

## GEOTECTONIC OUTLINE OF ANGOLA

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### RÉSUMÉ

*Ce travail est destiné à présenter, pour la première fois, une esquisse tectonique de l'Angola. En premier, les principales unités géotectoniques de ce pays sont définies et caractérisées: le bouclier angolais, d'âge égal ou supérieur à 2000 millions d'années; l'arc du Zaïre, d'âge Pan-Africain; l'arc de Moçâmedes; d'âge encore mal déterminé mais se plaçant entre le dépôt des séries du groupe du Congo Occidental et les intrusions alcalines du Sud de l'Angola; le graben de Cassange d'âge triasique-jurassique et le horst de Cuanza ainsi que l'arc du Congo, d'âge jurassique probable.*

*En second, suit une description succincte du complexe de base de l'Angola en mettant en évidence les principaux travaux de caractère géochronologique.*

*Il est montré que les âges les plus anciens se rencontrent dans le prolongement du bouclier du Kasai au Sud-Ouest (près de 2.900 millions d'années).*

*L'existence du système Kibaras en Angola est discutée et il est conclu que ce nom est utilisé improprement, car la ceinture orogénique qu'il définit ne passe pas dans la région étudiée; il faudrait utiliser le terme de Séries métamorphiques du Nord-Est de l'Angola.*

*Au Sud de l'Angola, il est admis que le grand complexe gabbro-anorthosique (Kunene basic complex) s'est formé par suite d'une collision de plaques au Précambrien moyen. L'existence de nombreux dykes parallèles, orientés N60° W, datés d'environ 1900 M.A., est due à la réactivation de la Plate-forme Eburnéenne.*

*Il existe une ceinture orogénique, d'âge 1500-1700 M.A., à peu près parallèle à la côte et passant par les villes de Malange, Nova Lisboa, Silva Porto et Sá da Bandeira; on y trouve de nombreux noyaux de roches plus anciennes.*

*Cette bande est interprétée comme le produit d'un événement thermomagmatique, pour lequel l'auteur a proposé, dans un travail antérieur, le nom d'Événement Namib (1675±75 M.A.). Une seconde ceinture orogénique apparaît à l'ouest de la précédente. Les âges habituellement rencontrés dans granites s.l., des gneiss et des métasédiments, sont de l'ordre de 1300 M.A. A l'ouest de cette seconde ceinture, il semble en exister une autre où l'on rencontre des âges de l'ordre de 950±100 M.A. Il pourrait s'agir là d'un rajeunissement isotopique de la ceinture précédente ou d'un autre événement thermique de grande amplitude.*

*Sur cet ensemble l'orogénèse Pan-africaine s'est marquée par l'apparition de nouvelles ceintures orogéniques: Damara, Congo Occidental et Malombe-Macondo.*

*Suit une description de l'évolution phanérozoïque de l'Angola, basée sur les principes de TUYEZOV (1966), intégrant tous les phénomènes géotectoniques apparus au cours des différentes étapes de l'évolution d'une plate-forme: transition, stabilisation et réactivation. L'étude de l'ambiance géotectonique de la mise en place des roches alcalines et des granites intrusifs est, ici, plus particulièrement développée. A la fin de l'article est fournie une liste complète des déterminations géochronologiques intéressant l'Angola, avec toutes les références les concernant.*

### SUMMARY

*This paper presents for the first time a tectonic outline of Angola. It begins by defining and characterizing the principal geotectonic units of the basement. A description of the phanerozoic evolution is given according to the principles of Tuyezov (1966). Evidence is presented for the genetic processes of the emplacement of plutonic and hypabyssal rocks. Finally, a complete list is given of all the radio-isotopic geochronological ages existing in the Angolan part of the African Platform. Also the origin of the geochronological data and the values utilized in the respective calculations are given.*

## RESUMO

Neste trabalho, apresenta-se pela primeira vez, um esboço tectónico de Angola. Começamos por definir e caracterizar as principais unidades geotectónicas de Angola: Escudo Angolano, de idade igual ou superior a 2.000 milhões de anos; Arco do Zaire, de idade Pan-Africana; Arco de Moçâmedes, de idade não muito bem determinada, mas compreendida entre a deposição do Grupo do Congo Ocidental e as intrusões alcalinas do Sul de Angola; Graben do Cassange de idade Triásica-Jurássica e Horst do Cuanza e Arco do Congo, provavelmente de idade jurássica.

Segue-se uma descrição sucinta do complexo de base de Angola evidenciando os principais trabalhos de índole geocronológica.

Mostra-se que as idades mais antigas se situam no prolongamento do escudo do Kasai para sudoeste (cerca de 2.900 milhões de anos). Discute-se a existência do sistema Kibaras em Angola e conclui-se que o nome está impropriamente usado por aquele cinturão orogénico não passar na área estudada, devendo ser usada a designação de Séries metamórficas do Nordeste de Angola.

No Sul de Angola, admite-se que o grande complexo gabro — anortosítico (Kunene basic complex) se desenvolveu como o resultado de uma colisão de placas no precâmbrico médio, e que a existência de numerosos diques paralelos e orientados N 60°W, com cerca de 1900 milhões de anos de idade, são o resultado da reativação da Plataforma Eburneana.

Formando um cinturão sub-paralelo à costa, e passando pelas cidades de Malange, Nova Lisboa, Silva Porto e Sá da Bandeira, de idade 1500-1700 milhões de anos, ocorrem numerosos núcleos antigos. Esta faixa é interpretada como sendo o resultado de um evento termomagnético a que, em trabalho anterior o autor propôs o nome de Evento Namib (1675±75 m.a.).

Numa segunda faixa paralela à anterior, são vulgares idades da ordem dos 1300 milhões de anos afetando granitos s.l., gnaisses e metassedimentos. A oeste desta segunda faixa, parece ocorrer uma outra com idades da ordem dos 950±100 milhões de anos. A sua interpretação poderá ser a de um rejuvenescimento isotópico ou revelar só por si um outro evento térmico de maior amplitude.

Sobre este conjunto evoluíram os cinturões de idade Pan-Africana: Damara, Congo Ocidental e Malombe-Macondo.

Faz-se em seguida uma descrição da evolução fanerozoica de Angola, seguindo os princípios de Tuzeyov (1966) procurando enquadrar todos os processos geotectónicos que ali ocorreram, nos diferentes estágios de evolução de uma plataforma: transição, estabilização e reativação, sendo dada ênfase especial ao ambiente geotectónico de implantação das rochas alcalinas e dos granitos intrusivos.

Terminamos fornecendo uma lista completa de todas as determinações geocronológicas, em Angola, com indicação da sua origem e principais valores usados nos cálculos.

## ГЕОТЕКТОНИЧЕСКИЙ ОЧЕРК АНГОЛЫ

## РЕЗЮМЕ

Цель настоящей работы — представить, в первый раз, тектонический очерк Анголы. Во-первых, даются определение и характеристика главных геотектонических единиц этой страны: ангольский щит, возрастом в 2000 миллионов лет или более; заировская дуга, пан-африканского возраста; мосамедова дуга, возраст которой еще не был точно определен, но относится к периоду между осадением серий группы западного Конго и щелочными интрузиями южной Анголы; грабен Кассанге, триасо-юрского возраста, и горст Куанза, а также дуга Конго, вероятно юрского возраста.

Во-вторых, кратко описывается основной комплекс Анголы, при чём выделяются важнейшие работы геохронологического порядка.

Показано что элементы самого древнего возраста встречаются в продолжении казайского щита на юго-западе (около 2900 миллионов лет).

Обсуждение вопроса системы Кибарас в Анголе приводит к выводу, что наименование это в данном случае неверно, так как определяемый им орогенический пояс не проходит через изученную область; вернее употреблять термин — метаморфические серии северо-восточной Анголы.

Допускается, что крупный габбро-анартозитовый комплекс (Kunene basic complex), на юге от Анголы, образовался вследствие столкновения плит во время среднего Докембрия.

Наличие многочисленных параллельных дайк, с направлением С 60° — З, возрастом около 1900 М.л., является последствием реактивации эбурнеанской платформы.

Существует орогенический пояс, возрастом в 1500-1700 М.л., приблизительно параллельный берегу и проходящий через города Маланге, Нова Лисбоа, Сильва Порто и Са да Бандейра; в нем наблюдается множество ядер более древних пород.

Эта полоса интерпретируется как продукт термомагматического явления, которое автор, в предыдущей работе, предложил назвать Явлением Намиб (1675±75 М.л.). Второй орогенический пояс появляется на западе от первого. Граниты, в широком смысле слова, гнейсы и метаседименты имеют обычно возрасты порядка 1300 М.л. На западе от этого второго пояса повидимому существует еще другой, где наблюдаются возрасты порядка 950±100 М.л. Возможно, что здесь произошло изотопическое омоложение предыдущего пояса или какое нибудь иное термическое явление широкой амплитуды.

Во всей этой совокупности пан-африканский орогенез характеризуется появлением новых орогенических поясов: Дамара, Западный Конго и Маломбе-Макондо.

Следует описание фанерозойского развития Анголы, на основе принципов Туйезова (1966), объединяющих все геотектонические явления которые произошли в течение различных этапов развития платформы: переход, стабилизация и реактивация. Здесь особенно подробно изучаются геотектонические обстоятельства размещения щелочных пород и интрузивных гранитов. В конце статьи приводится полный список определяющих геохронологических данных для Анголы, с соответствующими справками.

## INTRODUCTION.

Due to advances in geological concepts, a complete knowledge of the regional tectonics is necessary to comprehend the evolution of a given region.

A large number of data from, both field and laboratory are necessary to construct a tectonic map. The first group is fundamentally a knowledge of the stratigraphic location and preferred directions of the various units of the basement complex. The second group can be divided into two, 1. a complete petrography of the units, and 2. their geochronology.

Half of the territory of Angola is not yet mapped geologically. There is a lack of tectonic information on the basement complex, and geochronological data are scarce and unsystematically collected, so that their interpretation is difficult. The purpose of this paper is to integrate the currently available information from all sources (including those outside Angola) in order to prepare an interpretation of the geological history of Angola.

There are about 400 geochronological dates from Angola, two thirds of which are from the South-West quadrant of the country. There are few previous attempts (less than two dozen publications) to correlate regional geochronological data with geotectonic data. Of these, only MENDES (1968), MENDES and VIALETTE (1972) and TORQUATO (1974) try to interpret the evolution of the entire Angolan territory. Others either describe purely local features with few observations, or, as in the case of CARVALHO (1969 and 1972) attempt to interpret major regions, by collecting and integrating data published by others.

A Summary of the available analytical findings is given in appendices 1, 2 and 3. In the attached diagram we tried to present all known ages, as well as the methods of analysis and the material utilized.

## CHARACTERIZATION OF THE PRINCIPAL GEOTECTONIC UNITS OF THE BASEMENT COMPLEX.

### General.

Since this is the first time that a Tectonic Outline of Angola has been presented and because some of the geotectonic elements presented here have been defined only in a publication of limited circulation (TORQUATO, 1974), we shall try to give a complete picture of the problem.

In order to elaborate the Tectonic Outline of Angola we have followed the models suggested by ALMEIDA (1966, 1969 and 1971) for the preparation of the Tectonic Map of Brazil since these are suitable for this purpose, taking into account the geographical situation of Angola in the maps of continental reconstruction.

There is no doubt that errors and omissions will be found in this Tectonic Outline, however, it is always necessary to have a first approximation which can then be improved by future investigations.

The limits of the various geotectonic provinces were determined mainly by coordinating the geochronological data with the Geological Outline of Angola by MOUTA (1954) on the scale of 1/2 000 000

with geological sheets of the High Zambezi and Western Congo Group regions on the scale of 1/250 000 and using also the work of TORQUATO (1974) and Torquato and others (in preparation) respectively for the desert regions of Moçâmedes and East of Sá da Bandeira. The localization of alkaline rocks was taken from LAPIDO-LOUREIRO (1967 and 1973). We have learned that a new Geological Map of Angola will be published shortly on the scale of 1/1 000 000. When this becomes a reality, a new approximation of this tectonic outline can be attempted.

#### *Angolan Shield (Escudo Angolano).*

The term 'Angolan Shield' is used to denote a part of the Congo Craton, which is an integral part of the present African Platform. It is a large anteflexure, practically without sedimentary cover, located in Angola between the meridian 18° East and the Atlantic Ocean and the parallel 10° South and the frontier with South-West Africa.

Its age is debatable and probably is very complex, since the values range from about 500 millions upward to more than 2 000 million years; however, we can affirm that the Angolan Shield was consolidated starting from a paraplatform of the Eburnean age, and has suffered during the Pre-cambrian various orogenic events that gave it certain characteristic features as we shall see later on. In designating these, the concepts of HUANG (1954) were used; he classified platforms as ortho and paraplatforms, according to the type of sedimentation, folding and magmatism.

#### *Zaire Arch (Arco do Zaire).*

In the NW region of Angola, limited on the East by the fold belt of the West Congo Group, there is an arched area whose axis is situated offshore in the Atlantic Ocean, with approximate orientation of N 25° W. This arch, in the initial stage of reconstruction between South America and Africa, could be interpreted as a great anteflexure whose flanks would be respectively the coastal region of Angola, here defined as the Zaire Arch, and the Brazilian region between the outcrops of Macaubas Formation and the sea.

Its age cannot be determined exactly because of the lack of radiometric dating covering the region. However, taking as a basis the determinations of CAHEN *et al.* (1963)—for the Boma migmatites—and DELHAL *et al.* (1971)—for the Noqui alkaline granite—and because of the fact that the erosion surface cuts indistinctly the rejuvenated gnaissic/migmatitic region as well as the metasediments of the West Congo

Group, as will be discussed later on, we can only affirm that the arching occurred after the end of Pan-African events in the region (446 M.Y.) and before the sedimentation of Lower Luloe (carboniferous).

