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PHENOMENA OF RIVER INCISION AND TERRACE FORMATION ON THE EASTERN FOOTHILLS OF OLYMPUS MOUNTAIN, GREECE

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Within the pediments and the alluvial fans (glacis) of the eastern foothills of Olympus mountain, rivers have been deeply incised and several paired terraces have been formed.

It was found that river incision and terrace formation was started on the higher part of the area and shifted progressively towards the coastal area. This was due to local tectonism, expressed as uplift and block-faulting at the upper part of Olympus foothills. The changes in local relief and the followed river downcutting occurred in this area during the Middle to the Upper Quaternary.

INTRODUCTION

Along the eastern foothills of Mount Olympus, Greece, alluvial fans form a bajada approximately 25 km long and 5—15 km wide. Although the fans belong to more than one generation, they can be grouped as follows from the north to the south (Fig. 1):

— Vrondou fan
— Dion fan
— Litochoro fan
— Topoliani fan
— Leptocaria fan

The surface of the bajada forms a concave profile with slopes steeper at the higher area of fanheads (5—11°) and smoother at the lower area of fan-toes (1—2°). The fanheads rest on the pediments of Olympus mountain at altitudes 300—450 m a. s. l., while the fans-toes joined to a unique body and extend further east from the plain of Katerini and the present coastline of Thermaikos gulf (Fig. 1, Pl. 1).

Research carried out in this area for several years yield significant results concerning morphological, morphogenetic, tectonic, and sedimentological

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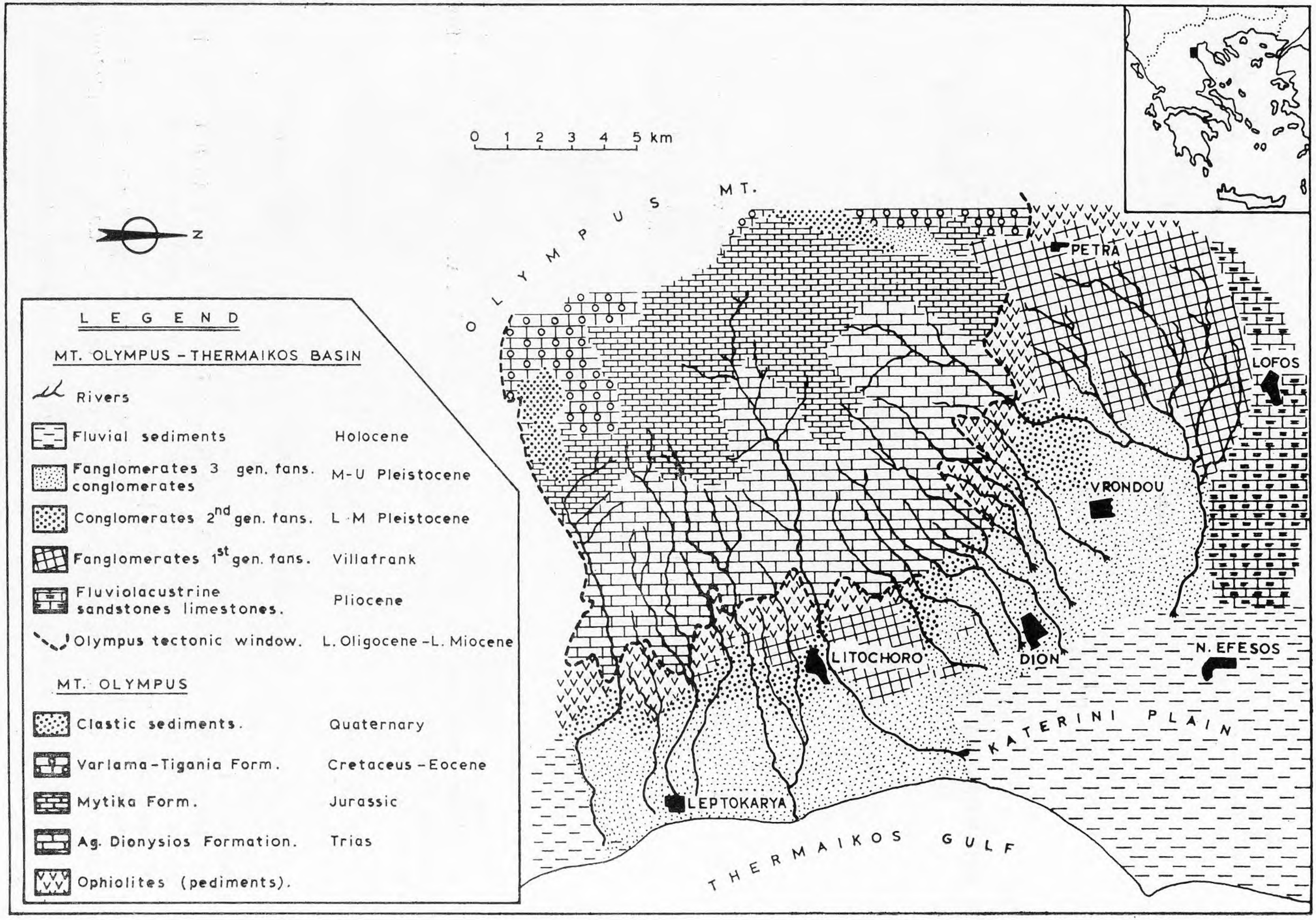

Fig. 1. Geological sketch map of the marginal zone of Olympus Mt. — Thermaikos Basin.

