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Geological heritage conservation of Ohrid Lake

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Abstract. Ohrid Lake is situated in the south-eastern part of Albania, at the border area between Albania and Macedonia. This boundary goes through the lake in a NW-SE direction. It has a considerable depth (295 m), thus being the deepest lake of the Balkan peninsula. Regarding to geological formations, the Lake mainly lies above ultrabasic rocks of the Shebeniku ophiolitic massif and carbonatic rocks of Late Triassic - Late Jurassic age.

In the southeastern part of the lake, localized into Upper Triassic limestones, there is a dense network of underground springs. One of the greatest river in Albania, Drini i Zi, springs from the Ohrid Lake, too. But on the other hand, groundwater supply has a predominant role. Thus, a natural equilibrium exist in its hydrodynamic regime.

Except for the beautiful view of the lake, the interesting geomorphological situation dominating over the lake and on its bottom should be emphasized. In recent times, the landscape around the lake and above all, the lake water, has been threatened by different factors resulting in their pollution and destruction.

Besides the lake, in the area over it there are several interesting geological sites.

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Key words: Balkan Peninsula, Ohrid Lake, Geoconservation

Introduction

In the framework of ProGeo activities, recently in Albania, several projects about the geological heritage conservation have been launched. Of course, an important part of this heritage are geological sites, which are numerous and very interesting in Albania. The present paper is focused on the Ohrid Lake, a jewel of Albania nature, included in the preliminary list of geological sites of Albania. Due to its aesthetic, touristic and curative values, to its graben-form structure, to its interesting hydrodynamic regime, rare fauna, etc., the Ohrid Lake is considered as one of the most outstanding lakes in the Balkans and in Europe, and is listed within the proposal-list of Balkan heritage. But, on the other hand, it is a threatened site that needs a serious restoration and a rigorous protection.

Since many times ago, the lake and the adjacent area have served as a touristic spot, not only for Albanians but also for foreign tourists, due to its beautiful landscape and agreeable climate.

Up to now, nothing has been done for Ohrid Lake conservation, which really needs more attention.

Regarding to its total rehabilitation, much to do belongs to the future.

Geographical features

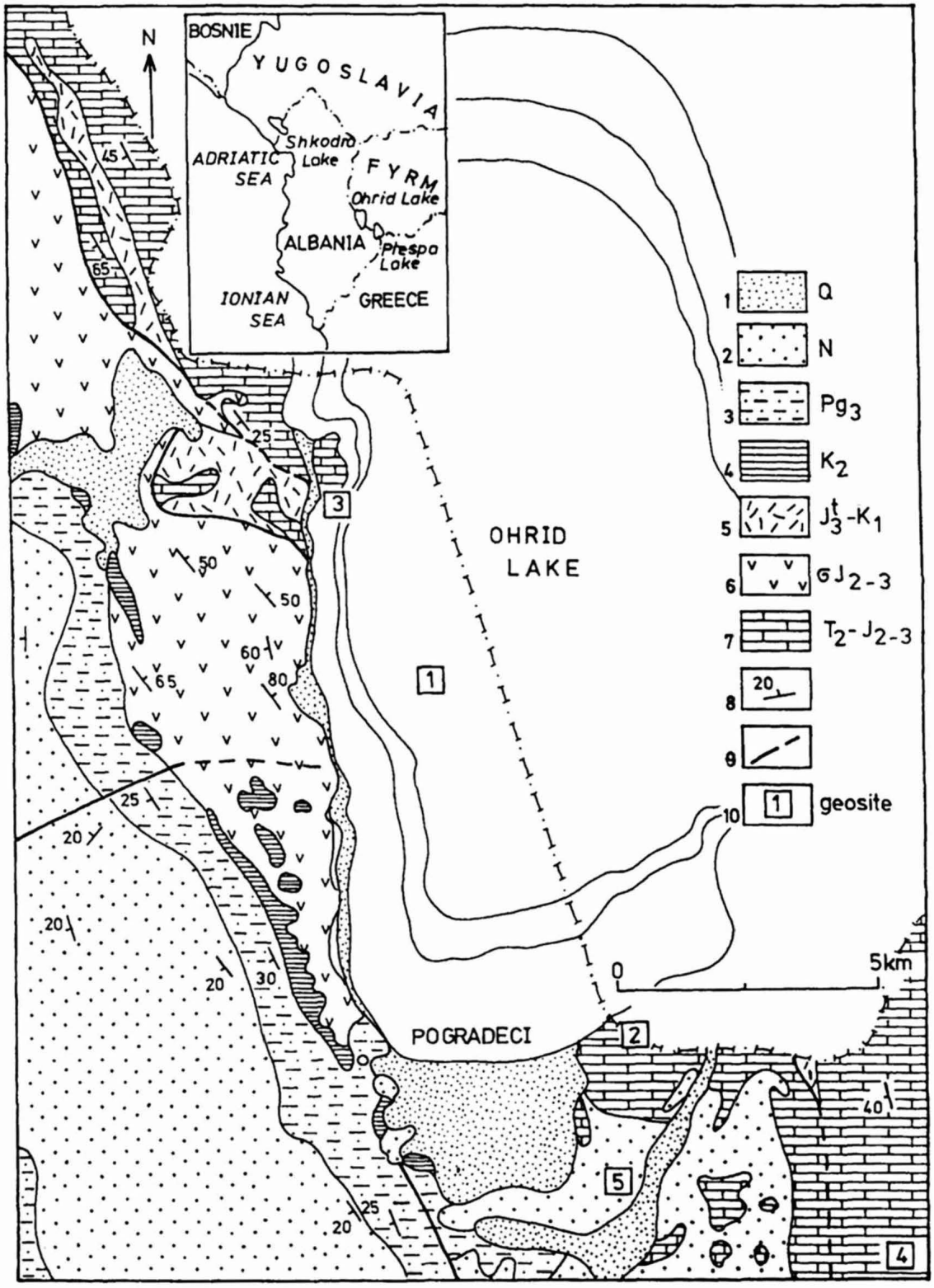
The Ohrid Lake is situated in the southeastern part of Albania, just in the border between Albania and Macedonia. Its surface is 365 sq. km. (from which 111.4 sq. km are spreaded within the Albania territory while the other part belongs to Macedonia). The length from North to South is 30.4 km, as the width 14.5 km. The water of the lake is clear and very limpid. The color is blue, and the transparency, high (15 - 20 m). The lake is deep. The average depth is 138 m, while the maximum one is 295 m. As result of their depth the volume of the lake-water is considerable (50 km^3). The winding coefficient of shoreline is small (1.3), which shows that shores are straight lines (Physical Geography of Albania).

