Mativa granite (and the Yoyo

(1) STANTON et al. (1963) and all other workers subdivided their West Congo "System" into several "series". We use here the internationally adopted lithostratigraphic nomenclature but emphasize that a formal definition of these units has not yet been achieved for Angola.

granite) is 1027 ± 56 Ma old or a little older (CAHEN *et al.*, 1978b). Disconformity .or unconformity observed along most of the contacts of the Mayumbian with the overlying Sansikwa (LEPERSONNE, 1977, 1979; photogeol. observations and, at Gombe, between the Sansikwa and the Mativa granite (TACK, 1973a).

10. Deposition of arenites, sandy pelites and pelites of the Gombe Subgroup of the Sansikwa Group of the West Congo Supergroup (TACK, 1973a; CAHEN, 1978a, 1978b).

11. Movements resulting in overlapping or disconformity between 10 and 12 (LEPERSONNE, photogeological observations).

12. Deposition of Sansikwa-Lungezi Subgroup (type Sansikwa of Lepersonne, 1951) of the Sansikwa Group of the West Congo Supergroup (CAHEN, 1978a).

13 and following : deposition and deformational episodes of the rest of the West Congo Supergroup. The main greenschist facies to amphibolite facies metamorphism occurred at 734 ± 10 Ma and a later phase occurred between 734 ± 10 Ma and about 600 Ma ago (CAHEN *et al.*, 1976).

Only two regional metamorphic event are recognized, the first associated with the Tadilian orogeny 2088 ± 60 Ma ago and the second with the main phase of the West Congo orogeny 734 ± 10 Ma ago. If the intervening events were accompanied by metamorphis, it was everywhere of lower grade than that attained during the West Congo orogeny.

In NW Angola events 1 and 2 are recognized and are respectively called "Basement Complex" and "Basement Orogeny" (KORPERSHOEK, 1964). Events 3 - 11 are not identified or are merged together, all deformational phases being ascribed to the West Congo orogeny and formations listed under 4, 6 and 9 above attributed to an expanded Sansikwa. Granites (9) are considered as post-West Congo Supergroup in age (STANTON *et al.*, 1963; SCHERMERHORN, 1976).

Detailed correlations from one side of the frontier to the other have now been worked out (CAHEN, 1977a; LEPERSONNE, 1979). A complete account of these correlations would be too involved for the purpose of this paper so that only three examples are given :

- The "Upper Arkose or S1s" unit of northern Angola as defined by STANTON *et al.*, (1963) corresponds
  a) to the base of the Sansikwa Group of Lower Zaïre,
  b) to Mayumbian volcanic-sedimentary rocks,
  c) to Zadinian metasediments,
  depending on the regions considered.
- The Cocavuma or "S2" unit of Angola corresponds at one place to part of the Sansikwa of Lower Zaïre, and at another to Zadinian pelites.
- The Zadinian (both lower and upper) corresponds to the "Western facies" of the Sansikwa in Angola as defined by STANTON *et al.* (1963) whereas an "eastern facies" in reality comprises some Zadinian, the Mayumbian, the Yoyo granite and some true Sansikwa.

Event 12, 13 and following are interpreted similarly on both sides of the Angola-Zaïre frontier.

According to KORPERSHOEK (1964) the interpretation of part of the "normal" Sansikwa of the northern area of the Noqui-Tomboco map sheet is based on a photogeological link from the more southerly region studied by SCHERMERHORN.

The area around the Vista Alegre Pluton has been studied by SCHERMERHORN (1976 and unpublished). In the eastern part of the map (fig. 1) beds with regular NNW trends comprise the "Terreiro" or upper subgroup of the Angola Sansikwa and the succeeding formations of the West Congo Supergroup. This part corresponds to the West Congo Supergroup of Zaïre with the Sansikwa of Lower Zaïre at its base. The latter is younger than 1027 ± 56 Ma (CAHEN *et al.*, 1978b). Samples of S3 ("Terreiro") quartzite of STANTON *et al.* (1963) collected some 80 km to the SE of Vista Alegre near Samba Caju yielded a palaeomagnetic pole position which is in agreement with this age assignment (JONES *et al.*, in prep.).