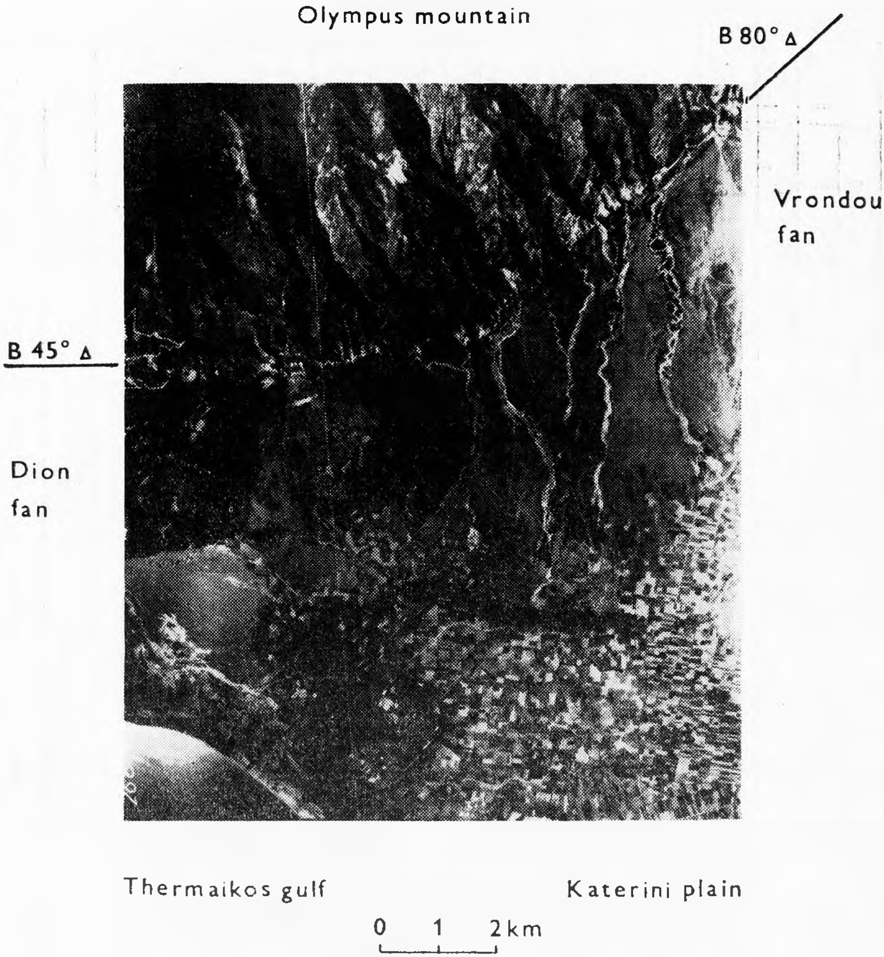

Plate 1. Air plate of the eastern foothills of Olympus mountain as appear at the area of Dion and Vrondou fans.

processes and their contribution to the paleogeography of the area (Psilovikos 1981).

This paper deals with the phenomena of river incision and terrace formation within the pediments and the alluvial fans of Olympus and provides a model to explain processes operated in this area during the Quaternary.

GEOLOGICAL SETTING

The eastern foothills of Olympus occupy a marginal area between Olympus mountain (synclinorium) and Thermaikos basin (graben). Mount Olympus xxxxxx First Generation ======= Second Generation oooooo Third Generation

ALLUVIAL FANS	RIVERS	TERRACES 1	2	3	4	5	6	7	8	9	Channel altitude and length: Fanhead in m	Int. Point in m	in km	Drainage Basin in km^2
VRONDOU	Poros										400	20	12.5	20.3
VRONDOU	Agia Kori										340	80	5.0	8.5
VRONDOU	Araplakos										320	50	5.0	11.0
VRONDOU DION	Gavrolakka										260	80	2.5	4.5
DION	Orlias										220	20	4.0	12.5
DION	Xyles										260	30	3.2	11.2
DION	Paliokalyva										280	40	3.0	7.2
DION	Korakas										300	18	4.5	8.0
LITOCHORO	Enipevs										400	15	7.2	55.0
TOPOLIANI	Topoliani										420	0	6.0	11.8
TOPOLIANI	Agiou Mina										400	15	5.0	6.2
TOPOLIANI	Maltas										320	30	4.5	13.5
LEPTOCARYA	Lazi Griva										260	120	2.3	20.1

Table 1. River characteristics within the alluvial fan deposits of Olympus Bajada. River terraces are numbered from the higher to the lower pair along the corresponding river valleys. The material which appeared along the walls of river valleys is given below the pairs of terraces

corresponds to a tectonic window (Godfriaux, 1968) opened through the paleozoic crystalline rocks of the Pelagonian nappe after the Upper Eocene thus, bringing about the dolomites, dolomitic limestones and flysh deposits, the main formations of Olympus (2.911 m). These formations have been deposited in a marine environment between the Trias and the Eocene. Thermaikos basin is part of the greater Axios Vardar basin which was subsided to more than 3.000 m since the Lower Miocene and filled up with conglomerates, sandstones, marls, and limestones, which are fluviolacustrine, estuarine and marine deposits (Christodoulou 1965, Lalechos and Savoyat 1977).

