Πρακτικά	6ου Συνεδρίου		Μάϊος 1992
Δελτ. Ελλ. Γεωλ. Εταιρ.	Τομ. XXVIII/1	σελ. 457-472	Αθήνα 1993
Bull. Geol. Soc. Greece	Vol.	pag.	Athens

THE RECENT DRAINAGE NETWORK OF THASOS AND ITS TECTONIC AND MORPHOLOGICAL BACKROUND

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ABSTRACT

The hydrography of the island of Thasos at the southeastern edge of the Rila-Rhodope-Massif (cf. KRONBERG, MEYER and PILGER 1973) is marked by a distinct asymmetry of the drainage network. The main reason for that is an uplift-axis at the northeastern part of the island, that separates the areas of contrasting drainage patterns.

Because of the fault-line-scarp, running parallel to the uplift axis and a vertical tectonic displacement, causing high relief energy in the northeast (Ypsarion, 1.204 m), dendritic patterns have been developed. A similar situation occurs in the NW-part of the island.

Contrasting the hydrographical situations in the NW and NE, within the southwestern part of Thasos, long and rather rectangular catchment areas exist and dendritic patterns are restricted to the valley heads.

Apart from the influence of faults to the river and valley development there is evidence that the paleo valleys, as well as river courses on young pleistocene sediments, have been developed

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without tectonic control. During quaternary uplift alpidic fault lines become relevant for major river capturing processes.

INTRODUCTION

The geology of Thasos is marked by a succession of metamorphic beds, mainly consisting of marbles and gneisses (cf. VAVELIDIS 1984). West of the Ypsarion Mts. the beds are generally dipping slightly towards southwest.

Because of the specific morphological and tectonic situation, three different geomorphological regions can be separated, each with different geological, tectonic and morphologic influence on the drainage patterns. Using data from Landsat TM, from topographical and geological maps and from field observations the paper wants to show the major reasons for the development of the recent drainage network.

HYDROGRAPHIC FEATURES OF THE RIVERS

The hydrography of Thasos is marked by contrasting patterns. The distribution of the various catchments (cf. Fig. 1) reveals semicircle-like patterns in the northeastern part of the island. Within the northwest the drainage areas can be narrow and rectangular. In the southwest more or less parallel NE-SW striking catchments dominate, which strongly contrast the other parts of the island.

A closer look at the river systems suggests a distinct relation between the catchment and the type of drainage pattern.

Figure 1: Hydrography of Thasos

Source: Map 1:50.000 Thasos Sheet
Sketch: H. Weingartner, 1991
Cartography: G. Decker, W. Gruber, F. Lackner

Due to this correlation in the northeast, dendritic patterns dominate. In the northwestern areas the dendritic patterns have already been interrupted by a main river with short subsequent and obsequent tributaries. The southwestern part finally shows trellis-like patterns that are mainly developed within areas of tilted sedimentary rocks (cf. OLLIER 1981). The roots of the southern rivers reach back to the Ypsarion range. Only the three longest rivers (Marion Ammos, Kastron Ammos and Dipotamos) drain about 50 % of the whole island. Dendritic patterns are restricted here to the head of the valleys.

Concerning the lengths of the rivers very different dimensions within the different parts of the island can be found (cf. Fig. 3).