In the western part of the Vista Alegre area, the Vista Alegre Pluton is intrusive into the "Lundo Arkoses" of SCHERMERHORN (1976) which, together with other sequences marked S1, are assigned to the lower Sansikwa of Angola of the Lulumba Subgroup. The S2 or Uonde Subgroup is considered to be the middle Sansikwa and is also represented in this area. The Lulumba Subgroup rests unconformably upon a Basement Complex (SCHERMERHORN, 1976).

The structural trends are irregular and generally transverse to the regular NNW trends of rocks in the eastern part of the sheet. This is ascribed by SCHERMERHORN (1976) to cross-folding. This cross-folding does not penetrate into the regular eastern part of the map.

Near the bridge across the River Dange at 14° 47'E, 8°26'S, between the bridge itself and the old

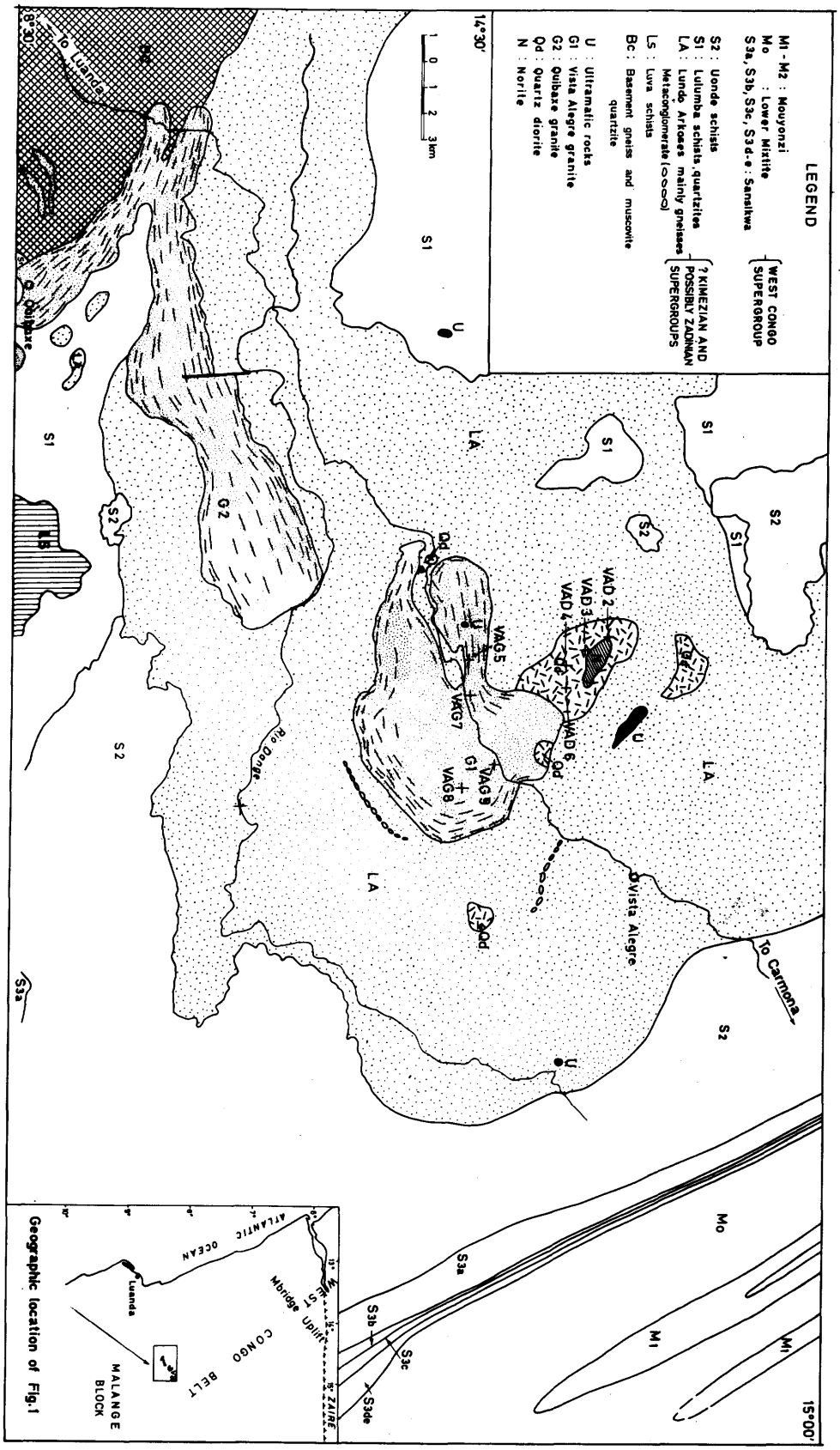

Figure 1.- Simplified geological map of the Vista Alegre and Quibaxe regions, showing location of Vista Alegre Pluton and sample sites (adapted from SCHERMERHORN, unpublished and 1976, but with our lithostratigraphic interpretation).