The Climate is characterized from fresh summer and soft winter. The amplitude of annual average temperature is 18.4 °C. The water temperature in summer is about 1°C higher than air one. The annual average precipitation is 760 .1 mm.

Regarding to the fauna, the presence of a rare sort of fish, called "Korani" makes the Ohrid Lake, a unique one throughout of the Europe.

Geological setting

The Ohrid Depression takes part within the Mirdita Tectonic Zone, one of the internal zones of the Albanides. The main formations that form the geological setting are ultrabasic rocks of the Shebeniku Ophiolitic Massif and Upper Triassic - Lower Jurassic carbonatic rocks of the carbonate margin. The contact between them goes through the lake bottom. Middle Triassic neritic siliceous limestones emerge within Lini Peninsula. A Tithonian - Lower Cretaceous sedimentary tectonic ophiolitic melange is also present. The ultrabasics of the Shebeniku Ophiolitic Massif are transgressively covered by small outcrops of Upper Cretaceous limestones with rudists. The ophiolitic basement is transgressively and unconformably covered also by Oligocene flysch deposits, and Neogene molasse represented by conglomerates, clays, sandstones etc. (Geological Map of Albania) (Fig. 1).



As a result of river and lake activity, there are present alluvial, proluvial, and wetlands deposits of Holocene age.

Hydrologic-hydrogeological characteristics

The surface of Ohrid Lake aquifer is 1414 sq. km, while the average altitude is 1000 m, being so, a lake of the mountain type. The absolute altitude of water table is 693 m. The annual amplitude of level-oscillations of the lake is 0.20 up to 0.78 m, while during perennial period it amounts up to 135 m (Hydrogeological Map of Albania).

In the south-eastern part of the lake, localized into the Upper Triassic - Lower Jurassic limestones, there is a dense network of underground springs. That shows a interesting phenomenon, not only for the water discharge, but also for its quality and curative values. These springs emerge in Tushemishti and Shen Naumi.

The bulk chemistry of the lake water is distinguished by the low contents of several salts dissolved in water, especially phosphates and nitrates. There are observed small quantities of organic phosphorus and nitrogen. In general, the water mineralization of the lake varies from 200-250 g/l. The main part of mineralization is occupied by Ca and Mg bicarbonates. So, according to the bulk chemistry, this lake belongs to Ca-bicarbonates group.

Hydrodynamic regime

Also, regarding to its hydrodynamic regime, the Ohrid Lake is a special one. As a matter of fact, the Ohrid Lake is an outflowing one. One of the greatest river in Albania, Drini i Zi, springs just from it. But on the other hand, here, it predominates a great role of groundwater supply. Thus, a natural equilibrium exists in its hydrodynamic regimen, do not bringing problems to their water amount and to its great level-oscillations.

