

Active Tectonic Segmentation on the Micro Plate of Northern Sumatra Based on Distribution of Earthquake Epicenter in July 2020

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ABSTRACT

The main goal of this study to increase awareness of earthquake activity due to local faults that have so far received "less attention". Continuous observations can be made on site (on active faults), by using portable seismographs and/or by utilizing the Indonesia Tsunami Early Warning System (Ina-TEWS) network broadband sensors adjacent to these active faults. However, observing using a Portable Seismograph for a long period of time will certainly require a large amount of money. Therefore, it will be more effective to utilize data from seismic sensors that are relatively close to the suspected faults. Based on the analysis that has been carried out, it can be concluded that, in the period from July 1, 2020 to July 31, 2020, there have been 79 earthquakes in the North Sumatra region, with magnitudes between 2.0 – 5.2. The location of the earthquake was dominated by land earthquakes with shallow depths, namely 0-60 km with 54 events and at sea 25 occurrences. The most earthquake occurrences in the period 01 July 2020 - 31 July 2020 occurred around Cluster 1 (local fault Aceh Central, Batee-A, Aceh South, Pidie Jaya and Lot Aceh North, Seulimeum-South), namely 15 earthquake events, so it is classified as a cluster. which is very active in the July 2020 period. In the July 2020 period, seismic activity around the Tripa 2 and Oreng local faults was low compared to other local faults in Northern Sumatra, while in June 2020 there was no seismic activity around the Tripa local faults. 2, and the Oreng fault.

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1. INTRODUCTION

The Sumatran subduction belt is the line where the Indo-Australian Plate subducts under the Eurasian Plate. The Indo-Australian plate is moving northward at a speed relative to the Eurasian plate of 5-6 cm/year [1]–[5]. This causes the island of Sumatra to have two geological conditions that can affect seismic activity and the tectonic conditions of the island of Sumatra. First, the subduction zone which is the boundary between the Indian-Australian plate which dips into the Eurasian plate. This zone has the potential to cause an earthquake with a relatively larger magnitude so it is very likely to cause a tsunami [6]. Second, the Sumatran fault zone, also known as the Sumatra Fault Zone (SFZ) divides the island of Sumatra into two, stretching along the Bukit Barisan mountains, from the Andaman Sea to the Semangko Bay [7]–[9]. These two zones make the island of Sumatra very vulnerable to earthquakes. The distribution of seismicity and tectonic review in an area can be viewed qualitatively using statistical methods, so that the level of earthquake activity can be known [10], [11]. The purpose of this study is to increase awareness of earthquake activity due to local faults that have so far received "less attention". Continuous observations can be made on site (on active faults), by using portable seismographs and/or by utilizing the InaTEWS network broadband sensors adjacent to these

active faults. However, observing using a Portable Seismograph for a long period of time will certainly require a large amount of money. Therefore, it will be more effective to utilize data from seismic sensors that are relatively close to the suspected faults.

2. DATA AND METHOD

Earthquake record data is very useful because it can provide information on the subsurface geological structure as well as the level of tectonic activity. With one (or more) major earthquake accompanied by many aftershocks, we expect new and better information. In this study, data was collected from the recording of the InaTEWS seismograph sensor network and the results of earthquake analysis using the Seiscomp3 Deli Serdang Geophysical Station in the northern Sumatra region for a period of 1 month from July 1, 2020 to July 31, 2020 in order to display the state of regional tectonic activity. The selected earthquake events are earthquakes with a magnitude <5 SR and are classified based on the range of Magnitude $M < 3.0$; $3.0 \leq M < 4$; and $4 \leq M < 5$.

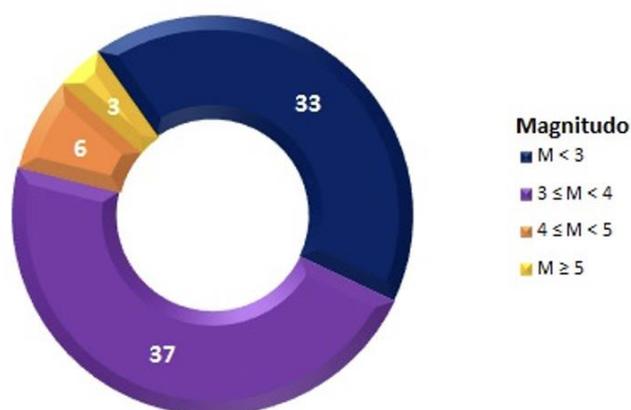


Fig. 1. Diagram of the number of earthquakes by magnitude in the North Sumatra Province July 1, 2020 to July 31, 2020

The high level of seismicity in the North Sumatra region is caused by the subduction of the Indo-Australian Plate which subducts under the Eurasian Plate to the west of Sumatra Island and the large fault of Sumatra Island. Micro-earthquakes recorded in the North Sumatra Province for a period of 1 month from July 1, 2020 to July 31, 2020 were 79 events. With the number of earthquakes $M < 3.0$ as many as 33 events, $3 \leq M < 4$ as many as 37 events, for earthquakes $4 \leq M < 5$ as many as 6 events, and earthquakes $M \geq 5$ as many as 3 events as shown in Figure 1.

