REVIEW OF SOME OUTSTANDING PROBLEMS IN THE PRECAMBRIAN GEOLOGY OF SURINAME

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INTRODUCTION

In the last decade, knowledge of the basement geology of Suriname has greatly increased as a result of the intensive mapping campaign of the Geological and Mining Service of Suriname, and geochronological research by the ZWO Laboratory of Isotope Geology at Amsterdam, the Netherlands. These concerted efforts resulted in the publication of a full-colour geological map of the country at 1:500.000 in two sheets (Geological and Mining Service, 1977), on which 37 different rock units distinguished in the Precambrian alone, and which is based on photogeology, aerogeophysical survey, 35 years of field work, a sample collection of 100.000 (one hard-rock sample per sq. km), of which about 50.000 thin sections were made, and about 700 drill cores. About 300 Rb-Sr, K-Ar and U-Pb whole-rock and mineral age determinations were carried out. The accompanying explanation to the geological map is being printed at present (Bosma et al., in press; de Vletter (ed.) in press.).

As a result, the broad outlines of the geology are well established. The Precambrian basement of Suriname consists of two high-grade metamorphic belts of Lower Proterozoic or possibly Archaean age, a Lower Proterozoic greenstone belt, and a vast granitoid-volcanic complex between these metamorphic belts. The basement carries a few remnants of flat-lying Middle Proterozoic continental sediments, and is cut by abundant Middle Proterozoic and Permo-Triassic dolerite dykes. Unconsolidated Cenozoic sediments form a fringe of up to 150 km wide in the coastal area. The basement was essentially formed during the Trans-Amazonian Orogenic Cycle between 2000 and 1870 Ma ago. Younger tectonic movements accompanied by shearing, mylonitization and low-grade metamorphism culminated during the Nickerie Metamorphic Episode around 1200 Ma ago. A review of the basement geology was published recently by Bosma et al (1983). The main structural units are depicted in Fig. 1, the stratigraphical column in Table 1.

During the compilation of the geological map and the accompanying text, a number of problems were encountered, of geochronological, stratigraphical and tectonic character, which partly are specific to Suriname, but partly are shared with other countries in the Guiana Shield. It is the purpose of this paper to present these problems in order to further discussions with geologists from other parts of the South American shields.

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(1) THE PRESENCE OF AN ARCHAEAN BASEMENT IN SURINAME

An outstanding problem is whether or not sizeable parts of the Guiana Shield are of Archaean age. There is one school of thought which believes in an Archaean age of *e.g.* the Kanuku Complex in Venezuela, Kanuku Granulites in Guyana, Falawatra Group in Suriname, Ile-de-Cayenne Group in French Guiana, Complexo Guianense in Brazil (cf. Routhier, 1980). This school draws also support from investigations in areas outside the Guiana Shield. For example Danni et al. (1982) state that in spite of the fact that most isotope determinations on gneisses sampled in Central Brazil yielded ages between 2000 and 500 Ma it has been argued on geological grounds that the high-grade region is of Archaean age. Greenland is another example of contradiction between field and isotopic evidence (Windley, 1977, p. 99).

The opposing school, however (cf. Gibbs & Olszewski, 1982) is of the opinion that apart from the older Imataca complex in the extreme northwest of the Guiana Shield, the "Archaean" age determinations are either relatively unreliable K-Ar or Rb-Sr model ages, or have subsequently been reinterpreted or rejected. This school may also draw some support from the fact that in French Guiana, where a new series of age determinations is carried out, areas in the south, formerly dated as Archaean, now show Trans-Amazonian ages. Testard, (pers. comm., 1983) states that the presence of older relics cannot be excluded but needs to be proved. The position of the Ile de Cayenne is as yet uncertain.

Suriname witnessed a similar process. There are two belts of high-grade metamorphic rocks in Suriname, the Falawatra Group and the Coeroeni Group. The Falawatra Group in NW Suriname, which forms the backbone of the NE-SW stretch Bakhuis Mountains horst, consists for the greater part of charnockitic to enderbitic granulites with minor amounts of basic granulites, amphibolites and layered anorthosites, sillimanite gneisses and quartzites, and intruded by pyroxene granites. The Coeroeni Group consists predominantly of pelitic and quartzofeldspathic gneisses with minor amphibolites, quartzites and calcsilicate rocks. Both complexes show more or less concentric isograd patterns and domal structures. The sillimanite gneisses of the Falawatra Group are considered to be equivalents of the Coeroeni Group gneisses, mantling and infolded into an older core of charnockitic granulites (Bosma et al., 1983).

