Geo-Eco-Trop, *1981*, 5 (1) 13-28

GEOMORPHOLOGY OF THE NORTHERN AGGRADATION PLAINS OF THE LAKE VALENCIA BASIN (VENEZUELA)

Géomorphologie des plaines d'aggradation au nord du lac de Valencia (Vénézuela)

L. PEETERS*

RESUME

L'auteur étudie l'influence des divers éléments de l'environnement physique sur l'évolution de la géomorphologie des plaines d'aggradation situées au nord du lac de Valencia. Les mouvements récents le long d'une série de failles ainsi que la lithologie du sous-sol interviennent dans l'explication des formes des bassins fluviaux. Les failles et les changements de niveau du lac ainsi que l'activité anthropique récente expliquent les grands traits des réseaux hydrographiques. Les nombreux glissements de terrain peuvent être classés suivant une datation relative. L'étude des anciens cônes de débris confirme l'existence de périodes paléoclimatiques du type semi-aride. L'auteur propose un essai de corrélation entre les différentes phases de l'évolution géomorphologique des plaines d'aggradation et la succession des paléoclimats quaternaires du bassin lacustre.

ABSTRACT

This paper deals with the influence of various elements of the physical environment on the geomorphologic evolution of the aggradation plains north of lake Valencia. The shape of the river basins depends on recent fault movements and on lithology. The general trend of hydrography results from fault movements, changes in lake level and recent anthropic activity. The numerous landslides are classified according to their relative age. The study of old debris cones confirms the existence of a semi-arid paleoclimate. Finally the author proposes a tentative correlation between the geomorphic evolution of the aggradation plains and the paleoclimates of the lake basin.

* Laboratorium voor Aardrijkskunde, Rijksuniversitair Centrum, Middelheimlaan 1, 2020 Antwerpen. Also, Vrije Universiteit Brussel, Pleinlaan 2, 1050 Brussels, Belgium.

INTRODUCTION

Research on the geomorphology of the aggradation plains north of lake Valencia is based on geomorphologic mapping consequent on studies of aerial photos and on fieldwork. The area covers the region between rio Cabriales, at the west, and the basin of rio Honda, at the east, where the Fila El Picacho and the peninsula of La Cabrera form the eastern limit.(1)

The aerial photos are those of the 1951 survey of Aeromapas Seravenca. Although this survey is already old, it offers the advantage of displaying a lot of geomorphologic elements, which nowadays are completely hidden by dwellings. The valley of rio Cabriales is a good example to show how the study of the geomorphology of debris cones is becoming difficult - if not impossible - due to the tremendous expansion of the city of Valencia.

Most of the geomorphologic symbols used on the maps are those published by I.T.C., which are widely accepted as such in geomorphology (VERSTAPPEN & ZUIDAM, 1975, ch. VII-2).

This research could be carried out thanks to funds of various institutes. In Venezuela full cooperation was obtained from the "Instituto para la Conservacion del Lago de Valencia". In Belgium funds were obtained from the Ministry of Education, INQUA and R.U.C.A. To all those institutes the author feels greatly indebted.

The shape of the river basins

On the maps the shape of the river basins is indicated by the main divides separating the basins. Due to the lack of published maps on 1/25.000 the upper part of the following basins could not be represented but can be observed on the maps on 1/100.000 : Cabriales, San Diego and Guacara. Hence, the missing area for the basins of rio Cabriales and rio San Diego appears to be very small. On the contrary, the missing catchment basin of rio Guacara consists of an important fan-shaped area of run-off, upstream from Vigirima and converging towards one single river down-stream from Vigirima.

Considering rio Cabriales and rio San Diego-Guayos, it is a striking fact that the normal fan-shaped dendritic drainage pattern does not exist. As a result of this the valleys of those rivers show an elongated shape over important distances with but one or two N-S main

(1) The two sheets of the map are inserted at the end of this issue.

rivers in the central part and without important tributaries. There exists but one important E-W depression located at the basis of a striking fault escarpment. This depression represents the remnants of a former E-W drainage along the fault line as testified by a series of E-W gaps between the main basins. All those characteristics are found back in the morphology of the Guacara basin, down-stream from Vigirima. River basins east of Guacara display a normal dendritic drainage pattern. In fact those basins developed only the upper part of the former ones, which is located close to the fault escarpment.

The N-S elongated valley-shape exists also west of the area represented on the maps, as shown by the valleys of rio Torito and rio Guataparo (PEETERS, 1968, p. 10). In this case erosion has been guided by a series of N-S faults along which the eastern valley side was lowered with regards to the western one. However, the existence of such faults is not visible in morphology as far as rio Cabriales, rio San Diego-Guayos and Guacara are concerned, as there is no evidence of differences in altitude between the western and eastern divides. In this case the elongated shape of the valley could be the consequence of erosion, guided by N-S cracks and diaclases. Indeed, the influence of N-S diaclases upon the orientation of drainage is a well-known fact in the hydrography of the lake basin of which several examples have been mentioned north and nord-east of Maracay (PEETERS, 1968). However a thick series of sediments makes it impossible to discover those diaclases in the hidden bed-rock.