During the Upper Pliocene-Lower Villafrankian pediments were formed around the foothills of Olympus, in a warm semi-arid climate (Psilovikos, 1981). These pediments are still extensive on the western foothills but they have very limited areal extend on the eastern foothills of Olympus. This is possibly due to neotectonic activity, mainly block faulting and vertical movements of the faulted blocks along the marginal fault zone of Olympus mountain — Thermaikos basin.

The formation of alluvial fans resulted from the combined action of climatic and tectonic phenomena during the Villafrankian and the Quaternary (Cvijic 1908, Schneider 1962, Godfriaux 1968, Faugeres 1977, Psilovikos 1981). The fans are composed of coarse calcareous fanglomerates, conglomerates and sands derived from Olympus. They belong to three different generations.

The first generation has thick hard fanglomerates which occupy the deepest beds but appear also on the higher part of the bajada. At present the material is highly tectonized and karstified.

The second generation has alternated beds of hard and lose conglomerates which occupy the upper beds on the high and middle part of the bajada. The have also been affected by younger faulting.

They third generation has very coarse clastic material which was deposited at the lower part of the bajada. They have also affected by younger faulting and erosion phenomena.

RIVER VALLEYS

The rivers which drain the eastern part of Olympus mountain to Thermaikos gulf have been deeply incised within the pediments and the alluvial fan deposits. Usually more than one river crosses the area af each alluvial fan (Table 1).

The river valleys present the following characteristics:

1. They are formed inside the body of the alluvial fans and like their corresponding rivers fail to reach the sea (except Topoliani). The intersection points which are now found at altitudes 20—120 m a.s.l. along the fan-toes mark the lower end of the river valleys (Fig. 1, Pl. 1).

As the rivers enter the pediments and alluvial fans from Olympus mountain (Pl. 2) their valleys are wide open (250—500 m) and deep (45—85 m), but they become progressively narrow (20—50 m), and shallow (3—8 m) near the intersection points. In the case of Topoliani, Enipevs and Poros valleys the river cross the hard fanglomerats of the first generation near the surface. Thus, the valleys become narrow (80—130 m) and deep (50—80 m) at that part of their courses.

Plate 2. General view of Enipevs river valley at the area of Litochoro village.

Most of river channels within the alluvial fans follow a meandering course (Pl. 1, Pl. 3).

2. Several paired terraces have been formed within these river valleys. Each pair of terraces begins from the deeper part of the valley sides at the area of fanheads and develops along them progressively thereby reaching the surface of the fans. There they continue only for a short distance as single diverging terraces. Before the higher pairs of terraces reach the surface, lower ones are developed within the valleys. At a point along the valleys, more than two pairs of terraces are found (Pl. 4). The areas where the terraces reach the surface of the fens mark formed successive intersection points. This is indicated by the diverging terraces, the concentration of coarse material in the form of lobes and the formation of palaeochannels at the area of the former river mouths. The terraces are erosional ones opened in the material of all generations. Their surface is wide (50—150 m) near the area of fanheads and becomes progressively narrow (5—15 m) towards the intersection points. Their surface slope remains always smoother than the corresponding surface slope of the fans. The terrace walls are very high (20—30 m) and steep at the upper part of the bajada. The number of paired terraces is not the same for all river valleys as shown in Table 1. The valleys which were formed in the same alluvial fan tend to have the same number of paired terraces (Table 1).

3. The river incision started after the deposition of the second generation of alluvial fans. This is evident at the higher part of the foothills along natural cross-sections on valley walls. The downcutting affected first the material of the second generation (superimposed fans) and continue down to the hard pediments or fanglomerates of the first generation. Erosion was predominant at the area of fanheads and deposition occurred at the area of fan-toes at the same time. River incision shifted later to the lower part of the fans as shown by the corresponding shifting of the intersection points downfan, even after the deposition of the first generation of fans. Normal

