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ON GEOMORPHOLOGY OF NORTHERN AND WESTERN NEW CALEDONIAN ULTRAMAFIC MASSIFS

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INTRODUCTION

A geomorphological study of the western and northern New Caledonian ultramafic massifs has recently been revived through an ecological study of the mining area of the territory (Jaffré, Latham 1974, Latham 1975 a and b). Davis (1925), Avias (1953) and Routhier (1953) have established the outlines of the landform evolution of these mountains as a stratigraphic scale of the end of the tertiary and of the quaternary. Later on Orloff (1968), Wirthman (1965), Saos (1972), Trescases (1969, 1973) and the B.R.G.M. team (1965-1975) have tried to state these data in different sectors of the territory. When reviving this question we applied to characterize the different phases of the landform evolution through the residual elements which were then formed. From these data we tried to go further into the tectonic evolution of these massifs and to reconstruct a paleoclimatic scheme from the end of the tertiary to the quaternary.

I - DESCRIPTION OF THE OBSERVED LEVELS

Six main levels have been recognized on the Belep, Tiebaghi, Koniambo and Boulinda massifs (Fig. I).The first four levels are ferrallitic and they fit with Davis and Routhier's cycle I ; the fifth which is bisiallitic fits with the phase II and III of these authors and the sixth with the recent alluvial formation.

A - Level I - Plateau with massive hardpan

Level I is particularly well developed on Tiebaghi and Belep massifs. Only dismantled scraps of it are found on Boulinda mountain and it seems to be missing on Koniambo. It is a hematitic and goethitic massive hardpan level. On Tiebaghi and on Belep its mean thickness reaches five meters. It overlies very deep weathered horizons of the peridotites. Often a dismantlement appears in surface. Karst forms can be observed on these plateaux : caves, dolines or even ouvala. At the lower limit of this hardpan a water level appears and at this water level contact, iron stalagtites have been formed showing the present iron mobilisation process.

This level is probably the older hardpan indicator of the territory. We can draw a parallel between this level and the ferrugineous hardpan observed in the lower miocene limestone at Népoui (Latham 1974).

B - Level II : Peneplain with dismantled brecciated hardpans

The level II is assumed to be a remaking of level I subdued to a cycle of dismantlement, erosion and rehardening. Particularly well developed in the Boulinda and Koniambo massifs, it can be as clearly observed on the Tiebaghi mountain as in the Belep islands. This level is made of mixed brecciated hardpans and

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ferrugineous gravels. One can observe massive hardpan boulders included in those blocks. When getting important in extension, as for the Boulinda and Koniambo massifs, this phase gives the landcape a dented look (Avias 1953) due to a large development of Karstic relief.

This level cannot be given an age and it would be difficult to find out any element in it to be dated.

C - Level III - Peneplain and shouldering with rounded ferruginous gravels and with pisolithic hardpan

The level III made of gravels and pisolithic hardpan is inequally found all over the massifs. Well developed in the Boulinda mountain, it is less developed in the Koniambo, Tiebaghi and Belep massifs.

This level is made of a thick mantle of ferrugineous gravels, with a shiny rounded looking, and presenting mainly grains between 1 and 1.25 mm, overlying a weathered horizon with a mean depth. Those grains may be cemented to give a pisolithic hardpan, as clearly shown in the Tiebaghi mountain. The question about the origin of those gravels can be raised : are they products derived from a remaking of the level II or were they made there ? From their location, often rising above the landcape and from their inner structure (ferrugineous cover having turned elements of different natures into concretion), they are assumed to be neoformation products.

Far too few elements don't allow us to give an age to this level. However, if they are neoformation elements, we might suggest that the period before their genesis would have been marked by an intense scouring of these areas, which would have taken away any possibility of remaking up to the former level. We have to deal with a period of strong erosion which could be compared with the peridotite pebble formations found at Muẽo (Gonord, Trescases 1970). This formation would be given a plioquaternary age by these authors.

D - Level IV : Shouldering with ferruginous round gravels and hematitic red earth

The level IV appears to be a remaking of the previous level. It is overlying the smectite floor and it looks particularly developed on the Kafeatẽ (plateaux) on Koniambo and on the Tiebaghi massif.

Its composition is an accumulation of ferrugineous round unpolished gravels. Those gravels may be found recemented in hardpans. One can note, in association with those gravely accumulations, pockets of red earth particularly rich in hematite. The aspect of this formation, the morphoscopy of those ferrugineous gravels, the sometimes brutal way of coming into contact between the formation and the weathered rocks, have yielded to assume that we have to deal with a partly allochthonous formation, derived from the previous level.

No age can be given with accuracy to this period. However we must note that it deals with the last ferrallitic stage of the uplift of those massifs. It is often found overlying at only a few meters a giobertite level, as observed in the Belep islands and the Boulinda mountain.