Another characteristic of valley shape is a striking narrowing of the valley between the middle and lower course of the river. It is highly probable that at the place of this narrowing a local base level was active at the moment when a second fault-movement lowered parts of the graben of Valencia, south of this narrowing. But in this case it is also difficult to trace such a fault-line on the maps as it is hidden by an important series of sediments.

This fault-line may be part of the fault-zones appearing in morphology west of Valencia; it may also be the hypothetic fault of La Cabrera mentioned on the geological map of TAHAL (1970, Fig. V/B-I). Anyway, one point is very well established : the morphology of the divide of Fila El Picacho continuing into the peninsula of La Cabrera shows no fault morphology at all. Hence, the fault-zone responsible for a second lowering of the graben of Valencia must either stop in the environment of Mariara

(TAHAL, 1970) or be located south of the peninsula of La Cabrera (PEETERS, 1968).

The possible influence of the lithological composition of the bed-rock on valley-shape has been taken into consideration too.

On the maps, the geologic boundaries have been reported according to the geological map of TAHAL (1970). Although important lithological differences exist amongst the various geologic formations, which belong to the Cretaceous, they seem to have no influence on the main valley shapes of aggradation. On the contrary, lithology may intervene upon the morphology and drainage pattern of the rocky valleys which however are not studied in detail in this paper. Nevertheless the following observations may be of interest.

Rocky valleys are all V-shaped with steep valley-sides. Locally they may be asymmetric as one of the valley sides is a structural one of which one slope coincides with the dip of the layers.

In the basin of rio Cabriales the bifurcation ratio and the drainage density of some tributaries located on different types of rocks have been calculated and the results are given on table I.

Mean bifurcation ratio			
Stream order	Micaschist	Calcschist	Granite-gneiss
1	5,2	5,1	3,2
2	3,2	2,6	2,4
3	2,7	2,7	4,5
4			
Mean drainage density (in km^{-1})			
	2,63	3,87	3,79

Tab. I.

The bifurcation ratio on micaschists and calcschists shows an identical trend for both types of rock : too high values for the ratio order 1/order 2; normal values for the other ratios. Hence, changes in drainage pattern are to be expected in the upper course of the rivers. Moreover, in some cases the drainage patterns looks very irregular. Tributaries may be located on only one valley side. This may be due - as already mentioned - to the influence of the dip of the geologic layers which may exceed slope values of 45°. Consequently one of the valley sides is a structural one (Fig. 1, n° 274). The change in value of the bifurcation ratio on granite-gneiss is just the reverse one, compared with the schists. Abnormally high values occur in the lower course of the rivers which seem to be far away from a stage of equilibrium.

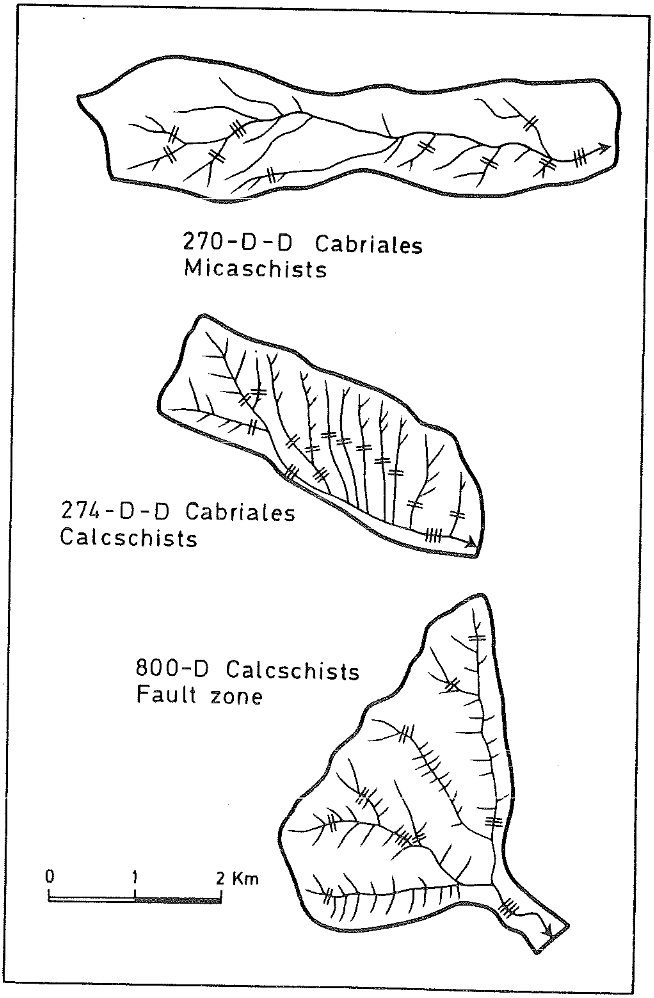


Fig. 1

The position close to the fault-line of La Entrada may explain such a situation. The same may be true for the abnormally high values of the lower orders for rivers on calcschist of the young fault-escarpment west of Valencia (Fig. 1)

Drainage density on either granite or calcschists looks similar. The numerous rivulets on granite may be due to the abundance of cracks and diaclases in this type of rock. The high drainage density on calcschists is linked with the numerous schistose levels which offer less resistance towards erosion.