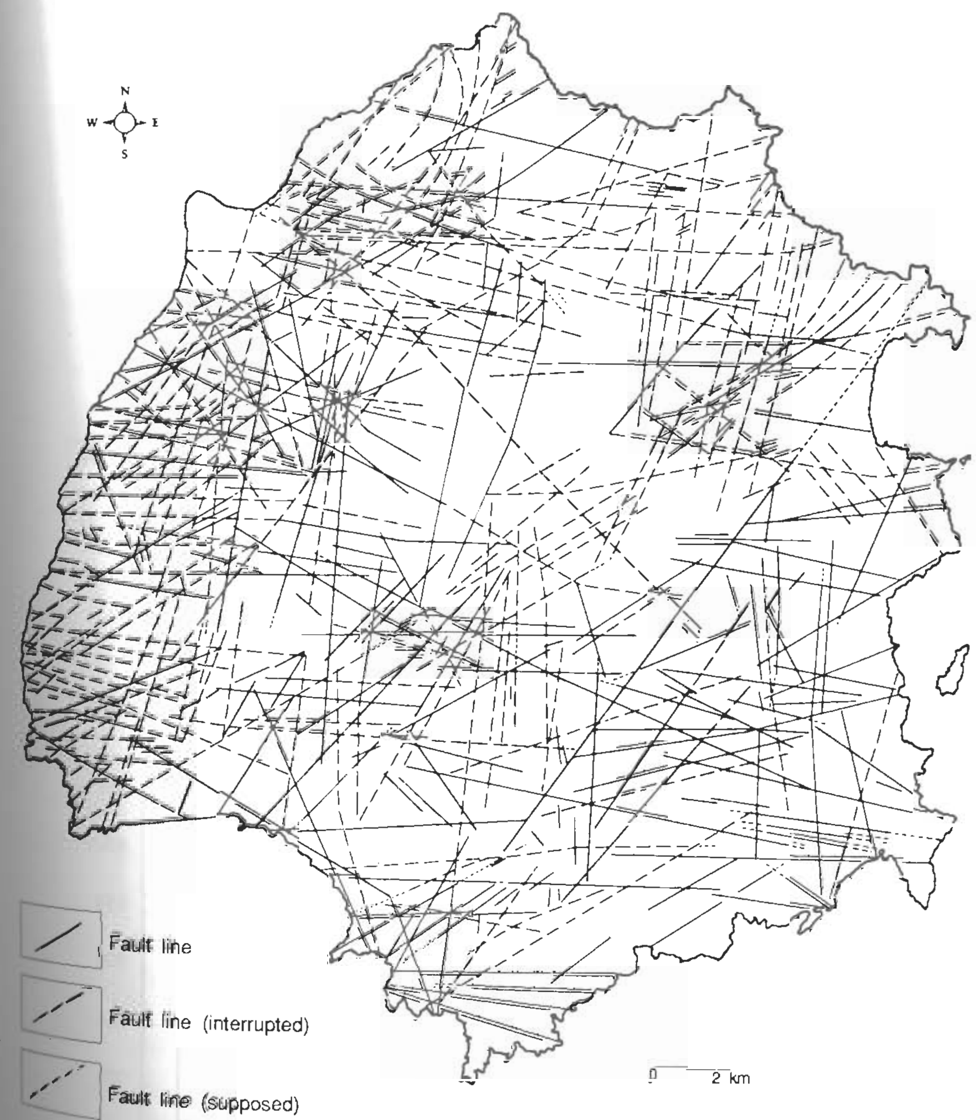
Whereas the rivers of the southwest measure lenghts up to 20 km and more, the rivers within the other areas are much shorter. The shortest rivers are developed in the northeast and east, where their maximum lengths range from 2 to 6 km.

The longitudinal profiles (cf. Fig. 4-7) reflect the different river courses. In their middle courses the southwestern rivers show only a gentle inclination for long distances. Steps within the course of the rivers are not unusual.

In the SE, steps within the longitudinal profiles are common, too. The inclinations are generally higher here and the lower courses show steeper inclinations.

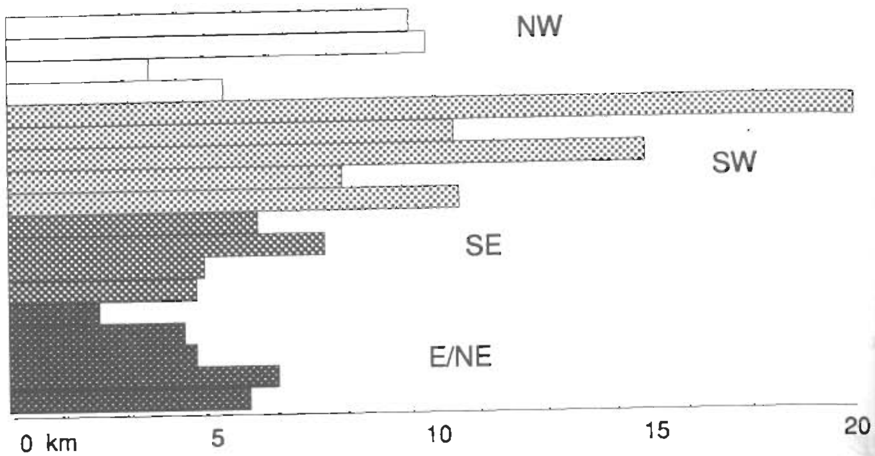
The rivers of the NW and NE (Fig. 6 and 7) remind us on mature valleys (cf. LOUIS 1968) with a distinct longitudinal profile concavity. These profiles are marked by a flattening towards the sea. Steps within the river profile can rarely be found.