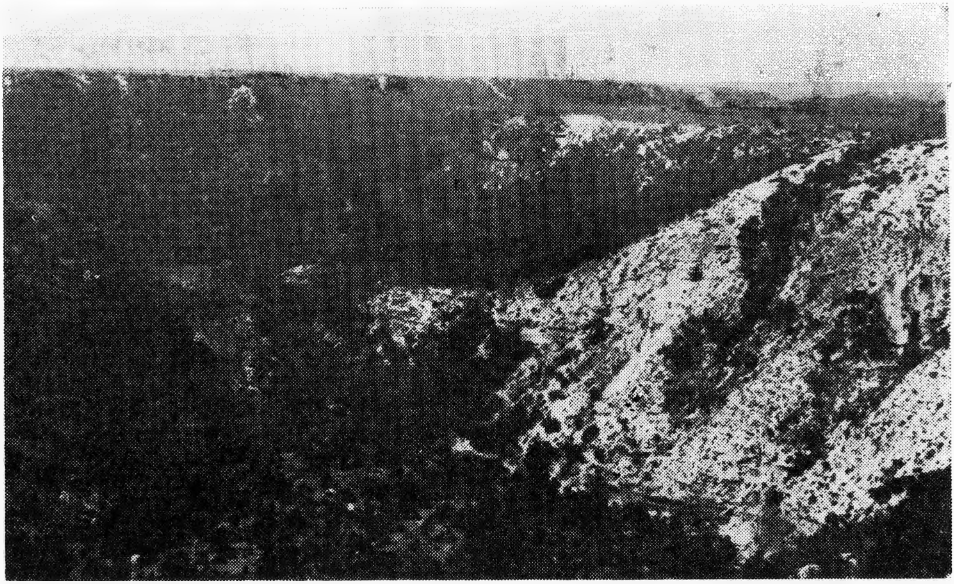

Plate 3. Morphological features of Topoliani river valley, as appear at the area of Topoliani fanhead (looking downstream).

faulting and vertical movements of the faulted blocks have affected the original pattern and distribution of the material in all generations of fans. Tectonic terraces on the surface of the pediments and alluvial fans, as well as nick points associated with waterfalls along the present river channels, are both features indicating recent tectonic activity in this area.

PROCESSES OF RIVER INCISION AND TERRACE FORMATION

Interpretation of processes operated during river incision and terrace formation in the area investigated, is constrained by the following observations:

— The river downcutting started from the pediments and fansheads after the deposition of the second generation and shifted to the fan-toes after the deposition of the third generation of fans.

— The downcutting was not countinuous, but episodic. Each episode is characterized by two periods: A first period of significant accelerated erosion associated with river downcutting and terrace formation; and a second period of mild erosion associated with lateral cutting of channels by winding rivers and modification of channel bottoms (future terrace surfaces).

— The number of episodes were roughly the same for rivers which were incised in the same alluvial fan; but were different for rivers which were incised in different alluvial fans of the zone (bajada). At this point it is necessary to emphasize the present difference in relief between alluvial fans which difference is particularly characteristic at the area of fanheads (Table 1). The author believes that these differences are due to postdepositional

changes associated with tectonic movements, such as uplift and block fault movements.
— Although the sea is very to close to the Olympus eastern foothills and the present coastline cuts the lower part of Topoliani and Litochora fans (Fig. 1), the river flows and channels fail to reach the sea (Topoliani). The intersection points are now found well onto the fans. This failure can be attributed to

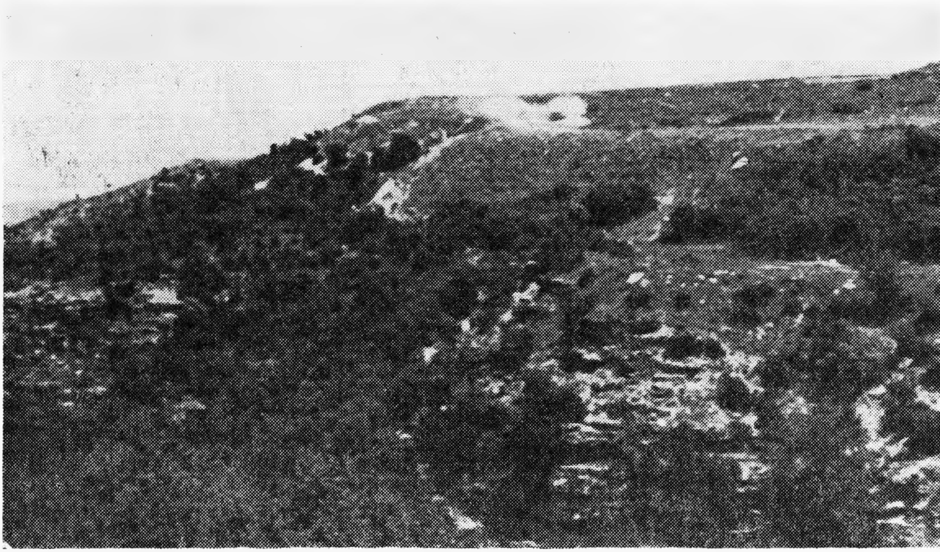

Plate 4. Successive river terraces formed within the fanglomerates of Litochoro fan.

several factors namely infiltration, seasonel rainfalls, small drainage basins on Olympus and tectonism.
— Significant tectonic activity is mainly recorded at the higher part of the foothills. Block faulting and vertical movements resulted in the formation of several tectonic terraces on the surface and nick points with waterfalls in river channels. Such upward and downward movements caused differentiation in the relief between the mountain and the individual alluvial fans or even between different alluvial fans of the same bajada.

