Metamorphic Rocks in West Irian

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Low-grade metamorphics of West Irian occur to the east of Geelvink Bay associated with two narrow belts of basic and ultrabasic igneous rocks which represent ophiolitic suites of an eugeosynclinical development beginning in Early Mesozoic time. In both of these belts there are indications of regional metamorphism under high pressure and low temperature conditions.
Within the miogeosynclinal, Australian-sided part of the Papuan Geosyncline, on the other hand, metamorphic rocks seem to be associated with intrusives of medium to acidic composition.

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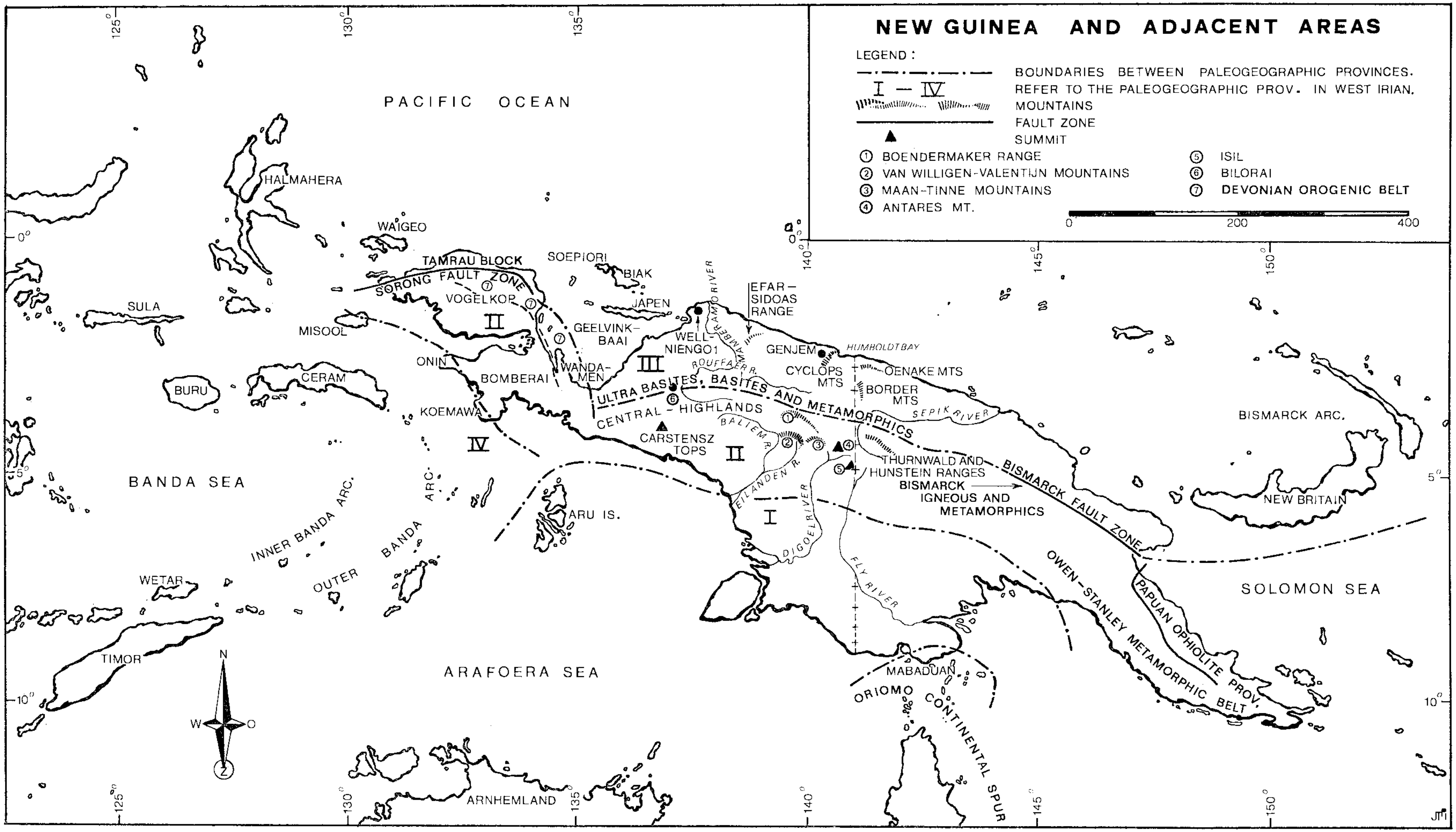

NEW GUINEA AND ADJACENT AREAS
LEGEND :
BOUNDARIES BETWEEN PALEOGEOGRAPHIC PROVINCES.
I — IV REFER TO THE PALEOGEOGRAPHIC PROV. IN WEST IRIAN.
MOUNTAINS
FAULT ZONE
SUMMIT
① BOENDERMAKER RANGE
② VAN WILLIGEN-VALENTIJN MOUNTAINS
③ MAAN-TINNE MOUNTAINS
④ ANTARES MT.
⑤ ISIL
⑥ BILORAI
⑦ DEVONIAN OROGENIC BELT
0 200 400
PACIFIC OCEAN
HALMAHERA
WAIGEO
SULA
MISOOL
TAMRAU BLOCK
SORONG FAULT ZONE
VOGELKOP
SOEPIORI
BIAK
JAPEN
GEELVINK-BAAI
WANDA-MEN
ONIN
BOMBERAI
BURU
CERAM
KOEMAWA
BANDA SEA
INNER BANDA ARC.
OUTER BANDA ARC.
WETAR
TIMOR
ARU IS.
ARAFOERA SEA
ARNHEMLAND
WELL-NIENGO1
MAMBERAMO RIVER
EFAR-SIDOAS RANGE
GENJEM
HUMBOLDT BAY
CYCLOPS MTS
OENAKE MTS
BORDER MTS
ROUFFAER R.
ULTRA BASITES, BASITES AND METAMORPHICS
CENTRAL - HIGHLANDS
BALIEM R.
CARSTENSZ TOPS
EILANDEN R.
DIGOEL RIVER
SEPIK RIVER
THURNWALD AND HUNSTEIN RANGES
BISMARCK IGNEOUS AND METAMORPHICS
BISMARCK FAULT ZONE
FLY RIVER
MABADUAN
ORIOMO CONTINENTAL SPUR
OWEN-STANLEY METAMORPHIC BELT
PAPUAN OPHIOLITE PROV.
BISMARCK ARC.
NEW BRITAIN
SOLOMON SEA
N
W
O
Z
125°
130°
135°
140°
145°
150°
0°
5°
10°