E - Level V : The ancient alluvial plain

The level V spreads at the bases of the massifs. It corresponds to the ancient alluvial plain formation, set after the last uplift. During the uplift, other episodes of stability may have occurred as high alluvial levels witness it, with giobertites in the Boulinda and Belep massifs. However, the most developed level is the ancient alluvial plain which is found at 5 to 10 meters up to the present water level. It is formed with black clay in surface and a green one in depth, a nontronite type clay overlying either the rock pebbles. The latter being relatively slightly weathered. In the clayey formation, fine ferrugineous gravels, silicified element debris or laso silicifications in place and giobertite horizons are observed. Giobertite often appears at the boundary between clayey horizon and the pebble bed. Gypsum has also been added to this formation (Routhier 1953). Ferralitic allochthonous overlappings with mainly hematites can be observed too over this alluvial plain.

The last important uplift of the massifs ended by the settling of this ancient alluvial plain during a period marked by a sea level slightly higher than the present one. And as the last important sea level, higher than the present one is assumed to be 120.000 years BP in age (Lalou et al, Bloom et al 1974, Bernat et al 1976) one can thus derived this ancient alluvial plain settling to be of the same age.

F - Level VI : The recent alluvial terrace

The level VI appears to be the present alluvial terrace. It is made of materials belonging to mean texture in its inland part and of very fine clay in the mangrove. Those materials are mostly still not well transformed from a mineralogical point of view. We have not found in the rocks any accumulation of giobertite or other neogenetic minerals that could be observed in the previous levels.

The beginning of this formation settling is recent. It might have begun during the holocene high sea level. It is going on presently.

II - COMPARISON OF THESE LEVELS WITH PREVIOUS WORKS - Attempt of stratigraphical scale

In short, six levelling surfaces can be observed in those massifs. They correspond to six stability phases which would have occured between the miocene age and the present time. This study led us to a subdivision of the peneplain as suggested by Davis and Routhier into geomorphological levels. This hypothesis was yet partly assumed by Wirthmann and Trescases. We have tried here to give precise details about these subdivisions through morphological characteristics (Table I).

It appears that four phases of uplift stabilisation marked in field by four different geomorphological levels correspond to the Davis and Routhier's cycle I. These levels would agree with the first three levels studied by Trescases and Wirthmann. Later on, the ancient alluvial plain and the recent alluvial terrace are in agreement with the levels previously observed by these authors.

Thence, it appears that the stratigraphy we have established on those massifs through following the general scheme given by the previous authors, has yielded to go further in this scheme in bringing more accurate details, particularly about the massifs themselves.

III - DISTRIBUTION OF THE LEVELS IN THE MASSIFS AND ITS TECTONIC CONSEQUENCES

The distribution of these levels and the decreasing in altitude gradient, that can be observed along from the center of the island to its Northern part rise the question of the uplift of those massifs.

Davis and Routhier assumed the island to be turned into a peneplain, when occurred an uplift phase during which a warping movement directed South West took place. This bent would have been demonstrated by the peneplain slope, towards the sea and the slope of the basement of some massifs. These observations are not inconsistent with the hypothesis of a transverse subsidence of the islands. The slope of the Tiebaghi and Belep's plateaux does confirm this hypothesis. On the Boulinda massif we can observe a noticeable difference in altitude between the located inland levels and those set close to the sea. But the symmetry of those levels in relation with the oldest level (see Fig. 3) implies the uplift to have occurred by steps and not at the same time. Besides those steps are settled the same way though if note at the same altitude, on the four studied massifs. This hypothesis was yet considered by Carroue and Espirat in their geological bulletin on Poya in 1967. We can thus assume that the uplift of those massifs occurred in four steps, fitting with Davis phase II or Avias and Routhier's phases II and II b. However, the amplitudes in altitude of those steps vary from a massif to another in decreasing Northward. Garnier (1867) already noted the constant decrease, as far as going to the North, of the altitude's in formations of same ages and natures. Those conclusions were resumed by Davis and Routhier who assumed a longitudinal warping. The gradient in altitude has been confirmed by our observations. It would have also affected all the steps of the uplift (see Fig. 4). Even if the gradient in altitude from a massif to another were not strictly linear as Routhier already noted it, the importance of this phenomenon would imply a general tectonic explanation. Dubois et al (1974) when interpreting the erosion rate computed by Baltzer and Trescases (1971), assumed that an uplifting movement of 1000 m due to the continental unloading, would correspond to an erosion of 9 000 m of ultramafic material. But they used in that hypothesis an elastic model. More recent discussions with Dubois, when using a visco elastic model which integrates the notion of time as suggested by Walcott (1970), led us to assume that the thickness of the initial ultramafic mantle might have been much weaker. In fact Walcott, applying the Nadai's relaxation curves, multiplies approximately three times the effect of a force operating up on such a model during about 20 million years. That would lead us thus to an age far much reasonable in the New Caledonian context.

Thence, the distribution of those levels has shown that the uplift occurred by steps and that its origin may be explained through a continental unloading process when applied to a visco-elastic model.