The first Rb-Sr whole rock analyses of the charnockitic granulites of the Falawatra Group did not show any linear arrangement, and remained unpublished. Then, four samples from the Bakhuis area were analysed by Gaudette et al. (1978) and plotted together with two samples from the Supamo gneisses in Venezuela into a single Rb-Sr isochron, yielding an age of 2760 Ma. So, for some time, in spite of the questionable sampling procedure, an Archaean age was assumed for these rocks. However, an intensive sampling campaign along fresh exposures blasted for the construction of the Bakhuis railroad, and the subsequent analysis indicated that no arguments remain for an age greater than 2.4 Ga. The Rb-Sr data points all fall within an envelope between 2.0 and 2.4 Ga, including those by *Gaudette et al (1978)*, whereas the zircon U-Pb age obtained of 2026 Ma corresponds very well with the lowermost array of Rb-Sr data points (Priem et al., 1978). Gaudette et al's ages therefore can be ascribed to a fortuitous arrangement of too few data points.

Another source of information is afforded by the metamorphic history of the high-grade belts, the interpretation of which has varied likewise. In both belts there is evidence for a first synkinematic phase of metamorphism at low-pressure amphibolite-facies to granulite-facies conditions, synchronous with migmatization, and a second, static phase of metamorphism in which lower-pressure mineral assemblages from the first phase were replaced by higher-pressure assemblages. Especially the replacement of cordierite is noteworthy, leading to parageneses with all three Al_2SiO_5 polymorphs, staurolite, garnet, gedrite, orthopyroxene, sapphirine and surinamite (Dahlberg, 1973, de Roever, 1975, Kroonenberg, 1976, de Roever et al., 1976).

Originally, before radiometric age data were available, the first phase of metamorphism in the Coeroeni Group was interpreted to be of pre-Trans-Amazonian age, and the second, static higher pressure phase to be Trans-Amazonian, on account of the similarity of the higher pressure mineral assemblages with those of the higher-grade parts of the greenstone belt (see below). However, radiometric dating in the Coeroeni Group gave a well-defined 2001 Ma 6-point Rb-Sr isochron with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7027, leaving little room for a substantial pre- Trans-Amazonian metamorphic history, (Priem et al, 1977). Although the Falawatra Group pelitic gneisses with evidence for a two-phase metamorphic history were not analysed, the low $^{87}Sr/^{86}Sr$ ratio for the charnockitic granulites between 0.7023 and 0.7035 tell the same story. A detailed analyses of the main mineral parageneses in the Coeroeni Group, including microprobe analyses of the constituing minerals, showed that the metamorphic history can better be viewed as representing a prograde and a retrograde stage of the same metamorphic event (Kroonenberg, 1976).

In spite of the lack of evidence from geochronological and petrological data for a pre-Trans-Amazonian history, a possible Archaean origin is still maintained for the charnockitic granulites of the Falawatra Group alone (Bosma et al., 1983), on the basis of the following arguments.

(1) Within the charnockitic granulites small dykes of granulite-facies metadolerites and some bodies of garnet-bearing metanorites have been found, which are lacking in the Falawatra Group and Coeroeni Group pelitic gneisses. These bodies record intrusion prior to the main granulite-facies metamorphism, but posterior to the main phase of migmatization, thus indicating that a major metamorphic event occurred before the last granulite-facies metamorphism. Moreover, relics of deformed hornblende and biotite have been found as inclusions in orthopyroxene, indicating that the former event possibly was lower-grade (de Roever, 1975; Roever & Bosma, 1975; Bosma et al., 1983).

(2) There is a great similarity in both lithologic nd metamorphic characteristics between the Falawatra Group charnockitic granulites and those of the Imataca Complex in Venezuela. The latter complex was shown by Montgomery & Hurley (1978) to have undergone a Trans-Amazonian granulite-facies overprint over an 3.0-3.4 Galower-grade metamorphic phase. It is postulated that granulite-facies metamorphism in the Falawatra Group completely erased all evidence for earlier phases of metamorphism and its protolith age; the only possible evidence might reside in the large scatter of the data points (Bosma et al., 1983).