Drainage density on micaschists is lower. As may be seen on figure 1, the drainage pattern is characterized by the importance of the main river and consequently elongated valleys originate. Any anthropic change on the drainage system will mainly affect the main river course.

The hydrography

Erosion is dominating in all of the river basins. In the lower course of the main river, erosion became active since the historical lowering of the lake level. Erosion in the middle and upper course is linked with the general uplift of the Cordillera de la Costa and with the humid-tropical climate of today. Several terrace scarps were cut into the soft sediments of the aggradation plains. Valleys are V-shaped into the hard bed-rock whereas canyons with a flat bottom are eroded into the soft sediments of the aggradation plains. At places, where the river flows on soft sediments but close to the contact with the hard bed-rock of the surrounding hills, the river bed becomes asymmetric (e.g. near the gap of La Entrada, where rio Retobo was pushed south by the abundant debris coming from the north; the upper course of rio Cura, where important landslides on the eastern valley side pushed the river towards the west). Widening of the canyon beds occurs either by lateral move of the river bed or by collapse of the steep banks.

The load of the important rivers consists mainly of coarse sand which - according to the large annual changes in discharge - is transported over long distances during the rainy season and deposited during the dry season. Moreover, there is a small area of permanent sedimentation in the lower course of the main rivers, close to the lake border. This may impede some rivers from reaching the lake (e.g. rio El Guamacho, rio Honda). Those which finally come into the lake form a small delta (e.g. rio Ereique, rio Cura).

At some places the morphology of the aggradation plains shows the presence of large alluvial cones (e.g. rio Guacara, rio Ereique, rio Cura). Except for rio Guacara, the boundaries of those alluvial cones are difficult to trace on aerial photos. Hence, the boundaries of the alluvial cones of rio Ereique and rio Cura, as they appear on the maps, must be considered as hypothetic, although the general shape is reliable.

Rio Ereique and Rio Cura both cross their alluvial cones in the centre. Hence the fan-shape of the original cone did not alter very much. On the contrary rio Guacara eroded most of the western flank of the cone and passes alongside of the remnants of the cone.

It is a striking fact that the area of the lake deposits is narrowing at the contact with the cones. Hence, the alluvial cones impeded the ultimate transgression of lake Valencia to go farther inland and originated prior to this transgression, during which they stayed above the water of lake Valencia (PEETERS, 1968, 39-40). The formation of such alluvial cones is to be understood if one accepts the existence of a sudden lowering of the longitudinal slope value of the river bed. Moreover, all of them are located just down-stream of the already mentioned narrowing of the N-S valleys. Hence, one may suppose that they originated at the foot of the fault scarp, south of the narrowing of the valleys. A series of borings were made in the alluvial cone of rio Guacara (TAHAL, 1970, Vol. II/A, pp. AP.V/23, borings V 301, 303, 304, 305, 307). All of them consist of coarse sediments (gravel, sand) and some of them went down as deep as 150 m. None of the borings reached the bed-rock. This points to the fact that sedimentations of the cones occurred at the same rate as the lowering down of the graben along the fault-line. The latter appears to be a very important one with vertical movements already exceeding 150 m. It may be of general interest to notice that in this case Guacara and San Joaquin are both located on this fault-zone.

The maps display numerous fossil river beds in the aggradation plains, which can easily be detected on aerial photos. Some of them point to a shifting aside of the main river. The former N-S bed of rio Cabriales was situated more to the east. The same is true for parts of the N-S bed of rio San Diego. The former bed of rio Honda lies west of the actual zone. As far as rio Cabriales and rio San Diego are concerned, as the former bed lies close to the rocky hills, shifting might have been the consequence of important supply of debris, coming from the east. But such an explanation does not count for rio Honda.

Apart from sideward shifting, the main rivers show several small river beds which is the consequence of the unstable run-off in aggradation plains.

Of much importance is the fact that most of the tributaries, when arriving into the aggradation plain, do not reach the main river any more, although this was the normal way of run-off formerly. For many of them run-off ceases either when they come into the aggradation plain or when they reach the boundary between old debris cones and the real aggradation plain. This is due to the general lowering of the ground-water level as a consequence of the use of water for both agricultural or industrial purposes. The latter favoured infiltration of run-off into the permeable sediments of the aggradation palin. The ultimate consequence of the inpoverishment of superficial run-off is an important lowering down of river water coming into the lake. The same can be said with regard to the area immediately inland of the boundary of the historical lake deposits. This area displays an important drainage system, which to-day dried up and turned into a fossil one. Finally, it must be stressed that some straight parts of river beds are without doubt anthropic ones as they follow ancient drainage or irrigation ditches (e.g. lower rio Cura).