Introduction

The geology of New Guinea, the third largest island on Earth, is still fragmentarily known, despite the fact that detailed investigations and summaries have been published, mainly in the last decades, which throw some light upon its geological position. In the first place Visser & Hermes' compilation (1962) ought to be mentioned, which represents the geological results of twenty-five years of oil-exploration in western New-Guinea. A more detailed study of a considerably less extended area, in northeast Vogelkop Peninsula, was published in a final report of the 'Foundation Geological Investigation Netherlands New Guinea' (d'Audretsch, Kluiving & Oudemans, 1966).

As to the Australian part of New Guinea, a paper by Thompson & Fisher (1965) should be mentioned giving a summary of its tectonical setting and mineral deposits. In 1961, the Australasian Petroleum Company (A.P.C.) published a report on the geological results of oil-exploration in the western Papua Territory.

Two papers on subjects of more than local importance are of particular interest, viz., Hermes' paper on the Papuan Geosyncline (1968), a contribution to the discussion of the concept of geosynclines; and Verhofstad's (1966), describing glaucophane-lawsonite rocks. These, though not yet discovered in situ, should occur along the northern edge of the Central Highlands in West Irian.

Sodium-amphibole- and sodium-pyroxene-bearing rocks have been known in West Irian for more than half a century.

Frenzel in 1883 and Schoetensack in 1887 established that stone adzes from Humboldt Bay consist of chloromelanite. Gisolf (1921) described a sericite-crossite schist from the Cyclops Mountains. Glaucophane possibly occurs in one or two samples. Mrs. de Sitter-Koomans (in Le Roux, 1948) and Verhofstad (1966) furnished petrographical descriptions of stone implements from the Central Highlands. Schürmann (1951) mentioned chloromelanite in heavy mineral concentrates from upper Tertiary sediments in southern West Irian. Earlier still, in 1903, Wichmann (1917) investigated a deposit of chloromelanite boulders north of the Cyclops Mountains. Mention was made of glaucophane-bearing rocks in the Australian part of New Guinea by Verhofstad and Smith & Green. In 1965 Dallwitz informed Verhofstad that a leucoxene-lawsonite-richterite schist had been found in the Waria River area. Smith & Green (1961) described glaucophane in Wowo Cap, eastern part of Papua.

It may be recalled that glaucophane-bearing rocks occur in world-wide alpine-type orogenic zones. Schürmann (1951) and van der Plas (1959) enumerated occurrences of glaucophane distributed all over the world, whereas van der Kaaden (1966) dealt with Turkey, Greece and Yugoslavia in particular. De Roever (1964) published a list of glaucophane occurrences additionally to van der Plas'. In the Circum-Pacific region glaucophane-bearing rocks have been reported a.o. from Kamchatka (Dobretsov & Ponomareva, 1965); Sakhalin (Yegorov et al., 1967); Japan (Miyashiro, 1961); Taiwan (Foster, 1965; Yen, 1966); Philippines (Coleman & Lee, 1962); Celebes (de Roever, 1947; 1950); Australia (Quodling, 1964); New Caledonia (Coleman, 1967); New Zealand (Landis & Coombs, 1967); Washington State, U.S.A. (Misch, 1959; Stout, 1964); California, U.S.A. (Coleman & Lee, 1963); Mexico (Hirschi & Quervain, 1933; Cohen, 1963); Guatemala (Williams, 1964; Mc. Birney et al., 1967) and Chili (Saliot, 1968).

In the present paper, which summarizes our present knowledge on metamorphism in West Irian, little is added in the way of facts. It should be realized that most geological explorations in this inhospitable and often inaccessible terrain had an economic purpose. Again, rock and mineral descriptions, and the field data obtained by many geologists in the course of time naturally are of varying quality. Most of the terrains treated in this paper have not been properly mapped geologically but merely reconnoitred. Other areas, the Maan-Tinne and van Willigen-Valentijn Mountains for instance, have been studied exclusively from aerial photographs.

Acknowledgements – The author is much indebted to Prof. J. J. Hermes and Prof. W. P. de Roever, Amsterdam, for their critical reading of the manuscript. The latter kindly put an additional list of references on Circum-Pacific occurrences of glaucophanitic rocks at the author's disposal.

Geological framework

From a structural point of view, Australian and Melanesian elements can be seen in the whole of New Guinea (van Bemmelen, 1939; Glaessner, 1950; Klompé 1957), affecting each other and so giving rise to the peculiar physiography. The high areas generally appear as gravimetric maxima and the basins as minima (Visser & Hermes, 1962).