#### *Moçâmedes Arch (Arco de Moçâmedes).*

If we look at a geological map of Angola, it is evident that the Kalahari and West Congo Group sediments are eroded according to a curved shape of center situated between Lucira and the Cape of Santa Maria.

This arch has not stayed on the same place throughout the course of geological time. Approximately 130 millions years ago (a period which is supposed to have been of maximum Phanerozoic magmatic activity in Angola) the location of this arch was somewhat different; it started a little northward from the city of Moçâmedes and its direction was that of the Lucapa Graben embodying the principal alkaline points. This phenomenon of migration of structure heights is quite common in other parts of the world, notably in Brazil, for example, the Ponta Grossa Arch where the variations are much more widely known than those of the Moçâmedes Arch.

Its age cannot be accurately determined. Judging from the geological field data, we can only say that it is posterior to the West Congo Group and anterior to the intrusion of alkaline rocks which are situated in its median region and which are considered to have resulted from the crustal instability caused by this arch. If we consider the geochronological dates existing in the region between Moçâmedes and Benguela showing us that the region has been cold after the Namib event\* (1675±100 M.Y.) and the spatial disposition of the West Congo and Damara belts, we see that the arch is in effect much more anterior (Precambrian age), because the curvature of the line joining the two above mentioned belts indicates the existence of a positive crustal region prior to the sedimentation. The age is the post-Congo Group, nowadays magnificently exposed, being probably the result of the phenomena of the reactivation of the platform.

#### *Cassange Graben (graben de Cassange).*

Although with this same designation, but with a somewhat different tectonic significance, Cassange Graben has been well known already during many years.

This graben cuts the African platform with the general direction N 28° W; in Angola it has a length of approximately 800 kilometers (continues to Zaire)

\* Described by TORQUATO (1974).

and its width, inferred through the diabasic alignments and alkaline rocks, is of 230 kilometers.

As we shall see later, its age cannot be easily determined according to the proposed scheme. However, it is possible to say that the process was complex and that probably it lasted during a great period of time.

#### *Cuanza Horst (Horst do Cuanza).*

Cutting the West Congo Group in the E-W direction involving the cities of Salazar and Malange, there is a raised block constituted fundamentally by charnockites and granulites. This belt is probably connected with the charnockite Kasai Complex, passing through the Cuango region where geochronological datings are carried out with the aim to determine the rocks that occur there (DELHAL and others, 1976).

Observing the structural map of the Cuanza Basin to the West, it is easy to verify that the existing transcurrent faults, which originated the formation of the Cuanza Horst, continue through the mesocenozoic sediments, going disappearing in the middle of the continental platform. These faults represent probably the result of the reactivation processes of the Angolan Shield.

The age of the elevation in the block of the Cuanza horst can be deduced by observing the geological map. Thus, in our opinion its age is the post-West Congo Group, taking into account the fact that the Base Complex outcrops cutting those rocks and previous to the deposition of the first sediments of the Cuanza Basin. The existence of the greatest angolan sedimentary basin exactly in front of the Cuanza horst suggests that its formation is due fundamentally to the accumulation of materials eroded from the raised block and transported to the sea by the drainage existing at that time.

#### *Congo Arch (Arco do Congo).*

This arch affects Angola exclusively in its Northwestern part, in the regions of Santo Antonio do Zaire and Cabinda. Its orientation is N 75 E and it seems to be the result of mesozoic reactivation of the Congo craton. Its probable age is post Zaire arch and precedes the deposition of the Basins of Cabinda and Santo Antonio do Zaire.

### TECTONIC EVOLUTION OF ANGOLA.

#### *Basement complex.*

The angolan part of the Congo craton, in spite of being stable from the end of the Pan-African Cycle, passed during the Precambrian through various stages of cratonization which impressed on it peculiar characteristics and which, in a certain way, more or less evident, remained distinguished

either in the form of well dated folding belts, or in the form of isotopic rejuvenation of age common to various points of the globe.

By the observation of the available geochronological data, many of which already published, others in the phase of publication, we can verify that the angolan region which was the first area of cratonization, was that connected with and integrated in the Kasai Shield through its continuation to the West to the Dondo region, (passing through Salazar, Malange and Cuango). This shield in Angola is less evident because almost all the region is covered by Phanerozoic sediments. Meanwhile, by the observation of the valleys of the rivers Luembe, Cassai, Chiumbe, Luachimo, Chicapa, Lovua and Luxico (REAL, 1959), it is inferred that the thickness of sediments is really small and that the region between Henrique de Carvalho and Portugalia can be included in the Kasai shield. The oldest ages encountered in this region are of 2898 and 2915 million years (data extracted from F. MENDES, 1968, recalculated to  $R_0 = 0,705$  and presented by TORQUATO, 1974), both through Rb/Sr datings, the first one in a biotite and the second one in a feldspar. In the same region there are other determinations in the order of 2500 million years. In the geological map of Angola (sheets nos 69 and 87) these rocks form the Basement Complex which is probably the gneiss correlation of High Luani and of the gabbro-noritic and charnockitic Kasai Complex (DELHAL and FIEREMANS, 1964 and DELHAL and LEDENT, 1971). Over these rocks are bedded the Metamorphic series of Northeast of Angola and possibly they represent the correspondent of the Dibaya Complex in Kasai. This metamorphic complex is improperly called «Kibaras System» by geologists of the Diamond Company of Angola who still use the terminology introduced in Lunda by ANDRADE (1945) who included Angola in a stratigraphic division adopted by ROBERT (1931) for the Kibaras Mountains in Central Katanga. In this region the existence of the belt rocks nowadays known as Kibaras-Burundian-Karagwe-Ankolian rocks is considered impossible due to the radiometric ages of this belt and of the Dibaya Complex rocks and due to the fact that the above mentioned belt does not pass through Lunda. Meanwhile the Kibaras-Burundian-Karagwe-Ankolian rocks give maximum ages in the order of 1400 million years, the Dibaya Complex is much older and its age can reach 2700 million years.

After the cratonization of the Lunda region and of the Salazar/Cuango belt in the Lower Precambrian, a great part of Angola continued its evolution during the Middle and Upper Precambrian. On the South, approximately 2.200 million years ago (SILVA and others, 1973 and AMARAL and TORQUATO, 1974) the

great gabbro-anorthositic complex of the South of Angola (Kunene basic complex) was emplaced with its genesis still poorly defined. However, in accordance with the field data and according to the present ideas of the Plate Tectonics (TORQUATO and others, in preparation) it may be interpreted as a result of an ocean bottom in collision with the Sá da Bandeira region.

In effect, the presence of an orogenic belt of about 2000 million years (Quipungo Belt) with rough orientation NE-SW, bordering part of the Northwestern complex and the presence of a great number of acid intrusions and extrusions (porphyries) aligned along this belt, suggest the presence of a subduction zone.

In the center and in the North the various eburnean sediments were granitized and the region was cratonized. Small nuclei of phyllites, green schists and quartzites with general orientation N 45° to 60°W, remained and may not have been exposed to the posterior events or they may have resisted without increasing the degree of metamorphism. However, the rocks may appear rejuvenated isotopically, as it is the case of the rocks encountered in the Espinheira and Muende River Region, which are, undoubtedly, of superior age in comparison with the Namib event (1675±100 M.Y.), but its radiometric study revealed ages in the order of 1200 million years (TORQUATO, 1974).

The numerous basic dikes with orientation N 60° W, present in the Southern region of the sheet 395 and in the North of the sheet 417, are somewhat younger (1900 M.Y.). These dikes probably are the result of activation of the Eburnean Platform.

Located in the belt sub-parallel to the coast, covered on the East by the Kalahari sands, with approximate direction of SW-NE passing through the cities of Malange, Nova Lisboa, Silva Porto and Sá da Bandeira, there occur jointly, with older nuclei, numerous ages (Rb/Sr) of the order of 1500-1700 million years, obtained especially in biotites and total rocks. This fact is interpreted as a result of a thermo-magmatic event for which, in a previous publication (TORQUATO, 1974), we suggested the name of Namib Event.

A second belt parallel to Namib and of smaller dimension, occurs on its Western side. There, the ages in the order of 1300 million years are common, affecting granites and gneisses, as well as the metasediments (isochrone Rb/Sr). During this geological period, which was referred in the above mentioned publication as Muende Event, but which could probably be correlated with Kibarian Event (CAHEN *et al.* 1967-1971), an emplacement of granites occurs in various regions (sheets 338, 395, 399 and probably other ones still undated). We can also find there, in large regions of south West Angola between

Nova Lisboa and Foz do Cunene, isotopic rejuvenation produced by cryptomorphous phenomena. It is possible that on the High Zambeze parallel to the Pan-African belt there is a small area affected by this event, due to the fact that the Kibarian-Burundian belt enters that region.

Another zone of ages between 950±100 million years, presenting somewhat more dubious definition, seems to occur on the Western side of Muende belt. It begins in the region of the Cunene River, near Iona, and because of the lack of geochronological data it cannot be defined on the Benguela latitude. These ages may correspond either to the isotopic rejuvenation caused by the vicinity of the Pan-African belt, or by itself it may represent some other thermal event.

Over this group of rocks, already associated with the orthoplatform and usually called the Congo Craton, there were deposited the Pan-African sediments of the fold belts of Damara, West Congo and Malombe-Macondo. Besides these, it is possible to encounter the sediments with this age either in the Cassange Basin or in the Lunda region which proves that the seas of the Upper Precambrian covered a great part of the North of Angola. The vergence directions of the 3 fold belts point towards the interior of Angola, clearly defining the Western and Eastern limits of the Congo craton which served as a foreland to this orogenic cycle.

It is possible that the Leba limestones, which apparently (but falsely) overlie concordantly the Chela quartzites, may be also of Pan-African age. Confirmation of this fact would make inevitable the extension of the Upper Precambrian seas in direction to the South. Evidences do not appear in the central region of Angola only because of the great erosion caused by the Moçâmedes archment.

Before finishing these short reference concerning the Base Complex of Angola, we must point out a somewhat strange fact: a little bit to the North of the city of Sa da Bandeira tectonic directions assume almost a right angle and the absence of orientation in the granitic rocks of the region makes the problem even more difficult. It probably could be explained by the presence in that local of the limite between the Quipungo orogenic belt (directions NE-SW) and its foreland.

#### *Stage of transition.*

According to ТУРЕЗОВ (1966) the process through which a certain region in tectonic development passes from the geosynclinal stage to the stage of orthoplatform, is long and is characterized by various intermediate stages. The first one begins after the tecto-genetic phenomena where terminated and accompanies the beginning of the orogenesis and its respective molasses.

In Angola this stage started with the deposition of the sediments superlying the «Schisto-gréseuse» series of the West Congo Group, which represents the Superior Terrigenous Sequence according to the concepts of BELOUSOV (1965) geosynclinal evolution or the AUBOIN (1965) Flysch Phase. These molassic sediments are well represented in Angola in the Pungo-Andongo region, making way for a great conglomerate existing there. As far as we know, in Angola these rocks are the only ones that may be considered as real molasses.

In the sheet 399 (Cahama) alkaline granites of red colour occur and by the Rb/Sr dating method they gave the age of  $417 \pm 12$  million years. By its position in relation to the Pan-African belts, the Cahama granite should be considered as anorogenic, probably representing a transition period.

More southward, near the city of Moçâmedes, there are volcanic rocks classified as trachyandesites. They overlie the precambrian regional granites and are covered by a thick sequence of conglomerate of Ante-Aptian age. The radiometric analysis using total rock gave the value of 105 million years, which is absolutely incompatible with the field data, and could be due to possible escape of radiogenic argon. In analogy with other similar rocks and by its stratigraphic position, it is possible that these rocks are an evidence of a transition stage.

#### *Stage of stabilization.*

In the second stage of evolution there is already a platform where the subsidence phenomena begin together with the appearance of two great sineclises separated one from another by the Moçâmedes Arch. Their ages may be attributed to the Permian-Carboniferous since on its base the most ancient sediments, associated with basins, are those of Karroo, although, at least in the Congo sineclise, under the Karroo deposits, there are sediments of the West Congo Group. However, these are continental sediments of «schisto-gréseuse» series.

On the North, there is the Congo sineclise with the tillitic sediments of the Lutoe series (Karoo) bedded directly either over the Precambrian Basement Complex or over the top sediments of the West Congo Group. On the South, the Kalahari sineclise appears completely filled in by Kalahari sediments, however, it is probable that the Karroo rocks may appear in the sub-surface given the fact that relatively near in the Southwest Africa there are common outcrops of this age.

The Moçâmedes archment, besides having served as an element of separation between the two structural elements above mentioned, it probably functioned, as it does today, as a divider of waters along the Angolan territory. Thus, it may be admitted that the rocks of the Angolan Karroo System and those

of the Southwest Africa had an independent geological evolution, in spite of being deposited during the same time interval under similar environmental conditions and with a common source of material (Moçâmedes Arch).

Until today it has never been found out through the lateral passage the real connection between the Karroo sediments, which outcrop occur in the Cassanje Basin and in the Lunda region. Due to their geographical proximity they were always considered as having been deposited there through the same process and inside the same basin. However, specially referring to the Cassanje series it is possible that fact is not true on the totality of all the sediments, if the following facts must be taken into account :

- (1) The faultings that caused the appearance of the Cassanje paleograbens have superior age than those that gave origin to the graben nowadays situated in its central region.
- (2) The thickness of the Cassanje series in the Basin with the same name, is much greater than that in the Lunda region.
- (3) The lack of a perfect correlation between the sediments of the two regions.
- (4) The absence of the remnants of Karroo sediments in the Malange plateau, except in the indicated regions.