3. RESULT AND DISCUSSION

Based on data from the 2017 Indonesia Earthquake Source and Hazard Map from the National Earthquake Study Center Team and research results [7] and summarized in the book on the tectonic face of Northern Sumatra [6]. North Sumatra province is crossed by several faults. Some of these faults have been identified and several parameters are known, such as sliprate and M_{max} value.



Fig. 2. Earthquake clusters in Northern Sumatra in July 2020

Seismicity data due to fault activity in Northern Sumatra from July 1, 2020 to July 31, 2020 is shown in Figure 2. The criteria for determining earthquakes due to fault activity here are that the earthquake occurred on land, the depth was less than 30 km and the magnitude was less than 5. From the seismic data, it can be identified 5 clusters of earthquake sources due to fault activity in Northern Sumatra and its surroundings.

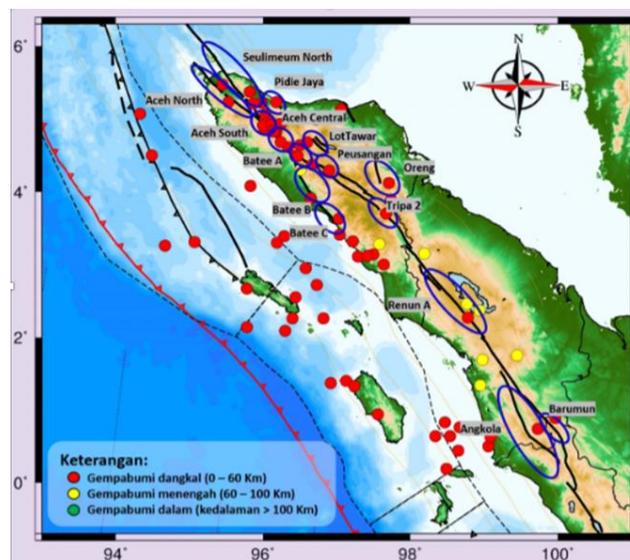


Fig. 3. Seismicity map segmentation due to fault activity in Northern Sumatra 1 July 2020 to 31 July 2020

The results of seismic segmentation of fault activity in the North Sumatra region for the period 1 to 31 July 2020 can be seen in Figure 4. The dominance of the Aceh Central segment/fault in July 2020 occurred 12 times. Based on clusters for the Northern Sumatra region, the results of segmentation or clusters describe Cluster 1 (Aceh North, Seulimeum-South) Judging from the location and depth of the hypocenter, the earthquakes in this area include shallow earthquakes which are thought to be the result of local fault activity in Aceh North and Seulimeum-South which causes rock deformation, thus triggering an earthquake. In the period

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01 July 2020 to 31 July 2020, 15 earthquakes occurred in this fault segment. In cluster 2 (Aceh Central, Batee-A, Aceh South, Pidie Jaya, Lot Tawar), Judging from the location and depth of the hypocenter, the earthquakes in this area include shallow earthquakes which are thought to be the result of local fault activity in Aceh Central, Batee-A, Aceh South, Pidie Jaya and Lot Tawar which caused rock deformation, thus triggering an earthquake. In the period 01 July 2020 to 31 July 2020, 9 earthquakes occurred in this fault segment. In cluster 3 (Tripa-2, Oreng fault), Judging from the location and depth of the hypocenter, the earthquakes in this area include shallow earthquakes which are thought to be the result of the local Tripa-2 fault and the Oreng fault which caused rock deformation, thus triggering an earthquake. In the period from July 1, 2020 to July 31, 2020, there were 3 earthquakes in this fault segment. In Cluster 4 (Renun-A), judging from the location and depth of the hypocenter, the earthquakes in this area include shallow earthquakes which are thought to be the result of the local faults of Barumun and Renun-A causing rock deformation, thus triggering an earthquake. In the period from July 1, 2020 to July 31, 2020, there was 1 earthquake in this fault segment. And in cluster 5 (Barumun, Angkola), Judging from the location and depth of the hypocenter, the earthquakes in this area include shallow earthquakes which are thought to be the result of the activities of the local Barumun and Angkola faults that cause rock deformation, thus triggering an earthquake. In the period 01 July 2020 to 31 July 2020, 2 earthquakes occurred in this fault segment.