Figure 2: Tectonic Faults



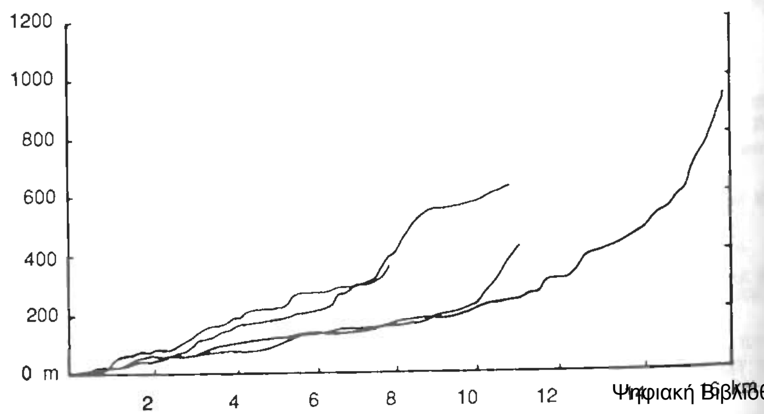
Source: Landsat TM Scene 183-32/2
Topographic Source: Map 1:50.000 Thasos sheet
Sketch: [illegible], H. Weidinger, H. Weingartner
Cartography: G. Herzog, F. Lackner

Figure 3: Length of rivers in morphologic areas



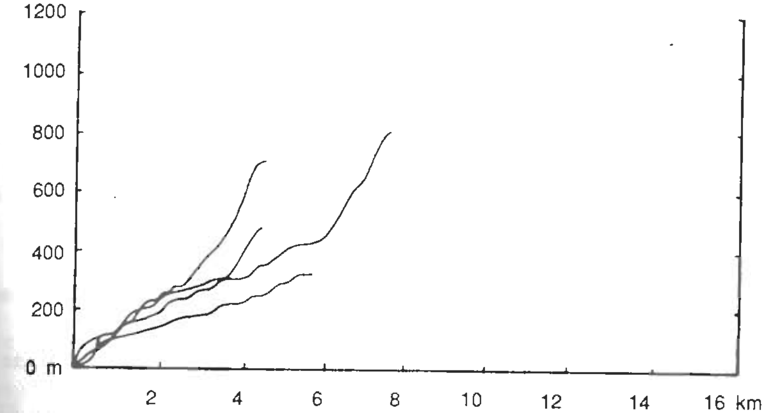
Sketch: H. Weingartner, 1991
Cartography: F. Lackner

Figure 4: Longitudinal profiles in the SW of Thasos



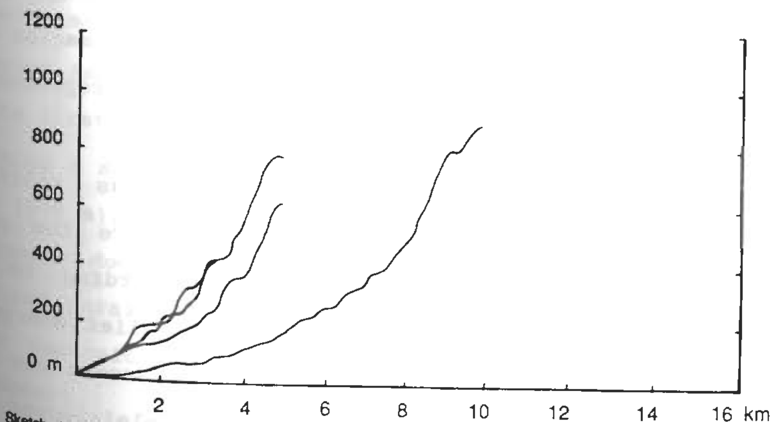
Sketch: H. Weingartner, 1991
Cartography: S. Kollarits, M. Kolmberger, F. Lackner