Forte do Dange on the road from Vista Alegre southwards to the locality formerly called Salazar, KRÖNER (1974) observed biotite feldspar gneiss with migmatitic features within SCHERMERHORN's Lundo Arkoses, showing strong isoclinal recumbent folding on EW axes, upon which are superimposed small-scale open folds with approximately NS orientation.

GEOCHRONOLOGY

Four specimens of Vista Alegre granite (VAG 5, 7-9), one specimen of granite within diorite (VAG 6), and three specimens of quartz-diorite (VAD 2-4) were collected in 1973 by the second author accompagnied by H. CORREIA then of the University of Luanda (Angola). The samples, each at least 10 kg in weight, were crushed at Luanda. Further mineral separation and all analyses were carried out in Tervuren and Brussels (Belgium).

Both U-Pb and Rb-Sr investigations were undertaken as part of the programme of the Belgian Centre for Geochronology. The decay constants used are those recommended by the I.U.G.S. Subcommission on Geochronology (STEIGER & JÄGER, 1977) and are given in tables 1 and 2. The computations follow WILLIAMSON (1968) for Rb-Sr and YORK (1969) for U-Pb. The errors on the results are given at the 1 σ level.

Crushed rock samples were processed as outlined by DEUTSCH *et al.* (1965). Sample dissolution was carried out following KROGH (1971); lead and uranium analyses were made in a Varian MAT TH5 mass spectrometer of the Belgian Centre of Geochronology at the Université Libre de Bruxelles. Isotope ratios for modern lead were used for common lead corrections and are given in table 1. The laboratory errors are for $^{206}Pb/^{238}U = 2$ o/o, for $^{207}Pb/^{235}U = 2{,}5$ o/o. Pb isotopic composition for the USGS 981 standard lead was mea-

Table 1.- U-Pb analytical data on zircon fractions from diorite (VAD) and granite (VAG) of the Vista Alegre Pluton

Spec. N°	U ppm	tot Pb ppm	rd Pb ppm	Pb204	Pb206	Pb207	Pb208	Pb207/Pb206	Pb206/U238	Pb207/U235
VAG 5/9a	90.2	85.7	82.0	0.060	72.339	9.460	18.141	1950 ± 10 0.119596	1843 ± 34 0.3306	1896 ± 24 5.4575
VAG 5/9b	274	94.7	89.6	0.073	71.880	9.770	18.277	1988 ± 10 0.122288	1604 ± 30 0.2826	1779 ± 23 4.7674
VAD 1/3	601	213	212	0.007	72.348	8.804	18.841	1962 ± 5 0.120385	1680 ± 30 0.2978	1809 ± 18 4.9424
VAD 4/6a	406	137	133	0.039	75.739	9.631	14.591	1958 ± 10 0.120125	1664 ± 30 0.2945	1798 ± 20 4.8794
VAD 4/6b	253	81.1	79.1	0.034	75.323	9.582	15.061	1988 ± 29 0.122142	1580 ± 29 0.2777	1755 ± 20 4.6394

constants employed : $\lambda^{238}U = 1.55125 \times 10^{-10}\,a^{-1}$; $\lambda^{235}U = 9.8485 \times 10^{-10}\,a^{-1}$; $^{238}U/^{235}U = 137.88$

correction lead = 1, 18.6, 15.7, 38.9

errors : 2 σ

sured as : $^{207}Pb/^{206}Pb = 0.91415 \pm 0.0014$, $^{208}Pb/^{206}Pb = 2.1633 \pm 0.0004$, $^{204}Pb/^{206}Pb = 0.59195 \pm 0.00022$.

The zircon crystals are brown, predominantly transparent with frequent inclusions and infrequent zoning; no overgrowths were observed. The zircons from granites are mostly subhedral and larger than those from diorites which are generally subhedral to rounded.