Landslides

Landslides are mentioned on each of the two maps. Some of them are isolated ones; others clearly are grouped. According to the relative uniformity of slope value on the rocky valley sides, landslides must be of different ages. The most recent ones are those where the deposition area is still clearly linked with the scar (type 4). Older are those where the deposition area already moved farther downward and is separated from the scar (type 3). Still older are those where to-day no more relation exists between the position of the deposit and the scar, the former being transported either by gravity or by running water (type 2). Finally at many places devoided of important rivers bare rock outcrops. In this case even the scar morphology has disappeared (type 1). Vegetation too may be used to distinguish landslides of different ages, which allows a subdivision of type 4; the youngest landslide deposit is covered by an open grass vegetation with only a few trees whereas the older one supports a tree-vegetation. Obviously the most unstable situations are represented by types 4 and 3, where downward moving of the depositions area to the valley bottom is still to be expected in the near future.

According to the maps the following areas display landslides in groups; upper Retobo (type 4); upper San Diego, left valley side (type 4); catchment basin of rio Amargosal (types 4 and 3); divide Cura-El Guamacho (type 2 predominant); upper El Guamacho, left valley side (type 2). Moreover, type 1 also appears either as isolated hills or in areas where most of the hills are composed of bare rock. The latter is frequent in the area between San Joaquin and La Cabrera. On the contrary, west of San Joaquin hills are still covered by weathered debris although the debris cover is, clearly, already affected by creep. One may wonder why landslides seem to be concentrated in specific areas. Such concentration may be related to lithologic characteristics such as well orientated textures in either micaschists or gneiss. Il we look at the geologic boundaries on the maps, such an explanation does not appear to be satisfactory. Areas of landslides on the divide between rio Cura and rio El Guamacho as well as those located on the left valley side of rio El Guamacho belong to both the formations of Peña de Mora and Las Brisas. Moreover, most of the rocky hills without debris cover between San Joaquin and La Cabrera lie in the area of the formation of Las Mercedes.

Tectonic instability may also account for numerous landslides. The group of landslides at the upper-Retobo lies close to a young fault morphology and the other areas of landslides all appear not far north of an important fault zone. Hence, it is not excluded that earth-quakes account for those landslides.

Finally selective deforestation also favours landslides, but we have no data on this anthropic intervention.

In case of the valleys of rio Ereique, rio Cura and rio Guamacho it is obvious that debris of landslides filled up the valley floor within a short time. Figure 2 shows a longitudinal profile of the morphology of landslide debris in the valley of rio Cura.

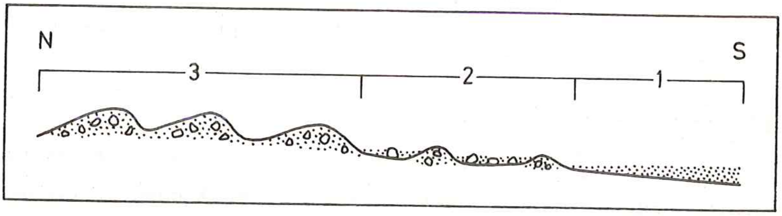


Fig. 2 : Rock-stream morphology in the valley of rio Cura.

The following morphologic units can be distinguished :

1. Flat outwash cone : gray, sandy clay with small, angular quartz pebbles; no rock blocks;
2. Residual outwash plan : irregular topography of small hills of heterogeneous material (sand, clay, gravel, blocks); gray, sandy clay with isolated blocks of fresh granite and gneiss between the hills;
3. Series of asymmetric hills (steep slope down-stream) right across the valley floor and composed of very heterogenic debris (blocks of fresh granite and micaschist in a matrix of sand and clay).

As already mentioned, this sudden supply of debris pushed the bed of rio Cura against the western valley side. The whole bulk of debris is moving down-stream as appears from the asymmetric hills (rock-stream). To the south fine material is carried away and sedimented in zone 1. Concomitant with this, the hill-morphology is attacked and finally disappears.

The same type of debris fills the valleys of rio Ereique and rio El Guamacho. Although the irregular topography is still visible, transverse asymmetric hills have already disappeared, which proves that those debris on the valley floor must be older than those of rio Cura. Only zones 1 and 2 of the valley of rio Cura still exist.

As appears from the description above, debris of landslides finally arrive on the valley floors. In most cases this is due to mass-transport. Hence the load of the river suddenly increases at such a rate that arriving in the aggradation plain the load exceeds the limit one and alluvial fans originate at the foot of the hills. Most of the recent alluvial cones were formed this way. As transport distance is generally very short, the composition of the alluvial cones hardly differs from that of the landslide debris. Hence the former is very heterogeneous with a predominance of angular elements. Moreover such an evolution explains the presence of important alluvial cones linked with only small rivers. The fan shape of recent alluvial cones is still well preserved in morphology.

Old debris cones

The contact between the aggradation plain and the rocky hills is generally fringed with old debris cones. In most cases a break in slope between the old cones and the flat topography of the aggradation plain clearly appears on aerial photos and could be checked in the field. However in some areas such a break of slope could not be distinguished on the photos and checking in the field was impossible as many of the cones are private property. This explains why some cones are not mentioned on the maps.