Hermes' paleogeographical units (1968) reflect the geological history of West Irian since early Permo-Carboniferous time: in southern West Irian, the incomplete, practically horizontal succession is identified with the Australian Platform sequence. Here, lower Cretaceous to subrecent sediments overlie rocks of a possibly Cambrian age.

From Permo-Carboniferous to Tertiary time the sediments of the Central Highlands and their continuation in the 'neck' of the Vogelkop (Bird's Head), Bomberai and the largest part of the Vogelkop, were deposited under miogeosynclinal conditions. These miogeosynclinal deposits were dislocated and uplifted in Tertiary and Quarternary time.

The areas north of the miogeosyncline represented an eugeosynclinal habitat in old Tertiary and possibly earlier times. Subsequently uplift took place in young Tertiary and Quarternary. David's (1950) Papuan Geosyncline in West Irian comprises both of the above mentioned miogeosynclinal and eugeosynclinal units as outlined by Hermes (1968).

The fourth paleogeographical unit, comprising Misool, Onin and Koemawa, lies between the Australian Platform and the Moluccan Geosyncline.

While New Guinea east of Geelvink Bay, the Bismarck Archipelago and the Solomon Islands are considered to form part of a Circum-Pacific zone of late Tertiary to recent tectonism (Thompson & Fisher, 1965), the westernmost part of New Guinea and the adjacent islands were supposedly strongly influenced by the Indonesian system of structural trends (Hermes, 1968). On the other hand, it has been surmised that orogenic events resulting in the outgrowth of the Australian continent also played a role in New Guinea during Carboniferous and earlier times (Rickwood, 1955; Klompé, 1957; A.P.C., 1961). Klompé even suggested the existence of a Variscean belt which can be traced from northern Queensland to southern New Guinea, Ceram, the Aru Islands, the Sula Spur and Timor, also including the Banda Sea.

According to Hermes, the Banda Sea area may have obtained its present form as a result of a collision between the Australian and the Asian continent, possibly since middle Tertiary (Hermes in Visser & Hermes, 1962; Hermes, 1968). He further suggested that owing to this collision, the western part of the Papuan Geosyncline was torn from the continent and bent backwards resulting in its present inverted S-shape.

Glaessner (1950) considered the miogeosynclinal province of the Papuan Geosyncline, together with the Australian Platform, as a part of the Australian Craton. On the other hand, the eugeosynclinal volcanics and sediments in West Irian, from Oligocene time onward, for the larger part rest supposedly on oceanic crust. According to Australian geologists, the hinge in the eastern part of New Guinea between the miogeosynclinal and eugeosynclinal parts of the Papuan Geosyncline is mostly faulted, probably even accompanied by considerable horizontal displacements. Thus, the Bismarck Fault zone according to Rickwood (1955) should be considered as a part of the eastern continuation of the eugeosynclinal boundary of West Irian. The Stanley Fault, dividing the Owen – Stanley Metamorphic Belt from the Papuan Ophiolite province in the 'tail' of eastern New Guinea (Dow & Davies, 1964), is another example. However, the eastern continuation of the North New Guinea paleogeographic unit of West Irian, i.e., the Northern New Guinea Arc (Thompson & Fisher, 1965) appears to cut off the above 'tail' unit.

Metamorphic rocks

Visser and Hermes distinguished three groups of metamorphic rocks in West Irian, viz.: metamorphics of the north coast east of Japen; metamorphics of the northern part of the Central Highlands; schists and gneisses of western Geelvink Bay and the northeastern Vogelkop.

The first group is closely associated with basic and ultrabasic rocks which form part of the ophiolitic suite of the Papuan Geosyncline. The basic and ultrabasic rocks, with or without metamorphics, can be traced with interruptions from north of Halmahera in the west, via Waigo, Japen, Biak, the Efar-Sidoas Range and the Cyclops Mountains to the Border and Oenake Mountains (both beyond the international border) in the east. The basic and ultrabasic rocks together with associated metamorphics form Visser and Hermes' Basement Complex east of Japen. Contacts between igneous and metamorphic rocks are invariably faulted.

The metamorphics of the Basement Complex in the Cyclops Mountains and in the oil exploration well Niengo 1 in the western Mamberamo delta, are probably older than upper Cretaceous (Visser & Hermes, 1962).

A short description of the basic and ultrabasic rocks in the area from Japen to the north and west will be given first.

WAIGEO AND ISLANDS NORTH OF GEELVINK BAY

On Waigeo and adjacent islets, a strongly deformed non-metamorphic complex of medium to basic volcanics, basic and ultrabasic intrusive rocks, graywackes, conglomerates, interstratified marls and radiolarites is transgressively overlain by a succession of middle to upper Pliocene limestones, which are at least 1,450 m. thick. The oldest rocks of Waigeo are serpentinites (with gabbro or diorite porphyrite and gabbro pegmatite dikes), harzburgite, dunite, pyroxenite and norite (van der Wegen, 1963). These are certainly pre-Oligocene in age. The volcanics, graywackes and conglomerates are of an Oligocene to lower Miocene age. The volcanics consist of andesite basalt, pillow-lava, tuff and agglomerates. Fault-bounded serpentinites also occur within the volcanic succession as WNW – ESE – striking lens-shaped bodies. In the Ware Bare rivulet on east Waigo, the present author frequently observed pebbles of amphibolite and amphibole schist among the river bed clastics which consist mainly of volcanics and serpentinite.