IV - AN ATTEMPT OF PALEOCLIMATIC RECONSTRUCTION

The pedogenetic interpretation of those levels led us to a paleoclimatic scheme near to that presented by Tercinier (1962) : hot humid periods from the end of tertiary to the beginning of quaternary, followed by subactual much arid climate. The analysis of the geochemical formation conditions of the neogenetic products, plus the study of the present climate, give us further precisions.

A study of the pluviometry which affects the Boulinda massif, unfortunately during too short a time (1 year), showed a gradient in the precipitations, neatly observed as a function of the altitude (Latham, Jaffré 1976). This gradient is unchanged whatever the seasons may be and is not due only to hurricanes which implies that a drying up of the climate in the plain is not evidently associated with a drought period on the massifs. This is a main point to explain the preservation on those massifs of a flora often very specific and showing quite a lot of archaic species.

The period during which the first four levels were formed, has been marked by different climatic phases. The relics of the most humid period are only known, the latter having probably destroyed the less stable elements which could have been formed during dryer periods. The relics are mainly ferruginеous hardpans and fine gravels as also silcretes. Through the ferruginеous products one can distinguish the hematite, the geothite and the more or less well crystallized iron hydroxides. The climatic meaning of hematite as relics of a drought period was a question raised several times (Van Houten 1961, Walker 1967, Schwertman 1971). Though that hypothesis has been recently called in question (Walker 1974), it is nevertheless in a good agreement with the New Caledonian context. Presently we can find this mineral under a pulverulent state in dry areas when the soils of more humid areas contain just goethite and not well crystallized hydroxides (Latham 1975 b).

In level I, the hardpan presents a certain porosity.It is made of stratified red cores, rich in hematite surrounded by more or less opened channels, coated by black goethite. It would be in agreement with Maignien's relative hardpans (1958), the iron of this hardpan would later on under the effects of humid climates and thanks to organic material, have been disolved and transformed to give the landscape its present karstic aspect and to impregnate those pores and channel with goethite.

During the settling of levels II and III hot humid climates would have prevailed. Only traces of hematite are found in the elements formed in those levels. The hardpans would have been formed in medium with temporary alternate hydromorphy, as observed presently in the plain of the lakes or in different dolines.

At level IV, the red soils rich in hematite reappear, we have seen previously that they were partly derived from the level III. However they have evolved <u>in situ</u> to get rich in hematite. The conditions of this mineral formation are then fulfilled (Schwertman 1971). Soils are often of little depth and overlie upon a weathered horizon rich in smectite and with a basic reaction. We must note that the only fine earth is found with a hematitic predominance, the ferruginеous fine gravels are goethitic.

The first great uplift and the settling of the ancient alluvial plain were marked, first by a rough sedimentation, then with a finer sedimentation. Vertisols developed within those fine sediments as also giobertite and opale resinite accumulations. Relatively arid climates then prevailed on the Western coast. Those climates would have allowed those carbonate and opale accumulations as also gypsum and eolianite formations (Avias, Coudray 1965) though all those elements have not been proved to be contemporaneous. We can too probably attribute to them the formations of broad ravines of erosion as one can observe on the Tiebaghi massif and in the Belep's. During that period a relatively humid climate was probably prevalent on the massifs allowing the survival of the vegetation and the maintenance of water bearing beds which permited the formation of the neogenetic products of the plain.

It seems that since, as Baltzer and Dugas (1976) suggested it, that climate would have obviously gone on in those areas, with however a more humid tendancy presently. The latter hypothesis is based on the fact that we have not found any authigenic carbonates in the recent alluvial terrace.

The Table II summarizes the paleoclimatic evolution of those massifs from the miocene age to the present time. Thus it appears that after ferrallitic phases more or less intense up to the pleistocene, the more recent climates which affected the island were of more arid types. That aridness which reached its maximum in intensity during the giobertite and the gypsum formations, would tend to lessen presently.

If we compare those data with the Australian continent case, we can derive that a long ferrallitic period covered the end of the tertiary to the beginning of the quaternary (Jessup 1961, Galloway, Van de Graaf 1962, Mulcahy, Churchward 1973). After those humid tropical periods, dryer periods took place which would have allowed the carbonated soils and vertisol formations (Mc Arthur, Bettenay 1960, Blackburn, Sharpenseel 1973). Conjointly, in the Fiji islands, ferrallitic geomorphological levels were evidenced (Dickinson 1965). Those levels would have settled at the end of the Cenozoic. Those conclusions lead us to assume that the suggested paleoclimatic scheme, though very succint, appears reasonable regarding the data given by the neighbouring territories.

CONCLUSION

Thus this study has allowed to know and characterize morphologically and mineralogically six main geomorphological levels on the Northern and Western massifs of New Caledonia. The survey of those levels brings further accurate details to the stratigraphical data previously given by Davis - Routhier and Trescases. Their distribution has shown that the uplift of the massifs was carried on by steps and that its origin might be in a continental unloading process when associated with a visco-elastic model. Their natures allow to establish a paleoclimatic scheme with humid tropical phases from the end of the tertiary to the beginning of the quaternary, followed by relatively arid phases during the pleistocene ; a scheme coherent enough with regard to the given results in the area.