The composition of the cones is a very heterogeneous one : lensshaped layers of clay and gravel alternate with heterogeneous sediments (clay, sand, gravel, angular pieces of quartz and schist, blocks of granite and gneiss). The heterogeneity in sedimentation appears clearly from observations made possible by the numerous outcrops into the old cones of the basins of rio Ereique, north of San Joaquin and of rio El Guamacho. None of the local horizons could be followed on the field over more than a few hundred meters and the composition of the sediments is a very heterogeneous one : coarse gray fluviatile sands and gravel with cross-bedding; gray clay; sandy debris with huge blocks. Such a heterogeneous composition - as well as the absence of rounded pebbles - points to an origin similar to that of the recent debris cones. Landslide debris probably moved down to the valley floors and were transported by rivers over only short distances. Moreover, run-off along the valley sides took weathered debris away, as happened during the historical period on the peninsula of La Cabrera. Several data support an age older than that of the recent cones, such as : the position of recent cones resting upon older ones; the absence of the typical fan-shape; the very flat topography; in the case of red cones the diagenesis, which turned the originally loose deposit into a hard consolidated one.

To-day many of them are intersected by a series of recent canyons. Taking into account the flat topography of the cones, one may conclude that the original irregular topography has been flattened by sheet erosion during semi-arid climatic conditions. Linear erosion linked with a humid climate such as the actual one stands for the formation of the canyons. Hence, the flat topography points to the existence of at least one semi-arid period during the evolution of the cones (PEETERS, 1968, p. 62).

On the field two types of old cones can be distinguished : red-brown cones, the material of which has been submitted to a diagenesis, making the sediments very consolidated and hard; gray to brownish cones, where most of the sediments are still unconsolidated. There is no difference between the two types as far as the clay minerals are concerned. Both contain illite and kaolinite; paragonite occurs in some of them.

	< 20 μ	20 - 50 μ	50 - 200 μ	200 - 2000 μ
Ancient red debris				
632	34	15	30	21
618	19	14	32	35
620 (clay horizon in soil)	40	16	24	20
Ancient gray debris				
671/3	7	5	15	73
671/0	7	5	15	73
671/00	7	8	20	65
671/1	4	6	38	52
662	12	10	28	50
615	5	6	28	61
Outwash sediments from ancient gray debris				
665	16	17	32	35
667	16	20	50	14
Recent weathered debris on micachist				
618/bis	23	16	29	32
728	36	21	20	23
734/3	20	15	22	43

Tab. II.

Table II gives the granulometric composition of some representative samples. All of them show a very heterogeneous distribution of grain size. Comparing the gray cones with the red ones, it is obvious that the former are relatively poor in fraction < 20 μ and 20 - 50 μ whereas the fraction 200 - 2000 μ is relatively more important. Moreover, clay horizons of soils in the red debris may be easily distinguished (sample 620). The granulometry of recent weathered debris looks quite similar to that of the red debris. Hence, changes in granulometry during the evolution of the cones may be summarized as follows :

1. Weathered debris in situ with a relative high amount of the fine fractions (< 20 μ and 20 - 50 μ). These debris supply the material for landslides and the formation of debris cones.
2. The fine fractions of the debris cones are carried away either by ri-

vers or by sheetflood. As a consequence of this outwash the relative part of those fractions is lowered in the residual cone sediments (as showed by the granulometry of the ancient gray debris) but is enriched in the outwash sediments (samples 665, 667).

3. The red cones must have been once in a situation as described under 2). As they are older than the gray ones, weathering continued affecting them : the coarse fraction was broken down and consequently the fine fractions were enriched.

According to the maps each of the types of cones occupies a distinct area. Red cones appear in the southern parts of the elongated valleys of rio Cabriales, rio San Diego and rio Guacara. Up-stream only gray cones are found. Moreover east of the valley of rio Guacara red cones seem to be absent(1) and all the cones are gray ones. But it should be stressed that the aggradation plains east of rio Guacara do no show the elongated form of the valley and those valleys occupy a similar position as the northern parts of the valleys, west of Guacara.

Taking into account the diagenesis of the red cones, one must consider them as older than the gray ones. Moreover, the facies of the red cone deposits is similar to the one that outcrops at several places in the city of Valencia as well as to the facies of the debris cones which have been mentioned formerly along the road Valencia-Tocuyito-Carabobo and which were supposed to have originated during the humid tropical climate at the end Tertiary - beginning Pleistocene (PEETERS, 1968, p. 12). On the geologic map of TAHAL those deposits belong to the "aluvion antiguo II" (TAHAL, 1970).

The gray cones occupy important areas close to the fault zone of the northern parts of the aggradation plains. There the hinterland of supply of debris is much more extensive than that of the N-S spurs of the valleys. Moreover, both the steep slopes along the fault escarpment and the tectonic instability of this zone favour the transport of landslide debris. Hence, one could suppose that the general evolution of the formation of old debris cones has been as follows :

1. End Tertiary - beginning Pleistocene (humid tropical climate) : period of intense weathering on the hills; abundant debris and frequent occurrence of landslides, appearance of the red debris cones.