The original pattern and distribution of material was destroyed. The fanglomerates of the first generation are now found at or near the surface at different altitudes in Topoliani, Litochoro, and Vrondou fans, or are tracted in the subsurface at different depths. The slopes of the higher part of the foothills in the area of pediments and fanheads, which received on sediments for a long time, are expected to be smoother and less steep than thay are present.
Tectonic activity has also been recorded in recent times (earthquakes) along the area of Olympus foothills.

These observations suggest that the higher part of the foothills after the deposition of the second generation of alluvial fans have undergone successive erosional episodes. At the beginning of these episodes the rivers incised in the area of pediments fanheads and removed a considerable amount of material downfan. This material was deposited on the area of fan-toes, thus forming the third generation of alluvial fans. Erosion was then shifted to this recent material in the following episodes, causing river incision and terrace formation, at the lower part of the fans.

The episodic character of erosional-depositional processes was reflected in the successive pairs of terraces along the river valleys and the successive stages of shifting of the intersection points of the surfece of the fans (Fig. 3).

CAUSES OF REJUVENATION

Based on the priciples of geomorphology, the river incision and terrace formation within the pediments and the alluvial fans of Olympic foothills should be treated as a phenomenon of rejuvenation. The river which had, at the end of deposition of the second generation of alluvial fans, attained profiles of equilibrium or were aggregating on the area of the fans, were engadge actively in downcutting.

Rejuvenation may result from causes which are eustatic, static, or dynamic in nature (Thornbury, 1969).

Eustatic rejuvenation caused by eustatic changes in the sea level (diastrophic or glacial) are world wide in nature. If the author assumes that successive fallings of the sea level in the Thermaikos gulf were responsible for river incision and terrace formation in the investigated area, then it is expected that rejuvenation should have started from the river mouths and progressed upvalley (Fig. 2). Successive stages of falling in the sea level should have produced pairs of terraces well-developed at the lower part of the vallyes, and poorly-developed at the upper part of the vallyes.
Such a falling in the sea level are also expected to have produced the same number of river incisions and pairs of terraces in all the river valleys of the same area.

Based on the described so far characteristics of river valleys and terraces it is reasonable to reject such an assumption about eustatic rejuvenation.

Static rejuvenation may be caused by a decrease in river load, as it happened during the post-glacial period, or by an increase in rainfall and river volume without a corresponding increase in river load, or by an increase in stream volume through diversion from one river system to another. In the case studied, a possible decrease in river load during post-glacial times should have resulted in a limited scale normal or temporary fanhead incision. It seems difficult to assume that such a phenomenon could have occurred at several successive stages, producing corresponding successive stages of river incision and terrace formation. If so, then same number of episodes are expected to occur in all rivers of the same bajada:

— A possible increase in rainfall and river volume without a corresponding increase in load could have resulted in fanhead incision and terrace formation. But such a change is phenomenon of regional scale which is expected to affect all the rivers in the same area. It is also difficult to aspect such successive episodes of increased rainfall associated with a decrease in river load carried from Olympus mountain.

— No evidence has been found to support an increase in river volume through diversion from one river to another in the area investigated. The rivers have limited drainage basins on the mountain and short normal courses on the same side of the mountain and its foothills (Fig. 1).

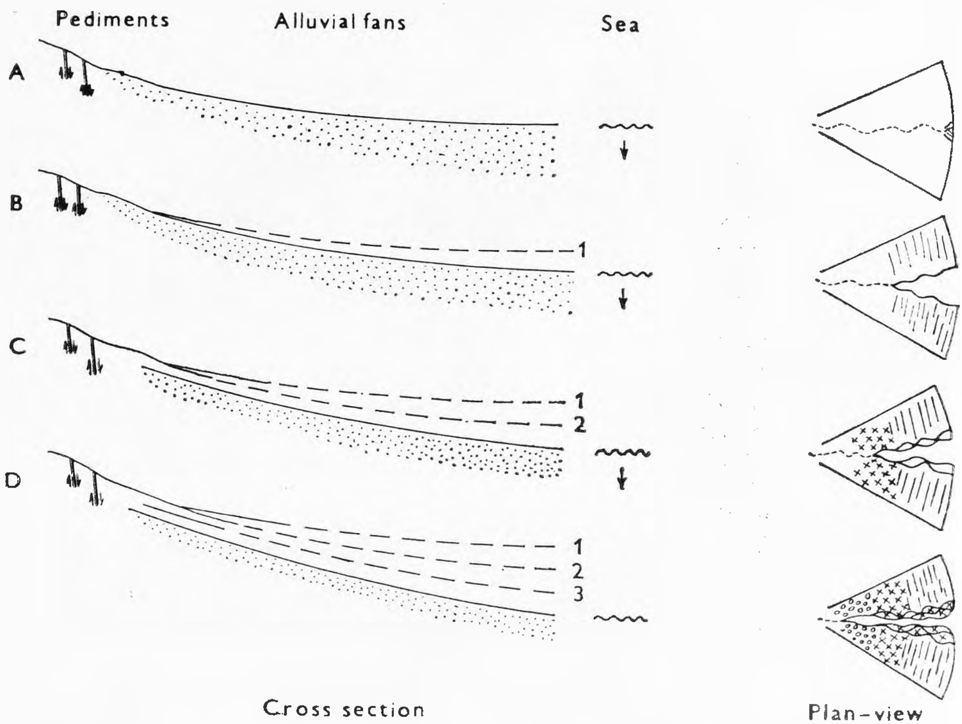

Fig. 2. River incision and terrace formation expected in case of eustatic rejuvenation in the pediments and alluvial fans of Mt. Olympus.