The question of a possible Archaean age for the Falawatra Group is not only relevant to the history of the high-grade belts themselves, but also to the whole tectonic setting of the Trans-Amazonian Orogenic Cycle. In southeastern Suriname there is evidence that at least part of the granites resulted from anatexis of preexisting granulitic rocks, which may indicate that a possible Archaean granulitic or lower-grade basement was not restricted to the Bakhuis Mountains alone, but underlied extensive parts of the Shield now occupied by remobilized Trans-Amazonian granites.

(2) TRANSAMAZONIAN DEPOSITIONAL ENVIRONMENTS

One of the most outstanding peculiarities of the Guiana Shield is the absence of Archaean greenstone belts. The extensive greenstone belt at the northern margin of the Shield is of Lower Proterozoic age (Choudhuri, 1980; Gibbs, 1980; Gibbs & Olszewski, 1982, Priem et al., 1980). Apart from the Imataca complex, the Guiana greenstone belt shares its problems with the Archaean ones, in sofar as nowhere the stratigraphic relations with the high-grade belts have been established unambiguously, and the geochronological data are inconclusive. The most reliable age for the deposition of the volcanic rocks in the greenstone belt has been obtained by Gibbs & Olszewski (1982). They found a 2250 Ma zircon U-Pb age for zircons from metagreywackes of volcanic origin from Guyana, as well as for some gneisses associated with the greenstone belt. Priem et al (1980) gave a 1950 Ma Rb-Sr isochron age for the Paramaka Formation basic metavolcanics from the Suriname part of the greenstone belt, but this age was convincingly demonstrated by Gibbs & Olszewski (1982) to reflect Trans-Amzonian metamorphism, rather than the age of the extrusion. But even Gibbs & Olszewski's data cannot solve the dilemma of the primogeniture between granulites and greenstones. The base of the volcanic — sedimentary pile of the greenstone belt has never been observed.

The stratigraphic succession observed in Suriname is, from the bottom upwards: (1) a volcanic-sedimentary series (Paramaka Formation), composed of a basal sequence of tholeiitic metabasalts, geochemically transitional between Archaean basalts and modern ocean floor basalts (Veenstra, 1978), associated with metagabbros, and followed by meta-andesites to metarhyolites; intercalations of metacherts and phyllites increase towards the top. (2) a volcaniclastic metagreywacke and phyllite series (Armina Formation), and (3) a meta-arenite to metaconglomerate series, equally of volcaniclastic origin (Rosebel Formation). The types and proportions of the volcanic and sedimentary rocks in the greenstonebelt (called Marowijne Group in Suriname), and elsewhere on the Guiana Shield are similar to those of the Canadian Archaean, but differ in these respects from the more mafic-ultramafic belts of the Australian, Indian and southern African Archaean (Gibbs & Barron, 1983, cf. Veenstra, 1978).

Within the greenstone belt a subdivision can be made into a southwestern part (zone 1b in Fig. 1) consisting mainly of Paramaka metavolcanics intruded by diapyric tonalite bodies, and unconformably overlain by Rosebel Formation metasediments, and a northeastern part (zone 1a in Fig. 1), consisting mainly of Armina Formation metagreywackes and intruded by two mica granite and biotite granite bodies. The asymmetric structure of the greenstone belt, the basic – to acidic succesion in the Paramaka Formation, and the geochemical characteristics, are suggestive of an island-arc – back-arc marginal basin tectonic setting. The basal volcanics would be covered by the erosion products formed at their first emengence, whereas greywackes were deposited by turbidity currents in an arc-trench clastic wedge. Although this is the most attractive geotectonic setting thinkable, int hust with two serious deawbacks.

In the first place, the occurrence of phyllite pebbles was noted in the Rosebel Formation (Bosma et al., 1983, which would indicate that a phase of uplift and metamorphism had taken place between the extrusion of the volcanics and the deposition of the Rosebel sediments. In the second place, north of the Armina Formation belt, a zone of high-grade gneisses is found, similar to those at the southwestern margin of the greenstone belt, thus detracting from the idealized asymmetric structure of the greenstone belt. Clearly, the interpretation of the tectonic setting of the deposition of supracrustals here requires more stratigraphical, geochemical and geochronological work.