---

(1) Locally red but non consolidated debris in situ representing weathered micaschists were found.

2. Slowing down of weathering processes during the semi-arid climate of the Pleistocene and during the period of alternating humid-semi-arid climates of the Holocene; special favourable conditions for supply of debris limited to the northern parts of the aggradation plains.

Such an explanation supposes the possibility of a superposition of gray debris upon red ones. Up to now this could not be demonstrated neither on the field nor by means of borings. Moreover, intermediate types of debris do occur. They are brownish and already consolidated but not as hard and resistant as the typical red debris.

The formation of the old debris cones must have been interrupted several times. Both the red cones and the gray ones display pedological horizons. Locally the red cones contain brown clay horizons with a platy structure, resting upon mottled clay. But one wonders whether those pedological horizons represent a general phenomenon or a local one. Anyway, up to now it has not been possible to correlate those different soils on the field.

The supply of debris has been interrupted frequently by periods of erosion. Indeed, in some of the gray cones, remnants of ancient valleys, eroded in the landslide debris and deposits of sheet flow can be seen (e.g. at El Viento and at El Milagro). Both the pebbles and the huge blocks of gneiss, granite and micaschists found in the landslide deposits are fresh and not affected by chemical weathering. Moreover, pollen analysis of black layers demonstrates dryer climatic conditions than those ones of to-day(1). Hence, sedimentation in the aggradation plains seems to have occurred mainly during a semi-arid climate.

To-day the fine fraction of all the old debris cones is carried away towards the central part of the aggradation plains. Going from the border of the aggradation plains towards the centre, the granulometry of the sediments becomes finer (TAHAL, 1970, Vol. II, p. B/5). At the surface this central part shows gray, sandy clay with very small quartz pebbles (see Tab. II, samples 665, 667).

Lacustrine deposits

Compared with former publications (PEETERS, 1971) only a few changes on the boundaries of lacustrine deposits have been made on both maps.

(1) With thanks to Prof. Dr. R. VANHOORNE, director of the Laboratorium voor algemene plantkunde, University centre Antwerp R.U.C.A., who provided the results of pollen analysis.

The most important change occurs north of La Cabrera, where east of the lower rio Honda a large former bay of lake Valencia was found, where Planorbis gray clay outcrops.

The aerial photos did not allow to detect historical terraces with accuracy except for some already known places where the escarpment of the terrace of 427 m appears clearly in morphology (Chambergo, Santa Clara, northern side of La Cabrera).

Tentative correlation between geomorphology and the general climatic sequences of the basin of lake Valencia[1]

Up to now the different climatic sequences of the lake basin linked with level changes offer the most suitable basis for subdivision of the Quaternary in this area.

The following correlation is proposed :

Humid tropical climate (end Tertiary - beginning Pleistocene).

Strong weathering; numerous landslides; formation of red debris cones with development of tropical soils.

Semi-arid climate (Pleistocene).

Slowing down of weathering intensity; predominant physical weathering; important debris cones limited to areas of easy transport (fault zones); gray debris cones filling up the aggradation plains; important alluvial cones of rio Guacara, rio Ereique and rio Cura.

Holocene climatic fluctuations from semi-arid to humid tropical.

Gray debris cones; filling up of ancient valleys into the gray debris cones by landslide deposits and deposits of sheet flow in the northern area of the aggradation plains (linked with fault movements ?); alluvial cones of rio Guacara, rio Ereique and rio Cura; old landslides of type 1 between San Joaquin and La Cabrera (?).

To-day humid tropical climate (historical period).

As a consequence of historical lowering of lake level : lacustrine aggradation plain (with terraces) and start of erosion in the lower course of the main rivers; rock-stream formation in the valleys of rio Ereique and rio El Guamacho and more recently in the valley of rio Cura;

(1) The existence of paleoclimates in the lake basin is mentioned in : PEETERS (1975), SCHUBERT (1980) and SALGADO-LABOURIAU (1980).

landslides of types 4, 3, 2; general lowering of ground-water level as a consequence of human activity and concomitant with this a general impoverishment of surface runoff in the aggradation plains (fossil riverbeds).

REFERENCES

PEETERS, L., 1968. Origen y evolucion de la cuenca del lago de Valencia. Caracas, 66 p.

PEETERS, L., 1971. Nuevos datos acerca de la evolucion de la cuenca del lago de Valencia (Venezuela) durante en Pleistoceno superior y el Holoceno. Caracas, 38 p.