Admittedly climatic changes during the Quaternary have affected the weathering and erosion processes on Olympus mountain and deposition of material on its foothills. But the described morphological features indicate that such an episodic character of river incision and terrace formation with different number of episodes in the same area are not expected to have resulted from regional changes of static rejuvenation.

Dynamic rejuvenation is caused by epeirogenic uplift of a land mass with accompanying tilting and warping. Such movements may be both regional and localized and associated with neighbouring orogenic movements.

In the case investigated, there is evidence that Olympus mountain has been repeatedly uplifted since the Upper Eocene (Godfriaux 1968, 1977). Faugeres

(1977) and Psilovikos (1981) suggested considerable uplift of Olympus pediments and the older alluvial fans during the Quaternary.

The considerable thickness of alluvial fan deposits estimated to be more than 500 m and the significant depth of river incision within these deposits, indicate that tectonism was very active in this area during and after deposition.

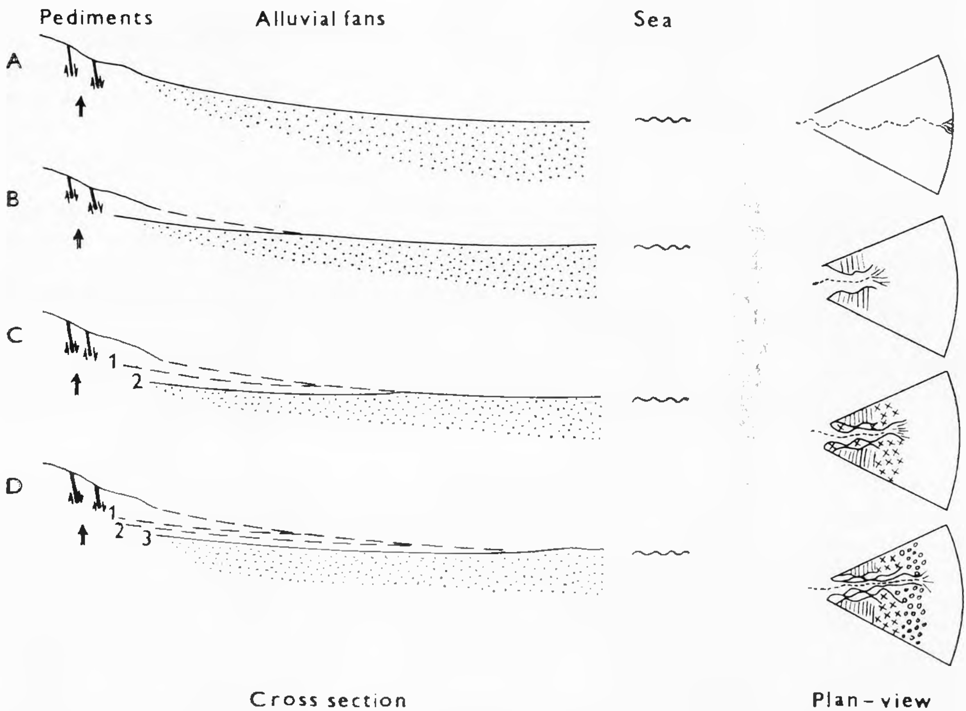

Fig. 3 .River incision and terrace formation, owing to dynamic rejuvenation in the pediments and alluvial fans of the Mt. Olympus.

The local tectonic base level which should be placed along the range bounding faults (Pl. 1) has changed in several episodes. Such changes accompanied by fault block movements along the margins of Olympus/Bajada, set up the mechanisms of rejuvenation which started from the pediments and the fanheads. The episodes of rejuvenation depended on the relative block fault movements towards the local tectonic base level of each alluvial fan. This process explains the different number of episodes which were recorded in rivers of different alluvial fans in the same area.

In order to explain the mechanisms of rejuvenation in the area of Olympus foothills, a comparative model is given in Figure 3. The model gives the morphological features expected along river valleys of the bajada in the case of dynamic rejuvenation.

River incision within the pediments and alluvial fans has so far been explained in terms of changes,

in tectonic regime (Davies 1938),

in climatic regime (Lüstig 1965),

in flow regime (Bluck 1964, Beaumont 1972, Beatty 1974),

in more than one of the above (Blissenbach 1954, Denny 1967).

Hooke (1967, p. 438) studying river incision in natural and laboratory fans, was able to distinguish between *Normal* and *Abnormal* fanhead incision.

Normal fanhead incision is not very deep (less than 30 m), so that overbank deposition occurs from time to time on the surface of the fan. It can be produced by two main causes:

alternation of debris flow and water flow, and shifting of the loci of deposition to topographic lows, due to piracies.