If we accept the geochronological evidence for a Trans-Amazonian protolith age for the Coeroeni Group gneisses and for the sillimanite gneisses of the Falawatra Group, than we must envisage Trans-Amazonian deposition to have taken place in two contrasting environments, one characterized by considerable contemporaneous volcanism (the greenstone belt), and one in which pelitic rocks predominate and in which there is little evidence for volcanic contributions. The difference in the role of the volcanics preclude an explanation in which the Coeroeni Group gneisses represent the higher-grade equivalent of the same supracrustal sequence. As both tho Coeroeni Group and the Falawatra Group are surrounded by Trans-Amazonian granites and acid metavolcanics, interpreted as remobilized older basement one could imagine deposition to have taken place in an intracratonic basin within the older basement (Bosma et al., 1983).

(3) TECTONIC SETTING OF TRANS-AMAZONIAN DEFORMATION AND METAMORPHISM

Whereas there is considerable uncertainty as to the protolith age of the three metamorphic belts, there is general agreement that metamorphism in all three belts took place during the Trans-Amazonian Orogenic Cycle. However, the structural trends of the belts, as well as the pressure regimes, differ strongly from one belt to another.

Both high-grade belts show concentric isograd patterns and a domal structure, and have a similar metamorphic history as outlined above. They show commonly isoclinal folding with often vertical axial planes. Their structural trends are highly discordant however. Structural trends are predominantly NE-SW in the Falawatra Group and NW-SE in the Coeroeni Group, in both cases roughly parallel to the strike of the belts. Both belts : meet each other in southern Guyana, just across the boundary with Suriname. The isograd map of Berrangé (1973, 1977) shows the Coeroeni Group trend being truncated by the border of the Kanuku Complex, the continuation of the Falawatra Group in Guyana. The junction coincides with a jump in metamorphic grade, but this may be due to later tectonic movements along the border faults of the high-grade belt. The triple-junction pattern present shows more resemblance to an intracratonic rift-rift-rift situation, and cannot easily be viewed in a continental margin setting (Bosma et al., 1983).

In the greenstone belt metamorphism is generally in the greenschist facies, with kyanite and chloritoid as indicative for fairly high pressures. Around diapyric intrusions the amphibolite facies is commonly reached, as well as along the peripheries of the greenstone belt. The metamorphism is synkinematic with tight to isoclinal folding on cm to km scale, with nearly horizontal fold axes roughly parallel to theW-E to NW-SE strike of the greenstone belt as a whole. This would suggest a rather simple style of deformation, but Burke et al (1976) suggest that greenstone belts are much more tectonized than has generally been recognized, and even that major slides are common. Testard (pers. comm.) agrees with this suggestion. In fact, van Kooten (1954) suggested even the possibility of large overthrusts in the Mindrinetti gold area near the Suriname river. Further field work is needed to give a clearer picture.

The W-E to NW-SE strike of the greenstone belt is abruptly truncated in NW Suriname by the Bakhuis Mountains Horst of NE-SW strike, but is resumed beyond the horst in the Avanavero area and in Guyana. Tectonic movements along the border faults of the Bakhuis Mountains can explain the abrupt transition, but cannot solve the problem of synchronous metamorphism in both belts with strongly discordant strikes and pressure regimes. If one considers the Trans-Amazonian gneisses mantling the granulitic core of the Falawatra Group as having been deposited in an intracratonic basin, one could consider the latter as an unopened arm of a triple junction. However, drilling into the basement of the coastal plain near Paramaribo and seismic studies in the offshore area indicate the continuity of the Bakhuis structure well into and possibly even beyond the greenstone belt, so that they rather appear to be intersecting belts (Bosma et al., 1983, Fig. 4). Clearly, there is no simple plate-tectonics pattern in which the major orogenic characteristics of the Trans-Amazonian Orogenic Cycle can be accommodated. Gibbs (pers. comm. 1983) visualized the shield being assembled bteween 2100 and 2000 Ma by events involving island arcs, collision arcs, deformation and cataclasis, and formation of granites. Marot and Capdevila (1980) believe that the Trans-Amazonian orogeny, as studied in French Guiana, resulted from the collision of a southern and a northern continent, the latter being represented by an island arc, a continental margin, and a marginal basin. A palinspatic reconstruction of the main events awaits in the first place paleomagnetic research in the crustal segments involved.