Visser and Hermes mentioned the occurence of greenschists in a zone of ultrabasic rocks along the north coast of Japen. The schists resemble those observed near Korido on the Island of Biak. The latter are traversed by basalt dikes and a more advanced grade of metamorphism is found in places where the dikes are more abundant.

From the same area Feuilletau de Bruyn (1921) described epidote-albite amphibolite, albite amphibolite and chlorite schists. He also mentioned the presence of actinolite schists, sericite and schistose serpentinite on the Island of Bepondi, northwest of Soepiori.

METAMORPHICS ON THE NORTH COAST, EAST OF JAPEN

Regional metamorphic rocks play an important part in the Basement Complex of the north coast, east of the islands lying north of Geelvink Bay. In well Niengo 1 the main metamorphic rock encountered is fine-grained containing albite, epidote, actinolite, quartz and chlorite. There are occasional intercalations consisting of calcite, ovoid metablasts of garnet, ore and some quartz. Foliation is apparent due to the alignment of albite metablasts and some epidotes.

According to Baker (1955), metablasts of albite and epidote occur particularly in the amphibolites and a few of the gneisses in the Cyclops Mountains. Both in these and the metamorphics of Niengo 1 schistosity is not a dominant feature. This agrees with Gisolf's observations.

The bulk of the metamorphics of the Basement Complex consists of fine-grained rocks, particularly epidote-albite schists, sericite-albite schists, actinolite schists, garnet-mica schists, calc-phyllites, chlorite schists, epi-marbles and quartzites. Baker (1956) suggested that the parent rock from which the amphibolites were derived, would be of a basic igneous composition. According to the same author, the talc-schists and schistose serpentinites present are derived from ancient peridotites and dunites which have been involved in the regional metamorphism (Baker, 1955). Any poikiloblasts present contain numerous remnants of earlier crystallization.

Wichmann (1917) visited the district of Orum or Ormoe in 1903 in order to trace the origin of chloromelanite stone adzes which at that time were known from the Humboldt Bay (Schoetensack, 1887). Orum is situated north of the Cyclops Mountains. In the bed of the Torare rivulet Wichmann discovered no more than a single locality of little worn chloromelanite boulders. He assumed that the chloromelanite had originally been intercalated with amphibolites, the latter supposedly being metamorphosed gabbros.

Gisolf (1921), describing rock samples from the Cyclops Mountains collected by Zwierzycki, identified rare examples of disthene-chloritoid schist, garnet-mica schist with much epidote, sericite-crossite schist with little rutile, and chloritoid schist. He also described biotite supposedly derived from chlorite as a result of magmatic activity at depth. In the Efar-Sidoas mountain ridge antigorite-magnetite schist surrounded by either metamorphosed or non-metamorphosed gabbro, peridotite, whether or not serpentinized, and hornblende diorite were found in small outcrops underlying Neogene sediments (van Dun, 1962). Rock samples from the Efar-Sidoas mountain ridge, collected by Dr. W. Vink – forrester in former Dutch New Guinea –, were shown to the present author, who was able to identify some prehnitized gabbro and glaucophanitic rock.

Gravimetrically a narrow zone of rather strong positive anomalies forming a patchy pattern occurs along the north coast (Visser, in Visser & Hermes, 1962).

METAMORPHICS OF THE NORTHERN PART OF THE CENTRAL HIGHLANDS AND SOUTHERN RIM OF THE MEERVLAKTE

In the Swart Valley, near the missionary station of Mamiet, a rather sudden transition exists from hard black shales in the south to epimetamorphic rocks such as phyllites and quartz-mica schist in the north (van der Wegen, 1966). A narrow belt of possibly Mesozoic clastic or epimetamorphic rocks, and ultrabasic to basic igneous rocks which are often serpentinized, mark the northern part of the Central Highlands and the area south of Geelvink Bay. The metamorphic rocks may be equivalents of unaltered Mesozoic (and Paleozoic?) sediments occuring further south. The low-grade metamorphic rocks presumably have been subjected to strong unidirectional pressure at a relatively shallow depth of burial (Visser & Hermes). North of the Wissel Lakes the Kembelangan formation (Jurassic-Cretaceous) is phyllitic. Bär (in Bär, Cortel & Escher, 1961) found Mesozoic fossils in schists of the Boendermaker Range. These schists strike into Jurassic sediments of the Upper Sepik Valley. To the south, these Jurassic deposits are supposedly underlain by the crystalline basement of the Thurnwald and Hunstein Ranges. This basement is a block of granodiorite with contacting schist and phyllite (Thompson & Fisher, 1965).

Verhofstad (1966) gave a detailed petrographic description of stone implements used by native tribes in the Central Highlands. The rocks are metamorphosed in the glaucophane schist facies and, apart from the quartz-glaucophane assemblage, appear to be derived from mafic rocks. He suggested a pre-glaucophane metamorphic stage in which uralitic amphibole was a more dominant mineral, superseded by the glaucophanitic metamorphism. Apart from a discovery of glaucophane-bearing rocks by the Australian alpinist H. Harrer in 1962, such outcrops have never been found in New Guinea. Evidently the specimens were derived from the above mentioned belt of ultrabasic and basic igneous rocks and low-grade metamorphics in the northern part of the Central Highlands.

METAMORPHICS WITHIN THE CENTRAL NEW GUINEA PALEOGEOGRAPHIC PROVINCE

Most metamorphic rocks in this province are associated with intrusions of medium to acidic composition. For an enumeration of igneous rocks, with or without observed thermal contact phenomena, reference is made to Visser & Hermes (1962). Apart from the N.E. Vogelkop occurrences, granitic intrusions are known from Permo-Carboniferous to Tertiary in the Papuan miogeosyncline.