Figure 5: Longitudinal profiles in the SE of Thasos



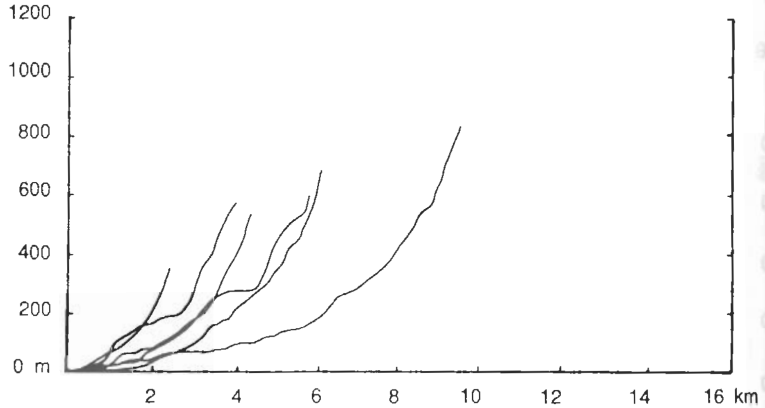
Sketch: H. Weingartner, 1991
Cartography: S. Kollarits, M. Kolmberger, F. Lackner

Figure 6: Longitudinal profiles in the NW of Thasos



Sketch: H. Weingartner, 1991
Cartography: S. Kollarits, M. Kolmberger, F. Lackner

Figure 7: Longitudinal profiles in the NE of Thasos



Sketch: H. Weingartner, 1991
Cartography: S. Kollarits, M. Kolmberger, F. Lackner

Due to the differences of the drainage patterns, as well as the different sizes and shapes of the catchments, the question arises if the influence of geology, tectonic and morphological processes are of importance for the development of the recent drainage network.

MORPHOLOGICAL, GEOLOGICAL AND TECTONIC IMPLICATIONS

As Fig. 1 shows, the drainage network of Thasos is marked by a remarkable asymmetry. The main reason for that is the uplift of the island with the axis in the northeast along the Ypsarion Mts. Along the axis a fault-line scarp has been developed, representing the main divide of the island.

The northeastern part of Thasos has been less uplifted, respectively it represents a downthrown area where the paleo relief has almost been completely eroded. According to the specific tectonic development of the area, the relief energy is high and the influence of gravity to the river channels was most important for the development of the young pleistocene and holocene drainage network. Dry valleys (Karstsacktal) near Potamia and Panagia with valley floors at 140 and 240 m with a steplike margin to the deeper holocene alluvial bay (cf. WEINGARTNER 1991) indicate an older drainage pattern.

The actual drainage of the northern and the southern part of Potamia bay has been developed very differently. This difference is caused by a different geological situation. Whereas the northern part of the bay consists of dolomite marble, the southern area is built up of gneisses, partly with sediment cover. According to these lithological differences the southern area is far more dissected.

Similar drainage patterns as in the NE area can be found in the NW sector of the island. Because of the Ais Matis ridge (average height 800 m), which is close to the sea, relief energy in this part of Thasos is also high.

Between Prinos and Kallirachis the drainage configuration shows a very close adaption to faults and joints. Even a fault dominated rectangular catchment area is visible (cf. Fig. 1). Similar drainage patterns are developed in the south between Astris and Bamburas. This shape of a catchment area indicates a rapid incision of the rivers.

A remarkable contrast to the rather short dendritic drainage patterns are the long drainage systems in the southwestern part of the island.