Inside of this scheme and based on these premises, we suggest that the evolution of that region will be considered in the following way:

- (1) Beginning of the deposition of the Karroo sediments in the Congo Sineclise.
- (2) After the deposition of the Karroo inferior sediments (Lutoe series) the faulting of the Basement Complex happened and also the formation of Cassanje paleograbens.
- (3) Progressive subsidence of the Cassanje paleograbens, resulting in a thickening of sediments, however, with environmental conditions similar to those of Lunda.
- (4) End of the deposition of the Karroo sediments and the reactivation of the paleograbens with new faults in the central region of the Cassanje Basin, causing the depression which is visible even today.

From their concise observations on the Angolan Karroo, Rocha Campos and OLIVEIRA (1972) came to the conclusion that the fundamental direction of drainage would be roughly from West to East and concluded that the source of sediments, in a continental reconstruction, would be a massif situated in the region between the two continents. This fact correlated by the presence of the Zaire Arch, is strengthening the hypothesis that the Congo

Basin had a parallel, but separate development in comparison with the Paraná Basin in Brazil.

Previously we reached the conclusion that the evolution of the Congo and Kalahari sineclises had occurred independently. With the introduction of the Zaire Arch we verify that the geological history of Congo sineclise must be interpreted exclusively by what is occurring there, and not as it has been done in the majority of cases, looking for its connections with the sedimentary remnants of the Karroo age scattered either in Africa or in the South America.

The Zaire Arch, the Congo Arch and the Cuanza horst, are structural units which were evolved during the stabilization phase of the platform. The arches were formed at the beginning, conditioning the sedimentation of the Karroo permo-carboniferous deposits, the Cuanza horst served as a source of the materials that filled the top of the Cassanje paleograbens, which appeared in the reactivation stage.

#### *Stage of reactivation.*

It is a proven fact that platforms after completely consolidated can enter a period of reactivation which will impress on them peculiar characteristics and influence the internal arrangement causing a complete structural reorganization, expressed by reactivation of antique faultings and archments, mountains in block, intensive volcanic activity, formation of tectonic basins, emplacement of granitic plutonism and cratonic alkaline and also important mineralizations. The activity is always dispersed throughout the whole platform, without selective relationships to the regions of the old geosynclines.

The angolan part of the Congo craton began its process of reactivation in the Triassic through basic and ultrabasic volcanism. In the regions of Novo Redondo and Foz do Cunene there are dated diabasic dikes belonging respectively to the Triassic and the Lower Jurassic.

Contrary to what occurred in Brazil where the activated areas were usually those that consolidated last (ALMEIDA, 1969), in Angola it seems there is no correlation between the various phenomena attributed to this stage of reactivation and the regions formed or affected by Pan-African cycle.

In Angola there are various aspects associated with the reactivation, such as the basic and alkaline magmatism, the tectonic basins, the granite of Morro Vermelho (Red Hill) and the elevation of the entire coastal region with the consequent formation of abundant conglomerates.

The basic magmatism is extended throughout the whole region occupied by Angola, with major activity occurring in the regions of Novo Redondo, Moçamedes, Foz do Cunene, Alto Zambezi and

Lunda. Dikes and swarms of basic dikes in other regions occur, mainly in the Tchivira-Bonga region, but the lack of radiometric data and the presence in Angola of basic magmatism with various ages, does not permit us to define them as belonging to the reactivation stage before collecting more data.

The alkaline magmatism in Angola has been already the subject of some publications, some dealing with local characteristics, studying a determined complex, others dealing with more general characteristics, trying to correlate them to the scale of the country.

Since 1958, when SOUZA MACHADO presented in Angola for the first time the hypothesis of a unique alignment of the carbonatite rocks, mentioned by LAPIDO-LOUREIRO (1967), RODRIGUES (1970) and again LAPIDO-LOUREIRO (1973), the ideas concerning alignments varied and, ranging from the initial unique alignment suggested by SOUZA MACHADO, to several ones with almost perpendicular directions mentioned by RODRIGUES. Finally LAPIDO-LOUREIRO mentioned a belt of parallel alignments. According it will be shown, our opinion is considerably different.

As the other publications have already been the object of analysis by other authors, we refer here exclusively to the two latter ones.

The conclusions adopted by RODRIGUES (1970) concerning the inclusion in Angola of alignments of alkaline rocks with the general direction NW-SE, are not considered valid by us, because the tectonic conditions, in which they were emplaced, were not taken into account. Later we shall try to define these environments and shall try to show that there is no reason for the new alignment suggested.

The genesis of the carbonatites, fundamentally associated with the system of « rifts » suggested by LAPIDO-LOUREIRO (1973), equally in our opinion does not seem valid, because of lack of evidence for « rifts » we do not accept, as such, a region where they presumably occur. But the explanation given by the same author for the Virulundo carbonatite « plug » is in absolute accordance with our ideas and as the author affirms, the efforts of prospection along the great Chela scarping should be intensified.

The author thinks that for the establishment either of fundamental directions of genesis, it is necessary to study the tectonic environment of such intrusions. The conclusions of F. F. M. de ALMEIDA (1971 (a)) concerning identical intrusions in Brazil, are certainly valid for the angolan region.

In first analysis, it is possible to classify the alkaline rocks of Angola in four groups of rocks, with well defined characteristics.

(1) During the Triassic and the Jurassic the Moçamedes Archment was affected by a notable

elevation as verified by the lack of coastal sediments in its terminal region. This caused the crustal instability which is evidenced by the intrusions of numerous alkaline structures, mainly syenitic, carbonatitic and kimberlitic, in the southwestern quadrant of Angola. On this point we agree with Lapido-Loureiro that there is no alignment but a belt, however we do not see the necessity of looking for aligning these alkaline points in the manner done by the author, as its distribution is not attributed to a system of parallel faults, but to a line of structural weakness.

(2) The numerous Lunda kimberlitic intrusions are intimately related with the reactivation along the line indicated in 1, as well as to the lowering of the graben in the important crustal region (Lucapa Graben).

(3) The alkaline intrusions as many as 12, and which are situated along the coast of Angola, can be correlated with the processes of continental drift, since these intrusions are found in regions of ancient « rifts » and in regions of crustal instability.

In view of the opposite tectonic conditions presented by structures situated in the Moçâmedes Archment (compression) and along the coast (expansion) we do not accept the alignments by RODRIGUES (1970). Although it is generally known that the directions, indicated by him, are common in Africa, we think that at least in the above mentioned cases they cannot be defined by a simple presence of the alkaline rocks apparently aligned only according to the map scale.

(4) The structures of Cuito and Calucinga probably are related to the mesozoic reactivation suffered by the Cassanje graben. This is clearly shown by the aligned series of sharp intrusions of basic rocks.

Because of the lack of geological data, we could not give our opinion concerning the Kimberlitic Center of Canengo.

We do not have as yet sufficient data to characterize geochronologically the various alkaline intrusions. MENDES (1968) cites that a biotite extracted from a syenite of the Tchivira massif, gave the age of  $112 \pm 8$  M.Y. This same age recalculated with  $R_0 = 0,705$  increased to  $126 \pm 4$  M.Y. In the region of Morro Vermelho (Red Hill) more alkaline rocks were dated (TORQUATO, 1974). Their ages fell in two groups with  $122 \pm 7$  M.Y. and  $177 \pm 7$  M.Y.

Various data concerning angolan alkaline rocks are being carried out and it seems, at least mean-

while, that the age of 130 million years is common.

The tectonic basins in Angola are distributed in great majority along the coastal line, overlying the crystalline basement with extensive faulting. With different genesis (elevation of the region northward from the Cunene River), at the terminal part of the river there is a basin filled in by the Cunene Formation (TORQUATO, 1974).

The alkaline cratonic granite of the Morro Vermelho (154 M.Y.) (TORQUATO and ALLSOPP, 1973) is an evidence of the reactivation to which the platform was subjected.

The elevation of the whole coastal belt of Angola is equally closely correlated with the reactivation. The process should have been considerably similar to what happened in Brazil and gave the origin to the Serra do Mar (Sea Mountains). In Angola there have not been discovered as yet the lines of fault that caused the elevation of the internal regions, but we do not doubt that it will be necessary to revise and bring up to date the proposed mechanisms of the successive continental flexures with faultings on the Eastern side.

We have neither evidence of great foldings sub-parallel to the coastal line which are expressed by flexures, nor the present concepts of SIAL and SIMA admit between them the physical separation with possible regions of lowering.

In our opinion, the depressions of monoclinical type have not occurred; on the contrary, during the reactivation stage of the platform, the whole coastal region of Angola was, and still is undergoing a continuous epirogenetic process.

As a part of reactivation we should also quote the extensive conglomerates situated along the base of the coastal sedimentary basins and the fluvial deposits present in the region of Muende River near the Cunene mouth (described by TORQUATO, 1974).

During the extensive period of tectonic inactivity that characterized the Tertiary Era, sediments typical of the orthoplatform (Kalahari system) were developed and even today they cover the whole Eastern half of Angola.

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## APPENDIX 1

## ANALYTICAL DATA FOR Rb/Sr FROM ANGOLA

(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	T2	16°56.3'	11°43.2'	Granodiorite	T.R.**	184.44	328.29	0.7235	1.623	644	a)	B.P.I.	0.7089
	T3	16°56.3'	11°46.8'	Granite	T.R.	115.63	1010.06	0.7075	0.331		a)	B.P.I.	0.7089
	T6	16°54.5'	11°49.7'	Granite	T.R.	326.54	49.58	0.8595	19.029	536	a)	B.P.I.	0.7089
	T6A	16°54.5'	11°49.7'	Granite	T.R.	284.84	30.78	0.9259	26.736	550	a)	B.P.I.	0.7089
	T8	16°58.5'	11°52.7'	Granite	T.R.	266.75	88.94	0.7791	8.666	580	a)	B.P.I.	0.7089
	T10	16°58'	11°53'	Granite	T.R.	308.73	50.10	0.8598	17.805	607	a)	B.P.I.	0.7089
	T11	16°57.9'	11°53.5'	Granite	T.R.	259.25	66.84	0.8115	11.208	656	a)	B.P.I.	0.7089
	T12	16°57.8'	11°54'	Granite	T.R.	295.02	102.16	0.7785	8.352	565	a)	B.P.I.	0.7089
	T13	16°57.1'	11°54.3'	Granite	T.R.	473.87	50.71	0.8084	22.933	560	a)	B.P.I.	0.7089
	T21	16°49.5'	11°56.4'	Granite	T.R.	180.20	107.20	0.7476	4.861	539	a)	B.P.I.	0.7089
	T22	16°53.7'	11°57.8'	Granite	T.R.	239.11	61.77	0.7999	11.184	551	a)	B.P.I.	0.7089
	T23	16°54.2'	11°58.8'	Granite	T.R.	252.72	54.65	0.8167	13.363	547	a)	B.P.I.	0.7089
	T5	16°56.3'	11°46.7'	Granite	T.R.	279.61	67.04	0.7373	12.051	163	a)	B.P.I.	0.7084
	T16	16°56.3'	11°46.7'	Granite	T.R.	206.77	89.87	0.7249	6.648	168	a)	B.P.I.	0.7084
	T17	16°56.3'	11°46.7'	Granite	T.R.	261.76	52.27	0.7407	14.470	151	a)	B.P.I.	0.7084
	T19	16°56.3'	11°46.7'	Granite	T.R.	263.71	87.90	0.7255	8.668	133	a)	B.P.I.	0.7084
	T20	16°56.3'	11°46.7'	Granite	T.R.	279.19	30.47	0.7681	26.473	153	a)	B.P.I.	0.7084
	10.504	6°00'	13°33'	Granite	T.R.	276.8	15.6	1.2887	54.18	473	b)	C.B.G.	0.9107
	10.504	6°00'	13°33'	Granite	Feldspar	388.3	10.1	1.7548	122.4	473	b)	C.B.G.	0.9107
	10.504	6°00'	13°33'	Granite	Biotite	1614	18.7	2.9140	303.8	446	b)	C.B.G.	0.9107
	23.109	6°05'	13°30'	Granite	T.R.	475.0	5.34	3.4215	325.0	451	b)	C.B.G.	1.2864
	23.109	6°05'	13°30'	Granite	Feldspar	822.6	2.59	17.684	2448	445	b)	C.B.G.	1.2864
	23.109	6°05'	13°30'	Granite	Aegirine	21.68	4.80	1.3793	13.92	453	b)	C.B.G.	1.2864
	R.G.G.2884b	5°55'	12°58'	Granite	Muscovite	749	7.7			483 ± 10	c)	S.G.G.N.	
	R.G.G.2884b	5°55'	12°58'	Granite	Muscovite	749	7.7			485 ± 10	c)	S.G.G.N.	
	R.G.G.10626	5°53'	13°07'	Quartzite Pegmatite	Muscovite	510	20.5			695 ± 35	c)	S.G.G.N.	
	32/HC/72/397	16°11'	13°29'	Granite	T.R.	171.7	126.2	0.7896	3.938	1446 ± 141	e)	C.P.Geo	0.705
SPR-301	G77/338			Granite	T.R.	260.0	24.4	1.2824	30.845	1262 ± 44	f)	C.P.Geo	0.705
SPR-302	G78/338	14°43.8'	14°58'	Granite	T.R.	258.0	23.4	1.2824	31.916	1220 ± 32	f)	C.P.Geo	0.705
SPR-300	G70/338	14°49.9'	14°52.3'	Porphyry	T.R.	197.7	149.5	0.7992	3.828	1654 ± 62	f)	C.P.Geo	0.705
SPR-298	G38/317	14°29'	14°6.5'	Granite	T.R.	136.0	17.2	1.2604	22.888	1631 ± 52	f)	C.P.Geo	0.705
SPR-299	G39/317	14°28.8'	14°6'	Granite	T.R.	106.0	11.2	1.5033	27.396	1954 ± 51	f)	C.P.Geo	0.705
SPR-340	G75/318	14°14.5'	14°43'	Tonalite	T.R.	129.0	253.7	0.7424	1.472	1708 ± 117	f)	C.P.Geo	0.705
SPR-665	G64/338	14°45.2'	14°52.2'	Porphyry	T.R.	187.0	159.4	0.785	3.42	1565 ± 61	f)	C.P.Geo	0.705
SPR-303	G91/297	13°48.8'	14°22'	Granite	T.R.	273.0	12.0	2.863	65.855	2194 ± 66	f)	C.P.Geo	0.705
SPR-312	G19/337	14°36'	14°18.2'	Granite	T.R.	218.2	168.2	0.8247	3.755	2134 ± 99	f)	C.P.Geo	0.705
SPR-313	G31/317	14°17'	14°2.6'	Granite	T.R.	61.1	335.5	0.7205	0.527	1972 ± 368	f)	C.P.Geo	0.705
SPR-314	G42/317	14°15.2'	14°18.3'	Granite	T.R.	149.8	408.0	0.7360	1.063	1955 ± 158	f)	C.P.Geo	0.705
SPR-315	G50/318	14°3.4'	14°42'	Granite	T.R.	206.6	212.4	0.7926	2.816	2083 ± 81	f)	C.P.Geo	0.705
SPR-365	G81/337	14°37'	14°3.5'	Porphyry	T.R.	84.0	595.0	0.7164	0.400	1840 ± 438	f)	C.P.Geo	0.705
SPR-366	G83/337	14°37.5'	14°04'	Porphyry	T.R.	147.0	303.0	0.7451	1.404	1916 ± 132	f)	C.P.Geo	0.705
SPR-367	G88/298	13°34.7'	14°36.3'	Rhyodacite	T.R.	129.2	153.3	0.7791	2.440	2035 ± 107	f)	C.P.Geo	0.705
SPR-379	G89/297	13°47'	14°12.8'	Rhyodacite	T.R.	123.6	362.4	0.7403	0.987	2389 ± 199	f)	C.P.Geo	0.705
SPR-380	G90/297	13°44.7'	14°15.8'	Rhyodacite	T.R.	193.7	170.3	0.8129	3.292	2190 ± 79	f)	C.P.Geo	0.705
SPR-316	G51/338	14°33'	14°57.7'	Gneiss	T.R.	66.0	456.0	0.7227	0.419	2465 ± 406	f)	C.P.Geo	0.705
SPR-383	G52/338	14°36.5'	14°57.7'	Gneiss	T.R.	101.9	334	0.7309	0.763	1969 ± 179	f)	C.P.Geo	0.705
SPR-378	G57/338	14°38.6'	14°54.4'	Gneiss	T.R.	117.4	138.9	0.7823	2.447	2115 ± 117	f)	C.P.Geo	0.705
SPR-381	G61/318	14°26.6'	14°48.2'	Gneiss	T.R.	39.50	443.0	0.7132	0.288	2127 ± 545	f)	C.P.Geo	0.705
SPR-362	G62/337	14°40.4'	14°28'	Gneiss	T.R.	78.22	315.0	0.7254	0.469	1906 ± 246	f)	C.P.Geo	0.705
SPR-308	439/75	17°15'	11°47.3'	Granite	T.R.	163	257	0.719	1.84	417 ± 91	g)	C.P.Geo	0.708
SPR-309	439/95	17°10'	11°53.3'	Gneiss	T.R.	226	115	0.765	5.72	678 ± 34	g)	C.P.Geo	0.708
SPR-310	416/273	16°48.7'	11°59.3'	Granulite	T.R.	167	110	0.724	4.40	251 ± 40	g)	C.P.Geo	0.708