The question about the possibility of extending this scheme to the whole island may be raised. At first sight, the problem appears more complex in the large South massif where a breaking tectonic might have modified the geometrical ratios existing between the different levels. A further knowledge of those levels, connected with the study of the bed rock weathering face, would probably lead us to a best understanding of the region.

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References

- AVIAS J. - 1953 - Contribution à l'étude stratigraphique et paléontologique des formations antécrétacées en Nouvelle-Calédonie. Thèse fac. sc. Nancy - Science de la Terre n° 1 et 2 Nancy 276 p.
- AVIAS J., COUDRAY J. - 1965 - Sur la présence d'éoléanites en Nouvelle-Calédonie C.R. sommaire soc. géol. de France Fasc. 10 p. 327-328.
- BALTZER F., TRESCASES J.J. - 1971 - Erosion, transport et sédimentation liés aux cyclones tropicaux. Cah. ORSTOM sér. Géol. vol. III n° 2 p. 221-244.
- BALTZER F., DUGAS F. - 1976 - Sur l'âge des croutes calcaires et des éolianites du quaternaire de la Baie de St. Vincent, Nouvelle-Calédonie. Bull. soc. Fr. d'étude du quaternaire (sous presse).
- BERNAT M., LAUNAY J., RECY J. - 1976 - Datations à l'ionium uranium de quelques formations coralliennes émergées de Nouvelle-Calédonie et des îles Loyauté. C.R. Acad. Sci. Paris t. 282 sér. D p. 9-12.
- BLACKBURN G., SCHARPENSEEL H.W. - 1973 - Time and process in gilgaï formation. Western Victoria, Australia Proc. 9th INQUA congr. Christchurch.
- BLOOM A.L., BROECKER W.S., CHAPPEL J.M.A., MATTHEWS R.K. and MESOLELLA K.J. - 1974 - Quaternary sea level fluctuation on a tectonic coast. New 230 th/234 U dates from HUON peninsula, New Guinea. Quaternary research 4. p. 185-205.
- B.R.G.M. - 1965 - 1975 - Carte géologique à l'échelle du 1/50.000 de la Nouvelle-Calédonie. BRGM Paris.
- CARROUE J.P., ESPIRAT J.J. - 1967 - Carte géologique de la Nouvelle-Calédonie à l'échelle du 1/50.000 ; feuille Poya, plaine des Gaïacs - BRGM Paris.

- DAVIS W.N. - 1925 - Les côtes et récifs corralliens de la Nouvelle-Calédonie. Ann. Géogr. T 34 n° 191.

- DICKINSON W.R. - Dissected erosion surfaces in Northwest Viti Levu, FIJI. 23 p. unpublished.

- DUBOIS J., LAUNAY J., RECY J. - 1974 - Uplift movements in New Caledonia, Loyalty islands area and their plate tectonics interpretation. Tectonophysics vol. 24 p. 133-150.

- GALLOWAY, VAND DE GRAAF - 1962 - Alluvial terraces, slope deposits and soils in the Hunter Valley N.S.W. CSIRO, Canberra Techn. memorandum 62/4. 9 p.

- GARNIER J. - 1867 - Essai sur la géologie et les ressources minérales de la Nouvelle-Calédonie. Ann. des mines 6ème sér. XII p. 1-92.

- GONORD H., TRESCASES J.J. - 1970 - Observations nouvelles sur la formation post-miocène de Muéo (Côte Ouest de la Nouvelle-Calédonie). Conséquences paléogéographiques et structurales C.R. Ac. Sc. Paris sér. D t. 270 p. 584-587.

- JAFFRE T., LATHAM M. - 1974 - Contribution à l'étude des relations sol-végétation sur un massif de roches ultrabasiques de la côte Ouest de la Nouvelle-Calédonie : Le Boulinda. Adansonia sér. 2, 14 (3), p. 311-336.

- JESSUP R.W. - 1961 - A tertiary quaternary pedological chronology for the south eastern position of the Australian arid zone. J. soil. Sci. 12, p. 199-213.

- LALOU E., DUPLESSY J.C., NGUYEN HUU VAN - 1971 - Données géochronologiques actuelles sur les niveaux des mers et la paléoclimatologie de l'inter-glaciaire RISS-WURM. Rev. géog. phy. et de géol. dyn. vol. XIII Fasc. 5, p. 447-462.

- LATHAM M. - 1974 - Nouvelle observation de la coupe de Népoui (Nouvelle-Calédonie) ; conséquences sur la géochronologie de l'étagement des niveaux cuirassés sur les massifs de roches ultrabasiques. C.R. Acad. Sc. Paris t. 279, p. 1055-1058.