Looking at the course of the main rivers along the SW, the following main features can be observed:

1. Marion Ammos shows within its head area no adaption to faults. For the first time west of Fengari (726 m) a N-S striking fault is determing a short part of the river course. As far as to Kokkini Petra (316 m), W-E and NW-SE striking faults without influence to the course dominate. Beginning with Kokkini Petra the river is developed parallel to a fault line. Considering the whole river course tectonic elements are rather unimportant for the valley development.

2. On the other hand the course of Kastron Ammos is almost completely bound to faults. Evidence for this are sudden changes of the river course. Examples are found in the south of Fengari (726 m), where the NE-SW direction sharply changes towards south

or south of Kastron (492 m), where the river suddenly changes to SW direction. A similar situation is obvious in the north of Limenaria, where Kastron Ammos and Platanorrema change their direction towards the south. All these changes of the river directions are caused by river capturing, which was favoured by increasing vertical erosion along the fault lines.

3. A close correlation to faults is evident along the southern branch of Dipotamos. South of the Kuklia-Korifi ridge and south of Ypsilanti Vrachos, the river course runs along a fault line. West of the Kuklia-Korifi ridge the river is pushed to the east side of the valley, and the whole depression clearly agrees with a NE-SW striking fault line which can be traced towards the north as far as Panagia bay. East of Theologos a fault line has probably also influenced the valley development.

4. Avathnias Potamos and Vrachorrema show a correlation with faults along their middle and upper course. In its lower course Vrachorrema changes its direction with a characteristic knick point from SW to SE. Papinas Ammos, as well as the river of the Thimonia valley, both east of Vrachorrema, reveal no adaption to faults.

All these mentioned rivers are marked by the same pattern in their lower course. They suddenly change their previous NE-SW direction towards southeast and discharge into the sea after having passed remarkable incisions and gorges. Between the river mouths notable cliffs are developed. The changes in the lower course of the rivers also show no influence of fault lines.

In respect to the dissection of the relief, bedrock is of importance. On Thasos mainly marbles and gneisses are responsible for the differences within the drainage patterns. A first glance

at the hydrographical map (Fig. 1) already mirrors the spatial distribution of the different bedrock units. In some areas the borders between the different units are separated very accurately (i.e. Kentria - Pevkon). Contrary to the dendritic patterns on gneisses, the subaerial drainage on marbles reveals parallel and subparallel patterns and the role of faults and joints seems to be more important. Many examples on the western slopes of Ais Matis and between Potos and Astris prove this assumption.

On the other hand V-shaped valleys appear where absolutely no connection to a fault line can be found. Convincing examples are the Ambelorrema and the Langiada valley north of Theologos. Only fault lines crossing both valleys exist.

Between Kamenos Vrachos and Kedreli, within the southern head of Langadia, in an altitude between 900 and 1.000 m, a slightly west dipping paleo dendritic pattern is cut into the Profitis Ilias marbles. This paleo pattern can only be explained by the postulation of a former sediment cover which was dissected by the dendritic pattern. After this the pattern must have cut into the marbles through erosion and corrosion. An uplift of the area probably has accelerated the process. Towards the west, the head discharges via a confluence step of more than 200 m into the V-shaped Langiada valley.

The neogene sediments at the southwest corner of Thasos are very intensively dissected (cf. Fig. 1). The reason for it is the erodability of the sediments. Structural control of the dendritic dissection is almost absent. This area differs remarkably from the bordering marble areas.

In some cases the valley morphology strongly influences the course direction of the tributaries. Within the middle course of the

Dipotamos (valley of Theologos) and along the valley of Kastron, the tributaries are cut parallel into the valley pediments. The parallel courses of the tributaries of the Marion Ammos valley are dissecting the gentle dipping and consolidated pleistocene talus cones. The Marion Ammos itself is pushed towards the southeastern valley side. The basis for this drainage pattern was obviously the uniform inclined surface, that enabled an undisturbed waterflow. These special geomorphological situation supported the development of a trellis-like pattern.