(4) RELATION OF ACID MAGMATISM TO TRANS-AMAZONIAN OROGENY

The granitoid-volcanic complex which separates the three metamorphic belts of the Surinam basement from each other falls apart into three domains,

1. *within the greenstone belt* tonalite diapyrs occur as concordant intrusive bodies amidst Paramaka basic metavolcanics (zone 1b in Fig. 1), and two-mica granites occur in a similar tectonic setting amidst Armina metagreywackes (zone 1a in Fig. 1). Foliation is common in these rocks, especially along the margins, the schistosity of the surrounding amphibolite facies rocks is parallel to the contacts (Veenstra, 1978), so that syntectonic intrusion is the most plausible way of emplacement of these bodies. The easternmost tonalite diapyrs are entirely surrounded by greenstone-belt metamorphic rocks, but the southernmost ones pass gradually through a migmatitic zone into the more homogeneous granitoid complex of central eastern Suriname.

2. *in central-eastern Suriname* (zone 2a in Fig. 1), the main granite type is a greyish, medium-grained biotite granite to granodiorite, with common migmatitic aspect, and numerous map-scale to outcrop-scale enclaves of granulites and migmatitic gneisses, as well as pyroxene granites, suggesting an origin by extensive anatexis of high-grade metamorphic rocks at a comparatively deep level of exposure. Deviating granites such as the two-mica granites of central Suriname are regarded to have originated by anatexis of pelitic parent rocks.

3. *in central western Suriname,* the main granite type is a megacryst-bearing medium-grained biotite granite, which is associated with large volumes of various types of subvolcanic granites (fine grained biotite granites, granophyric granites and leucogranites), as well as with acid to intermediate metavolcanic rocks (Dalbana Formation). The Dalbana Formation acid volcanics show low-grade contact metamorphism due to the intrusion of the granites. The close association of granites with subvolcanic and volcanic rocks suggest a shallow level of exposure (zone 2b in Fig. 1).

The spatial and temporal relationships between the syntectonic intrusions, the deep-level granites and the shallow-level granites constitue one of the major problems in the Precambrian basement of Suriname and the neighbouring countries. In Suriname, both geochronological and stratigraphical arguments have been put forward to regard the whole granitoid-volcanic complex as having formed during a later stage of the Trans-Amazonian Orogenic Cycle (Bosma et al., 1983), whereas for instance in Brazil (Santos, 1980) and Guyana (Gibbs & Barron, 1983), they are regarded as anorogenic. We will examine both points of view in detail.

In Suriname, transitions from one domain to another cannot be regarded but gradual. The transition between the tonalite bodies and the deep-level granites is marked by an increasing migmatitic character of the tonalites which in turn pass through nebulitic rocks into the homogeneous deep-level granites. The transition from the deep-level granites to the shallow-level domain is based more on the nature of the associated rocks than on the characteristics of the granites themselves. In field outcrop and hand specimen both granite types are commonly difficult to distinguish, and in no way there is a sharp split in exposure level. There is a continuous increase in acidity, moving from the greenstone belt intrusions to the shallow-level granites.

Priem et al (1971) obtained a reference isochron of 1870 Ma for all granitoid and acid volcanic rocks of the Surinam basement, including samples from all three depth zones. Individual deep-level granites indicate slightly higher ages (1923 Ma, Bosma et al., 1983), gabbro bodies such as found associated with the granitoid rocks all over the country (De Goeje Gabbro) slightly lower, down to 1818 Ma. Detailed geochronological work is needed to unravel the timing of granite intrusion within the timespan indicated by the reference isochron, but the fact that there is no sharp break in age between the syntectonic intrusions in the greenstone belt and the other two domains precludes to consider the main event of acid magmatism as anorogenic. Although the ages shown by the acid igneous rocks are consistenly lower than the metamorphism in the greenstone and granulite belts, they are still 150 Ma away from the 1655 Ma ages obtained by Priem et al (1973) for the undisputedly anorogenic volcanic ash layers intercalated in the Roraima Formation sandstones, of which no intrusive equivalents are known in Suriname. We conclude therefore, that in Suriname there are no compelling reasons to exclude the acid magmatism from the Trans-Amazonian Orogenic Cycle.