At first, regarding to the lake discharging:

- Through the Drini i Zi river (the only discharger of the lake), from the lake it is removed an annual volume 1083.10^6 m^3 water, or a average perennial discharge 34.4 m^3/l, or 70.7 % of total discharging from the lake.

- Also, an annual water mattress of 663.7 mm, or annual volume 239.10^6 m^3 or 29.6 % of total discharging from the lake, evaporates from the surface.

While, regarding to lake recharging, it is supplied:

- From the water discharging of Prespa lake which is situated 157 m above Ohrid Lake level. Its discharge is accomplished across the underground ways which appear the fissures form, karstic holes etc.The water discharge from the Prespa Lake is 16 m^3/s.

- From the water of karstic structures of Mali i Thate, that is performed through a great number of underground springs. Among them, we are mentioning Shen Naumi springs, Driloni, springs, Tushemishti ones. These springs has a average discharge 16.3 m^3/s, or a annual volume-513.4 10^3 m^3, or 39% of total water recharging into the lake.

- From precipitation. The perennial mattress of precipitation in Ohrid Lake Aquifer is 815 mm, or a annual volume 810.10^6 m^3 or 61% of total water recharging into the lake.

Geomorphology of the Ohrid Depression

The Ohrid Depression, from the genetic point of view, takes part in the chain of tectonic depression that intersects the older structures. It was formed at the same time with other newer graben structures of southern part of Albania. The Ohrid graben has been reactivated with a great amplitude. Even now it is still subsiding with an amplitude of 2-3 mm/year, meanwhile surrounding structures uplift with a greater amplitude than 5-6 mm/year. This is reflected in:

-the existence of the lake until now

-considerable contrasts of the relief within the adjacent areas

-high seismic activity

In the past, the lake had greater dimensions than nowadays, and had been situated above 1000 m of altitude. The Ohrid Lake was connected closely with other lakes that covered the whole southeastern part of Albania. The surface continually decreased, and, inconsequence, the erosion of the regressive Drini i Zi River gradually retreated the lake water up to the actual level. This neotectonic history is witnessed by the lake terraces situated on surrounding slopes; by the presence of two fields related to the lake deposition; and by the transformation of the Lini Isle into the present peninsula.

Fig. 1 Geological Map of Ohrid depression and geological sites of the area.
1 - Quaternary alluvial, proluvial and lagoon deposits; 2 - Neogene continental deposits (clays, sands, coals, conglomerates); 3 - Upper Paleogene (marls, conglomerates, limestones, coals); 4 - Upper Cretaceous limestones; 5 - Upper Jurassic (Thitonian) - Lower Cretaceous melange; 6 - Middle - Late Jurassic Shebeniku ophiolitic massif; 7 - Middle Triassic - Middle-Late Jurassic (limestones, dolomites, cherts,); 8 - bedding; 9 - fault; 10 - geosite: 1 - Ohrid Lake site; 2 - Tushemisti springs; 3 - Lini Peninsula; 4 - Karst of Mali i Thate; 5 - Erosional valley of Plloça

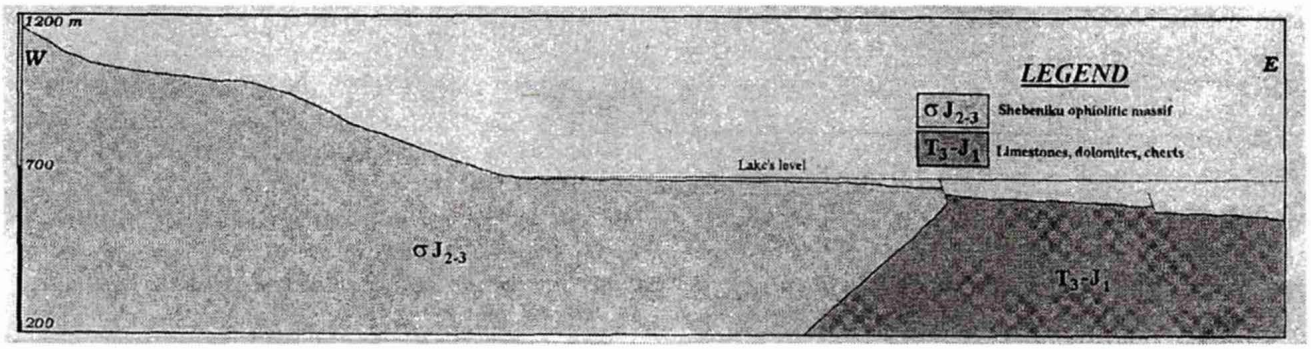


Fig. 2. Cross section of Ohrid depression showing the scaled form of lake basement
1 - Shebeniku ophiolitic complex; 2 - limestones, dolomites, cherts

As mentioned above, the lake surface decreased continuously. This decrease is a direct consequence of the evolution of the outflowing lake and the bottom subsidence which makes it a long-living lake.