Rb and Sr concentrations were measured at Tervuren by XRF techniques on a SRS 1 sequential X Ray spectrometer. The accuracy of duplicate analyses, checked by interlaboratory comparisons and comparison with isotope dilution is, for specimens with more than 50 ppm of Rb and of Sr, well within 2 o/o (DEMAIFFE *et al.*, 1979). The dissolution techniques are described by DEUTSCH *et al.* (1965). All $^{87}Sr/^{86}Sr$ ratios were normalized to $^{86}Sr/^{88}Sr = 0.1194$. The NBS $SrCO^3$ standard nº 987 is 0.71015 ± 0.0008 - (2 σ average of 7 measurements).

U-Pb results.

Five zircon fractions (table 1 and fig. 2) two from granites, two from associated quartz diorites and one from quartz diorite and granite occurring within diorite, are well aligned on a lead-loss chord in a Concordia diagram. The upper intercept of the calculated regression line with Concordia is at 1940 Ma (MSWD : 0.042) while the lower intercept yields a geologically meaningless negative age of - 328 Ma. However, the 1 σ error of the regression line is large enough to allow positive lower intercepts with Concordia between 0 and 536 Ma which are statistically correct and geologically meaningful (fig. 2). The ages are between 1967 Ma (for zero intercept) and 2047 (for 536 Ma intercept) respectively and, since the rocks were intruded in a molten state (SCHERMERHORN, 1976; KRÖNER in 1973), we consider this range as the best approximation to the age of crystallization and intrusion of the Vista Alegre Pluton.

A post-tectonic West Congo age as postulated by SCHERMERHORN (1976) would necessitate that the zircons are inherited from an intrusive magma, emplaced at any time after the main phase of the West Congo orogeny, i.e. after 734 ± 10 Ma. Such an inheritance would not occur without some lead loss at the time of the post-tectonic West Congo intrusion. The points would plot on a chord linking about 2000 Ma with any post-West Congo age or, if the episodic lead loss at the post-West Congo age was accompanied by

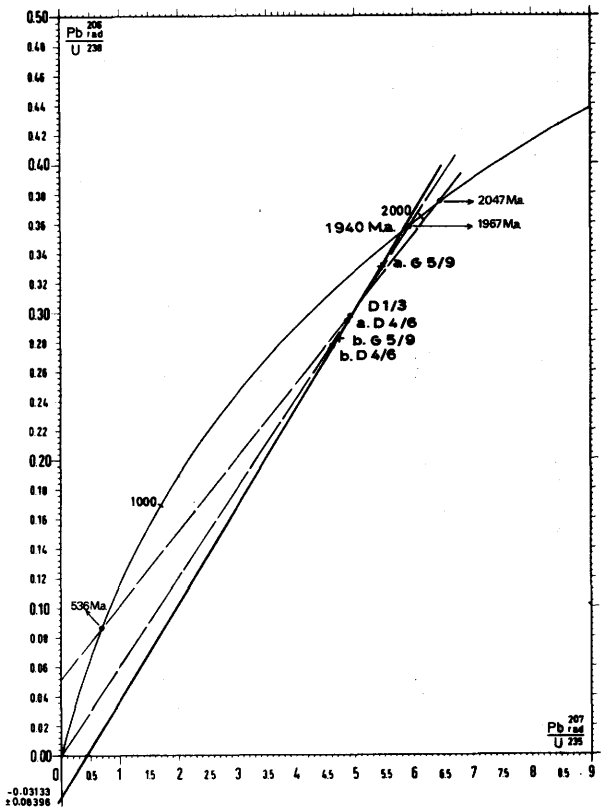

Figure 2.- Concordia diagram for five zircon fractions from the Vista Alegre Pluton

continuous loss, the points would plot within a triangle the summits of which would be about 2000 Ma, a post tectonic West-Congo age and zero. It is obvious from fig. 2 that this is not the case. This is not surprising since inherited zircons with traces of their origin are extremely rare in intrusive magmatic rocks of deep-seated origin which, on the strength of the field data, is the case for the Vista Alegre Pluton. Neither is there any microscopic evidence in favour of inheritance.