- LATHAM M. - 1974a - Géomorphologie d'un massif de roches ultrabasiques de la côte Ouest de la Nouvelle-Calédonie, Le Boulinda. Cah. ORSTOM sér. Géol. vol. VII, n° 1, p. 17-37.

- LATHAM M. - 1975b - Les sols d'un massif de roches ultrabasiques de la côte Ouest de la Nouvelle-Calédonie : Le Boulinda 1ère et 2ème partie. Cah. ORSTOM, sér. Pédol. vol. XIII p. 27-40 et 159-172.

- LATHAM M., JAFFRE T. - 1976 - Note préliminaire sur la pluviométrie affectant un massif de la côte Ouest de la Nouvelle-Calédonie : Le Boulinda 5 p. multigr. ORSTOM-NOUMEA.

- MAIGNIEN R. - 1958 - Le cuirassement des sols en Guinée. mém. serv. carte Géol. Als. Lorr. Strasbourg 239 p.

- McARTHUR W.M. et BETTENAY E. - 1960 - The development and distribution of the soils of the swan coastal plain. Western Australia. CSIRO Austr. Div. Soil pub. n° 16.

- MULCAHY M.J. et CHURCHWARD H.M. - 1973 - Quaternary environments and soils in Australia. Soil sci. vol. 116 n° 3 p. 156-159.

- NADAI A. - 1963 - Theory of flows and fracture of solids Mc GRAW HILL New York 755 p.

- ORLOFF O. - 1968 - Etude géologique et géomorphologique des massifs d'ultrabasites compris entre Houailou et Canala (Nouvelle-Calédonie)mém. univ. Montpellier 06 p. 79-175.

- ROUTHIER P. - 1953 - Etude géologique du versant occidental de la Nouvelle-Calédonie entre le Col de Boghen et la Pointe d'Arama. Mém. soc. géol. Fr. t. 32, n° 67, 271 p.

- SAOS M.C. - 1972 - Dans notice de la carte géologique de Prony au 1/50.000ème BRGM-Orléans.

- STEPHENS C.G. - 1971 - Laterite and silcrete : a study of the genetic relationship of laterite and silcrete and their companion material and their collective significance in the formation of the weathered mantle, soil relief and drainage of the Australian continent. Geoderma vol. 5, n°1, p. 5-52.

- SCHWERTMANN V. - 1971 - Transformation of hematite to geothite in soils. Nature vol. 232, August 27.

- TERCINIER G. - 1972 - Les sols de la Nouvelle-Calédonie. Cah. ORSTOM sér. Pédol. vol. 1, n° 1 p. 1-53.

- TRESCASES J.J. - 1969 - Premières observations sur l'altération des péridotites en Nouvelle-Calédonie. Cah. ORSTOM sér. Géol. vol. 1, n° 1, p. 27-57.

- TRESCASES J.J. - 1975 - L'évolution géochimique supergène des roches ultrabasiques en zone tropicale et la formation des gisements nickelifères de Nouvelle-Calédonie, mém. ORSTOM n° 78.

- VAN HOUTEN F.B. - 1961 - Climatic significance of red beds. In Nairn. A.E.M. ed. Descriptive paleoclimatology : New York interscience pubs. Inc. p. 89-139.

- WALCOTT R.I. - 1970 - Flexural rigidity, thickness and viscosity of the lithosphere J. geophys. res. vol. 75 p. 3941-3954.

- WALKER T.R. - 1967 - Formation of red bed in modern and ancient deserts. Géol. Soc. America bull. vol. 78 p. 353-368.

- WALKER T.R. - 1974 - Formation of red beds in moist tropical climates : a hypothesis. Geol. Soc. of America bull. V 85 p. 633-638.

- WIRTHMANN A. - 1965 - Die reliefentwicklung von Neukaledonien. In Tagungobericht und wissensechaftliche Abhandlugen. Deutscher geographentag Bochum p. 323-335.

Table I - CORRELATION BETWEEN OBSERVED LEVELS AND PREVIOUS DATA

OBSERVED LEVELS	CORRELATION DAVIS, ROUTHIER	CORRELATION AVIAS, TRESCASES, WIRTHMANN	PRESUMED AGE
Plateaux with massive hardpans	cycle I of D, A and R	Level I : peneplain	Lower Miocene
Peneplain with brecciated dismantled hardpans	Phase IIa of A and R denting of the peneplain		Plioquaternary
Peneplain and shoulderings with rounded iron gravels and pisolithic hardpans		Mueo formation of GONORD and TRESCASES	
Shouldering with round iron gravels and red lateritic earth	Phase IIb rough erosion	Level II b or piedmont level of T	Pleistocene About 120.000 BP
Older alluvial plain	Phase III coastal and fluvial plioquaternary formations	Level IIc of continental spreading	
Recent alluvial plain	Phase IV of D and R	Phase III of T	Recent