A homogeneous and very thick sedimentary succession of Early Paleozoic age exists in central and northeast Vogelkop and most probably in a belt along the entire south-west and south coast of Geelvink Bay (d'Audretsch, et al., 1966). Sedimentation took place under geosynclinal conditions. Silurian rocks and probably older ones are strongly folded and show a varying degree of metamorphism. The intrusion of several granitic batholiths followed in a post-kinematic stage of a Devonian orogeny, mainly in or near a belt of high-grade regional metamorphic rocks.

In the Central Highlands there are no indications of an orogeny in Devonian time, at least, the Lower Paleozoic in the upper reaches of the Digoel and Eilanden River has not been subjected to such an orogeny.

Pebbles of igneous and metamorphic rocks were frequently found in the talus fan along the southern slopes in the Eilanden River area (van der Wegen, 1966). Some represent intrusives of mainly medium to basic composition and amygdaloidal basalts. The latter are most probably of an Early Paleozoic age, whereas the intrusive are certainly younger. Among the pebbles of the Eilanden-West River lime-silicate rocks, quarts-biotite-cordierite schist, epidote-quartz rocks, hornblende-quartz-albite schist, and chiastolite schist were observed (van der Wegen, 1966). Van Bemmelen (1949, p. 715) mentioned contact metamorphic rocks from the Snow Mountains (the main watershed of the Central Highlands): quartz-prehnite-wollastonite-epidote rock; chiastolite-cordierite-biote hornfels; wollastonite-garnet hornfels; and a quartzitic coal-bearing sandstone passing into a biotite hornfels.

It is conceivable that the metamorphics are associated with the intrusives. The former are of a thermal metamorphic type rather than regional metamorphic. Outcrops of these intrusive and metamorphic rocks should occur in the Maan-Tinne and van Willigen – Valentijn Mountains which form part of the main watershed of the Central Highlands situated in the belt of pre-Jurassic rocks. The presumed source area of the pebbles mentioned above may well be comparable with the crystalline basement of the Thurnwald and Hunstein ranges in the eastern part of New Guinea. The diorite-porphyry of a stock-like body of the Isil top to the south of the Antares Mountains (van der Wegen, 1966) is certainly of a Neogene age and so may the granodiorite of the Antares Mountains (Bär, et al., 1961). Most of the inclusions in the diorite porphyry are silicified shales, some, amphibolites. The amphibolite inclusions might indicate the existence of a chrystalline basement at depth.

In central and southern New Guinea, unmetamorphosed rocks of an Early Paleozoic age exist side by side with chrystalline rocks which are probably much younger. The problem arises whether such occurrences are to be considered as tectonically raised crystalline blocks of a Carboniferous or higher age (Varicean orogenic belt, Klompé; Oriomo Continental Spur, A.P.C.).

ROCK SAMPLES KEPT AT THE RIJKSMUSEUM VAN GEOLOGIE EN MINERALOGIE

The following samples have been examined microscopically and by X-ray powder photography.

Dark blue, greenish flamed, hard and tough, fine to medium grained rocks: these are lawsonite-epidote-glaucophanites, for instance numbers RGM 140657 (1157), – 140658 (1164) and – 140666 (1179), or glaucophane-bearing rocks with remnants of augite, such as RGM 140661 (1171) and RGM 140663 (1173). The latter are most probably pyroxenites transformed into glaucophanitic rocks. The glaucophanites are hardly schistose, but microscopically often show microfolding. The RGM-numbers are the registration numbers of the Rijksmuseum. The numbers in parentheses refer to Mrs. de Sitter-Koomans' contribution in Le Roux (1950).

RGM 92392 is a so-called 'chloromelanite' adze obtained from Genjem, a village situated about 25 km. west of Lake Sentani. The rock appears to consist of grass-green pyroxene, epidote, albite, possibly phengitic muscovite, some garnet and no quartz. Optical data of the pyroxene are: $N_Y = 1.685 \pm 0.005$, $N_Z \wedge c = 40°$, low bi-refringence, colourless in the thin-section. D-spacing of the reflection 221 is 2.929 Å. The mineral is most probably a jadeite-rich, acmite-poor chloromelanite (Tröger, 1962; Essene & Fyfe, 1967). The albite and epidote were formed later than the pyroxene. The greenish amphibole may be a product of alteration of pyroxene. It is inferred that the source of this particular rock eventually will be found in the northern Cyclops Mountains.

A number of stone adzes were collected from Bilorai, a village on the Doraboe River in the Upper Rouffaer River area, by Dr. G. de Koning and donated to the Rijksmuseum. One of the adzes shows green amphibole remnants in a lawsonite-epidote-glaucophane schist (RGM 92387). Two pebbles of epidote-garnet-albite gneis from the Cyclops Mountains have also been examined: sample RGM 141654 consists of poikiloblastic-idioblastic albite with quartz inclusions; pistacite is idioblastically developed. The garnet is most probably a spessartine-rich pyralspite (N = 1.791, cell edge 11.640 Å) and the chlorite is of the ripidolite-type. Sample RGM 141673 consists of albite-poikiloblasts with prismatic borders and numerous quartz inclusions. Blue-green hornblende, garnet and clinozoisite are the dominant mafic minerals. The clinozoisite is developed poikiloblastic-idioblastically, with inclusions of, e.g., colourless mica, probably normal muscovite. Epidote and chlorite are minerals possibly derived from garnet.