\* See the legend for the significance of the columns

\*\* T.R. means total rock

(continue)

GEOTECTONIC OUTLINE OF ANGOLA

APPENDIX 1

(Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
SPR-311	417/29	16°33.5'	12°8.7'	Gneiss	T.R.	122	153	0.790	2.33	2367±134	g)	C.P.Geo	0.708
SPR-328	416/271	16°47.5'	11°59.3'	Granulite	T.R.	154	158	0.739	2.83	751±119	g)	C.P.Geo	0.708
SPR-329	416/274	16°49'	11°59.3'	Granulite	T.R.	210	98	0.764	6.24	613± 33	g)	C.P.Geo	0.708
SPR-330	417/30	16°33.5'	12°13.8'	Gneiss	T.R.	128	212	0.747	1.75	1484± 91	g)	C.P.Geo	0.708
SPR-331	439/77	17°7.5'	11°46.7'	Granite	T.R.	104	187	0.735	1.61	1143±107	g)	C.P.Geo	0.708
SPR-332	439/82	17°6.3'	11°46.3'	Granodiorite	T.R.	162	176	0.744	2.67	908± 60	g)	C.P.Geo	0.708
SPR-333	439/86	17°12.5'	11°52.2'	Granite	T.R.	185	185	0.743	2.90	810± 67	g)	C.P.Geo	0.708
SPR-359	439/76	17°15'	11°47'	Gneiss	T.R.	166	340	0.716	1.41	369±190	g)	C.P.Geo	0.708
SPR-360	417/46	16°57.5'	12°24.5'	Granite	T.R.	148	133	0.775	3.24	1393± 61	g)	C.P.Geo	0.708
SPR-361	417/45	16°57.5'	12°24.4'	Granite	T.R.	158	113	0.806	4.09	1611± 52	g)	C.P.Geo	0.708
SPR-362	417/44	16°58'	12°24.4'	Granite	T.R.	159	111	0.787	4.18	1277± 49	g)	C.P.Geo	0.708
SPR-363	439/88	17°12.5'	11°52.2'	Granite	T.R.	182	137	0.751	3.86	750± 53	g)	C.P.Geo	0.708
SPR-364	417/43	16°58'	12°24.4'	Granite	T.R.	161	132	0.784	3.56	1442± 58	g)	C.P.Geo	0.708
SPR-397	417/27	16°33.5'	12°8.7'	Gneiss	T.R.	172	51	0.929	9.98	1490± 39	g)	C.P.Geo	0.708
SPR-398	416/272	16°48.5'	11°59'	Granulite	T.R.	154	56	0.772	8.01	537± 27	g)	C.P.Geo	0.708
SPR-402	416/276	16°52'	11°59.1'	Granulite	T.R.	193	54	0.794	10.4	559± 19	g)	C.P.Geo	0.708
SPR-411	417/28	16°33.5'	12°8.7'	Gneiss	T.R.	142	41	0.964	10.3	1674± 40	g)	C.P.Geo	0.708
SPR-413	417/150	16°53.5'	12°27.7'	Rhyolite	T.R.	196	56	0.890	10.3	1187± 29	g)	C.P.Geo	0.708
SPR-415	439/74	17°15.5'	11°47.5'	Granite	T.R.	49	240	0.721	0.59	1467±1132	g)	C.P.Geo	0.708
SPR-416	439/84	17°13'	11°52.2'	Gneiss	T.R.	77	280	0.726	0.80	1478±408	g)	C.P.Geo	0.708
SPR-446	395/G9	16°22'	12°12'	Gneiss	T.R.	239	262	0.769	2.66	1550± 74	g)	C.P.Geo	0.708
SPR-447	395/G10	16°24.3'	12°10.3'	Gneiss	T.R.	117	259	0.723	1.31	761±300	g)	C.P.Geo	0.708
SPR-448	395/G10A	16°24.3'	12°10.3'	Gneiss	T.R.	92	393	0.717	0.68	857±239	g)	C.P.Geo	0.708
SPR-449	395/G12	16°10'	12°25.2'	Granite	T.R.	203	299	0.743	1.97	1192± 76	g)	C.P.Geo	0.708
SPR-450	395/G12A	16°10'	12°25.2'	Granite	T.R.	195	332	0.743	1.71	1382±156	g)	C.P.Geo	0.708
SPR-451	395/G12B	16°10'	12°25.2'	Granite	T.R.	213	286	0.754	2.17	1431± 92	g)	C.P.Geo	0.708
SPR-452	395/G12C	16°10'	12°25.2'	Granite	T.R.	214	319	0.745	1.95	1294± 80	g)	C.P.Geo	0.708
SPR-453	395/G12D	16°10'	12°25.2'	Granite	T.R.	189	327	0.743	1.68	1395± 92	g)	C.P.Geo	0.708
SPR-454	395/G6	16°27.2'	12°17.5'	Granite	T.R.	144	543	0.720	0.77	1037±203	g)	C.P.Geo	0.708
SPR-455	395/G6A	16°27.2'	12°17.5'	Granite	T.R.	145	562	0.723	0.75	1352±213	g)	C.P.Geo	0.708
SPR-456	395/G9A	16°21.7'	12°12'	Gneiss	T.R.	212	266	0.770	2.32	1797± 72	g)	C.P.Geo	0.708
SPR-457	395/G9B	16°21.7'	12°12'	Gneiss	T.R.	243	258	0.773	2.74	1587± 67	g)	C.P.Geo	0.708
SPR-458	395/G9C	16°21.7'	12°12'	Gneiss	T.R.	243	258	0.769	2.74	1504± 61	g)	C.P.Geo	0.708
SPR-459	395/G13A	16°14.5'	12°25.5'	Granite	T.R.	112	507	0.718	0.64	1034±229	g)	C.P.Geo	0.708
SPR-460	395/G13B	16°14.5'	12°25.5'	Granite	T.R.	125	473	0.720	0.77	1049±191	g)	C.P.Geo	0.708
SPR-461	395/G13C	16°14.5'	12°25.5'	Granite	T.R.	118	448	0.720	0.76	1026±199	g)	C.P.Geo	0.708
SPR-478	440/49	17°0.2'	12°28.7'	Granophyre	T.R.	204	89	0.844	6.72	1361± 35	g)	C.P.Geo	0.708
SPR-480	439/89	17°12.5'	11°52.2'	Granite	T.R.	128	66	0.766	5.65	696± 42	g)	C.P.Geo	0.708
SPR-481	439/98	17°10.3'	11°52.5'	Granite	T.R.	301	85	0.797	10.3	580± 21	g)	C.P.Geo	0.708
SPR-494	395/G13	16°14.5'	12°25.5'	Granite	T.R.	84	559	0.715	0.44	1023±428	g)	C.P.Geo	0.708
SPR-495	395/G6B	16°27.2'	12°17.5'	Granite	T.R.	141	531	0.722	0.77	1244±211	g)	C.P.Geo	0.708
SPR-496	395/G13D	16°14.5'	12°25.5'	Granite	T.R.	80	554	0.714	0.42	937±335	g)	C.P.Geo	0.708
SPR-497	395/G7	16°26.9'	12°17.2'	Granodiorite	T.R.	78	678	0.712	0.33	706±448	g)	C.P.Geo	0.708
SPR-498	395/G7A	16°26.9'	12°17.2'	Granodiorite	T.R.	83	650	0.714	0.37	1059±408	g)	C.P.Geo	0.708
SPR-499	395/G7B	16°26.9'	12°17.2'	Granodiorite	T.R.	62	1000	0.707	0.18	460±1109	g)	C.P.Geo	0.708
SPR-518	417/164	16°57.7'	12°27.2'	Granite	T.R.	223	19	1.100	34.6	767± 18	g)	C.P.Geo	0.708
SPR-520	440/70	17°1'	12°26.3'	Granophyre	T.R.	216	90	0.834	7.03	1205± 34	g)	C.P.Geo	0.708
SPR-522	440/79	17°4.5'	12°28.5'	Granite	T.R.	305	41	1.089	22.6	1136± 25	g)	C.P.Geo	0.708
SPR-568	417/149	16°52.9'	12°27.6'	Rhyolite	T.R.	226	33	0.868	20.1	539± 19	g)	C.P.Geo	0.708
SPR-652	416/264	16°49.9'	11°59.4'	Granulite	T.R.	31	261	0.716	0.34	1524±494	g)	C.P.Geo	0.708
SPR-653	416/268	16°44.8'	11°48.5'	Granulite	T.R.	2	420	0.703	0.02		g)	C.P.Geo	0.708
SPR-654	416/269	16°42'	11°56.3'	Granulite	T.R.	41	202	0.718	0.59	1129±276	g)	C.P.Geo	0.708
SPR-657	439/85	17°13.2'	11°52.2'	Gneiss	T.R.	13	304	0.713	0.12	2620±1462	g)	C.P.Geo	0.708

(continuc)

