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Tentative Morphostructural Interpretation of Space Images of the Eastern Rhodope Mountains

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The People's Republic of Bulgaria has initiated organizational and practical activities on environmental studies through space means. Most interesting and promising results have recently been obtained in the interpretation of space photographs made for geological and geomorphological studies.

The information obtained has been assessed as unique in its specific features and in its considerable precision in the information on the geological and tectonic structure of the country, hence in the structural control of a number of exogenic and endogenic ore deposits.

The first results of the geological and the geomorphological interpretation of space images for a part of the Bulgarian territory were reported at the Plenary Meeting of COSPAR (Varna, 1975). The results of fault tectonics studies and their importance to establishing the size, position and characteristics of the block structures have been demonstrated [1]. The specific ring volcanic structures, genetically connected with the fault-block structure in the eastern part of the Rhodope region, have been selected.

This paper deals with some preliminary data about the structure of the above-mentioned territory, resulting from the morphological interpretation of the space images. The landscape method of interpretation, which makes it possible to establish the main features of the morphostructural characteristics of the region in order to determine the taxonomic differentiation of the principal and secondary morphostructures of the block type, has been used in this case. Aerial photographs and geological, geomorphological, topographic and tectonic maps, as well as field studies were also taken into consideration in order to obtain a complete characteristic and a more detailed description.

Space images obtained by the American satellite ERTS-1 were used as initial material. Most successful are the pictures obtained in the 5th and 7th channels with wavelengths of 0.6—0.7 μm and 0.8—1.1 μm. These photographs have served for the interpretation not only of the Eastern Rhodope morphostructure, but also for the neighbouring territories of Northern Greece and North-Western Turkey (Eastern Thrace).

The space images interpretation of the Eastern Rhodope area reveals certain features indicative of the deep structure of the Earth's crust. These features are manifested by the clearly outlined relief elements and the river network, and, particularly, by the abrupt landscape changes, the phototone of which is closely connected with the different morphostructures. The distinctive zones between the different morphostructures manifest themselves in different manners. In some cases they have linear contours, coinciding with the steep slopes of the flanks (e.g. along the Xanthi fault of the Aegean sea), whereas in other cases a phototone change is to be observed, due to the change in the type of rock complexes in the different morphostructures. The contour of the Pliocene and Quaternary morphostructures appear on the space images most clearly. It is much more difficult to select the morphostructures formed during the Paleogene, and those of recent times, involved in an intensive uplift. In some cases their detection on the space photographs becomes easier because of the presence of linearly orientated ring volcanic structures. Some complications appeared in the boundary parts, especially in inherited depressions, where the different typological landscape units are not of a linear nature but have a complex configuration. The space images interpretation was made with the help of additional interpretation of relief features: orientation of the river network, direction of the watersheds, slightly observable changes of the phototone, and also with the help of all the available geological, geomorphological, tectonic, soil and similar maps, as well as by ground-based field studies.

The interpretation of the space photographs established not only the main morphostructures which reflect the deep structure of the Earth's crust in the Eastern Rhodope region, but also the secondary structural forms embraced by the main morphostructures. This concerns both the positive and the negative morphostructures.

Based on the different relief features and the landscape (density of relief dismemberment, valley-river network plan, lineamentary manifestation reflected in the outlines of ridges and river valleys, anomaly sectors in watershed configuration, and the landscape zones), the following main morphostructures have been established (Fig. 1):

I. Central-Eastern Rhodope low and middle-mountain domed block uplift, composed of crystalline rocks of the pre-Hercynian basement.

II. Marginal, inherited or inversed in recent times, late Alpine depressions, characterized by low-mountain, hill-ridge or valley relief, representing the alluvial-pluvial foot of the mountain morphostructures.

The Central-Eastern Rhodope domed block uplift takes a median place between the main morphostructures. It manifests itself as an independent unit with linear contours and relatively monotonous middle and low-mountain relief with moderate erosional dismemberment. The river-valley network is adapted to its configuration, as the main rivers are of the encircling type (Arda and Kroumovitsa) or of radial type, orientated from its central part to the periphery (the Bjala reka river, the rivers flowing toward the Aegean Sea, etc.).