Conclusions

In the Basement Complex along the north side of Hermes' North Paleogeographic province, regional metamorphism (apart from some thermal metamorphism) is limited to the north coast east of Japen Island. This metamorphism is most probably older than upper Cretaceous. The crystalline schists belong mainly to the epizone with some transitions to the mesozone. Chloromelanite and glaucophanitic amphibole are rarely known from the Cyclops Mountains. The minerals mentioned point to metamorphism under low temperature and high pressure conditions.

A second belt of basic and ultrabasic igneous rocks associated with epimetamorphic rocks of upper Mesozoic or lower Tertairy age appears along the northern edge of the Central Highlands. Its lawsonite-epidote-glaucophane schists could be products of a synkinematic stage of metamorphism due to tectonic processes accompanied by uplift and faulting along the northern border of the Papuan miogeosyncline in Early or Late Tertiary time. The faulting might even be associated with considerable horizontal displacements, that is, if we may draw a parallel with similar structural units in eastern New Guinea. Here Tertiary movements probably of strike-slip nature appear to have continued into Quarternary time.

Within the miogeosynclinal part of the Papuan Geosycline, and participating in the sialic crust since early Permo-Carboniferous or even earlier time, igneous activity mainly of medium to acidic composition – in deeper levels often of batholithic size – took place repeatedly. Consequently the temperature factor played an important role in the metamorphic processes.

Earlier still, in Devonian time, orogeny was accompanied by anatectic processes in N.E. Vogelkop. In order to be able to distinguish more sharply between the different types and stages of metamorphism in New Guinea, for instance according to Miyashiro's concept of facies series (1961), mapping on a regional scale has yet to be carried out in those areas from which crystalline rocks are known or their presence suspected. Again, zonal dispersion of index minerals in each of the metamorphic regions in West Irian should be investigated.

It may be recalled that pairs of Cenozoic metamorphic belts can more generally be traced from Japan (Miyashiro, 1961) to the Circum-Pacific orogenic belts (Matsuda, et al., 1967). For many of the orogenic belts of Cenozoic age around the Pacific Ocean the following units are characteristic:
(1) an inner or continental-sided belt with medium to acidic magmatism and higher temperature/lower pressure type metamorphism,
(2) an outer or ocean-sided belt with geosynclinal subsidence and thick accumulation of sediments, ophiolitic magmatism together with strong deformation of sediments, and regional metamorphism of the higher pressure/lower temperature type.

A similar subdivision may obtain in New Guinea. Suwa (1961) expressed the same opinion relative to glaucophanitic schists along the north coast on the one hand and gneisses of high-temperature-type – such as biotite-sillimanite gneiss, andalusite-biotite schist, sillimanite-pyroxene gneiss on the other, more to the south. However, the gneisses in the northeastern part of the Vogelkop belong to an older orogeny (see p. 7).

The gravimetric profile as drawn by Visser & Hermes from the Mamberamo area across the Central Highlands to southern New Guinea shows marked positive isostatic anomalies coinciding with both the Basement Complex along the north coast and the Central Highlands, whereas negative anomalies occur in the adjoining structural lows. Locally, along the northern edge of the Central Highlands, these positive anomalies are particularly strong (up to 200 milligals). Both gravimetric highs are situated in the above mentioned zones of basic and ultrabasic igneous rocks. In these zones metamorphism under conditions of low temperature and high pressure occurred, contrary to the conditions of metamorphism in the miogeosyncline. The latter, as observed in the Central New Guinea paleogeographic province, is characterized by thermal metamorphic phenomena.

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Plate 1

Muscovite-albite-epidote-chloromelanite schist. (RGM 92392). Fan-shaped chloromelanitic pyroxene (cpx) and xenoblastic epidote (e). Porphyroblastic albite (a) with muscovite (m) and finely intergrown clinozoisite. Blastesis of albite is at the cost of the pyroxene. Quartz is lacking. Adze from Genjem.
Magn.: 65 x / / nicols

Plate 2

Actinolite-epidote-lawsonite-glaucophane schist (RGM 92387). Glaucophanitic amphibole mass intergrown with finely dispersed opaque minerals and epidote (e). Lawsonite in veins (l) and intergrown with glaucophane (g + l).
Actinolite as rests (a). Adze from Bilorai.
Magn.: 65 x / / nicols

Plate 3

Augite-glaucophane schist (RGM 140661). Broken augite (au) altered into fibrous glaucophanitic amphibole. The latter shows micro-folding. Streaks of ore occur throughout the rock.
Adze collected by Le Roux.
Magn.: 80 x / / nicols