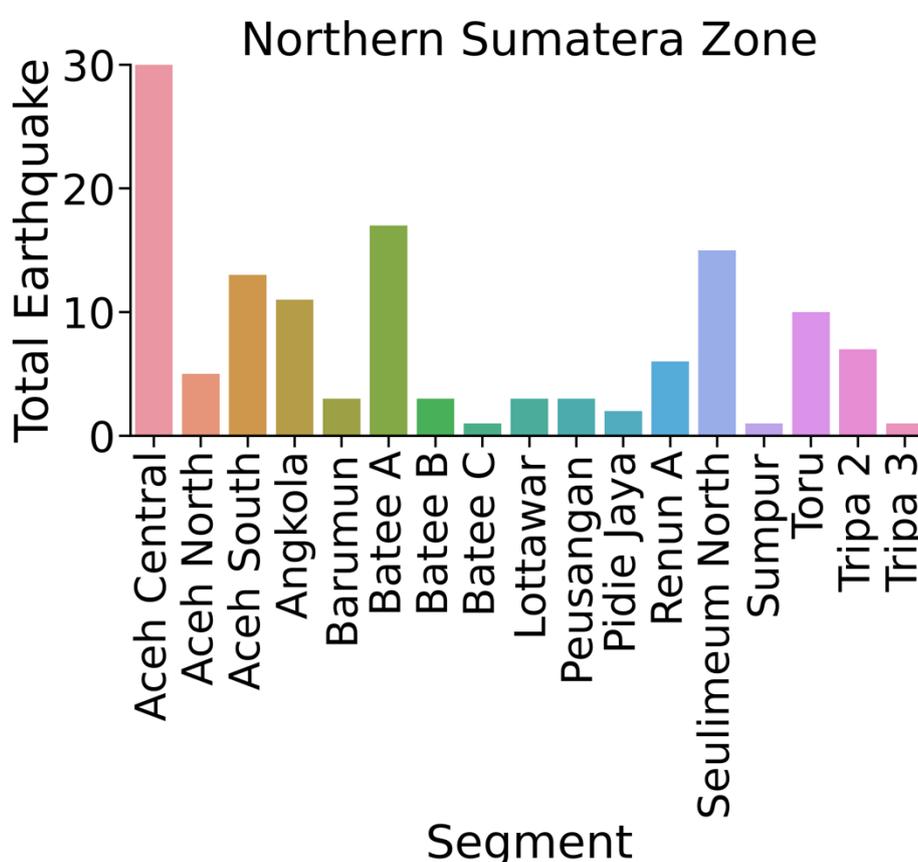


Fig.4. Segment activity analytic data in Northern Sumatra for the period January – July 2020

From the results of the study in July 2020, there was an increase in the activity of the Aceh Central segment from January-June 2020. The increase in earthquake activity in the Aceh Central segment increased by 12 times, bringing the total earthquakes in the Aceh Central segment to 31 events for the period January - July 2020. Analytical data in this study, it can be seen in Figure 5. The local segment in the North Sumatra region itself which is affected by the Toru, Angkola and Renun fault segments/faults in the July 2020 study was reduced.

4. CONCLUSION

Based on the analysis that has been carried out, it can be concluded that, in the period from July 1, 2020 to July 31, 2020, there have been 79 earthquakes in the North Sumatra region, with magnitudes between 2.0 – 5.2. The location of the earthquake was dominated by land earthquakes with shallow depths, namely 0-

60 km with 54 events and at sea 25 occurrences. The most earthquake occurrences in the period 01 July 2020 - 31 July 2020 occurred around Cluster 1 (local fault Aceh Central, Batee-A, Aceh South, Pidie Jaya and Lot Aceh North, Seulimeum-South), namely 15 earthquake events, so it is classified as a cluster. which is very active in the July 2020 period. In the July 2020 period, seismic activity around the Tripa 2 and Oreng local faults was low compared to other local faults in Northern Sumatra, while in June 2020 there was no seismic activity around the Tripa local faults. 2, and the Oreng fault, so that this fault needs to be watched out for. Broadly speaking, the occurrence of earthquakes in an area indicates that the fault activity in the area is active, so it is necessary to pay attention to especially the relatively 'silent' areas located between active faults because the possibility of a strong earthquake is getting bigger.

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