Table II - CLIMATE EVOLUTION RELATED TO NEOGENETIC PRODUCTS

Age	Level	Pedogenesis	Neogenetic products	Type of climate
Miocene	I	ferrallitisation	Hematitic massive hardpan	contrasted climate
Plioquaternary	II	ferrallitisation	Goethitic brecciated hardpan	Perhumid climate
	III	ferrallitisation	Goethitic rounded iron gravels	
	IV	ferrallitisation	Round iron gravels and hematitic red earth	contrasted climate
120.000 BP	V	bisiallitisation	Smectites, giobertite, opale, gypsum	Subarid climate on the coastal plain and humid in the mountain
Holocene	VI	bisiallitisation	Smectites	contrasted climate in the plain and humid in the mountain

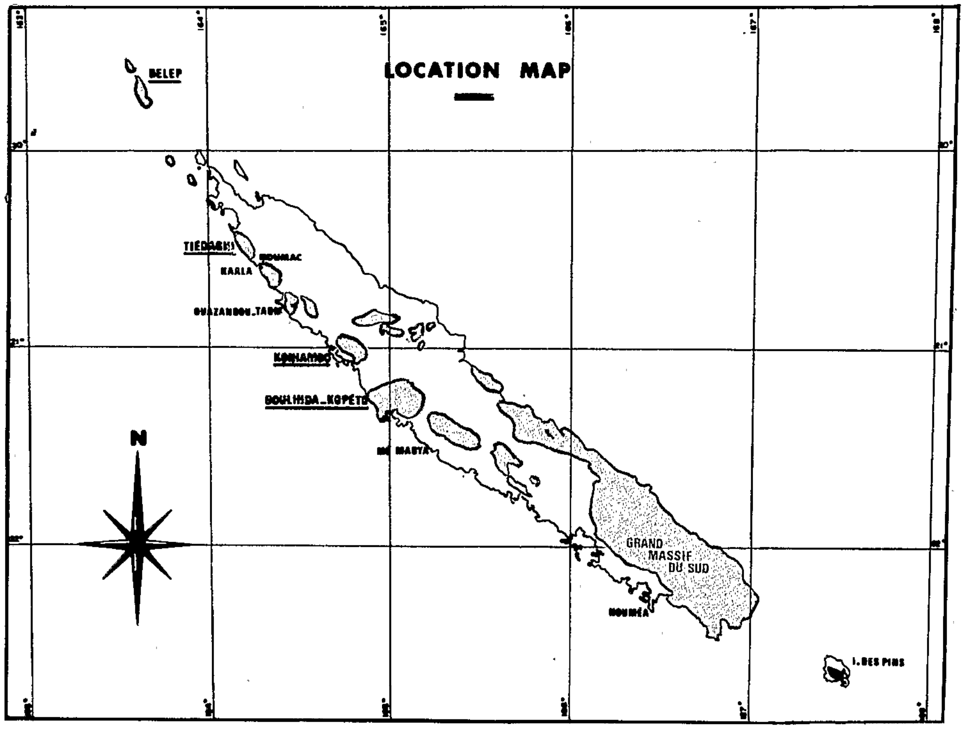


Fig. 1

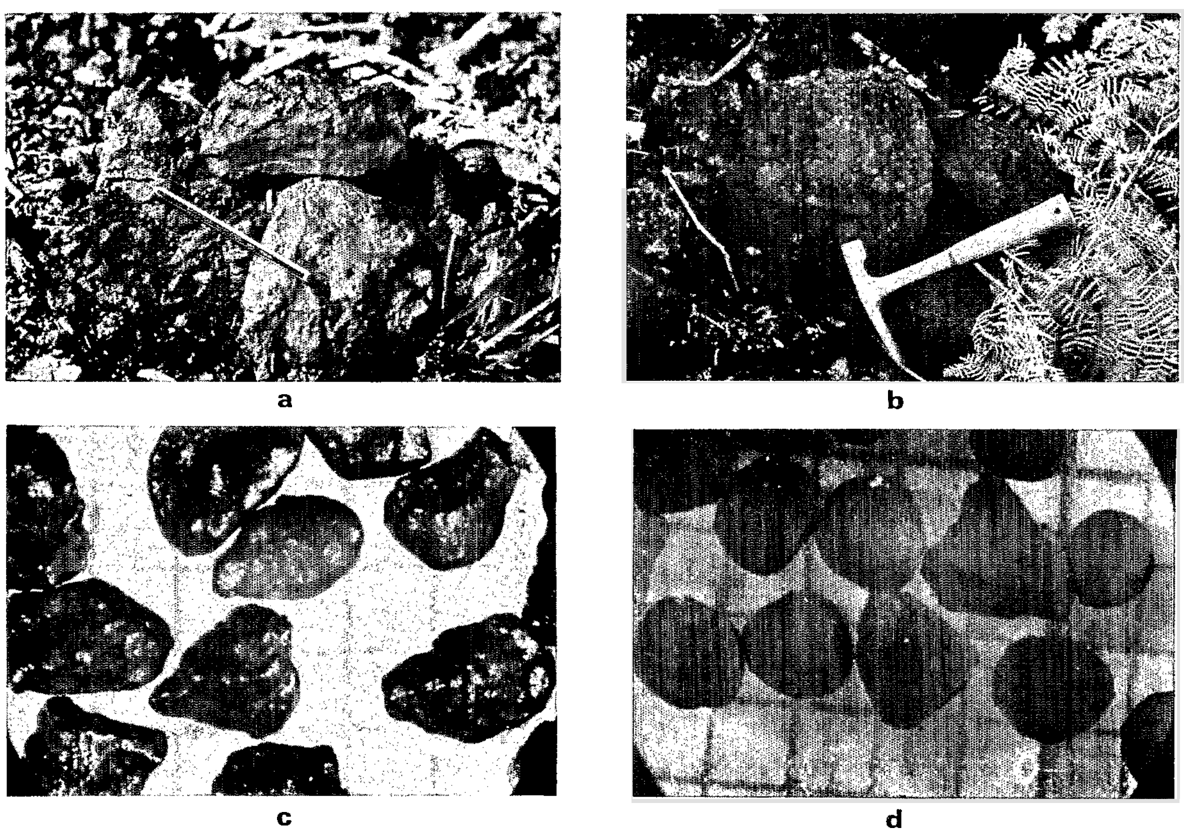


Fig. 2 - Morphoscopy of characteristic elements of the first four levels. 2 a massive iron pan; 2 b brecciated hard pan; 2 c ferruginous rounded shiny gravels; 2 d ferruginous round unpolished gravels.