APPENDIX 1  
(Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
SPR-661	417/68	16°34.3'	12°21.7'	Diorite	T.R.	53	457	0.714	0.34	1097±468	g)	C.P.Geo	0.708
SPR-662	417/69	16°34.3'	12°21.7'	Diorite	T.R.	54	545	0.712	0.29	816±515	g)	C.P.Geo	0.708
SPR-663	417/70	16°35.3'	12°20.9'	Granite	T.R.	140	257	0.744	1.59	1544± 93	g)	C.P.Geo	0.708
SPR-664	417/71	16°35.3'	12°20.9'	Granite	T.R.	159	229	0.749	2.02	1357± 77	g)	C.P.Geo	0.708
SPR-666	395/81	16°9.5'	12°24.8'	Granite	T.R.	192	327	0.741	1.71	1284± 83	g)	C.P.Geo	0.708
SPR-667	395/82	16°9.2'	12°24.7'	Granite	T.R.	200	300	0.746	1.94	1302± 89	g)	C.P.Geo	0.708
SPR-668	395/83	16°8.9'	12°25.9'	Granite	T.R.	188	307	0.743	1.78	1313±372	g)	C.P.Geo	0.708
SPR-669	395/84	16°8.6'	12°25.7'	Granite	T.R.	196	286	0.745	1.99	1253± 55	g)	C.P.Geo	0.708
SPR-671	417/52	16°34.8'	12°18.2'	Schist	T.R.	162	93	0.782	5.08	976± 56	g)	C.P.Geo	0.708
SPR-672	417/166	16°34.7'	12°5.9'	Granulite	T.R.	142	164	0.757	2.52	1300± 75	g)	C.P.Geo	0.708
SPR-673	417/167	16°34.8'	12°6.1'	Granulite	T.R.	167	302	0.746	1.60	1595±130	g)	C.P.Geo	0.708
SPR-674	417/168	16°35'	12°6'	Granulite	T.R.	140	173	1.083	2.43	9753±2462	g)	C.P.Geo	0.708
SPR-675	417/172	16°43'	12°26.3'	Shale	T.R.	198	74	0.864	7.83	1339± 44	g)	C.P.Geo	0.708
SPR-676	417/173	16°34.3'	12°28.5'	Shale	T.R.	104	113	0.761	2.68	1325±362	g)	C.P.Geo	0.708
SPR-677	417/174	16°32.5'	12°28.5'	Shale	T.R.	153	165	0.755	2.70	1170± 74	g)	C.P.Geo	0.708
SPR-678	417/175	16°31.8'	12°25.3'	Shale	T.R.	98	231	0.743	1.23	1882±237	g)	C.P.Geo	0.708
SPR-679	417/176	16°33.5'	12°28.3'	Shale	T.R.	77	301	0.734	0.75	2333±244	g)	C.P.Geo	0.708
SPR-399	399/Q26A3	16°0.5'	14°07'	Porphyry	T.R.	563.0	10.15	3.787	160.6	1294±258	h)	C.P.Geo	0.705
SPR-400	399/Q15H5	16°14'	14°11'	Granite	T.R.	327.0	5.79	2.501	163.5	743±149	h)	C.P.Geo	0.705
SPR-401	399/Q15G3	16°14'	14°11'	Granite	T.R.	222.0	3.90	1.717	164.8	417± 12	h)	C.P.Geo	0.705
SPR-307	399/Q8E3	16°25'	14°07'	Granite	T.R.	124.7	191.9	0.747	1.881	1495± 87	h)	C.P.Geo	0.705
SPR-327	399/Q8E4	16°25'	14°07'	Granite	T.R.	104.0	222.1	0.737	1.355	1588±184	h)	C.P.Geo	0.705
SPR-344	399/Q8E5	16°25'	14°07'	Granite	T.R.	106.0	224.5	0.737	1.367	1563±133	h)	C.P.Geo	0.705
SPR-797	CHISSOE	13°51'	15°45'	Granite	T.R.	152.9	152.7	0.7805	2.92	1736± 76	i)	C.P.Geo	0.705
SPR-798	CHISSOE-1	13°51'	15°45'	Schist	T.R.	242.2	214.5	0.8128	3.30	2086±418	i)	C.P.Geo	0.710
SPR-799	CHISSOE-2	13°51'	15°45'	Schist	T.R.	228.5	243.3	0.8013	2.74	2227± 99	i)	C.P.Geo	0.710
SPR-800	CHISSOE-3	13°51'	15°45'	Schist	T.R.	203.0	87.2	0.9288	6.88	2129± 58	i)	C.P.Geo	0.710
SPR-801	CHISSOE-4	13°51'	15°45'	Schist	T.R.	256.4	155.4	0.8649	4.85	2140± 51	i)	C.P.Geo	0.710
SPR-802	CHISSOE-5	13°51'	15°45'	Schist	T.R.	192.7	127.1	0.8532	4.45	2155± 64	i)	C.P.Geo	0.710
SPR-804	CHIRIVA-1	13°50'	15°41'	Schist	T.R.	166.9	120.8	0.8419	4.05	2179± 63	i)	C.P.Geo	0.710
SPR-805	CHIRIVA-2	13°50'	15°41'	Schist	T.R.	165.1	92.9	0.8748	5.23	2111± 58	i)	C.P.Geo	0.710
SPR-806	CHIRIVA-3	13°50'	15°41'	Schist	T.R.	190.3	56.4	1.0037	10.05	1960± 43	i)	C.P.Geo	0.710
SPR-807	CHIRIVA-4	13°50'	15°41'	Schist	T.R.	194.4	56.3	1.0161	10.30	1993± 49	i)	C.P.Geo	0.710
SPR-808	CHIRIVA-5	13°50'	15°41'	Schist	T.R.	164.8	173.0	0.8064	2.78	2316±130	i)	C.P.Geo	0.710
SPR-822	FIMA	13°54'	15°36'	Granite	T.R.	125.3	292.9	0.7425	1.24	2023±123	i)	C.P.Geo	0.705
SPR-803	CHICUCUTE	13°54'	15°34'	Granite	T.R.	149.2	328.6	0.7433	1.32	1946±114	i)	C.P.Geo	0.705
SPR-821	LINO	14°00'	15°37'	Granite	T.R.	125.0	350.9	0.7371	1.03	2077±142	i)	C.P.Geo	0.705
SPR-820	MOINHO	13°54'	15°43'	Granite	T.R.	676.0	18.4	4.0843	141.79	1602± 84	i)	C.P.Geo	0.705

The Figures columns means:

- 1 - Laboratory number
- 2 - Sample number
- 3 - Latitude
- 4 - Longitude
- 5 - Rock Type
- 6 - Material used in analyse
- 7 - Total Rubidium in p.p.m.
- 8 - Total Strontium in p.p.m.
- 9 - Ratio  $^{87}\text{Sr}/^{86}\text{Sr}$
- 10 - Ratio  $^{87}\text{Rb}/^{86}\text{Sr}$
- 11 - Conventional age
- 12 - References
- 13 - Laboratory
- 14 - Initial ratio used in the calculation

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- b) DELHAL, J.; LEDENT, D.; PASTEELS, P., VENIER, J. (1971)
- c) CAHEN, I.; DELHAL, J.; LEDENT, D., REINHARD, M. (1963)
- d) SIMPSON, E.S.W., OTTO, J.D.T. (1960)
- e) UNPUBLISHED
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APPENDIX 2

ANALYTICAL DATA FOR K/Ar FROM ANGOLA.

(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SPK-1568	572-66-LL	11°14.6'	13°58'	Basalt	T.R.**	0.9640	5.105	59.6	128 ± 13	a)
SPK-1569	145-67-MP	11°20'	14°3.4'	Basalt	T.R.	1.2520	6.426	45.9	124 ± 10	a)
SPK-1571	G55-67-FG	11°50.5'	13°54.7'	Amphibolite	Amphibole	0.7850	18.62	36.1	517 ± 34	b)
SPK-1691	41-67-MP	11°22'	14°13.2'	Gneiss	Biotite	5.6970	131.5	1.37	505 ± 27	b)
SPK-1692	178-67-MP	11°28.5'	14°6.1'	Basalt	T.R.	0.9762	6.842	41.8	168 ± 13	a)
SPK-1694	G1-HC-377	15°43.5'	13°36.8'	Granite	Feldspar	9.7260	194.0	1.63	444 ± 30	b)
SPK-1695	1265-67-FG	11°45'	13°58.3'	Basalt	T.R.	1.4133	13.29	34.5	222 ± 16	a)
SPK-1696	G5-MS-207	11°43.9'	14°27.5'	Dolerite	T.R.	0.9640	105.1	1.62	1689 ± 67	c)
SPK-1699	10-HC-376	15°56.9'	13°29'	Norite	T.R.	0.6630	25.43	11.0	777 ± 41	b)
SPK-1702	841-67-FG	11°39.2'	13°49.7'	Basalt	T.R.	0.7426	2.540	51.0	84 ± 8	a)
SPK-1754	563-67-FG	11°49'	13°56.6'	Basalt	T.R.	1.4027	7.446	69.7	128 ± 11	a)
SPK-1755	147-67-MP	11°25.4'	14°4'	Dolerite	T.R.	1.2023	6.983	46.2	140 ± 8	a)
SPK-1756	731-67-FG	11°39.2'	13°48.5'	Syenite	T.R.	1.4124	5.032	33.7	87 ± 6	a)
SPK-1758	731B-67-FG	11°38.4'	13°49.3'	Basalt	T.R.	0.8242	3.560	78.1	105 ± 10	a)
SPK-1759	G6-MS-207	11°44.8'	14°28.7'	Syenite	T.R.	3.5350	99.71	3.93	601 ± 26	b)
SPK-1765	649-FG-68	11°54'	14°45.9'	Dolerite	T.R.	0.6300	105.5	3.55	2209 ± 66	c)
SPK-1766	G8-MS-207	11°43.4'	14°28'	Tinguaitite	T.R.	3.8182	1.434	57.4	92 ± 7	a)
SPK-1775	60-MP-64	14°30.2'	14°7'	Dolerite	T.R.	0.3670	44.76	8.30	1818 ± 60	c)
SPK-1777	583-67-FG	11°47.4'	13°53.5'	Dolerite	T.R.	0.5031	2.715	57.0	130 ± 9	a)
SPK-1778	679-FG-67	11°46.1'	13°58.8'	Amphibolite	T.R.	0.3130	40.63	86.0	1876 ± 246	c)
SPK-1779	143-67-MP	11°21.6'	14°2.7'	Dolerite	T.R.	0.7100	4.280	44.7	145 ± 9	a)
SPK-1780	662-FG-68	11°54.7'	14°49.3'	Dolerite	T.R.	0.4040	59.81	4.18	2054 ± 23	c)
SPK-1731	33-HC-376	15°55.8'	13°27.2'	Granodiorite	T.R.	3.7100	147.4	3.29	800 ± 13	b)
SPK-1782	180-HC-377	15°30.1'	13°32.2'	Porphyry	T.R.	2.8540	166.9	3.62	1025 ± 43	b)
SPK-2049	PUÇ-1-2450	9°37.2'	13°14.5'	Basalt	T.R.	1.9477	11.44	51.0	142 ± 12	a)
SPK-2065	BJ-1-3427	9°10.4'	13°33.8'	Basalt	T.R.	2.8800	11.33	59.9	96 ± 8	a)
SPK-2076	PUÇ-2-2570	9°37.2'	13°14.5'	Basalt	T.R.	0.8253	4.864	70.2	143 ± 13	a)
SPK-2083	RT-ANGOLA	14°1.9'	12°27'	Basalt	T.R.	1.5762	4.788	72.3	75 ± 7	a)
SPK-2442	MOÇAMEDES	15°1.8'	12°11.1'	Sandstone	Glauconite	6.5765	13.29	41.7	50 ± 2	d)
SPK-2515	G-33/317	14°7'	14°1'	Basalt	T.R.	1.1830	38.430	6.75	678 ± 27	e)
SPK-2518	G-54/317	14°4'	14°14.8'	Dolerite	T.R.	0.6605	42.020	8.64	1157 ± 26	e)
SPK-2519	G-12/317	14°18.7'	14°2.4'	Norite	T.R.	0.9140	31.070	6.14	704 ± 17	e)
SPK-2521	G-6/318	14°4'	14°32.3'	Dolerite	T.R.	0.9390	5.104	65.8	132 ± 13	e)
SPK-2524	G-24/317	14°3'	14°4'	Dolerite	Plagioclase	0.1609	10.440	36.1	1175 ± 69	e)
SPK-2525	G-36/317	14°27'	14°6.5'	Dolerite	T.R.	0.4485	64.192	7.67	2000 ± 250	e)
SPK-2526	G-40/317	14°23.5'	14°1.8'	Horblendite	Horblende	0.4570	47.730	7.77	1643 ± 40	e)
SPK-2527	G-58/338	14°42.2'	14°49'	Gabbro	Plagioclase	0.2955	40.660	12.6	1964 ± 61	e)
SPK-2528	G-59/318	14°29.8'	14°30.5'	Gabbro	Plagioclase	0.1785	264.5	5.65	5718 ± 51	e)
SPK-2529	G-3 /337	14°49.3'	14°14.1'	Anorthosite	Plagioclase	0.1295	19.93	9.24	2102 ± 51	e)
SPK-2531	G-4 /337	14°52.4'	14°19.4'	Anorthosite	Plagioclase	0.1215	19.520	8.36	2157 ± 43	e)
SPK-2532	G-17/317	14°12.7'	14°8.7'	Dolorite	T.R.	0.6895	50.370	2.76	1281 ± 22	e)
SPK-2534	G-29/317	14°12.4'	14°4'	Phonolite	T.R.	4.1200	13.800	21.7	82 ± 3	e)
SPK-2535	G-23/317	14°4.5'	14°4.5'	Norite	T.R.	0.7980	24.410	16.4	644 ± 27	e)
SPK-2537	G-5/318	14°5.6'	14°39.4'	Dolorite	T.R.	0.3215	24.010	13.6	1309 ± 99	e)
SPK-2538	G-16/317	14°11.8'	14°9.6'	Dolorite	T.R.	0.0920	5.027	61.9	1031 ± 65	e)
SPK-2539	G-2 /337	14°31'	14°5.2'	Dolorite	T.R.	0.3000	27.760	34.1	1514 ± 36	e)
SPK-2541	G-18/317	14°13.7'	14°10.3'	Dolorite	T.R.	0.6037	59.380	44.9	1600 ± 160	e)
SPK-2543	G-11/317	14°20.2'	14°2.1'	Phonolite	T.R.	3.8110	13.450	74.0	87 ± 11	e)
SPK-2546	G-27/317	14°0.5'	14°1'	Basalt	Plagioclase	0.341	1.550	86.5	111 ± 11	e)
SPK-2548	G-55/317	14°7.1'	14°1.1'	Pegmatite	Muscovite	8.670	998.600	6.71	1753 ± 42	e)
SPK-2553	G-28/317	14°7.1'	14°2.5'	Pegmatite	Feldspar	0.750	41.500	42.6	1043 ± 57	e)
SPK-2554	G-60/337	14°42.2'	14°18.2'	Pegmatite	Feldspar	9.041	309.500	9.73	708 ± 11	e)
SPK-2563	G-1 /318	14°7'	14°57.9'	Dolorite	T.R.	0.557	24.840	34.4	880 ± 340	e)