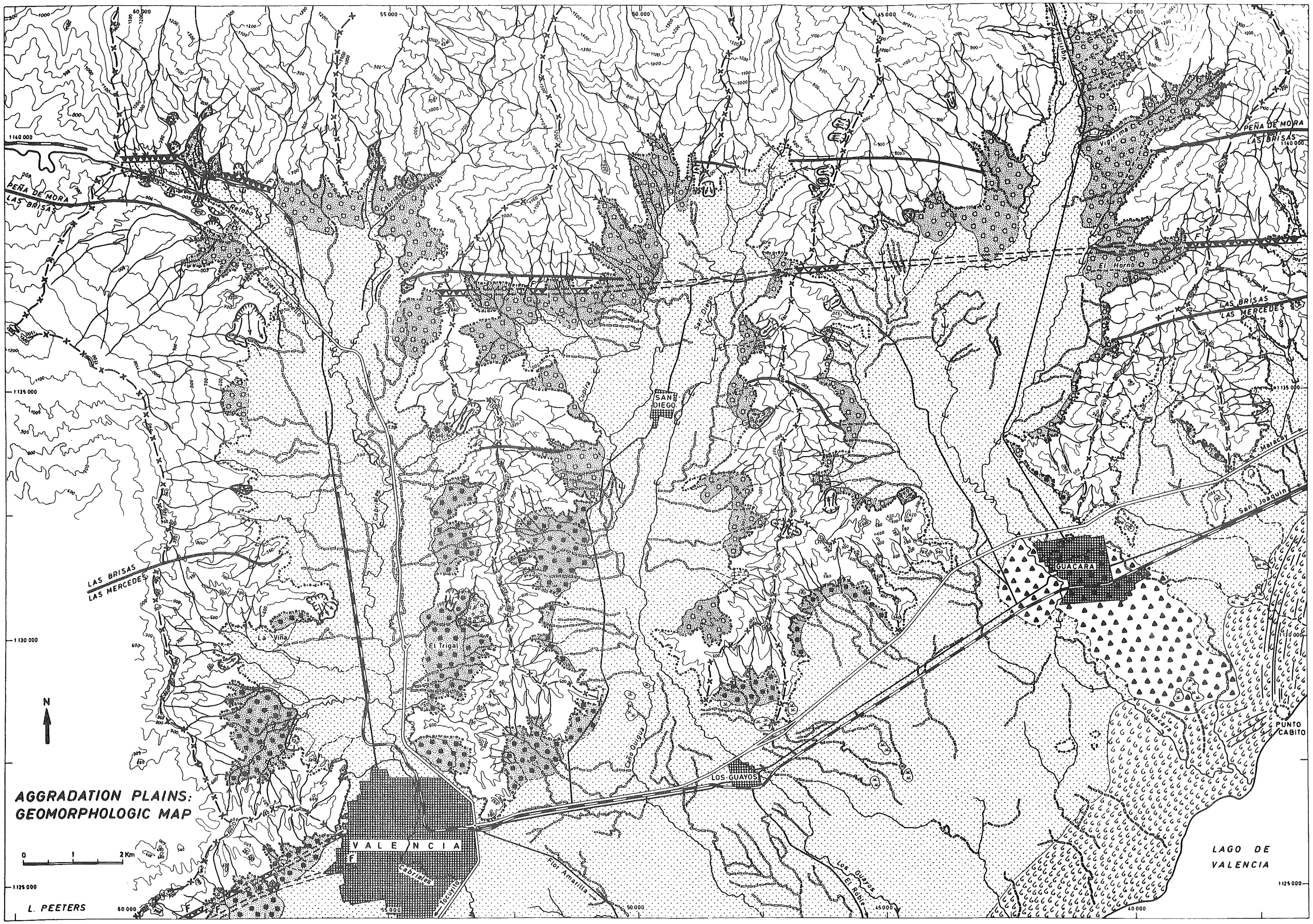
PEETERS, L., 1975. Evolucion de la cuenca del lago de Valencia de acuerdo a resultados de perforaciones. Caracas, 15 p.