Fig.3

CROSS SECTION IN NORTHERN

AND WESTERN ULTRAMAFIC MASSIFS OF NEW CALEDONIA

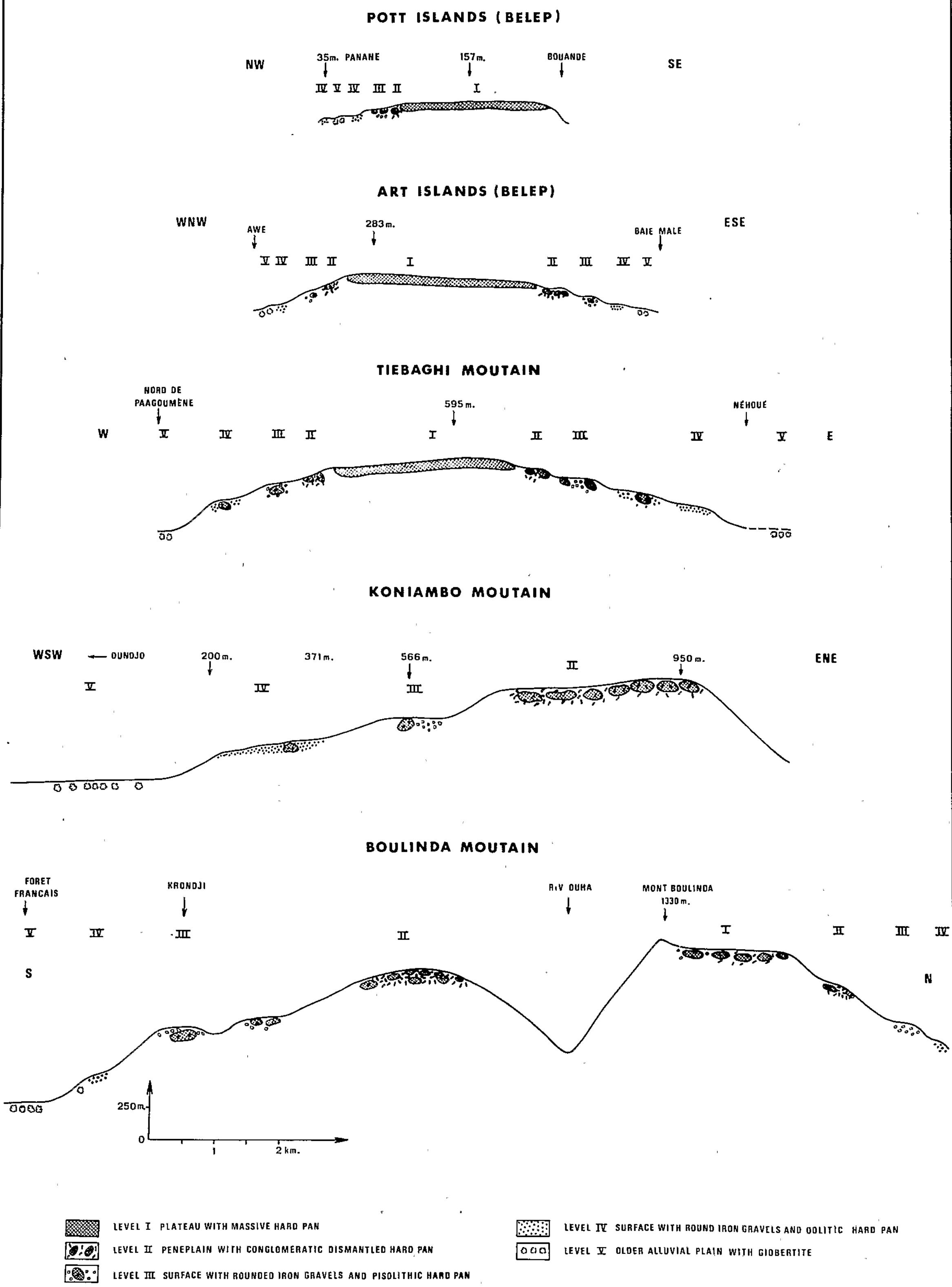
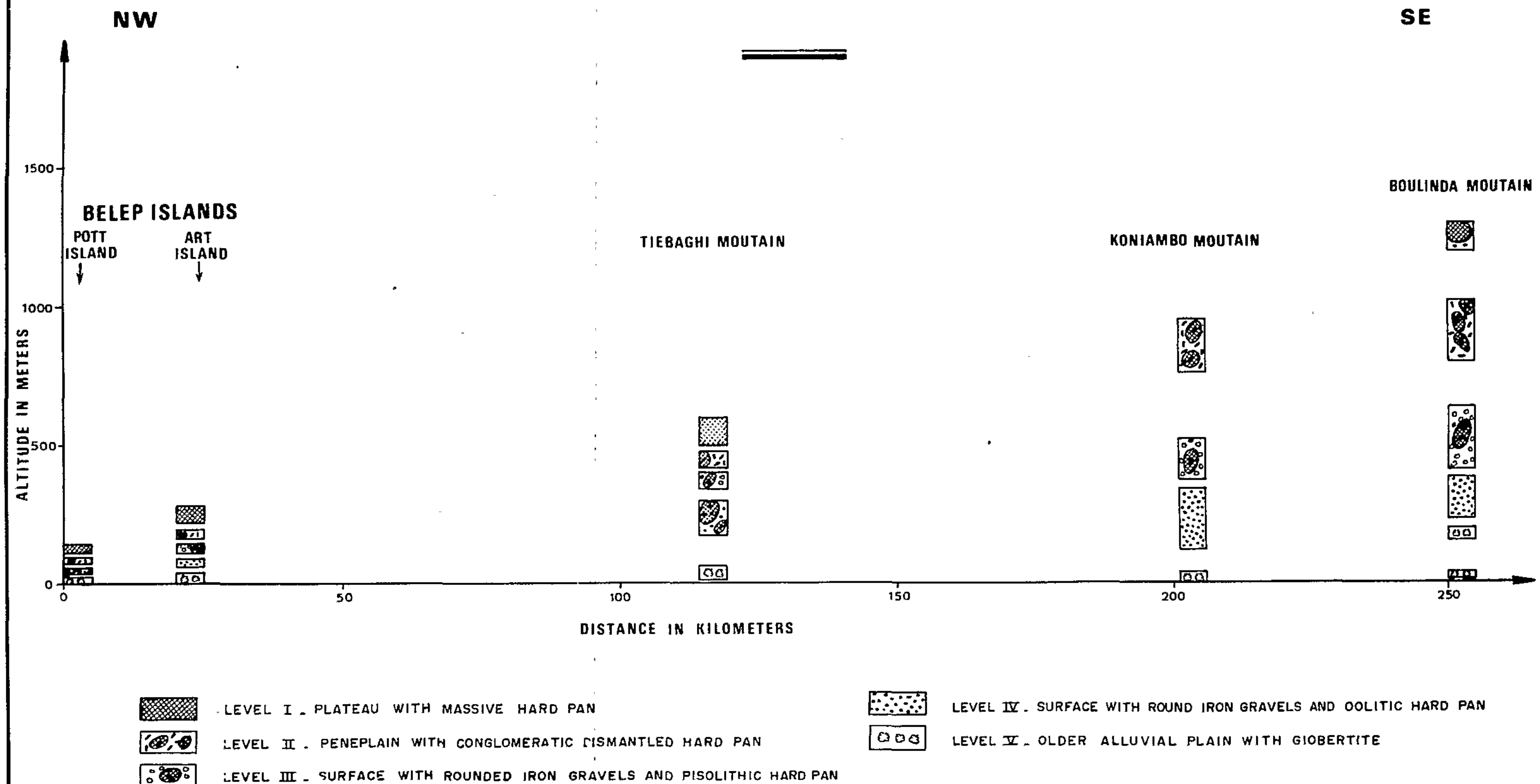


Fig. 4

ALTITUDINAL DISTRIBUTION OF FERRALLITIC AND MAGNESIC LEVELS IN NORTHERN AND WESTERN ULTRAMAFIC MASSIFS OF NEW CALEDONIA



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