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Assessment Of The Seismoactive Layers And Features Of The Albanian Earth's Crust.

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ABSTRACT

Accurate assessment of seismoactive layers represents large interests for recognition of real depth of seismic energy generation.The database of this study are relocated earthquakes of period 2001-2010 that are in considerable numbers, and due to the digital equipment records errors in determining of the depths are less than 3 km. Depth of generating earthquakes represent interest for seismoactive studies especially in seismic hazard assessment. Shallow earthquake with low energy causes higher damage in buildings than a deep earthquake with higher energy. In this study we present the determination of fault zones and low speed zones, which enable us for correct interpretations of Geodynamic phenomena of the Earth's crust. We can say that, these layers are promoters of seismic activity in Albania and can explain mobility of the earth's crust blocks and generating earthquakes from this movement. Most seismic events across our country have occurred in middle and upper crust of the earth. Based on the depths of earthquakes data is showed that the seismoactive layer in Albania earth crust has the bottom in the depth of about 20-25 km. These results are first steps towards more detailed geodynamic and seismotectonic analysis. In conclusion the hypocenter of earthquakes in the territory of Albania and its surrounding earth crust are explaned with active fault zones and lower velocity zones.

***KEY WORDS**: shallow earthquake, seismoactive layers, fault zones, lower velocity zones.*

1. INTRODUCTION

The Albanian region is historically subjected to strong earthquakes (Io>VIII EMS-98), as gathered from the intensity data. Currently, the seismicity of Albania is characterized by low-energy earthquakes. Accurate assessment of seismoactive layer represents large interests depth concrete recognition of seismic energy generation. Depth of earthquakes generating represent interes for seismotectonic studies especially in seismic hazard assessment. Shallow earthquake with smaller energy causes greater damage than a deep earthquake with greater energy. In this study we presented the determination of fault zones and low velocity zones, which enable us to correct interpretations of Geodynamic phenomena of the Earth's crust. We can say that, these

low-velocity layer, are promoters of seismic activity of Albania Earth's crust and can explain the mobility of the earth's crust blocks and generating of earthquakes from this movement. The database of this study are relocated earthquakes of period 2001-2010 that are in considerable numbers, and due to the digital equipment records errors in determining of the depths are less than 3 km. Most seismic events across the country, in a period of time 2001-2010 have occurred in upper and middle crust. By generalizing the data from the depths of earthquakes show that the seismoactive layer in Albania has the bottom to the depth of about 20-25 km. These results are a first step towards more detailed seismotectonic analysis. In conclusion the epicenter of earthquakes in the territory of Albania and its surrounding are concentrate mainly along active fault zones and along the lower velocity zones. It is known that seismicity is a partial phenomena of a tectonic activity of a long period of time [1]

The analysis of distributions of earthquakes with Ml> = 3 for the period 2001-2010 shows that 87% of earthquakes in the study have depths up to 25 km depth, while about 13% of them are over 25 km in depth.

II. DATA AND METHODS

The Albanian seismic network and the seismic stations of Montenegro, Thessalonica and Macedonia consist of 29 permanent seismic stations that operate with the BB and SP sensor types, covering Albania and the surrounding regions [39.00-43.00N; 18.50-21.50E]. Seismic phases recorded by the Albanian Seismic Network (ASN), integrated with data from the Montenegro, Thessalonica and Macedonia networks, were assembled to develop the database for this study. 4135 seismic events in this data set have magnitude rankings between 2.0 and 5.4; During 2001-2010 years was recorded a moderate seismic activity on the Albania territory and increase of activity in northeastern and southwestern part. There are 2038 located earthquake with ML>3 (Richter) for this period of time this criterion represents the high energy released by earthquakes in Albania for the analyzed period.

Location procedure was carried out through P and S onsets elaboration based on the local velocity model [2] and routine used for this purpose are Hypoinvers and Hypo 71 programs [3]. Complete and homogenous catalogue of earthquakes are provided for the period of time 2001-2010. Some formulae for determination of the magnitude according to the time duration of the seismic signal are also used [4].