\* See the legend for the significance of the columns

\*\* T.R. means total rock

(Continue)

APPENDIX 2  
(Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SPK-2564	G-8/317	14°29.9'	14°6.5'	Gabbro	T.R.	0.178	7.171	63.6	811 ± 26	e)
SPK-2565	G-60/337	14°42.2'	14°18.2'	Pegmatite	Feldspar	9.041	309.600	18.5	708 ± 14	e)
SPK-2568	G-67/317	14°37.8'	14°21.3'	Pegmatite	Muscovite	9.173	1125.00	31.9	1826 ± 61	e)
SPK-2450	416/17	16°55.2'	11°48.5'	Wehrlite	T.R.	0.204	0.030	87.1	37 ± 10	f)
SPK-2452	440/32	17°2.7'	12°16.3'	Amphibolite	Hornblende	0.374	1.761	19.5	918 ± 47	f)
SPK-2453	440/29	17°8.6'	12°22.3'	Hornblende Schist	Muscovite	0.057	0.160	92.4	598 ± 278	f)
SPK-2454	440/31	17°2.6'	12°15.8'	Amphibolite	Hornblende	0.464	0.129	9.7	596 ± 28	f)
SPK-2455	440/30	17°0.5'	12°16.6'	Amphibolite	Hornblende	0.126	0.061	33.3	940 ± 71	f)
SPK-2456	439/96	17°10.8'	11°54.2'	Olivine Biotite Dolerite	Biotite	7.120	14.390	5.0	449 ± 14	f)
SPK-2457	439/96	17°10.8'	11°54.2'	Olivine Biotite Dolerite	Plagioclase	0.114	0.272	54.1	524 ± 71	f)
SPK-2459	440/29	17°8.6'	12°22.3'	Hornblende Schist	Hornblende	0.196	0.556	35.0	604 ± 30	f)
SPK-2460	417/6	16°44.3'	12°6.8'	Amphibolite	Hornblende	0.386	1.097	16.6	605 ± 19	f)
SPK-2462	417/34	16°49.6'	12°16.3'	Amphibolite	Hornblende	0.086	1.204	12.0	1984 ± 50	f)
SPK-2464	416/266	16°45.5'	11°59.2'	Pyroxene Granulite	Hornblende	0.222	0.594	41.2	575 ± 37	f)
SPK-2465	416/158	16°54.0'	11°48.0'	Luzitanite	Biotite	7.122	3.580	34.0	122 ± 7	f)
SPK-2477	417/11	16°38.3'	12°1.6'	Epidote	Plagioclase	0.050	0.425	50.1	1423 ± 69	f)
SPK-2479	416/269	16°41.8'	11°56.3'	Biotite Hypersthene Granulite	T.R.	0.509	2.780	6.4	1031 ± 38	f)
SPK-2484	416/154	16°56.5'	11°48.0'	Bostonite	T.R.	5.351	3.951	9.8	177 ± 7	f)
SPK-2485	416/169	16°54.0'	11°49.0'	Mela - Monzonite	Biotite	6.348	3.446	48.0	128 ± 15	f)
SPK-2488	417/11	16°41.8'	12°1.6'	Epidote	Epidote	0.762	1.919	15.0	545 ± 20	f)
SPK-2490	417/95	16°48'	12°26.7'	Epi - Dolerite	T.R.	0.281	8.299	2.6	3008 ± 52	f)
SPK-2492	417/23	16°45.3'	12°7.7'	Leuco - Gabbro	T.R.	1.308	0.511	42.0	96 ± 15	f)
SPK-2501	417/133	16°32.4'	12°26.8'	Hornblendite	T.R.	0.211	3.209	4.4	2088 ± 40	f)
SPK-2510	417/134	16°32.9'	12°27'	Meta - Basite	Hornblende	1.545	6.335	67.0	822 ± 87	f)
SPK-2511	417/152	16°38'	12°29.7'	Meta - Basite	Plagioclase	0.482	0.981	17.0	452 ± 16	f)
SPK-2512	417/35	16°36.9'	12°15.6'	Meta - Hornblendite	T.R.	0.094	7.015	7.8	4519 ± 66	f)
SPK-2513	417/102	16°48.7'	12°26.5'	Olivina Dolerite	Plagioclase	0.199	108.5	1.0	8122 ± 195	f)
SPK-2502	439/97	17°11.7'	11°53.5'	Biotite Dolerite	T.R.	1.694	8.060	12.0	925 ± 22	f)
SPK-2604	439/99	17°7.7'	11°53.1'	Trachybasalt	T.R.	2.131	1.177	47.2	134 ± 8	f)
SPK-2607	416/70	16°55.0'	11°47.0'	Pyroxene Biotite	Biotite	6.961	3.179	84.6	111 ± 16	f)
SPK-2650	416/169	16°54.0'	11°49.0'	Mela - Monzonite	Hornblende	1.303	0.615	40.2	115 ± 7	f)
SPK-2652	416/184	16°56.0'	11°47.5'	Minette	Biotite	7.220	3.857	22.6	126 ± 10	f)
SPK-2654	416/219	16°55.8'	11°48.7'	Minette	Biotite	1.105	3.726	25.5	127 ± 5	f)
SPK-2658	416/26	16°56.0'	11°48.0'	Biotite Larvophyre	Biotite	5.530	2.354	80.1	104 ± 22	f)
SPK-2667	416/107	16°54.5'	11°46.8'	Leuco - Monzogabbro	Biotite	8.700	2.823	83.8	80 ± 20	f)
SPK-2671	416/62	16°54.5'	11°47.0'	Hornfels Metabasalt	T.R.	2.381	0.629	75.7	65 ± 6	f)
SPK-2673	416/52	16°55.8'	11°47.5'	Hornblende Biotite	T.R.	2.836	1.305	77.0	112 ± 11	f)
SPK-2676	417/22	16°46.7'	12°9.5'	Skarn	T.R.	0.325	2.256	74.1	1234 ± 127	f)
SPK-2686	416/72	17°1.7'	12°26.7'	Amphibolite	Hornblende	0.108	0.759	14.7	1250 ± 92	f)
SPK-2712	395/G14	16°24.5'	12°27.3'	Dolerite	T.R.	1.129	13.53	9.6	1798 ± 31	f)
SPK-2720	395/G14A	16°24.5'	12°27.3'	Dolerite	T.R.	0.096	1.257	8.0	1904 ± 79	f)
SPK-2723	417/107	16°48'	12°20.7'	Epi - Dolerite	T.R.	0.721	18.57	0.9	2806 ± 88	f)
SPK-2725	395/G14B	16°24.5'	12°27.3'	Dolerite	T.R.	0.116	3.370	8.6	2985 ± 156	f)
SPK-2726	416/156	16°56.5'	11°47.0'	Leuco - Diabase Porphyry	T.R.	5.950	1.721	7.8	71 ± 5	f)
SPK-2727	440/72	17°1.7'	12°26.7'	Amphibolite	Plagioclase	0.115	0.916	62.5	1362 ± 108	f)
SPK-2729	416/64	16°54.7'	11°48.0'	Meta - Latite	T.R.	0.510	0.395	46.3	186 ± 20	f)
SPK-2734	416/264	16°49.5'	11°59.5'	Biotite Hypersthene Granulite	T.R.	0.705	1.517	57.8	475 ± 29	f)
SPK-2744	395/G11-A	16°14.5'	12°25.7'	Epi - Dolerite	Hornblende	0.489	4.604	10.1	1534 ± 87	f)
SPK-2749	417/102	16°48.8'	12°26.5'	Olivine Dolerite	T.R.	0.378	81.17	1.2	6391 ± 53	f)
SPK-2751	395/G11	16°14.5'	12°25.7'	Epi - Dolerite	Hornblende	0.654	6.130	6.0	1528 ± 57	f)
SPK-2753	417/58	16°43.7'	12°25.6'	Olivine Dolerite	T.R.	0.192	23.47	3.5	5376 ± 53	f)
SPK-2757	417/116	16°46.4'	12°26.3'	Olivine Dolerite	T.R.	0.232	15.77	3.5	4354 ± 90	f)
SPK-2758	417/130	16°43.4'	12°28.9'	Olivine Dolerite	T.R.	0.219	13.94	1.6	4239 ± 43	f)

(Continue)

APPENDIX 2  
(Continuation)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
SPK-2772	395-G8	16°20.4'	12°017'	Dolerite	T.R.	1.503	1.237	19.9	196 ± 8	f)
SPK-2774	440-77	17°03'	12°025.6'	Amphibolite	Plagioclase	0.313	0.696	55.4	489 ± 29	f)
SPK-2778	440-77	17°03'	12°025.6'	Amphibolite	Hornblende	0.297	0.946	33.1	668 ± 33	f)
SPK-2871	417-171	16°47.2'	12°021'	Gneiss	Biotite	7.937	58.81	6.2	1294 ± 44	f)
SPK-2872	417-172	16°42.9'	12°026.7'	Phyllite	Muscovite	5.081	11.60	24.7	500 ± 20	f)
SPK-2874	417-13	16°37.3'	12°02.2'	Pegmatite	Muscovite	9.009	21.21	11.6	514 ± 14	f)
SPK-2875	417-9	16°55.5'	12°011.4'	Staurolite Garnet Gneiss	Biotite	6.073	14.96	14.0	535 ± 26	f)
SPK-2878	417-170	16°30.2'	12°023.8'	Norite	T.R.	0.803	3.199	76.4	804 ± 83	f)
SPK-2879	417-168	16°34.8'	12°05.7'	Acid Granulite	Muscovite	9.202	19.02	4.2	459 ± 28	f)
SPK-2880	417-168	16°34.8'	12°05.7'	Acid Granulite	Biotite	5.371	7.689	96.0	334 ± 206	f)
SPK-2883	440- 19	17°02.7'	12°023.2'	Granite Gneiss	Biotite	7.368	6.760	27.0	217 ± 10	f)
SPK-2893	439-106	17°10.8'	11°53.1'	Quartz Diorite Gneiss	Biotite	7.177	15.77	84.4	488 ± 93	f)
SPK-2895	439-76	17°12.4'	11°47.2'	Quartz Diorite Gneiss	Biotite	6.919	13.44	84.0	435 ± 77	f)
SPK-2897	417-156	16°51.9'	12°023.6'	Phyllite	Biotite	4.332	10.87	25.7	545 ± 35	f)
SPK-2898	417-25	16°53.8'	12°018.7'	Quartzite	Muscovite	9.290	14.35	89.7	352 ± 117	f)
SPK-2902	417-99	16°47.2'	12°026.8'	Granite Gneiss	Biotite	7.424	17.82	29.7	523 ± 22	f)
SPK-2904	417-152	16°38.1'	12°029.6'	Meta - Basite	Muscovite	6.649	15.72	87.7	521 ± 143	f)
SPK-2885	Lazulite	12°50'	14°34'	Pegmatite	Muscovite	8.7300	1104	63.0	1863 ± 140	g)
SPK-2959	F.V.Arriaga	14°40'	13°08'	Norite	T.R.	0.5613	50.28	5.02	1481 ± 39	h)
SPK-2923	F.443	17°06.5'	13°54'	Pegmatite	Muscovite	8.6675	662.0	1.81	1265 ± 43	i)
SPK-2976	T-DC	12°22'	14°43'	Dolerite	Plagioclase	0.2067	32.82	9.43	2142 ± 49	j)

The constants employed in calculations are:

$$\lambda_{\text{Total}} = 0.530 \times 10^{-9} \text{ years}^{-1}$$

$$\lambda_{\text{K}} = 0.585 \times 10^{-10} \text{ years}^{-1}$$

% of  $^{40}\text{K}$  in K total = 0.0119

The figures columns mean:

- 1) Laboratory number
- 2) Sample number
- 3) Latitude
- 4) Longitude
- 5) Rock type
- 6) Material used in analyse
- 7) % K
- 8)  $^{40}\text{Ar}$  Radiogenic  $\times 10^{-6}$
- 9) % Atmospheric Argon
- 10) Age K/Ar
- 11) References

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- h) TORQUATO, J.R. (1974)
- i) TORQUATO, J.R. e PAIXÃO, C. (in preparation)
- j) TORQUATO, J.R. (unpublished)

