

# Seismic Activity in the Ohrid Epicentral Area in the Period between June-September 2017

Dragana Chernih-Anastasovska<sup>a\*</sup>, Jasmina Najdovska<sup>a</sup> and Katerina Drogreshka<sup>a</sup>

<sup>a</sup>*Seismological Observatory of the Faculty of Natural Sciences and Mathematics, Ss. Cyril and Methodius University in Skopje, Republic of Macedonia*

\**dcernih@yahoo.com*

## Abstract

Seismic activity occurred in the period from June to September 2017 in the Ohrid region were manifested through a sequence of weak to moderate earthquakes. During this period more than 3000 earthquakes were recorded by the telemetric seismological network of the Republic of Macedonia and neighboring countries.

The strongest earthquake occurred on July 3, 2017y, at 11h 18min (UTC). As defined by the Seismological Observatory at PMF-UKIM, the local Richter magnitude of this earthquake was  $M_L=5.0$  and an epicentral intensity  $I_0=VII$  EMS-1998. The epicenter of this earthquake was 10 km east from Ohrid city, in the area of the Skrebatno village. The distribution of epicenters showed activity of the Pestani–Petrino faults in the northern parts of the region, with activity absence in its southern parts. Fault-plane solution of the strongest earthquake and more than 30 events with  $M_L \geq 3.0$ , showed activity of the west part of the Openica fault, as well.

The analysis of the latest events will help prove correlation with the past seismic activity as deduced from the historical records.

**Keywords:** epicentral area, seismicity, seismological network

## 1. Introduction

The territory of Southeast Europe where Republic of Macedonia belongs is one of the seismically most active regions in the continent and consequently a territory characterized by the highest seismic hazard and risk in Europe.

The territory of the country, is a part of the Mediterranean seismic belt, as a part of the Alps-Himalayan orogeny belt as an intra-plate area of active tectonics and high seismicity (Burchfiel et al., 2006). This territory represents a complex geological, tectonic and seismotectonic environment where definition and characterization of seismic zones with a high reliability is quite complex. That part of the Balkan Peninsula has been struck by a number of destructive earthquakes.

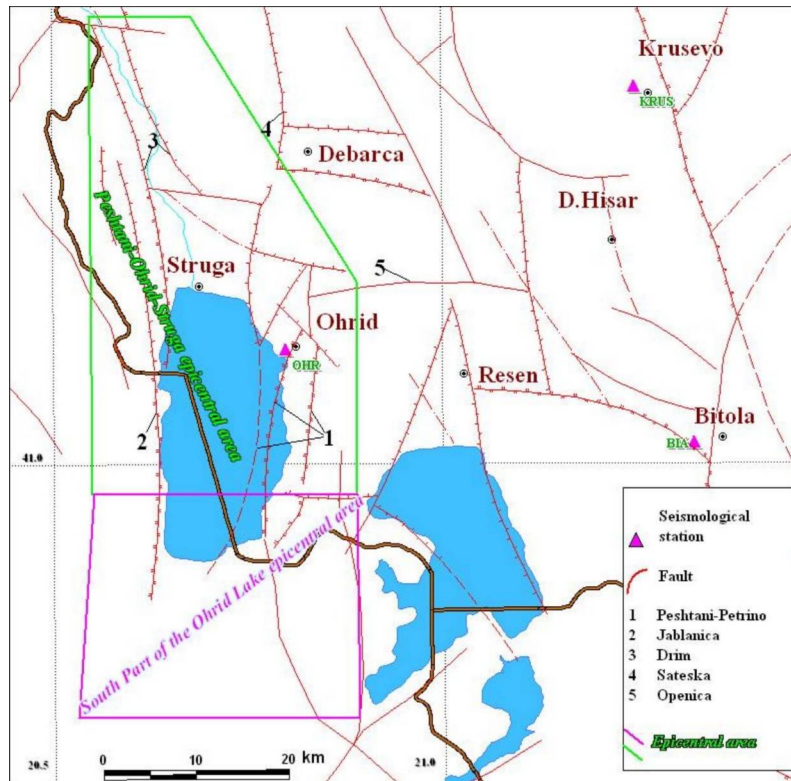
Taking into account these tectonic characteristics, the observed seismic activity of this region is one of the strongest of the peninsula. Ohrid Basin is located within the Dinarides-Albanides-Hellenides mountain chain, a fold-and-thrust belt formed in an Alpine orogeny late phase. [3]. This is a major north-south trending depression structure located on the border between Republic of Macedonia and Republic of Albania, associated with Korce basin in the Dinaride mountain belt [4].