Rb-Sr results

Eight whole-rock samples and four mineral concentrates were analyzed (table 2 and fig. 3). The representative points of the whole-rock samples plot on two aligments : points D6, G7 and G5 on an upper alignment and points D4, G8 and G9 on a lower one; points D3 and D2, nearest the origin are within limits of error compatible with both lines. Therefore two possibilities must be examined :

a) The upper line is defined by five points (D3, D2, D6, G7 and G5) its computation yields 1958 ± 35 Ma, Ri : 0.7041 ± 0.0003, MSWD : 2.71; the

lower alignment, defined by the minimal number of three points (D4, G7 and G9) yields 1655 ± 78 Ma, Ri : 0.7044 ± 0.0011, MSWD : 0.008.

b) The upper line is defined by three points (D6, G7 and G5), the result being : 1803 ± 67 Ma, Ri : 0.7068 ± 0.0011, MSWD : 0.26; the lower aligment is defined by five points (D3, D2, D6, G7 and G5) and yields 1619 ± 29 Ma, Ri : 0.7050 ± 0.0002, MSWD : 0.16.

Irrespective of the choice between the two possibilities, the following conclusions may be drawn at this stage : each of the lines is defined by points representing quartzdiorite and granite; this was also the case for the Discordia chord in the Pb/U method : the diorite and the granite are therefore co-magmatic, in accordance with the views of SCHERMERHORN (1976).

- No whole rock points fall below the alignments of 1650 ± 100 Ma nor above that of 2006 ± 45 Ma (this age corresponds to that indicated for the upper alignment calculated by four points only : D3, D2, D6 and G7). It is therefore clear that the rock is not younger than 1500 Ma and must thus be of pre-West Congo age, a conclusion in contradiction to SCHERMERHORN'S views of 1976.

The first of the two above mentionel possibilities is to be preferred for the following reasons :

- The two points D3 and D2 which might plot on both alignments have the poorest Rb content and it is extremely unlikely that, all other factors being equal, they would have closed later than the two samples which are richest in Rb (G7 and G5).

- The age obtained for the upper alignment : 1958 ± 35 Ma (or 2006 ± 45 Ma if only the four best aligned points are computed) is concordant with the more probable ages within the range 1940 ± 107 Ma unequivocally obtained by U-Pb.

- If D3 and D2 were assigned to the lower alignment the position of D6, G7 and G5 would be unexplicable :

Table 2.- Rb-Sr analytical data for whole rock (W.R.) samples and mineral concentrates of diorite (VAD) and granite (VAG) of the Vista Alegre Pluton.

N° and nature of specimen analyzed (see appendix)		Rb(+) ppm	Sr(+) ppm	$^{87}Sr/^{86}Sr$	$^{87}Rb/^{86}Sr$ ± 2 %
VAD2	W.R.	29.0	337	0.7107 ± 0.0003	0.2491
VAD3	W.R.	18.9	436	0.7080 ± 0.0004	0.1256
VAD4	W.R.	94.1	367	0.7221 ± 0.0001	0.7429
VAG5	W.R.	135	232	0.7503 ± 0.0003	1.6889
VAD6	W.R.	88.4	325	0.7272 ± 0.0001	0.7886
VAG7	W.R.	141	280	0.7451 ± 0.0008	1.4626
VAG8	W.R.	145	365	0.7319 ± 0.0006	1.1522
VAG9	W.R.	147	302	0.7380 ± 0.0003	1.4127
VAG7	plagioclase + quartz	9.2	29.0	0.7395 ± 0.0002	0.9231
VAG7	microcline	191	134	0.7680 ± 0.0006	4.1487
VAG9	plagioclase + quartz	14.9	50.4	0.7323 ± 0.0016	0.8569
VAG9	microcline	168	210	0.7504 ± 0.0002	2.3240