Abnormal fanhead incision is very deep (more than 30 m), so overbank deposition of the adjoining fan surface is almost impossible. This kind of incision can be attributed to two main factors: Climatic, and Tectonic.

Bull (1968 p. 102—103) named the fanhead incision as *Temporary* (Normal) can be attributed to two main factors: climatic, and tectonic.

Bull (1968. pp. 102—103) named the fanhead incision at *temporary* (normal) and *permanent* (abnormal).

Temporary incision may result from two mechanisms: mudflows which plug the deposits of alluvial fans and large variations in rainfall intensity.

Permanent incision is associated with the shifting of the loci of deposition from the fanhead to the fanbase and the enlargement of the fan. It can be caused by two mechanisms of erosion: uniform erosion and accelerated erosion. In the case of accelerated erosion resulting from climatic changes, on the upper part of the fan stream terraces are formed within the drainage basin and extend down the stream channel incised into the fan deposits.

Bull and Mc. Fadden (1977, pp. 120—121) distinguished four base level processes which affect the morphologies and processes of the stream and hillslope subsystems, the loci of erosion and deposition and therefore the topography of the basin. The effect of rapid uplift of mountains relative to the adjacent basins by either continuous or pulsatory uplift result in a distinctive suite of landsforms. Either channel downcutting in the mountains (Δw) and/or basin deposition (Δs) will tend to cause the stream to become entrenched into the fan apex, which will shift the loci of fan deposition down the fan. Counteracting the tendency to trench the fanhead is the uplift of the erosional subsystem along *the range-bounding fault* (Δu). Continued channel downcutting will occur only when uplift (Δu) equals or exceeds the sum of the two local base processes that are tending to cause the fandead trenching as shown by equation (1)

$$\Delta u/\Delta t \geqq \Delta w \Delta t + \Delta s/\Delta t \quad (1).$$

The author believes that tectonic activity along the range bounding faults of the eastern foothills of Olympus has been episodic during the Quaternary. The mountain and the upper part of the foothills have been repeatedly uplifted. The uplift was followed by faulting and block fault movements at the area of fanheads which have affected the local relief in this area. The river downcutting and incision in each pediment and alluvial fan favoured by the relative movements of the faulted blocks. In cases where the net results of those movements was uplift of fanheads, river erosion was accelerated there causing an episode of river downcutting and terrace formation. Such episodes seems to have occurred 8 times at Topoliani, Litochoro and Vrondou fans, 5 times at Dion fan and 4 times at Leptocarya fan, all through the Quaternary. The present difference in relief of pediments and alluvial fans along the range bounding faults associated with a similar difference in the number of river downcutting, of pairs of terraces and movements of intersection points downfan can only be explained by a purely local tectonic control. Changes in climate or river flow regime expected to have produced only a *normal or temporary* incision with similar characteristics in all the alluvial fans of the same bajada. The described incision is typical *abnormal or permanent* incision and it can be attributed to episodes of changes in local tectonism which have set up the corresponding mechanisms of rejuvenation.

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ЯВЛЕНИЯ ГЛУБИННОЙ ЭРОЗИИ И ОБРАЗОВАНИЯ ТЕРРАС НА ВОСТОЧНОМ ПОДГОРЬЕ ОЛИМПСКИХ ГОР (Греция)

Статья посвящена проблеме врезания рек и образования террас в педиментах и конусах выноса восточноро подгорья Олимпсих гор на окраине Олимпского массива. Педименты. представляющие собой самую высокую ступень подгорья, состоят из офиолитов и известняков. Конусы выноса, занимающие средние и нижние участки подгорья, образованы тремя поколениями известковых отложений (средний-верхний плейстоцен, нижний-средний плейстоцен, виллафранский ярус).

Морфология врезанных в педиментах долин указывает на то, что процесс врезания рек начинался в самых высокорасположенных учасках подгорья, а именно после осадконакопления второго поколения конусов выноса и постепенно передвинулся к лобовой части конусов (после осадконакопления их третьего поколения).

Процесс врезания рек не был континуальным, а поэтапным. Каждый этап характерен:

— сначала периодом убыстренной эрозии, врезанием вглубь водотоков, образованием террас и перемещением интерсекционных точек (т. е. точек „исчезновения" водотоков, что обусловлено инфильтрацией, сезонным характером осадков, небольшой площадью бассейнов, тектоникой) в направлении склона конусов,

— затем периодом умеренной эрозии, боковым врезанием речных русел и осадконакоплением материала перед интерсекционными точками.

В случае водотоков, врезанных в разных педиментах и конусах выноса на той же самой территории, можно отметить разное число таких этапов. Это обозначает, что причина врезания рек и образования террас вызвана в большей мере местными изменениями рельефа, нежели изменениями регионального характера, к каким относятся климатические изменения или же изменения уровня моря.

Автором предполагается, что местные изменения рельефа, которые вызвали в ход соответствующий механизм омолаживания рек, являются следствием поэтапного поднятия Олимпских гор в четвертичный период, сопровождающегося дифференцированными поэтапными поднятиями верхних участков их подгорья.