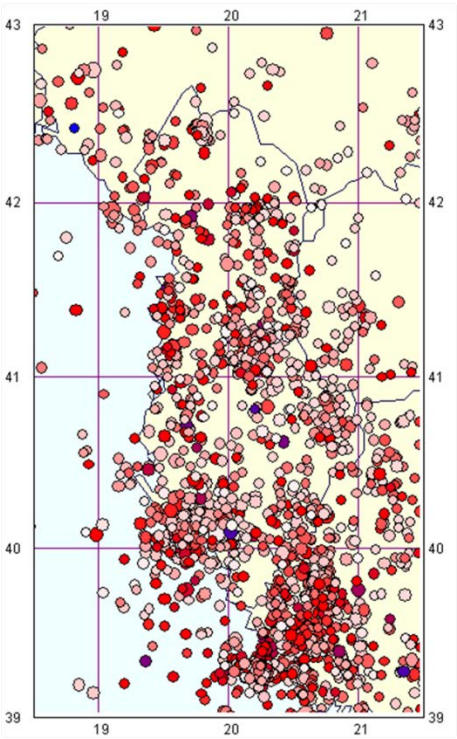

Fig 1. Epicentral map of earthquakes M>3.0 occurrenced during 2001-2010.

III. RESULTS AND DISCUSSION

III. 1. Earth crust

About 87% of earthquakes ML>3 (Richter) across the country during period of time 2001-2010 have bottom to the depth of about 20-25 km. By generalizing the data from the depths of earthquakes statements show that the seism active layer in Albania is in upper and middle crust. Analysis of earthquakes with ML> = 4.0 which represent most of the seismic energy generated in the years 2001-2010 gives these results for the layers of the earth's crust: 87.4% earthquakes with ML> = 4.0 have occurred in the bottom of depth 25 km. This indicates also that the seismic activity is mainly in the upper and middle crust (fig 2).

III. 2. Mantle

About 3.7% of earthquakes ML>3 (Richter) across the country during period of time 2001-2010 have occurred to the depth of over 40 km (fig 2). Low-velocity layers are in the upper mantle of our country and located in the depths of 60-85 km. This layer of the upper mantle includes three zones: the Adriatic zones, the Southeast and Northeast zones. Low velocity layer of mantel can be promoters of seismic activity under the Earth's crust in these areas [2]. It is known that the establishment of low-velocity layer in the upper mantle is characteristic of seismoactive regions. Having high temperature, it directly affects the Earth's crust. High temperature in these areas

may occur the melting of the rocks, and therefore, we will have expand the volume of rock, which will lead to increased vertical or horizontal strain and generation of earthquake [5].

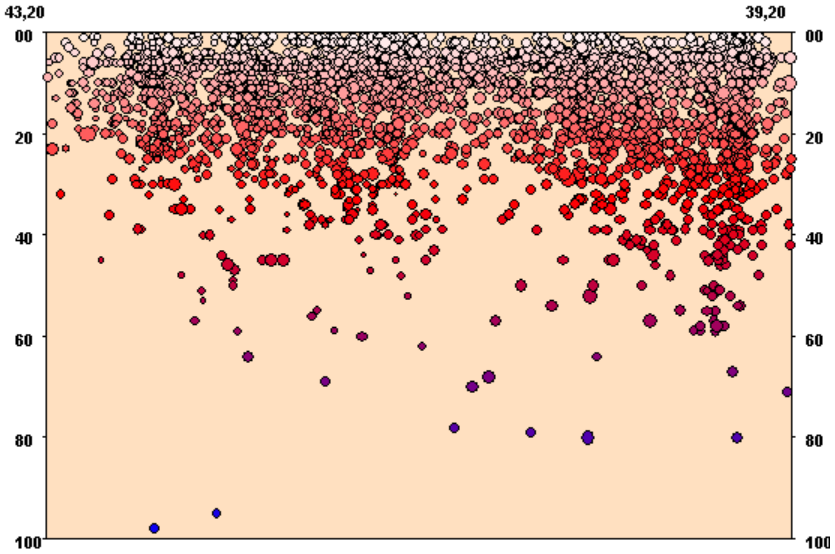

Fig 2. Earthquakes focus distribution in depth for earthquakes M>3.0 occurrence during 2001-2010.