constant adopted : $\lambda\ ^{87}Rb = 1.42.10.^{-11}\ _{xy}^{-1}$

(+) XRF for Rb and Sr by J. Delvigne and F. Mathonet-Durez, Tervuren

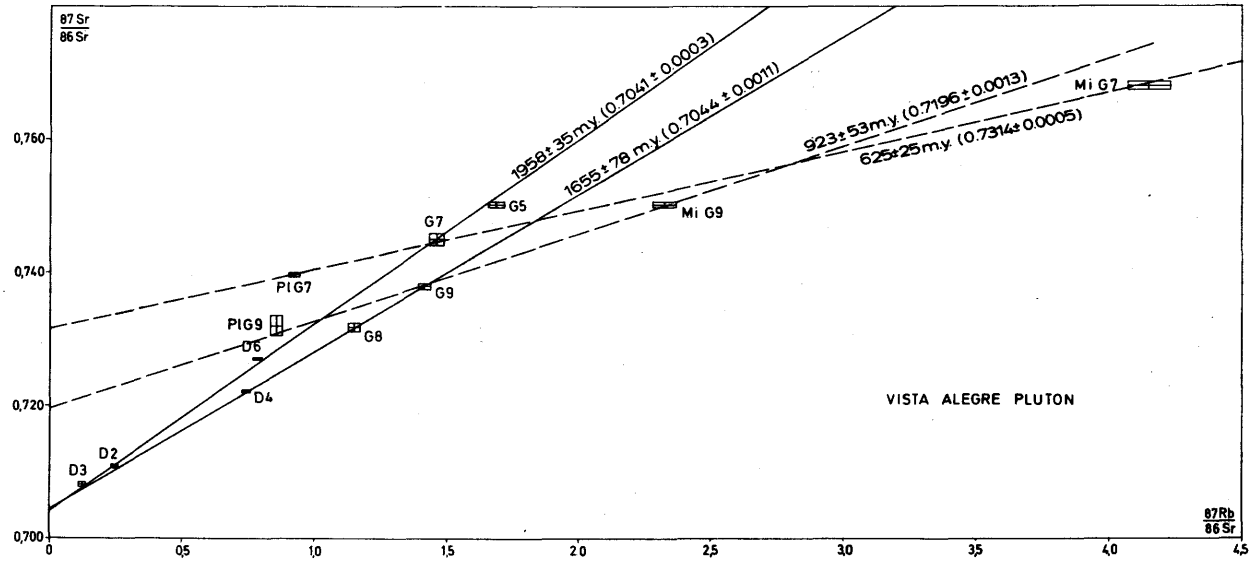

Figure 3.- Rb-Sr isochrons for whole rock samples and mineral concentrates from the Vista Alegre Pluton.

either the line yielding 1619 ± 29 Ma is the primary isochron and G7, G5 and D6 would be vestiges of an older intrusive which is in contradiction with the conclusion that the various facies of the pluton are comagmatic and with the U-Pb data, or the 1619 ± 29 Ma line is the result of an isotopic resetting. In this case an approximation to the original age of the pluton is obtained by calculating the model age of the average composition of the pluton with an initial ratio such as 0.701 or 0.702 : the result according to the value chosen, is between 1878 and 1924 Ma. In relation to this line, neither D6, G7 nor G5 which are the richest in Rb are correctly placed since they should fall below the model line as do G8 and G9 which are poorer in Rb.

The Rb-Sr data therefore point to an age of about 2000 Ma for the Vista Alegre pluton and, although less reliable than the Pb/U result, are in agreement with it.

The significance of the 1655 ± 78 Ma line defined by D4, G8 and G9 is rather uncertain. The line is defined by three points only so that a coïncidence may not be ruled out; the initial ratio (0.7044 ± 0.0011) is, within limits of error, identical with that of the line (0.7041 ± 0.0003) which appears to rule out rehomogenization but is compatible with total ^{87}Sr loss in all three rocks at 1655 ± 78 Ma. A thermal event influencing discrete parts of the pluton is therefore not excluded and it is noteworthy that postgranite ultramafic intrusives, one of which intrudes the westhern part of the Vista Alegre granite are mentioned by SCHERMERHORN (1976). No tectonic episode of an age similar to 1655 ± 78 Ma is known in Angola or Lower Zaïre, but plutonic manifestations of comparable age exist further south in Angola (see CAHEN & SNELLING, in preparation).

The influence of the Late Precambrian West Congo orogeny is not detected at the whole-rock level in the Vista Alegre samples and this is ascribed to the low alkalinity and the comparatively high strontium content of these rocks comparable to those of the Boma and Mpozo-Tombagadio migmatites (Lower Zaïre) which are also insensible to the influence of the West Congo orogeny at the whole-rock level (DELHAL & LEDENT, 1976). In contrast, more alkalic intrusives with low Sr contents in Lower Zaïre, such as the end-Mayumbian Yoyo and Mativa granites, were completely rehomogenized with respect to their strontium isotopic system during the West Congo orogeny (CAHEN *et al.*, 1978b).