To the East, the Central-Eastern Rhodope domed block uplift is limited by clear-cut slope flanks, well observable on the space photograph. The northern boundary is relatively clear, too. To the west (to the Momchil-

grad depression), this uplift is outlined by a series of oval volcanogenic structures. To the east, the block uplift is distinguished from the "Ergene" depression by its more dark-grey uneven phototone. Here the boundary is of a complex type (broken), and follows approximately the margin between

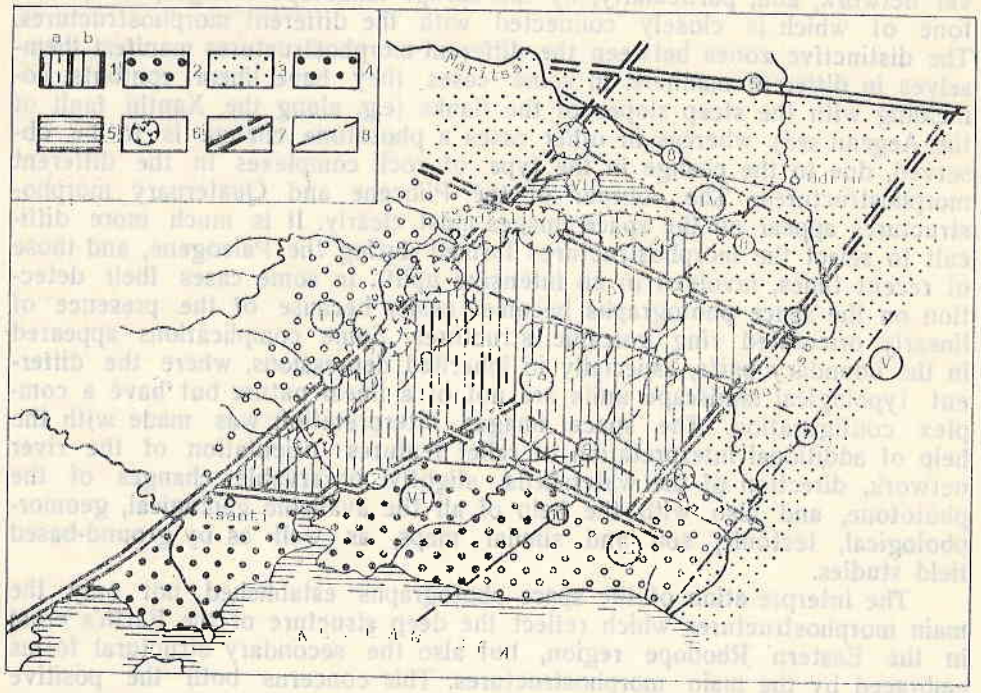

Fig. 1—Morphostructural scheme of the Eastern Rhodopes

Main morphostructures: 1—Central Eastern Rhodopian Arc — block uplift (I): 1^a Southern block, mid-mountainous; 1^b—Northern block, low-mountainous; 2—peripheral depressions with Late Alpine deposits of inverse development in the Neogene-Quaternary with Upper Paleogenic sediments and volcanics; Momchilgrad morphostructure with low-mountainous and hilly relief (II), Dimotica morphostructure with similar relief (III); 3-peripheral depressions with Late Alpine deposits with inherited development, with Upper Paleogenic and Neogenic sediments: Maritsa heterogenic morphostructure with hilly and plane relief (IV); "Ergene" morphostructure with hilly and plane relief (V); 4—peripheral depression with Late Alpine sediments of Pliocenic and Quaternary deposits; Aegean morphostructure with lowland relief (VI).
Second-range morphostructures: 5—Ibredjack horst within the Maritsa depression; 6—ring volcano-structures

Fault structures: 7—first range: Xanthi-Kroumovgrad fault (1); Gjumjurdjina fault (2); Eastern Thrace fault (3); Kamidol fault (4); Maritsa fault (5); 8—second-range faults; Bjala reka faults (6); Dimotica fault (7), Harmanli fault (8), Muglenik fault (9), Tirnava fault (10)

the crystalline basement and the Upper Paleogene and the Neogene-Quaternary sediments which fill the depression.