III. 3. The seismic activity of fault zones

The system of faults and spatial distribution of seismic activity shows that the Albanian territory and its surrounding areas have distinct seismic activity in some faults zones (fig 3). The seismic activity of fault zones of Albanian territory is the result of movement of the Adriatic microplate, which, displaced towards the North, exerts force on the blocks of Albanian orogen. . Epicentral map of 94 earthquakes with M>4.0 occurrence and the most seismogenic zones during 2001-2010 (fig 4):

3.1. **Longitudinal seismogenic fault zones**:

3.1.1. ***Adriatic seismogenic fault zone (1)***

It lies in the western part of Albania, continues along the Dalmatian coast and south, in Vlora, in Sazani Islands. This area is characterized by a compressed regime. General direction of compressed axes is NE-SW, almost normal to the coastline, where Adriatic plates collide with continental orogen. It is necessary to underline that this fault zone is located near the Albanian Orogen front, in convergence with Adria micro plate, and for this reason compress movements here are strongest ones. There is a great differentiation along the longitudinal tectonic rupture, on one side, the Miocene deposits crop out and, on the other, the Pliocene deposits sink deep towards the east. This tectonic position and the active tectonic faults are the source of earthquakes that have stricken Durres and the surrounding areas during 2001-2010 years. It is necessary to underline that Durres- Kepi i Rodonit fault zone in Adriatic seismogenic fault zone is most active in this period of time. In this area are 4 located earthquakes in the period 2001-2010 with value of magnitude ML >4.0 (Richter) and the largest has magnitude ML=4.5 (fig 4).