Two arguments have been put forward for an anorogenic character of the acid magmatism. In the first place, it is stated by some authors, e.g. Gibbs & Olszewski (1982) and Santos (1980) that acid volcanic rocks correlative with the Dalbana Formation overlie the greenstone belts with profound angular unconformity. However, in western Suriname, in the

Avanavero area, concordant contacts exist between the basic volcanics of the Matapi Formation, (correlative with the Paramaka Formation and belonging to the greenstone belt), the Ston Formation (mature metasandstones and metaconglomerates formerly correlated with the Rosebel Formation of eastern Suriname), and the Dalbana Formation metarhyolites (Loemban Tobing, 1969). Similar concordant contacts are reported from Guyana between the correlated Barama-Mazaruni Group, Muruwa Formation and Iwokrama Formation acid metavolcanics, respectively (Gibbs & Barron, 1983). This sheds some doubt upon the assertion by Santos (1980) that a long period of erosion followed the Trans-Amazonian Orogeny prior to the acid magmatism.

The second argument put forward is the strong contrast of structural style between the greenstone belt, characterized by isoclinal folding, and the acid metavolcanics, which have been deformed in broad open folds (Basei, 1978). Although the difference is clear, it is not evident why this should prove the acid volcanics to be unrelated to the Trans-Amazonian Orogenic Cycle. Rather the Trans-Amazonian orogeny should be regarded as having taken place in two phases, a first one characterized by strong deformation and metamorphism around 2000 Ma, and a second phase which was dominated by extensive remobilization of older basement, resulting in the acid magmatism (Bosma et al., 1983).

Some problems remain to be solved in this model, too. Especially it is difficult to see why syntectonic diapyric intrusive bodies plot neatly into the 1870 Ma isochron for the whole granitoid volcanic complex obtained by Priem et al (1971), whereas metamorphism in the surrounding greenstone belt took place around 1950 Ma (Priem et al., 1980). Until such discrepancies are solved by more detailed geochronological research on separate intrusive bodies, the orogenic — anorogenic controversy cannot be regarded as won by either party.

Ultimately, it is a matter of terminology, in sofar as the closing date of the Trans-Amazonian Orogenic Cycle is concerned. If one is inclined to exclude all rocks with younger ages than 1900 Ma from the Trans-Amazonian Orogenic Cycle, then of course younger rocks are anorogenic. It should be, however, the geological evidence, and not formal time boundaries which have to decide in these matters.

(5) SIGNIFICANCE OF THE NICKERIE METAMORPHIC EPISODE

In many areas in Suriname and the neighbouring countries, Trans-Amazonian rocks and Middle Proterozoic dolerite dykes show evidence of faulting, shearing and mylonitization, with predominating ENE trends. The border faults of the Bakhuis Mountains horst were formed or reactivated during the same event, and the boundaries of the Coeroeni Group contacts with the neighbouring granitoid-volcanic complex were offset. The main trend of the magnetic axes on the aeromagnetic maps in this area is ENE as well, intersecting geological boundaries. These phenomena were correlated by Barron (1969) with 1200 Ma mica ages and jointly described as K'Mudku Mylonite Episode, while Priem et al (1968) came to a similar conclusion as for young mica ages in Suriname, terming the event the Nickerie Metamorphic Episode. Mica age resetting in rocks that show Trans-Amazonian Rb-Sr whole rock and isochron ages is not only found near mylonite zones, but in the whole western part of the Suriname basement, as well as in Guyana, Venezuela, Colombia and parts of Brazil. Rocks with 1200 Ma Rb-Sr isochron ages are unknown in the Guiana Shield sensu stricto, roughly between Orinoco and Amazones rivers, but in the Colombian Andes a granulite belt showing such ages was demonstrated recently (Alvarez & Cordani, 1980, Kroonenberg, 1982). The latter author ascribes the effects of the Nickerie Metamorphic Episode to the same event that brought about granulite-facies metamorphism in the Colombian Andes; and hinted at a possible continental collision origin for this event. Gibbs & Barron (1983) raised an interesting new suggestion, decoupling the mylonitic events from the mica age resetting, and stated that it is not know, whether his event represents a discrete thermal pulse or simply crustal uplift with subsequent cooling and closure of isotopic systems. The answer for this question might well be found in central Suriname, where the eastern limit of mica age resetting has been found by Priem et al (1971). East of this limit Trans-Amazonian rocks show Trans-Amazonian mineral ages. New research on the exact nature of this boundary is necessary, therefore.