## 2. Ohrid region

Ohrid region is consisted of two epicentral areas: Pestani-Ohrid-Struga and South part of the Ohrid Lake Fig.1. This region is characterized by high seismic activity, frequent seismic microactivity ( $1.0 \leq M_L \leq 2.9$ ), a lot of earthquakes with magnitudes  $3.0 \leq M_L \leq 4.9$  and a few earthquakes with magnitude  $5.0 \leq M_L \leq 7.0$  happened in the past [1].

*Pestani-Ohrid-Struga epicentral area* is represented by the Ohrid valley that subsides between the adjacent terrains, typical horsts from 1.500 m to 2.000 m height. This epicentral area is intersected by tectonic active faults in NE-SW and E-W direction [2]. Some of these faults are completely or partly expressed in the relief [5]. The seismic activity of this epicentral area is influenced by a number of

faults: Pestani-Petrino faults, lying along the east edge of the Ohrid depression, the Jablanica fault, spread out along the west edge of this depression, Drim and Sateska faults lying north of this depression (with meridian direction) and west part of the Openica fault located in the east part of the depression (with E-W direction). Pestani-Petrino faults are linear step-like faults making scarps in the landscape and under the water.



**Figure 1:** Epicentral areas and faults in Ohrid region

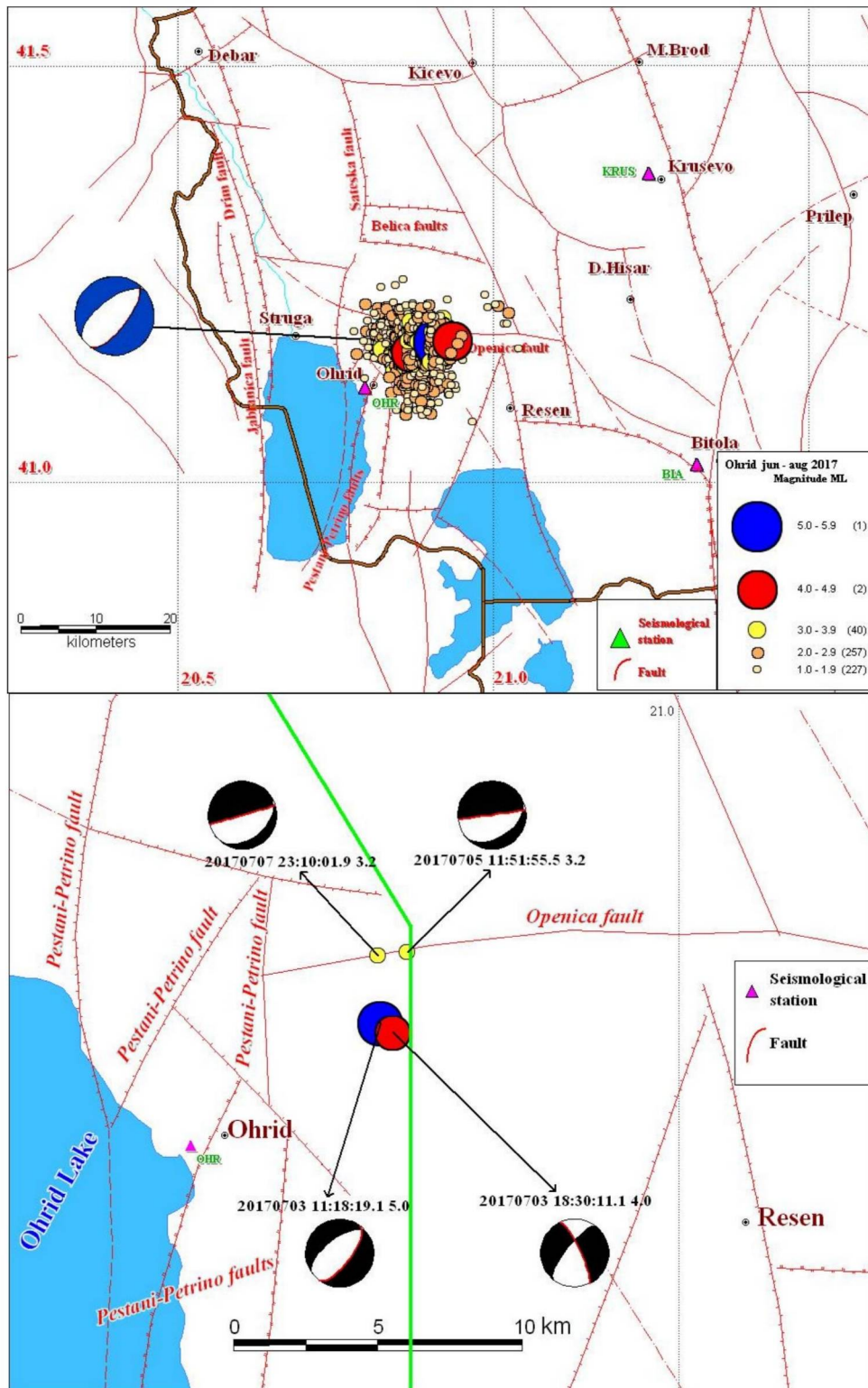
Most active faults in this epicentral area, approximately N-S oriented, are the Pestani–Petrino faults which are contrastively expressed in the relief in the east part of the Ohrid valley.