APPENDIX 3  
 Rb/Sr AGES PRESENTED BY MENDES (1968) AND RECALCULATED  
 WITH  $R_0 = 0.705$

(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
750	07°53'	21°07'	Gneiss	Biotite	415.24	126.97	3.247	<u>0.978</u>	<u>9.65</u>	1852 ± 62	1899 ± 57
751	07°22'	21°13'	Granite	Biotite	572.562	30.848	6.022	<u>3.172</u>	<u>66.3</u>	2479 ± 22	2485 ± 75
752	07°21'	21°12'	Diorite	Biotite	614.713	14.772	6.466	<u>8.607</u>	<u>213</u>	2479 ± 40	2481 ± 74
755	07°21'	20°49'	Granite	Biotite	705.012	40.226	8.675	<u>3.501</u>	<u>64.2</u>	2297 ± 70	2898 ± 87
755	07°21'	20°49'	Granite	Feldspar	-	-	-	0.775	1.88	2446	2497 ± 75
756	12°55'	14°50'	Granite	Biotite	705.012	20.962	4.991	<u>3.871</u>	<u>127</u>	1678 ± 40	1682 ± 51
770	11°08'	16°00'	Granite	Biotite	757.230	10.98	4.667	<u>8.210</u>	<u>345</u>	1463 ± 30	1465 ± 44
771	11°20'	16°20'	Gneiss	Biotite	677.884	84.627	4.373	<u>1.265</u>	<u>24.3</u>	1531 ± 36	1550 ± 47
772	11°20'	15°50'	Granite	Biotite	1149.103	6.486	7.683	?	?	1586 ± 31	?
773	12°09'	16°45'	Granite	Biotite	477.492	39.704	3.381	<u>1.656</u>	<u>37.8</u>	1678 ± 70	1691 ± 51
774	11°56'	16°41'	Granite	Biotite	531.030	10.994	3.796	<u>1.061</u>	<u>212</u>	1694 ± 34	1696 ± 51
775	12°20'	16°30'	Granite	Biotite	607.936	34.443	4.098	<u>2.082</u>	<u>57.6</u>	1599 ± 25	1607 ± 48
778	10°51'	14°22'	Gneiss	Biotite	459.431	19.842	0.9415	<u>1.217</u>	<u>69.9</u>	490 ± 8	497 ± 15
779	10°54'	14°16'	Gneiss	Biotite	835.072	24.233	1.776	<u>1.514</u>	<u>107</u>	509 ± 58	512 ± 15
780	10°54'	14°16'	Gneiss	Biotite	488.462	63.699	1.049	<u>0.882</u>	<u>22.4</u>	513 ± 59	534 ± 16
798	11°07'	23°58'	Granite	Biotite	645.543	43.780	5.405	<u>2.140</u>	<u>48.4</u>	1869 ± 40	1990 ± 60
799	17°03'	12°17'	Granite	Biotite	573.800	11.762	1.208	<u>1.873</u>	<u>156</u>	503 ± 26	506 ± 15
800	09°41'	14°49'	Granite	Biotite	516.184	14.398	3.032	<u>3.417</u>	<u>131</u>	1398 ± 73	1399 ± 42
802	15°01'	12°24'	Granite	Biotite	487.022	22.976	2.622	<u>2.019</u>	<u>68.8</u>	1281 ± 57	1287 ± 39
803	15°01'	12°26'	Granite	Biotite	549.474	35.558	2.122	<u>1.356</u>	<u>47.2</u>	920 ± 24	930 ± 28
804	12°29'	15°01'	Granite	Biotite	995.802	28.323	4.440	<u>2.605</u>	<u>120</u>	1062 ± 24	1066 ± 32
830	07°21'	21°12'	Granite	Biotite	551.09	23.988	5.726	<u>3.892</u>	<u>85.2</u>	2441 ± 123	2497 ± 75
831	15°07'	13°04'	Granite	Biotite	417.65	31.994	2.420	<u>1.542</u>	<u>39.9</u>	1371 ± 88	1412 ± 42
1292	11°11'	15°00'	Granite	Biotite	591.0	35.317	2.9255	<u>1.628</u>	<u>51.5</u>	1178 ± 44	1208 ± 36
1293	14°56'	12°28'	Granite	Biotite	606.57	34.223	2.2112	<u>1.413</u>	<u>53.5</u>	871 ± 24	893 ± 27
1294	14°53'	12°38'	Granite	Biotite	1960.54	15.536	8.411	<u>12.685</u>	<u>777</u>	1023 ± 53	1041 ± 31
1295	14°54'	12°43'	Gneiss	Biotite	664.31	76.788	2.894	<u>1.109</u>	<u>25.4</u>	1040 ± 62	1074 ± 32
1401	14°59'	12°40'	Granite	Biotite	414.22	84.811	0.955	<u>0.828</u>	<u>13.9</u>	551 ± 30	595 ± 18
1403	08°11'	21°47'	Gneiss	Biotite	860.31	50.95	5.8150	<u>2.019</u>	<u>53.8</u>	1605 ± 42	1640 ± 49
1404	07°42'	21°39'	Gneiss	Biotite	729.20	29.699	5.742	<u>3.143</u>	<u>86.0</u>	1872 ± 130	1902 ± 57
1405	08°16'	20°44'	Granite	Muscovite	314.67	15.396	2.672	<u>2.842</u>	<u>69.9</u>	2010 ± 20	2050 ± 62
1406	13°31'	13°56'	Granite	Biotite	542.82	30.494	3.090	<u>1.856</u>	<u>55.9</u>	1159 ± 22	1385 ± 42
1407	13°43'	13°57'	Granite	Biotite	469.95	44.958	2.851	<u>1.399</u>	<u>31.5</u>	1442 ± 22	1481 ± 44
1408	13°46'	13°41'	Granite	Biotite	477.47	51.604	2.887	<u>1.313</u>	<u>27.7</u>	1437 ± 7	1478 ± 44
1409	11°33'	15°35'	Granite	Biotite	1135.87	16.474	7.379	<u>8.940</u>	<u>353</u>	1544 ± 10	1570 ± 47
1410	14°22'	13°49'	Granite	Biotite	794.98	21.429	5.812	<u>4.486</u>	<u>144</u>	1734 ± 8	1766 ± 53
1411	14°06'	13°18'	Granite	Biotite	225.07	156.71	1.404	<u>0.804</u>	<u>4.09</u>	1483 ± 20	1620 ± 49
1530	13°56'	14°19'		Biotite	298.46	92.811	1.415	<u>0.869</u>	<u>9.22</u>	1525 ± 116*	
1532	13°54	14°21'		Biotite	499.84	32.778	0.2356	<u>0.785</u>	<u>43.4</u>	113 ± 8	126 ± 4
1544	11°58'	17°43'		Biotite	774.78	26.122	3.6531	<u>2.361</u>	<u>97.4</u>	1134 ± 164	1147 ± 34
1545	11°55'	17°40'		Biotite	529.29	31.896	3.4492	<u>1.942</u>	<u>52.6</u>	1557 ± 49	1582 ± 48
1546	11°55'	17°40'		Feldspar	-	-	-	0.7668	1.8686	2032	2213 ± 66
1547	07°40'	17°35'		Biotite	473.73	9.5129	4.7188	<u>10.695</u>	<u>279</u>	2361 ± 73	2392 ± 72
1548	09°20'	15°40'		Feldspar	-	-	-	0.8938	73.941	1867*	
1550	08°40'	15°40'		Biotite	605.05	51.532	5.0375	<u>1.811</u>	<u>36.8</u>	1964 ± 135	2016 ± 61
1550	08°40'	15°40'		Feldspar	-	-	-	0.7397	0.6124	4168*	
1551	09°00'	16°40'		Biotite	372.78	19.2173	2.8769	<u>2.498</u>	<u>64.4</u>	1830 ± 159	1867 ± 56
1552	09°00'	18°00'		Biotite	692.58	46.6216	5.7959	<u>2.151</u>	<u>47.9</u>	1981 ± 224	2024 ± 61
1554	10°30'	22°20'		Feldspar	-	-	-	0.8019	3.399	1793	1912 ± 57
1555	10°30'	22°20'		Feldspar	-	-	-	0.8122	3.3175	2017	2163 ± 65
1557	08°20'	21°20'		Biotite	339.81	30.0790	2.0556	<u>1.456</u>	<u>34.3</u>	2021 ± 58*	
1558	07°20'	20°30'		Biotite	601.82	23.6145	5.5216	<u>3.807</u>	<u>94.0</u>	2179 ± 152	2210 ± 66

\* See the legend for the significance of the columns

(Continue)

APPENDIX 3  
(Continuation)

(1)*	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1558	07°20'	20°30'		Feldspar	-	-	-	0.7252	1.6232	579	841 ± 25
1559	10°30'	22°00'		Feldspar	-	-	-	0.7378	0.7493	2456	2915 ± 87
1560	08°40'	20°40'		Feldspar	-	-	-	0.7602	1.8339	1789	2017 ± 61
1561	08°05'	20°15'		Feldspar	-	-	-	0.7378	0.7493	2222	2915 ± 87
1562	09°40'	21°40'		Biotite	255.40	47.6630	1.7993	<u>1.110</u>	<u>15.7</u>	1667 ± 513	1729 ± 52
1562	09°40'	21°40'		Feldspar	-	-	-	0.8631	4.3062	2342	2453 ± 74
1563	11°20'	23°00'		Biotite	630.84	13.3797	4.6398	<u>6.095</u>	<u>204</u>	1744 ± 122	1775 ± 53
1564	08°50'	21°00'		Biotite	564.16	16.0653	4.2056	<u>4.308</u>	<u>134</u>	1769 ± 140	1800 ± 54
1565	10°20'	22°20'		Feldspar	-	-	-	0.8219	3.8839	1910	2017 ± 61
1787	15°33'	13°26'		Biotite	-	-	-	1.1062	135.369	1728	
1788	15°44.5'	13°10.5'		Feldspar	-	-	-	0.7820	4.62	1023	1124 ± 34
1789	15°31.7'	13°25.6'		Biotite	-	-	-	3.5265	90.072	2079	2098 ± 63
1789	15°31.7'	13°25.6'		Feldspar	-	-	-	0.7785	3.3156	1348	1492 ± 45
1790	15°34.6'	13°26.2'		Muscovite	-	-	-	6.9845	248.694	1726	1696 ± 51
1790	15°34.6'	13°26.2'		Feldspar	-	-	-	1.1223	16.54	1667	1695 ± 51
1791	15°33.0'	13°25.2'		Biotite	-	-	-	4.0931	143.922	1554	1583 ± 48
1792	15°32.0'	13°17.5'		Biotite	314.68	24.747	2.2152	<u>1.709</u>	<u>39.4</u>	1671	1710 ± 51
1792	15°32.0'	13°17.5'		Feldspar	-	-	-	0.7627	2.0627	1604	1877 ± 56
1793	15°39.7'	13°22.0'		Biotite	382.46	16.175	2.6650	<u>2.713</u>	<u>79.96</u>	1653	1687 ± 51
1793	15°39.7'	13°22.0'		Feldspar	-	-	-	0.7555	1.9362	1494	1752 ± 53
1794	15°43.2'	13°10.5'		Biotite	250.668	13.524	1.4653	<u>1.944</u>	<u>58.7</u>	1389	1421 ± 43
1795	15°49.5'	13°04.5'		Biotite	226.433	11.932	2.3333	<u>3.177</u>	<u>66.6</u>	1575*	
1795	15°49.5'	13°04.5'		Feldspar	-	-	-	0.7241	0.6031	1254	2121 ± 64
1796	15°49.5'	13°04.5'		Biotite	272.18	7.866	2.2769	<u>4.844</u>	<u>138</u>	1509*	
1796	15°49.5'	13°04.5'		Muscovite	162.532	12.876	1.6682	<u>2.222</u>	<u>41.0</u>	1813*	
1797	15°45.2'	13°29.0'		Biotite	467.52	5.144	2.6051	<u>11.118</u>	<u>520</u>	1338	1349 ± 41
1797	15°45.2'	13°29.0'		Feldspar	-	-	-	0.9565	25.1658	1310*	
1798	15°47.3'	13°13.6'		Biotite	322.213	17.816	17.816	?	?	4231?	?
1799	15°39.3'	13°04.0'		Biotite	576.55	34.216	3.0524	<u>1.705</u>	<u>52.3</u>	1260	1290 ± 39
1799	15°39.3'	13°04.0'		Muscovite	-	-	-	1.096	15.858	1648	1657 ± 50
1799	15°39.3'	13°04.0'		Feldspar	-	-	-	0.7390	1.1488	1503	1984 ± 60
1826	08°15.8'	20°44.2'		Feldspar	-	-	-	0.7305	1.25	998	1374 ± 41
1826	08°15.8'	20°44.2'		T.R.	-	-	-	0.7885	1.11	4520?	4934 ± 148
1827	16°32.2'	13°17.3'		T.R.	-	-	-	0.7176	0.23	1610	3628 ± 109
1923	12°30'	14°00'		Biotite	681.20	20.4774	2.5409	<u>2.149</u>	<u>107</u>	890	909 ± 27
1923	12°30'	14°00'		T.R.	-	-	-	0.7327	0.9367	1367	1982 ± 60
2150	12°23'	13°45'		Biotite	527.81	49.9458	5.0638	<u>1.856</u>	<u>33.2</u>	2266?	2318 ± 70
2150	12°23'	13°45'		Muscovite	302.13	41.8062	0.6476	<u>0.872</u>	<u>20.7</u>	513	544 ± 16
2150	12°23'	13°45'		T.R.	-	-	-	0.7383	1.11	1583	2011 ± 60
2151	12°25'	14°30'		Biotite	518.07	36.6732	4.2279	<u>2.034</u>	<u>45.1</u>	1933	1975 ± 59
2151	12°25'	14°30'		T.R.	-	-	-	0.8043	1.24	4882?	5240 ± 157
2152	14°30'	14°05'		Biotite	737.10	29.9033	5.0495	<u>2.773</u>	<u>83.8</u>	1626	1659 ± 50
2152	14°30'	14°05'		T.R.	-	-	-	0.7419	1.73	1164	1436 ± 43
2153	13°00'	14°25'		Biotite	624.93	31.6892	3.7886	<u>2.089</u>	<u>63.3</u>	1441	1472 ± 44
2153	13°00'	14°25'		T.R.	-	-	-	0.7272	0.76	1344	1959 ± 59
2154	12°50'	13°25'		Biotite	514.77	15.0784	0.9860	<u>1.422</u>	<u>103</u>	459	471 ± 14
2154	12°50'	13°25'		T.R.	-	-	-	0.7338	0.88	1648	2191 ± 66
2155	14°10'	14°05'		Biotite	576.44	22.4991	4.0596	<u>2.945</u>	<u>88.3</u>	1671	1704 ± 51
2155	14°10'	14°05'		T.R.	-	-	-	0.7393	1.16	1569	1982 ± 60