Plate 1

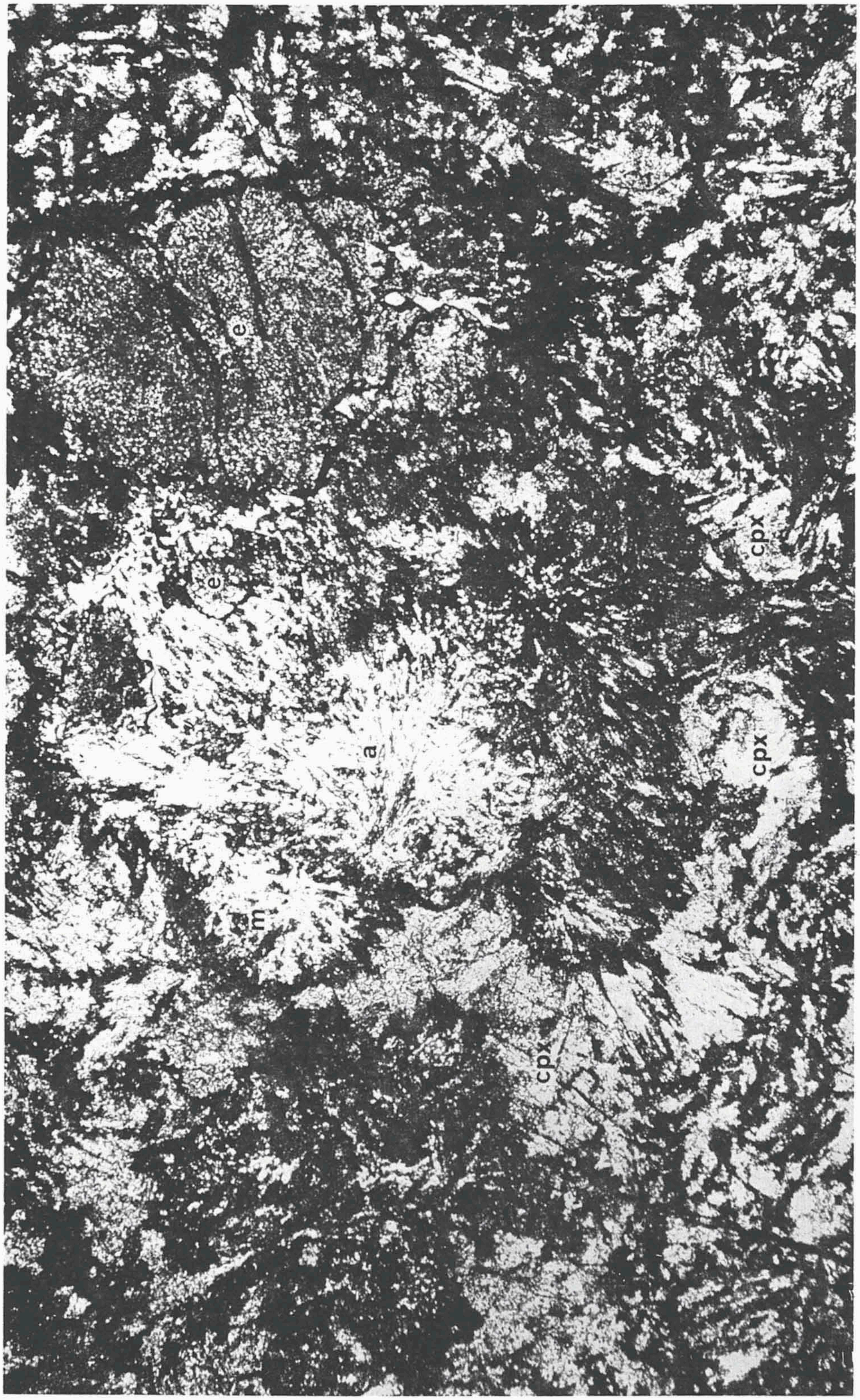


Plate 2

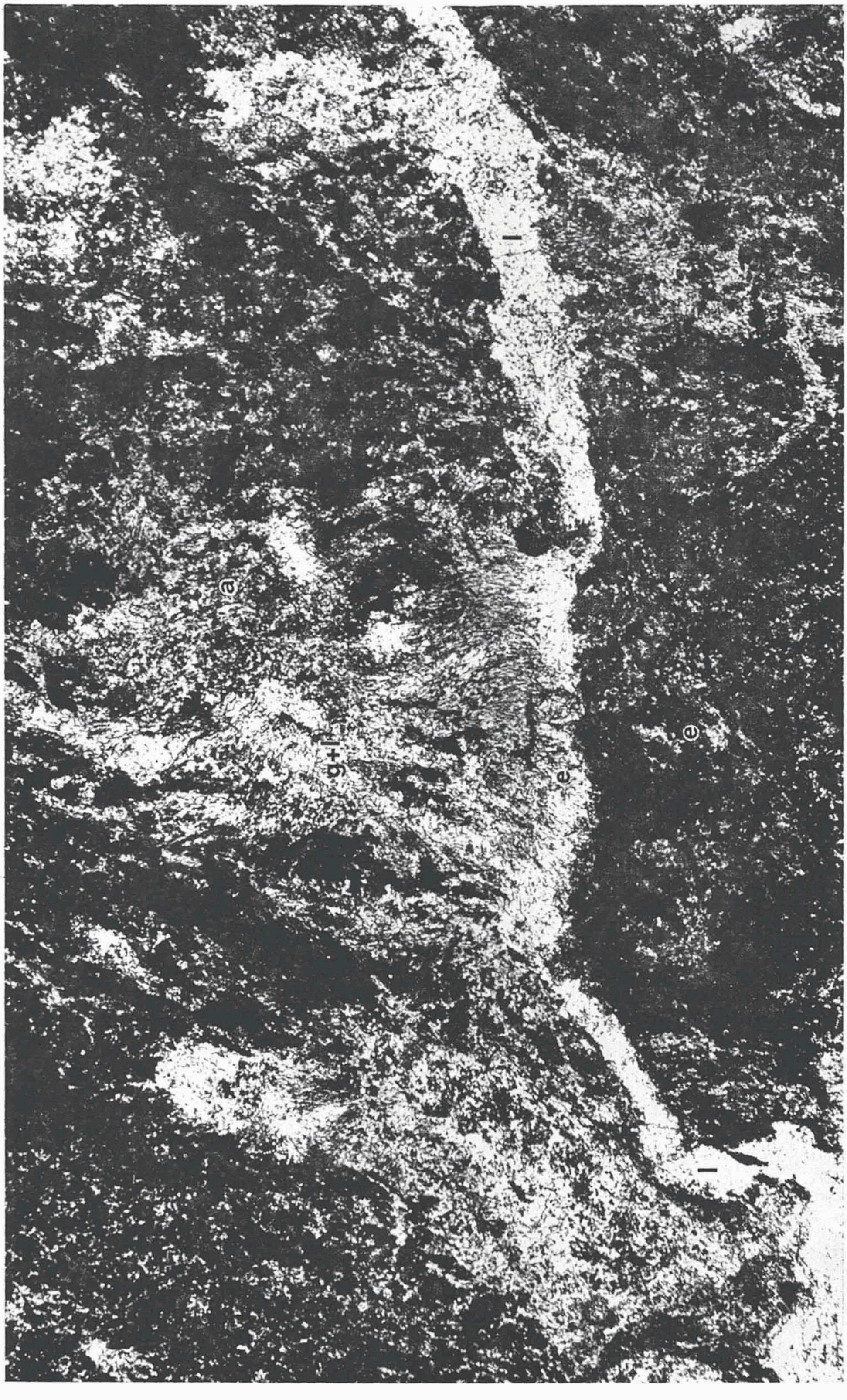
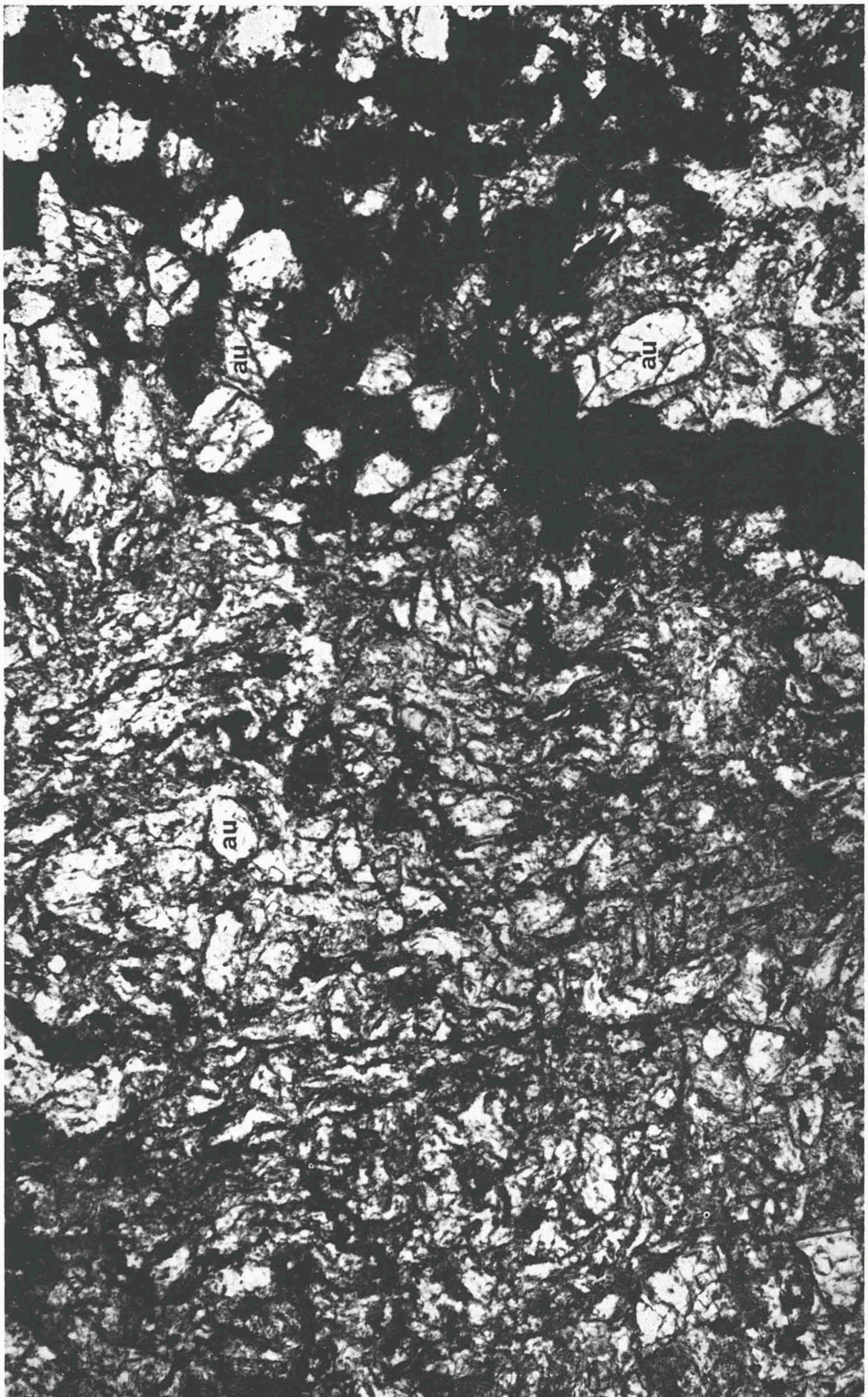


Plate 3



CORRIGENDA

Scripta Geologica 1 (1971); G. van der Wegen, Metamorphic Rocks in West Irian

Page 1 line 5 from top: read *eugeosynclinal* for 'eugeosynclinical'.

Page 2 the scale represents 800 km instead of 400 km.

Page 7 line 8 from bottom: read *Austrian* for 'Australian'.

Page 8 line 19 from top: read *intrusives* for 'intrusive'.