### 3. Seismic activity in the period June–September 2017

On June 18, 2017 in the epicentral region Pestani–Ohrid–Struga, a sequence of tectonic earthquakes were recorded. The strongest earthquake was on July 3, 2017, with Richter magnitude  $M_L=5.0$  and epicentral intensity  $I_0=VII$  EMS-1998 scale. The epicenters of the whole sequence were located about 10km east from Ohrid city center. They caused concern among the people in Ohrid and neighboring cities and villages and prompted the installation of a temporary station in the vicinity of the strongest earthquake location [6].

More than 3000 earthquakes were recorded in the period (18 of them with  $M_L \geq 3.5$   $I_0 > IV$ , Table 1) according to the Seismological Observatory of the Faculty of Natural Sciences and Mathematics in Skopje. Most of the earthquakes were felt by the local population (Table 2).

According to the previous seismotectonic investigations, the Pestani–Petrino faults are defined as the most active faults in this epicentral area. Source mechanisms of the  $M_L \geq 3.5$  earthquakes from this sequence showed mainly seismic activity of the north part Pestani–Petrino faults and activity of the west part of the Openica fault, as well. Locations of the earthquakes with smaller magnitude lying along the line of north part of Pestani–Petrino and west part of the Openica faults are evidence of this kind of activity.



**Figure 2:** Epicentral map of the earthquakes from the sequence June-September 2017 in the Ohrid region (up), focal mechanism of the strongest and some characteristics earthquakes (down).