Рис. 1. Схема геологических условий краевого участка Олимпских гор и бассейна Термаико.

Рис. 2. Схема глубинной эрозии рек и образования террас в случае, если бы имело место евстатическое омолаживание педиментов и конусов выноса в массиве Олимпа.

Рис. 3. Схема глубинной эрозии рек и образования террас как следствия динамического омолаживания педиментов и конусов выноса в массиве Олимпа.

Фотография 1. Аэроснимок восточного подгорья Олимпских гор в районе конусов выноса с населенными пунктами Дион и Вронду (Олимпские горы; дионский и врондуский конусы выноса, залив Термаико, Катеринская низменность).

Фотография 2. Вид долины реки Енипеус в районе населенного пункта Литохоро (Олимп, педименты, литохорский конус выноса).

Фотография 3. Морфологические черты долины реки Тополиани на вершине тополианского конуса выноса (вид в направлении тока реки).

Фотография 4. Следующие под собой террасы, образованные в осадконакоплениях литохорского конуса выноса.

Таблица 1. Характеристики рек в конусах выноса олимпской баяды. Террасы прономерированы от самой высокорасположенной по самую низкорасположенную пару в соответствующих долинах. Вид материала, выступающего на поверхность склонов долин, обозначен ниже порядкового номера пар террас.

Перевод: Л. Правдова

Antonios Psilovikos

JAVY HĹBKOVEJ ERÓZIE A TVORBY TERÁS NA VÝCHODNOM PODHORÍ OLYMPSKÉHO POHORIA (Grécko)

Príspevok je venovaný problematike zarezávania sa riek a tvorby terás v pedimentoch a náplavových kužeľoch na východnom podhorí Olympského pohoria na okraji masívu Olympu. Pedimenty, predstavujúce najvyšší stupeň podhoria, sú budované ofiolitmi a vápencami. Náplavové kužele, ktoré zaberajú strednú a dolnú časť podhoria, sú zložené z troch generácií vápnitých sedimentov (stredný—vrchný pleistocén, spodný—stredný pleistocén, villafranchien).

Morfológia dolín zahĺbených v pedimentoch naznačuje, že zarezávanie riek sa začalo v najvyšších partiách podhoria, a to po sedimentácii druhej generácie kužeľov a postupne sa presunulo smerom k čelu kužeľov (po sedimentácii ich tretej generácie).

Zarezávanie riek nebolo kontinuálne, ale etapovité. Každá etapa je charakterizovaná:
— najskôr obdobím urýchlenej erózie, zahlbovaním tokov, tvorbou terás a presunom intersekčných bodov (t. j. bodov „miznutia“ tokov, podmieneného infiltráciou, sezónnosťou zrážok, malou rozlohou povodí a tektonikou) v smere sklonu kužeľov,
— obdobím umiernenej erózie, bočným podrezávaním riečnych korýt a sedimentáciou materiálu pred intersekčnými bodmi.

Pri tokoch, zarezaných v rôznych pedimentoch a kužeľoch toho istého územia, možno zaznamenať rôzny počet takýchto etáp, čo naznačuje, že príčinu zarezávania riek a tvorby terás treba pripísať skôr lokálnym zmenám reliéfu ako zmenám regionálneho charakteru, akými sú klimatické zmeny alebo zmeny úrovne mora.

Autor predpokladá, že lokálne zmeny reliéfu, ktoré vyvolali korešpondujúci mechanizmus rejuvenizácie riek, sú následkom etapovitého zdvihu Olympského pohoria počas kvartéru, sprevádzaného diferencovanými etapovitými zdvihmi hornej časti jeho podhoria.

Obr. 1. Náčrt geologických pomerov okrajovej časti Olympských hôr a Thermaikoskej panvy.

Obr. 2. Schéma hĺbkovej erózie riek a tvorby terás v prípade, ak by bola nastala eustatická rejuvenizácia pedimentov a náplavových kužeľov v masíve Olympu.

Obr. 3. Schéma hĺbkovej erózie riek a tvorby terás ako následku dynamickej rejuvenizácie pedimentov a náplavových kužeľov v masíve Olympu.

Foto 1. Letecká snímka východného podhoria Olympského pohoria v oblasti náplavových kužeľov s obcami Dion a Vrondou. (Olympské pohorie; dionský a vrondouský náplavový kužeľ, Thermaikoský záliv, Katerinská nížina).

Foto 2. Pohľad na dolinu rieky Enipevs v oblasti obce Litochoro (Olymp, pedimenty, litochorský náplavový kužeľ).

Foto 3. Morfologické črty doliny rieky Topoliani vo vrchole topolianskeho náplavového kužeľa (pohľad v smere toku).

Foto 4. Pod sebou nasledujúce terasy vytvorené v sedimentoch litochorského kužeľa.

Tabuľka 1. Charakteristiky riek v náplavových kužeľoch olympskej bajady. Terasy sú očíslované od najvyššieho po najnižší pár v príslušných dolinách. Materiál vystupujúci v stráňach dolín je vyznačený pod poradovým číslom párov terás.