(Continue)

APPENDIX 3  
(Continuation)

The columns mean:

- 1 - Sample number
- 2 - Latitude
- 3 - Longitude
- 4 - Rock type (Where Known)
- 5 - Material used in analyses
- 6 - Total rubidium in ppm
- 7 - Total strontium in ppm
- 8 - Radiogenic strontium in ppm ( $R_0 = 0.712$ )
- 9 - Ratio  $^{87}\text{Sr}/^{86}\text{Sr}$
- 10 - Ratio  $^{87}\text{Rb}/^{86}\text{Sr}$
- 11 - Originally calculated ages with  $R_0 = 0.712$
- 12 - Ages recalculated using  $R_0 = 0.705$  and including an estimated analytical uncertainty of 3%
  - The numbers in *Italic* in 9 and 10 are results calculated by us using the analytical data published by Mendes (1968)
  - The constants employed in calculations are:

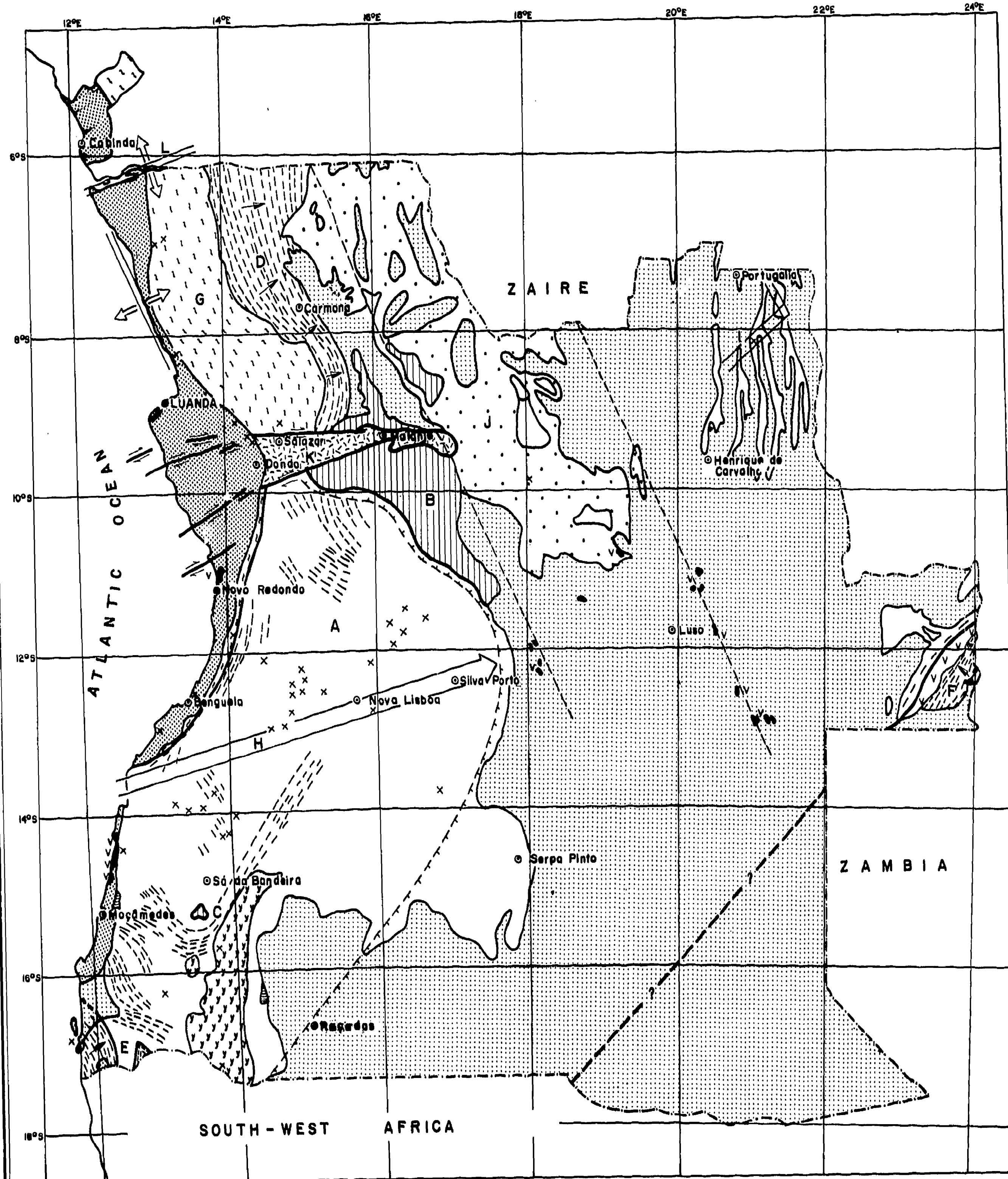
$$^{87}\text{Rb} = 0.2785 \times \text{Total Rb}$$

$$^{87}\text{Sr} = 0.0702 \times \text{Total Sr}$$

$$\lambda_{\text{Rb}} = 1.47 \times 10^{-11} \text{ years}^{-1}$$

- Questions marks indicate insufficient data
- Asterisks indicate where our calculations do not agree with the results reported by Mendes (1968)

# TECTONIC MAP OF ANGOLA



## LEGEND

### STRUCTURAL EVOLUTION

#### BASE COMPLEX (Precambrian)

- LOWER PRECAMBRIAN
- ANORTHOSITIC-GABBROIC COMPLEX (SOUTHERN ANGOLA)
- LATE PRECAMBRIAN CRATONIC AREAS AND BOUNDARIES OF PAN-AFRICAN/AFRICAN OR OLDER PROVINCES WITH THE STRUCTURAL TRENDS INDICATED
- PAN-AFRICAN OROGENIC BELTS AND/OR OROGENIC BELTS OLDER BUT REJUVENATED
- PARAPLATFORMS AND/OR OROGENIC BELTS OF PAN-AFRICAN AGE. THE ARROW GIVES THE GENERAL DIRECTION OF VERGENCE
- PRECAMBRIAN SEDIMENTARY COVER SLIGHTLY FOLDED AND METAMORPHOSED

#### STAGE OF TRANSITION (Cambrian - Ordovician)

- ACID VOLCANICS OR PLUTONS

#### STAGE OF STABILIZATION (Ordovician - Triassic)

- PALEOZOIC SYNECLISE (KARROO SEDIMENTS)
- CASSANGE PALEOGRABEN
- MOÇAMEDES ARCH
- CONGO AND ZAIRE ARCHES
- CUANZA HORST

#### STAGE OF REACTIVATION (Triassic - Recent)

- POST-KARROO SEDIMENTARY COVER
- TECTONIC COASTAL BASINS
- BASALTIC VOLCANISM (TRAP ROCKS OR NECKS)
- ALKALINE MAGMATISM
- CRATONIC GRANITE
- NORMAL AND/OR TRANSCURRENT FAULTS

#### GEOTECTONIC UNITS

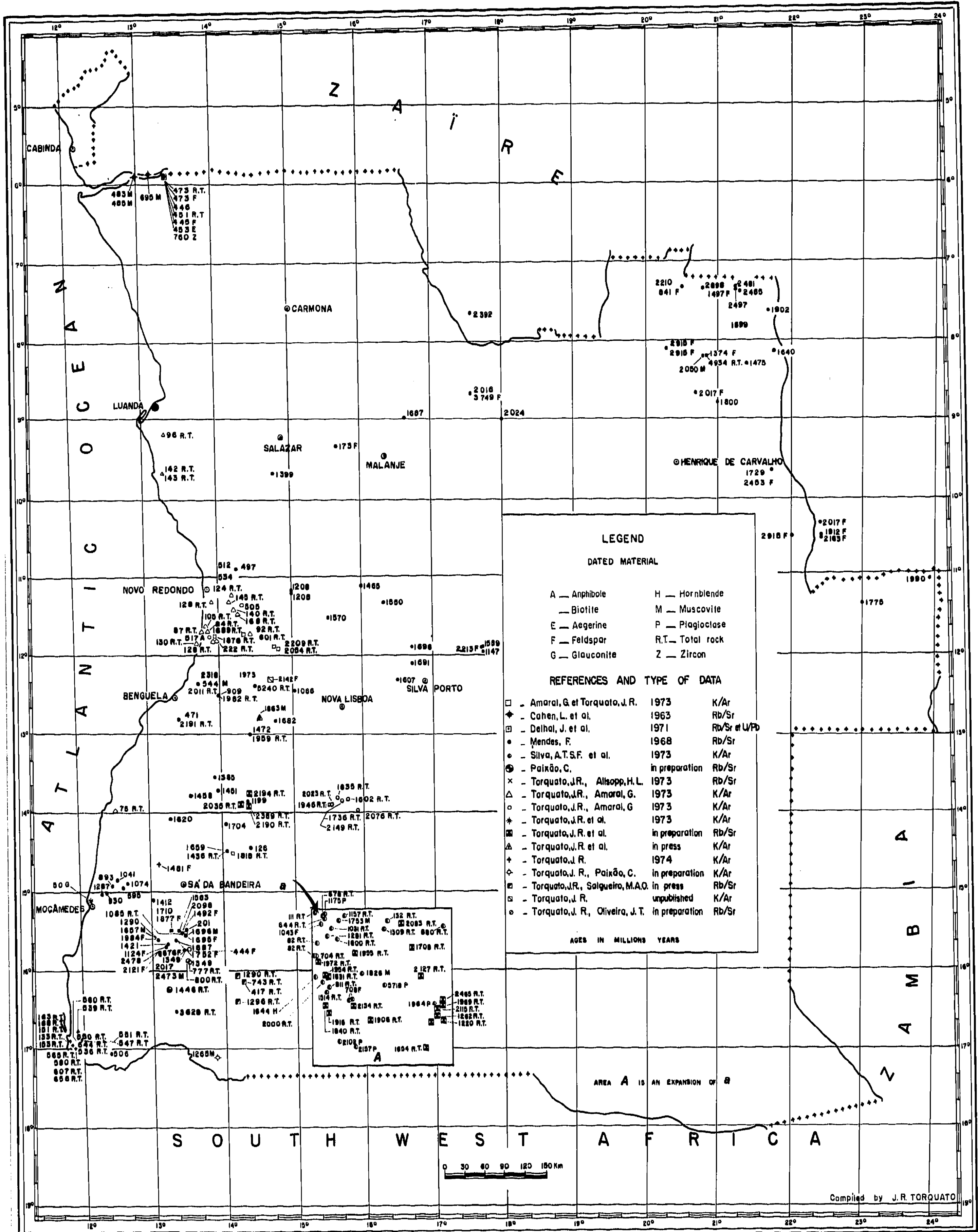
- A - ANGOLAN SHIELD ( $\geq 2000$  m.y.)
- B - WEST CONGO GROUP (500\*900 m.y.) (ORTHOPLATFOM.)
- C - LEBA LIMESTONE (500\*900 m.y.) (ORTHOPLATFOM.)
- D - PAN-AFRICAN OROGENIC BELT OF WEST CONGO GROUP ( $\approx 500$  m.y.)
- E - PAN-AFRICAN OROGENIC BELT OF DAMARA GROUP ( $\approx 500$  m.y.)
- F - PAN-AFRICAN OROGENIC BELT OF MALOMBE - MACONDO SERIES ( $\approx 500$  m.y.)
- G - ZAIRE ARCH (500 m.y.)
- H - MOÇAMEDES ARCH (PRECAMBRIAN)
- I - LUCAPA GRABEN (JURASSIC?)
- J - CASSANGE PALEOGRABEN (TRIASSIC? JURASSIC?)
- K - CUANZA HORST (JURASSIC?)
- L - CONGO ARCH (JURASSIC?)

Elaborated by Joaquim Raul Torquato with the data indicated in text.



GAM-1-12  
 140 E40 09 N  
 03 12

Cette mire doit être lisible dans son intégralité  
 Pour A0 et A1: ABERPPTLHJDDCGOUVWMSZXY  
 ZSaeocmuvnxirfkbbpqqjij 7142385690  
 Pour A2A3A4: ABERPPTLHJDDCGOUVWMSZXY  
 ZSaeocmuvnxirfkbbpqqjij 7142385690



Cette mire doit être lisible dans son intégralité  
 Pour AO et A1-ABERPTLJDDCGUVMNSZXY  
 ZSEOCMVNWXIRFKHBPQJIT 7142385690  
 Pour A2A3A4;ABERPTLJDDCGUVMNSZXY  
 ZSEOCMVNWXIRFKHBPQJIT 7142385690  
 140 00 09 N  
 GAM-1.12  
 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Fig. 2 - J.R. TORQUATO - TECTONIC OUTLINE OF ANGOLA

GEOCHRONOLOGICAL DATA FROM ANGOLA