During the formation of the Ohrid Depression, the karstic processes have played an important role, especially within the eastern part of it, where Upper Triassic - Lower Jurassic limestones are widespread. For that reason, the Ohrid Lake, as the other lakes of Albania, is considered as of tectonic-karstic origin.

Regarding to the relief, there are distinguished: 1/ relief type related to the structure and phenomenon of erosion; 2/ relief type related to lake deposition; 3/ relief type related to river deposition; 4/ relief type related to the activity of erosion-denudation.

The relief type related to the structure and phenomenon of erosion, is linked with new faults which form the highly eroded relief sectors. The purest eroded phenomenon is shown within Kalaja e Pogradecit conglomerates and Guri i Kuq limestones. In several sectors of lake coast, they are modelled by abrasion activity showing a abrasive coast (Lini Peninsula).

The relief type related to lake deposition, is a result of the Ohrid Lake activity. Its retreating is performed with the relative tranquillity periods. In consequence, terrace levels have been formed, and several isles have been transformed into peninsula (Lini and Ohrid). Adjacent fields related to lake depositions are parts of the lake basement. This is proven by their flat character and lake deposition.

Also, there is observed the river deposition. The relief related to it, is showed in the presence of several small fields of triangular shapes. In general, the relief is irregular, which is a consequence of the erosion of streams, landslides and their coarse, not-differentiated material composition.

The lake coasts are of accumulative and abrasive types, but the first one is predominant. Near the field, the coast is of the emersion type, formed during continuous retreating conditions. As result, there is a regular coastline, rather straight line. The rivers poured out there, brought fine materials, which was accumulated within moathrivers which in cooperation with waving of lake, formed a great beach.

The high abrasive coast appears in several small sectors. It is of the abrasive and tectonic-abrasive type. (Tushemishi, the western part of Lini Peninsula).

The lake bottom has an interesting morphologic character, too. Its basement is intersected along NW-SE direction from several tectonic contacts. These contacts maybe have been later transformed into strike-slip faults, during the PlioQuaternary, have acted as normal faults that have given to the lake bottom a graben morphology. So as result of these time after time fault, the lake basement up to its maximum depth has a scaled form (Fig. 2). The graben structures are observed in the northern and southern part of the lake caused by transversal faults. Geophysical survey showed that gravimetric and magnetometric potential fields confirm the presence of strike slip and transversal faults of second order (Neotectonic Map of Albania).

The Ohrid Lake observed as a Geological Site and the adjacent sites

The Ohrid lake is a rare geological site, due to its natural beautiful landscape that appears, climacteric conditions and curative values for the heart and blood vessels, its great altitude and depth, its graben form, etc. Another rare aspect is the hydrodynamic regime (Fig. 1).

In the adjacent areas, there are a number of geological sites of different type briefly described as follows:

If we talk about this region, we don't forget mentioning the karstic springs of Tushemishti and Shen Naumi, located within Triassic limestones over the lake. They are famous not only for its quality and great discharge into the lake, but also for its curative values (Fig. 1).

Another interesting site, just in the mentioned zone, is Lini Peninsula (Fig. 1). There are distinguished Triassic limestones with megalodonts, and, just here, the lake coast is the most beautiful than

everywhere. It is the only place, within Albanian border where a rocky coast exists. Thus, the Lini represents a geological site of palaeontologic-morphologic-neotectonic and aesthetic values.

An interesting phenomenon nearby the Ohrid zone is the karstic field of Mali i Thate, from which are nourished the marvellous springs we talked above (Fig. 1).

Just a little far from the lake, there is an erosional valley called Plloça valley, which separates two great structures, the Ohrid Depression and Korça one (Fig. 1).

The dangers that threaten the lake and the adjacent area

Although one of the most known touristic spot in Albania, nothing has been done for the protection of the lake from pollution and for its protection.

In recent times, from the exploitation of the nature having not in regard environmental damage, the lake has been threatened by different factors, resulting in pollution and destruction of the environment ecosystem.

The following first-order dangers which threaten the lake should be mentioned:

-Mining industry constructed near the lake
-Urban wastes deposited within not suitable places
-Sewage which are poured out into the lake
-Deforestation which helps erosion
-Row Materials removed from the lake-beach
-Lack of control on fishing
-The hydrodynamic regime is seriously threatened, if the hydropower stations on the Drini River would be constructed. As a matter of fact, this river possesses great power, but on the other hand, it is a danger for breaking down the water equilibrium.

As it can be seen, there are many problems that threaten the lake and the nearby area. Recently, in cooperation with the Macedonian government, efforts are made for a detailed study of pollution level of the lake, and to undertake the necessary steps for its restoration and protection.

Several projects are initiated and supported by international organizations for the rehabilitation of this marvellous lake.

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