The Central-Eastern Rhodope domed uplift is unevenly delevelled. It comprises two clearly distinguished blocks: Southern and Northern. The Southern middle mountain block is deeply dismembered by a dense river network. Its avarage altitude is between 1,000 m and 1,200 m. The Northern block is less uplifted, a moderately dismembered low-mountain type with an average altitude of 750-800 m. Both morphostructures are separated by the Bjala reka dislocation, to which the Bjala reka valley is also orientated [2]. This dislocation, according to the space photographs, continues in a western direction.

From all the marginal late Alpine depressions, most clearly expressed is the Momchilgrad depression which has a complex configuration of a heterogeneous type, manifested in the contemporary relief and successfully interpreted on the space photographs. It comprises a relatively monotonous, slightly dismembered relief of sedimentary-tufogenic deposits, ring contours of volcanogenic structures, and isolated top parts of the intragraben horsts.

The Low Thracian depression (Ergene), which appeared in Alpine time with thick deposits of the Neogene-Pleistocene age, according to the available data, is demonstrated as a well expressed independent morphostructure. This morphostructure is characterized by a slight dismemberment clearly observable on the space photographs.

More to the south of the Eastern Rhodope block morphostructure a superimposed young Aegean depression can be distinguished, particularly compensated by Neogene and especially by Pleistocene alluvial-proluvial deposits. The boundary between the Eastern Rhodope morphostructure and the Aegean depression is represented by a normal fault.

To the East of the Aegean depression, the Dimotikon morphostructure with an inverse development during the neotectonic epoque is satisfactorily outlined. It comprises clearly depicted secondary block and ring volcanic morphostructures with a characteristic radial river network.

The Maritsa depression is distinguished to the north of the Eastern Rhodope domed uplift. This is a complexly built heterogeneous morphostructure. It comprises several linear elongated negative and positive secondary morphostructures in a north-western direction, which agree with the plan of the hydrographic network. The linear orientation of the structural forms in a north-western direction is closely connected with the diagonal network of the fault zones. The Harmanli fault zone is most clearly observed on the space photographs. The component block-fault morphostructures within the limits of the Maritsa depression form a different phototone landscape which can be clearly observed on the multizonal space images.

All the morphostructures of the eastern part of the Rhodope massif are of a block type and are separated from one another by faults with north-western, north-eastern and sublatitudinal direction, clearly distinguished on the space photographs. The subparallel faults form sets with a constant and definitely determined direction. Some of the faults show fragmentary activation, not only in space but also in time, testified by the geological studies, i. e. they are long-living faults with an ancient set up, as e. g. the faults of Eastern Thrace, Xanthi-Kroumovgrad, Maritsa, etc. Some of them are related to the igneous activity during the Alpine tectono-magmatic cycle, accompanied by base metal mineralizations: Zvezdel-Galenit, Madjarovo, Lozen and other ore fields and zones.

The advantages obtained from the space photographs interpretation for the purposes of the morphostructural studies of the Eastern Rhodope Mountains are beyond dispute. They can be used to distinguish the main morphostructures which can be further studied in a more detailed manner by other methods as well, field studies included.

A positive assessment can also be made of the interpretation of faults with the aid of space photographs.

References

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Предварительная морфоструктурная интерпретация космических изображений Восточных Родоп

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(Резюме)

В настоящей работе излагаются предварительные представления о структурном строении Восточных Родоп, полученные в результате дешифрирования морфоструктур космических изображений. При решении поставленной задачи использовались космические изображения, полученные от американского технологического спутника ЕРТС-1. Самыми удачными оказались снимки, сделанные в диапазон 0,6—0,7 μm и 0,8—1,1 μm.

Дешифрирование космических изображений в обхвате Восточньх Родоп позволяет выявить признаки, свидетельствующие о глубинном строении земной коры и раскрывающиеся в ясно очерченных линейных элементов рельфа и сети рек, особенно в резких сменах ландшафта, чей фототон тесно связан с различными морфоструктурами.

На основании различных признаков рельфа и ландшафта выделены следующие главные морфоструктуры:

1) Центрально-восточнородопское низко- и среднегорное сводово-блоковое поднятие, сложенное кристаллическими породами догерцинского фундамента.

2) Периферийные, унаследованные или инверсные в новейшее время позднеальпийские депрессии, имеющие низкогорный, холмисто-грядовой или низинный рельеф, представляющие аллювиально-пролювиальные подножия горных морфоструктур.