**Table 1:** The strongest earthquakes ( $M_1 \geq 3.5$ ) in the Ohrid region, in the period June–September 2017.

Year	Month	Day	h:min:s	$\varphi$	$\lambda$	h(km)	$M_L$	$I_0$
2017	07	03	11:18:18.5	41.17	20.91	1.7	5.00	VII
2017	07	02	09:39:07.4	41.17	20.94	1.0	4.00	VI
2017	07	03	18:30:11.1	41.16	20.87	8.4	4.00	VI
2017	07	05	04:29:32.0	41.13	20.88	7.4	3.90	V-VI
2017	07	03	18:03:22.8	41.18	20.91	2.2	3.90	V-VI
2017	07	04	22:05:15.3	41.17	20.88	7.8	3.80	V-VI
2017	07	06	09:12:55.4	41.16	20.88	6.6	3.80	V-VI
2017	07	07	22:04:11.3	41.18	20.87	7.5	3.70	V
2017	07	12	22:19:53.7	41.16	20.91	7.5	3.70	V
2017	07	08	19:31:33.3	41.17	20.89	9.3	3.70	V
2017	07	08	20:52:58.6	41.16	20.87	9.8	3.60	V
2017	07	03	01:54:11.1	41.15	20.91	8.4	3.70	V
2017	07	07	05:18:26.8	41.14	20.90	9.4	3.60	V
2017	07	04	06:36:39.4	41.16	20.89	7.4	3.60	V
2017	06	20	13:10:33.1	41.20	20.92	1.2	3.60	V
2017	07	07	22:54:31.5	41.14	20.88	6.7	3.50	IV-V
2017	07	04	08:27:53.5	41.15	20.89	5.7	3.50	IV-V
2017	07	03	16:14:13.4	41.17	20.89	5.0	3.50	IV-V

**Table 2:** Number of felt earthquakes from the sequence June–September 2017.

Intensity $I_0$	III	IV	V	VI	VII
$N_0$	477	84	14	6	1

#### 4. Conclusions

During the period June–September 2017, the Pestani-Ohrid-Struga epicentral area experienced a sequence of slight to moderate earthquakes. More than 3000 earthquakes were recorded in that period, with 18 of them with magnitude 3.5 or greater. The strongest earthquake,  $M_L=5.0$ , occurred on July 3<sup>rd</sup>, 2017 with intensity in the epicenter  $I_0=VII$  EMS-1998 scale. Its epicenter and the aftershocks epicenters' were about 10 km east from Ohrid city center.

The seismicity in the Ohrid region is characterized by the occurrence of earthquakes of low magnitudes and rare occurrence of earthquakes with moderate to moderately strong magnitudes. The earthquakes that occurred were with depths of about 15 km (upper, granite layer of the earth's crust).

All this makes it possible to conclude that occurred earthquakes in Ohrid epicentral area are result of the system of Pestani-Petrino faults and activity of the west part of the Openica fault, as well. All this can be connected and is in good agreement with the recent tectonic activity in the region.

The results are expected to be important in hazard and risk assessment for the Balkan Peninsula.

#### References

- [1] Љ. Јордановски, Л. Пекевски, В. Чејковска, Д. Черних, Б. Христовски, Н. Василевски, Основни карактеристики на сеизмичноста на територијата на Република Македонија. Универзитет “Св. Кирил и Методиј”, Природно-математички факултет, Сеизмолошка опсерваторија, Скопје, (1998).
- [2] М. Арсовски, Тектоника на Македонија, Рударско-геолошки факултет, Штип, (1997).
- [3] K. Lindhorst, S. Krastel, K. Reicherter, M. Stipp, B. Wagner, T. Schwenk, Sedimentary and tectonic evolution of Lake Ohrid (Macedonia/Albania), *Basin research*, Manuscript ID: BRE-058-2012.R2, February (2014).
- [4] K. Reicherter, N. Hoffmann, T. Fernández-Steeger, Active tectonic in the Ohrid Basin (Macedonia/Albania), *Geophysical Research Abstracts* **11**, EGU2009-11385, EGU General assembly (2009).
- [5] N. Hoffmann, K. Reicherter, T. Fernandez-Steeger, C. Grutzner, Evolution of ancient Lake Ohrid: a tectonic perspective, *Biogeosciences* **7**, 3377–3386 (2010).
- [6] SORM – Сеизмолошка опсерваторија во Скопје Каталози на земјотресите во Република Македонија и пограничните подрачја, Фонд на Сеизмолошката опсерваторија при Природно-математичкиот факултет – Скопје, (2017).