CONCLUSION

The discussion of the outstanding problems has shown, that much can be gained by continuing geochronological, stratigraphical, geochemical and paleomagnetic research in future years, especially if this is carried out in conjunction with geologists from all Amazonian countries.

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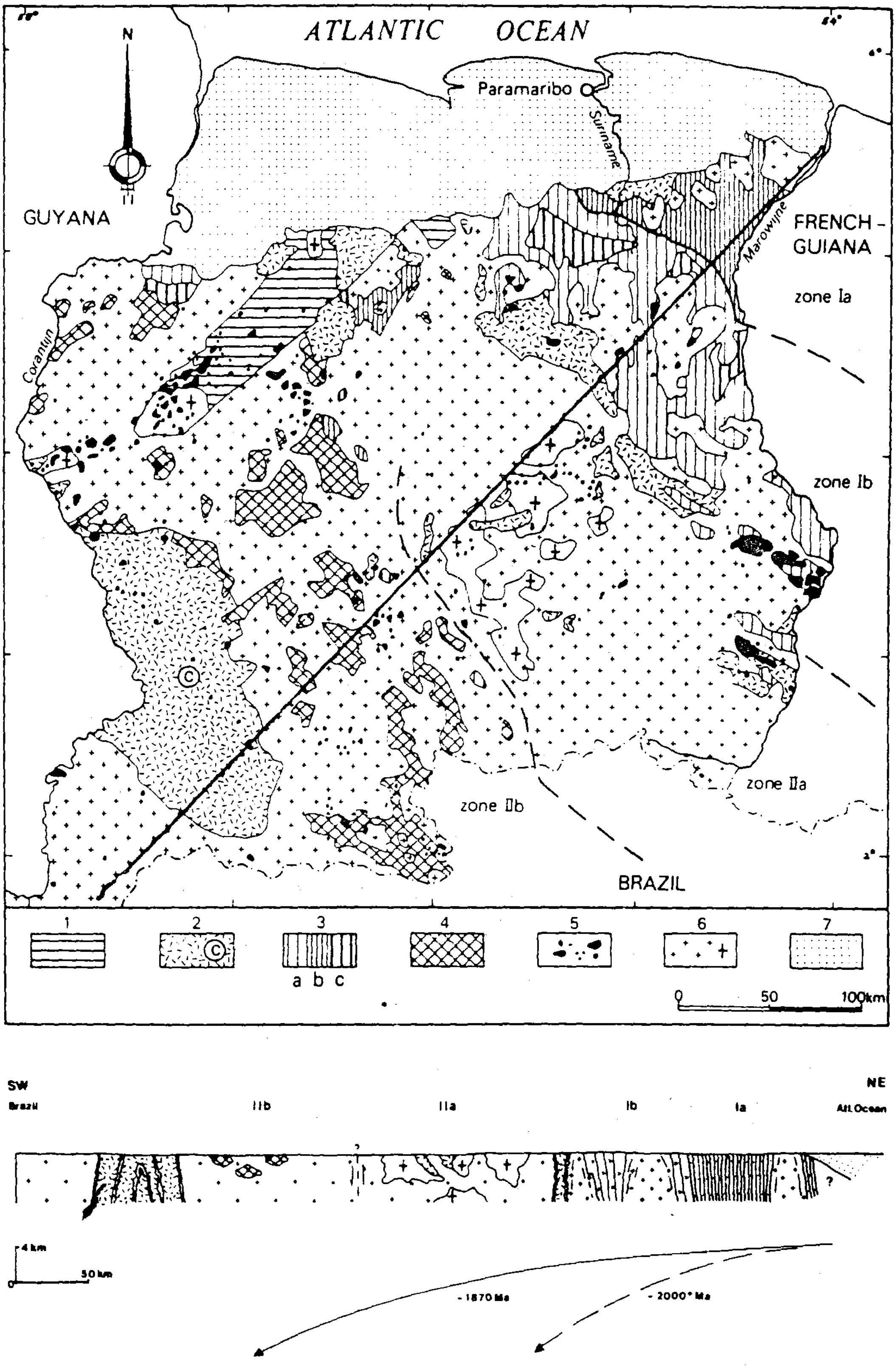