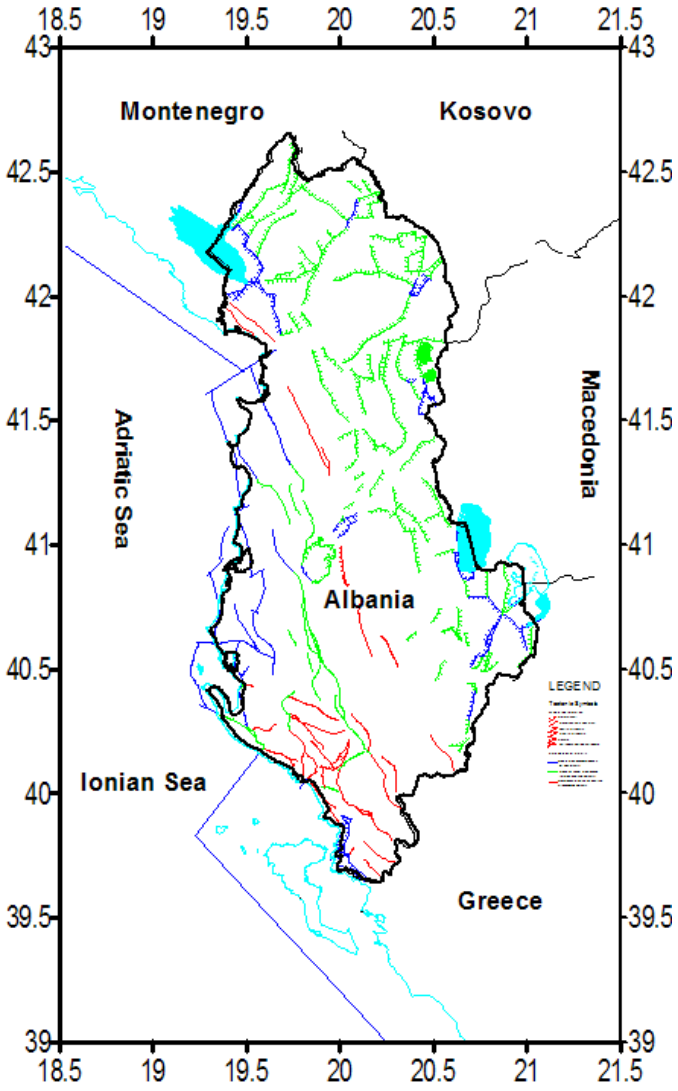

Fig 3. *Seismotectonic map of Albania (Aliaj, Sh.et.al 2000)*

3.1.2. ***Ionian seismogenic fault zone (2)***

There was a powerful differentiation in the Ionian zone on both sides of the mountains uplifts in their passage to flashy synclinal valleys, whether expressed with the presence of longitudinal tectonic faults or flexures of secondary nature, which, seems, pass through tectonic faults in their depth. On the surfaces of these uplifts, too, there are faults and flexures, expressed also with contrasts in relief; It appears very active in this period throughout its length. In this fault zone have occurred 20 earthquakes with magnitude ML = 4.0 (Richter) and 4 earthquakes with magnitude ML = 4.5 - 4.8 (fig 4).

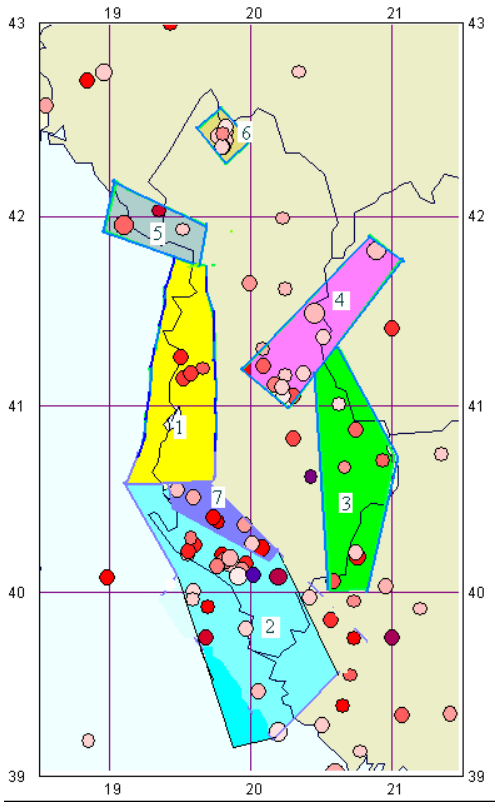

Fig 4. Epicentral map of earthquakes M>4.0 occurrence in the most seismogenic zones during 2001-2010.

3. 1.3. ***Korc-Ohrid-Peshkopi Seismogenic fault Zone (3)***

It is in Eastern part of Albania, and is the primary fault zones in the border of ophiolites zone of Pelagonian Mirdita and Korab massif, with an approximate NS direction. Pliocen-Quaternary depressions similar to grabens are located along this area, in Kukes, Debar, Ohrid, Bilisht. In the period under study this fault zone is active have 2 earthquakes with ML=4.5 and 1 earthquake has magnitude ML=4.9.

3.2.*Transversal fault zones*.

The structure of the Dinarides and Hellenides with the general direction NW-SE is interrupted by several transverse deep fault zones with NE-SW trend, which have been established since the beginning of the Alpine cycle. These areas are expressed in the form of flexures, transverse depressions complicated with deep faults that are well differentiated (fig 3).