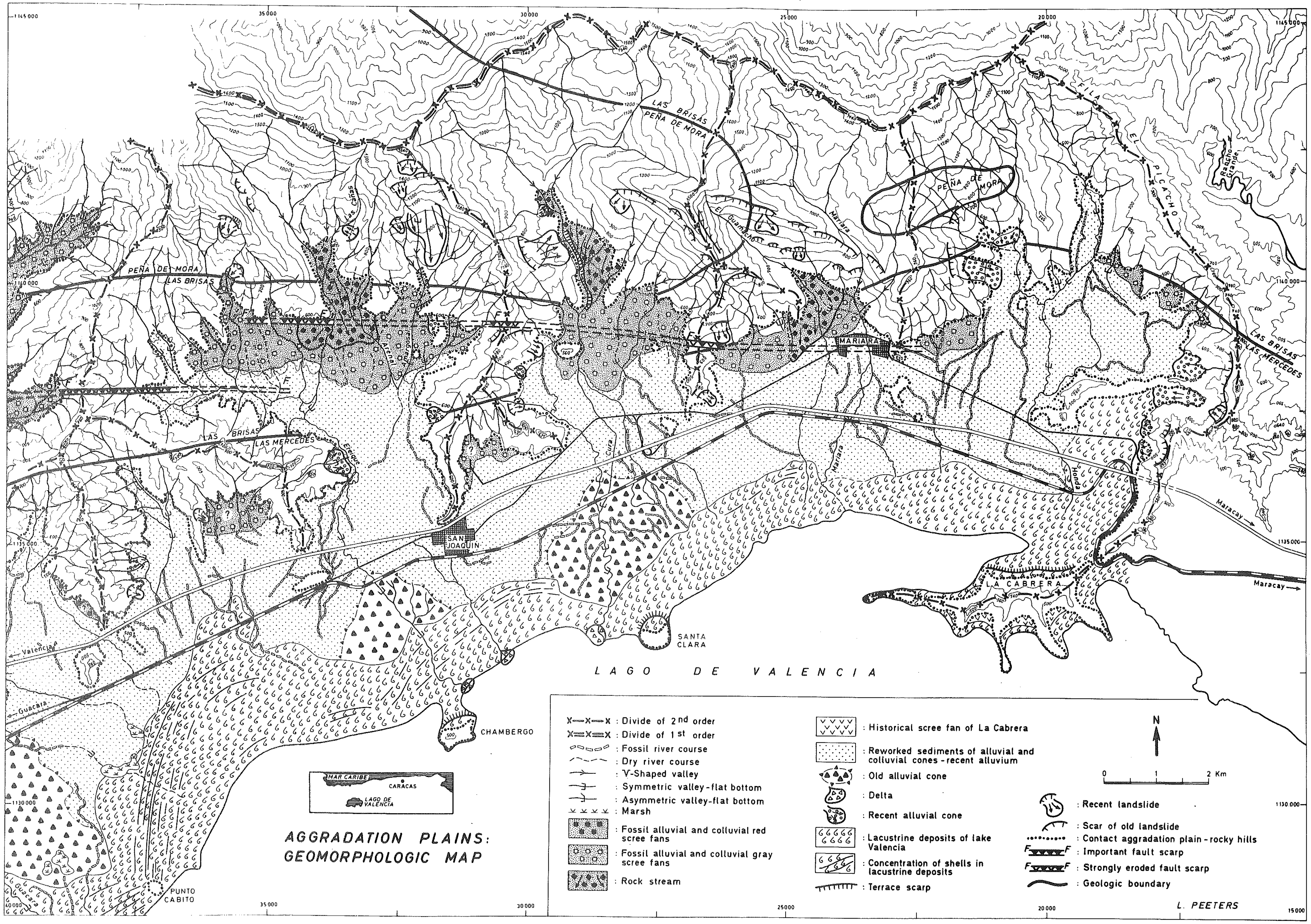
SALGADO-LABOURIAU, M.L., 1980. A pollen diagram of the Pleistocene-Holocene boundary of lake Valencia, Venezuela. *Rev. Paleobot. Palynology*, 30, 297-312.

SCHUBERT, C., 1980. Contribution to the paleolimnology of lake Valencia, Venezuela : seismic stratigraphy. *Catena*, 7, 275-292.

TAHAL, 1970. Estudio para el desarrollo de los recursos de aguas subterraneas en las regiones de Valencia, Barquisimeto, Coro, Pedegral, Maracaibo. Caracas, vol. II, 160 p., vol. II/A, 109 p.

VERSTAPPEN, H. and ZUIDAM, R., 1975. I.T.C. textbook of photo-interpretation. Enschede, vol. VII.


AGGRADATION PLAINS:
GEOMORPHOLOGIC MAP
L. PEETERS
N
0 1 2 Km
PEÑA DE MORA
LAS BRISAS
LAS MERCEDES
VALENCIA
GUACARA
LOS GUAYOS
SAN DIEGO
LAGO DE
VALENCIA
PUNTO
CABITO
El Trigal
La Viña


AGGRADATION PLAINS:
GEOMORPHOLOGIC MAP
: Divide of 2nd order
: Divide of 1st order
: Fossil river course
: Dry river course
: V-Shaped valley
: Symmetric valley-flat bottom
: Asymmetric valley-flat bottom
: Marsh
: Fossil alluvial and colluvial red scree fans
: Fossil alluvial and colluvial gray scree fans
: Rock stream
: Historical scree fan of La Cabrera
: Reworked sediments of alluvial and colluvial cones - recent alluvium
: Old alluvial cone
: Delta
: Recent alluvial cone
: Lacustrine deposits of lake Valencia
: Concentration of shells in lacustrine deposits
: Terrace scarp
: Recent landslide
: Scar of old landslide
: Contact aggradation plain - rocky hills
: Important fault scarp
: Strongly eroded fault scarp
: Geologic boundary
N
0
1
2 Km
MAR CARIBE
CARACAS
LAGO DE VALENCIA
L A G O D E V A L E N C I A
SAN JOAQUIN
MARIARA
SANTA CLARA
CHAMBERGO
PUNTO CABITO
LA CABRERA
LAS BRISAS
PEÑA DE MORA
LAS MERCEDES
FILA EL PICACHO
Maracay
Valencia
Guacara
L. PEETERS
35000
30000
25000
20000
15000
1145000
1140000
1135000
1130000