Fig. 1. Sketch map and cross-section of the main structural units of the Precambrian basement of Suriname. Legend: (1) Archaean (?) granulite belt; (2) Trans-Amazonian high-grade belts; (3) Trans-Amazonian greenstone belt (a.metabasalts ecc.b. metagreywackes; c. meta-arenite and metaconglomerates); (4,5,6) Trans-Amazonian granitoid volcanic complex (4) acid- intermediate metavolcanics (5) metagabbros (6)granitoid rocks; big crosses: pyroxene granites);(7) Cenozoic sediments. Dolerites and Roraima sandstones omitted. Environmental zonation: Ia: outer turbidite arc; Ib: main basic volcanic arc; IIa: deep-level acid magmatism; IIb shallow level acid magmatism. After Bosma et al., (1983).

Table 1.
General stratigraphy and geochronology of the basement of Suriname. All cited Rb-Sr ages have been recalculated for $\lambda = 1.42.10^{-11}.a^{-1}$. Authors of geochronological data are referred to in the text. *Denote hitherto unpublished data. (after Bosma et al., 1983)

ERA	OROGENY	ROCK UNITS		SEQUENCE OF EVENTS	AGE	METHOD
PERMO-TRIASSIC		APATOE DOLERITE		Tensional faulting, intrusion	230 ± 10 Ma	K-Ar whole rock 11 specimens
UPPER PROTEROZOIC	NICKERIE METAM. EPISODE	Mylonites		Shearing, low-grade metamorphism, mica updating	1200 ± 100 Ma	K-Ar and Rb-Sr, micas and hornblendes
MIDDLE PROTEROZOIC		KAYSER DOLERITE AVANAVERO DOLERITE		Tensional faulting, intrusion	1659 ± 27 Ma	Rb-Sr whole rock isochron Avanavero
		RORAIMA FORMATION		Continental sedimentation, acid pyroclastic volcanism	1655 ± 18 Ma	Rb-Sr whole-rock isochron pyroclastics
LOWER PROTEROZOIC	TRANS-AMAZONIAN OROGENIC CYCLE — Second Phase			Erosion - Uplift	1818 ± 165 Ma	Rb-Sr whole rock* De Goeje Gabbro Kabalebo
			De Goeje Gabbro		1845 ± 285 Ma	Rb-Sr whole rock* De Goeje Gabbro Maskita
			Dalbana Formation	Intrusion and acid Volcanism		
		GRANITOID-VOLCANIC COMPLEX	Shallow-level granites		1874 ± 40 Ma	Rb-Sr whole rock isochron, 32 samples
			Deep-level granites		1923 ± 55 Ma	Rb-Sr whole rock,* pyroxene granite
			Tonalite diapirs	Metamorphism		
	First Phase		Rosebel Formation	Shallow marine - continental sedimentation		
		MAROWIJNE GROUP	Armina Formation	Deep marine sedimentation	1950 ± 150 Ma 2000 ± 40 Ma	Rb-Sr whole rock isochron K-Ar whole rock* amphibolitic metadolerite
			Paramaka Formation	Basic to intermediate volcanism	2020 ± 100 Ma	K-Ar magnesioriebeckite Tapajé*
		COEROENI GROUP		Shallow-marine - continental sedimentation	2001 ± 97 Ma	Rb-Sr whole rock isochron
		FALAWATRA GROUP	gneisses	Shallow marine - continental deposition	2026 ± 20 Ma	U-Pb zircon, charn granulite
ARCH (?)		FALAWATRA GROUP	charnockitic granulites	Amphibolite-facies metamorphism? Sedimentation? Volcanism?		