3.2.1.*Elbasan-Dibra transversal fault zone (4)*

The Elbasani-Diber segment with direction SW-NE in Albania, represent an earlier transversal deep fracture, which has played an important role in development and structuring of Albanides in two sites of this segment. From the Seismotectonic point of view, the area belongs to a complex faulting environment, and according to the actual map of neotectonic zonation of Albania (Fig. 3), [6] It is located in the internal tectonic zone characterized by compressed movements. To this

fault zone are related many geological phenomena: Evaporate diapers of Dumrea and Peshkopi, tectonic windows of Okshtumi; the tectonic displacement of Shpati ultra basic massifs and Quaternary; the presence of the many buried anticlines under molasses formations; the source of sulfur hot waters; the presence of some hydrothermal mineralization and the last, the frequency and strong earthquakes, being active and now. On the Elbasani-Dibra transversal zone were located 11 earthquakes with ML>4.0 during year 2001-2010. The activity of this transversal zone was culminated with the Earthquake of September 6, 2009 (M_L = 5.4), occurred in Gjorica. The main event is a shallow one, with the hypocentral depth at 7.6 km. This fact explains the localized destruction in the epicentral zone.

The focal mechanism solutions show that this earthquake has been triggered from the activation of a normal fault with NE-SW direction, in conditions of an extensional tectonic regime [7].

3.2.2. *The Lezhe-Ulqini seismogenic zone (5)*

The Lezhe-Ulqini area, outer side of folded Alpine orogen with high mountains, hilly chains, extensive areas that are entirely under the power dynamics of rivers, abandoned riverbeds, lagoons and numerous wetlands, Shkodra Lake and very near the Adriatic Sea. Shkoder-Peje strike -slip fault constitutes the most important structural element that passes through the area. This area is characterized by a complex geomorphology and in addition, has been hit by numerous earthquakes. On the Lezhe-Ulqini area during year 2001-2010 were located 3 earthquakes with ML>4.0. An earthquake of magnitude (M_L=5.0) occurred on August 21, 2009, in Adriatic Sea 7 km southwest of Ulqini, epicenter coordinates 41.86°N; 19.13°E, the focal depth 12.9 km. From the focal mechanism solution results that the earthquake was triggered from a pure thrust fault with an NE-SW compression stress direction [8]. The focal mechanism solution of 2009 August 21 earthquake is quite clear that Lezha-Ulqini seismogenic zone shows that the compressed regime was the main cause of the seismic activity along the Adriatic coastline.

3.2.3. *Thethi transversal fault zone (6)*

In its north-eastern continuation, it seems to border on the Shkodra-Peja seismogenetic zone to the north. The fault of Thethi presents distinct seismic activity in this period 2001-2010 years with 5 earthquakes with magnitude ML >4 (Richter) and the largest earthquake has magnitude ML = 4.8 (Richter). This fault has been very active in generating microearthquakes.

3.2.3. *Vlora-Tepelena transversal fault zone (7)*

Vlora-Tepelena transversal fault zone is expressed mainly in the shape of a great flexure, complicated here and there with faults. During the true geosinglinal stage, the Vlora-Tepelena sector presented a flexture which separated the relatively shallow Ionian trough of southern Albania from the relatively deeper Ionian trough of lower Albania. It is expressed in the presence of earthquake epicenters in this period 2001-2010 years with 7 earthquakes with magnitude ML >4 (Richter) and the largest earthquake has magnitude ML = 4.9 (Richter).

4. CONCLUSIONS

The distribution of earthquake epicenters not omly in the areas of faults shows that zones with low velocity, are promoters of seismic activity in the Earths crust of Albania and can explain the mobility of soil blocks and generating earthquakes of this movement.

The seismoactive layer in Albania earth crust has the bottom in the depth 20-25 km Sizmiciteti of Albania is mainly caused from the collision between the Albanides orogen and Adria microplate as a part of the contact between African and Eurasian plates. Increase of tectonic deformations that through active tectonic fault generating the earthquakes and deformations in zones with low velocity make possible configurations of sizmicitetit our country. According to the actual map of neotectonic zonation of Albania these active zones belong to complex faulting environments that are the source of earthquakes during year 2001-2010.

In conclusion the epicenter of earthquakes in the territory of Albania and its surrounding are located in active fault zones and along the lower velocity zones.

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