Mineral concentrates were therefore separated from the Vista Alegre samples and were analyzed isotopically in order to try and detect the influence of the orogeny.

The potassium feldspar, plagioclase and whole-rock of VAG9 are colinear and yield an age of 923 ± 53 Ma with Ri : 0.7196 ± 0.0013, MSWD : 1.21 (fig. 3).

The same minerals for VAG7 are also colinear,

yielding an age of 625 ± 25 Ma, Ri : 0.7314 ± 0.0005, MSWD : 1.36. This is a typical West Congo "closure" age (CAHEN *et al.*, 1976; DELHAL & LEDENT, 1978; CAHEN *et al.*, 1978a).

The difference between the two secondary isochrons is explained by the fact that the potassium feldspar of VAG7 has a $^{87}Rb/^{86}Sr$ ratio nearly twice as great (4.1487) as that of VAG9 (2.3240) and that its strontium content is significantly lower at 134 ppm as against 210 ppm in VAG9.

This is in line with similar results obtained on the Noqui granite and other intrusive rocks in Lower Zaïre (CAHEN *et al.*, 1976). In our opinion the influence of the West Congo orogeny has resulted in a more thorough transfer of radiogenic strontium out of the G7 microcline than out of the G9 microcline.

CONCLUSION

Age

The U-Pb data clearly indicate an age of about 2000 Ma for the crystallization and intrusion of comagmatic granite and quartzdiorite, after the Tadilian orogeny (event 2 above). This conclusion is supported by the Rb-Sr data. The pluton is obviously considerably older than the West Congo Supergroup. The 1655 ± 78 Ma age indication, if meaningful, is also older than the West Congo Supergroup whereas the mineral isotope systems have been opened to varying degrees during the Late Precambrian west Congo orogeny as shown, for example, by the 625 ± 25 Ma whole-rock mineral isochron.

Stratigraphic implications of the age data

These are, for the Vista Alegre area, and probably for the whole of northwestern Angola as follows. The West Congo Supergroup begins with S3 or "Terreiro" of STANTON *et al.* (1963) which is continuous with the Sansikwa of Lower Zaïre. The palaeomagnetic pole position of JONES *et al.* (in prep.) for Terreiro quartzites to the south of Vista Alegre indicates an approximate age of about 1000 Ma, in agreement with the inferred age for the Sansikwa in Lower Zaïre.

The stratigraphic units below the Terreiro do not belong to the Sansikwa Group and are of pre-West Congo age. The names "Lulumba" and "Uonde", introduced for these rocks by STANTON *et al.* (1963) should be abandoned or redefined in their type area as names for pre-West Congo formations or groups.

We suggest that these rocks are comparable to the Kimezian and/or possibly the Lower Zadinian as defined in Lower Zaïre. The Basement Complex which unconformably underlies them may belong to a pre-Kimezian entity since some neighbouring age determinations on migmatitic gneisses by MENDES (unpublished) yield a Rb/Sr errochron age greater than 2600 Ma (with an initial ratio of 0.712) and the rocks thus appear to be definitely older than the Kimezian. At present it is just as likely that the "Basement Complex observed by SCHERMERHORN in the Vista Alegre area belongs to a pre-Kimezian entity than to the Kimezian.

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APPENDIX

VAD.2 (R.G. 71.590)	fine-grained diorite, in places sheared; the sample is from an unsheared and unfoliated part.
VAD. 3 (R.G. 71.591)	very fresh massive fine-grained diorite, unfoliated.
VAD. 4 (R.G. 71.592)	not so fresh, rather coarse, unfoliated diorite.
VAD. 5 (R.G. 71.594)	coarse granite, sheared and partly chloritized. Large potassium-feldspar porphyroclasts show aligment.

VAD. 6 (R.G. 71.593)	fine-grained granite, within diorite, reasonably fresh, unfoliated.
VAG. 7 (R.G. 71.595)	foliated coarse granite, not too fresh, similar to VAG. 5, not sheared.
VAG. 8 (R.G. 71.596)	foliated coarse granite, not too fresh, not sheared.
VAG. 9 (R.G. 71.597)	fresh coarse unfoliated granite from road cut.

N.B. VAD. 2...: field numbers.

R.G. 71.590...: numbers in register of Geological Departement of Musée royal de l'Afrique centrale, Tervuren, Belgium.