East of the bay of Potos the longitudinal profiles of the rivers change and the lenghts are notably shorter. Generally between 300 and 400 m altitude, a significant increase of the river gradient occurs. Along the middle course the inclination is rather gentle, but close to the sea the gradient becomes steeper again. This indicates a faster incision in the marbles beginning at a height of about 100 m. This process is reflected by the convexity of the longitudinal profile (cf. LOUIS 1968) along the lower course. This entranchement of the lower course into the hard marbles is a feature of all rivers in the southeast of the island. Morphologically it is of importance that the entranchement is cut into a paleo pediment zone, which runs at an average altitude of about 100 m parallel to the coast between Astris and Thimonia.

The severe vertical erosion together with the change of the river direction in the lower course can only be explained by river capturing by backward erosion from the sea. This change in the drainage pattern also indicates a younger change of erosion mechanisms and valley development.

The longitudinal profiles of the NW and the NE (cf. Fig. 6 and 7) show important similarities. Like for the spatial shape of

catchment areas high relief energy and paraclinal slopes seem to be of importance for the development of the longitudinal river profiles, too. The main feature is the concavity of the profiles, which is evident at all different river lengths. The middle and the lower course usually show a flattening of the profile. This flattening of the profiles is caused by the vast accumulations that have been developed according to the fast backward erosion.

TECTONIC DRAINAGE CONTROL AND TECTONIC STAGES

According to DOUTSOS & FERENTINOS (1984) the direction of the fault lines in northeastern Greece are related to different tectonic stages. Those striking NW-SE and NE-SW are of alpidic origin, those of N-S and W-E direction represent post alpine development.

Taking this into account, it is of interest that the valleys of the southwestern sector highly depend on NE-SW striking faults (i.e. Dipotamos valley, Kastron Ammos). The valley of Marion Ammos has obviously not been developed along a fault line (cf. Fig. 1 and 2).

If we look towards the heads of the rivers, we may see that for the initial development of the drainage systems faults are of no relevance. Even rivers deeply cut into the marbles, like the Langiada valley north of Theologos, which is incised more than 300 m, reveal no accordance to faults. Because of these observations it can be deduced that the development of the initial valley surface was independent from fault lines. Referring to Kastron Ammos and northern Dipotamos (valley of Theologos) we find indications for the course of the paleo rivers. The upper course of the Kastron Ammos and that of the Drosopigi Potamos are morphologically connected, crossing the marble plateau of Kastron. The northwestern border of this paleo valley is represented by a long ridge from Fengari (726 m) towards SW. In the SE the ridge system Tsuknida - Stefania (595 m) - Petrota (449 m) can be accepted as representing the paleo southern boundary. Within a younger stage, probably combined with an uplift, the Kastron Ammos was captured northeast of the plateau of Kastron.

A similar situation can be identified along the valley of Theologos, where the former Dipotamos valley can morphologically be traced via the area of Mandaludi (280 m) to the valley of the Melissas Ammos.

Therefore we may suppose that after the development of paleo valleys, running normal to the uplift axis, the alpidic fault lines have become of importance for the river courses.

Concerning the development of the main valleys, the second alpine fault direction (NW-SE) is of minor importance. Within the southern part of the island no influence of this direction is visible. In the NW the Prinon Ammos valley and the valley of Rachoni stick to this fault direction.

The neotectonic faults striking N-S and W-E (cf. DOUTSOS & FERENTINOS 1984) only control the courses of tributaries.

CONCLUSION

From the study of the hydrography of Thasos we may conclude that

1) within the southern part of the island remnants of paleo valleys exist, which have originally been developed in NE-SW direction without influence of tectonic faults.

2) until Middle Pleistocene planation processes (pediments) along the valleys occur (cf. WEINGARTNER 1991).

3) the disintegration of the Aegean continent during Middle Pleistocene (cf. MERCIER 1977) was of major importance for the further river and valley development. The morphological investigations (cf. WEINGARTNER 1991) prove a change from planation processes towards linear erosion (development of V-shaped valleys).

4) together with the change of morphodynamics tectonic faults became important for the river courses. Many cases of river capturing, as well as rapid incision processes (canyons) and dendritic drainage systems, mirror the hydrographic and morphological development during Younger Pleistocene and Holocene.

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