

Present-day Tectonic Regime from Focal Mechanism Data in South Sulawesi

by Seminar Internasional

Submission date: 03-Jan-2019 05:06PM (UTC+0700)

Submission ID: 1061292759

File name: ICoGes_2018_paper_3_Altin.pdf (752.96K)

Word count: 1586

Character count: 8421

Present-day Tectonic Regime from Focal Mechanism Data in South Sulawesi

**Muhammad Altin Massinai*, Muhammad Fawzy Ismullah Massinai,
Mustakima, Erfan Syamsuddin**

Geophysics Dept., Hasanuddin University

*altin@science.unhas.ac.id

Abstract. Focal mechanism used on tectonic regime study which is fault type determination in South Sulawesi. Fault parameter data consist of strike, dip and rake determined based on the first arrival polarity at earthquake waveform manually picked. The result were several beach-ball diagrams on 2010 – 2017 in South Sulawesi. Three reverse-oblique types, normal-oblique type and normal type caused by Palu-Koro Fault. In other pattern, there were Makassar Thrust: reverse type, two strike-slip types and four normal-oblique types. Walennae Fault signed by reverse type. Two reverse-oblique types and two normal-oblique types affected by Parang Loe Fault. All of them showed tectonic regime nowadays in South Sulawesi is complex.

Keyword. Focal mechanism; tectonic; South Sulawesi

1. Introduction

Sulawesi is located in the middle of the Indonesian archipelago which is an island that has impact of the tectonic activity. South Sulawesi is one of the arms of Sulawesi Island which is flanked by two active expansion zones, namely the Makassar Strait and Bone Bay, causing in a very high seismicity in this area [1].

In the area of South Sulawesi, besides some active regional faults, active subduction is also found. The existence of this active subduction can trigger the activity of the faults, so that the level of seismicity is high [2]. Active faults which are the source of earthquake zone include the Palu-Koro Fault in central Sulawesi, Walennae Fault in southern Sulawesi, Matano Fault and Lawanopo Fault in eastern Sulawesi, and the Gorontalo Fault in northern Sulawesi (Fig. 1). For overall, all of the faults which are the earthquake source zone are large-scale horizontal faults [3].

The South Arm Sulawesi tectonic model states that the Makassar Strait is interpreted as the foreland basin on both sides of the Sunda and Australian - New Guinea plates. Meanwhile the pre-Eocene oceanic crust (Lamasi Complex) to West Sulawesi occurred in the Late-Miocene oligocene while the Late Miocene West Sulawesi magmatic arc was thought to be the result of Continentals collisions [4]. This study using focal mechanism which known as one of common method used in seismicity. Energy released from the source of the earthquake and the determination of the type of fault that caused the earthquake based on the nodal plane from the results of the polarity of the hypocenter emitted waves.

Parameters in determining the orientation of the fault plane, [5]:

1. Strike (Φ) is the angle formed between fault direction in the north direction, measured clockwise ($0^\circ \leq \Phi \leq 360^\circ$).
2. Dip (δ) is the angle formed by the fault plane with the horizontal plane measured from the horizontal surface ($0^\circ \leq \delta \leq 90^\circ$).
3. Rake is the angle formed by the strike direction with the slip direction.
4. The relative shift (slip) (λ) is the relative shift in the fault measured from one block to another block in the fault area. Slip is a shift of points that previously coincided. Slip angle (λ), where the slip direction is based on the motion of the hanging-wall, ($-180^\circ \leq \lambda \leq 180^\circ$). If the fault is in the form of thrust fault $\lambda > 0^\circ$, whereas if the fault is normal fault then $\lambda < 0^\circ$.

How to identify the origin properties of this earthquake is called the earthquake focus mechanism. Through this technique every earthquake that occurs can be analyzed by a normal fault, reverse fault, or strike - slip fault. Each direction and slope can also be determined [6].

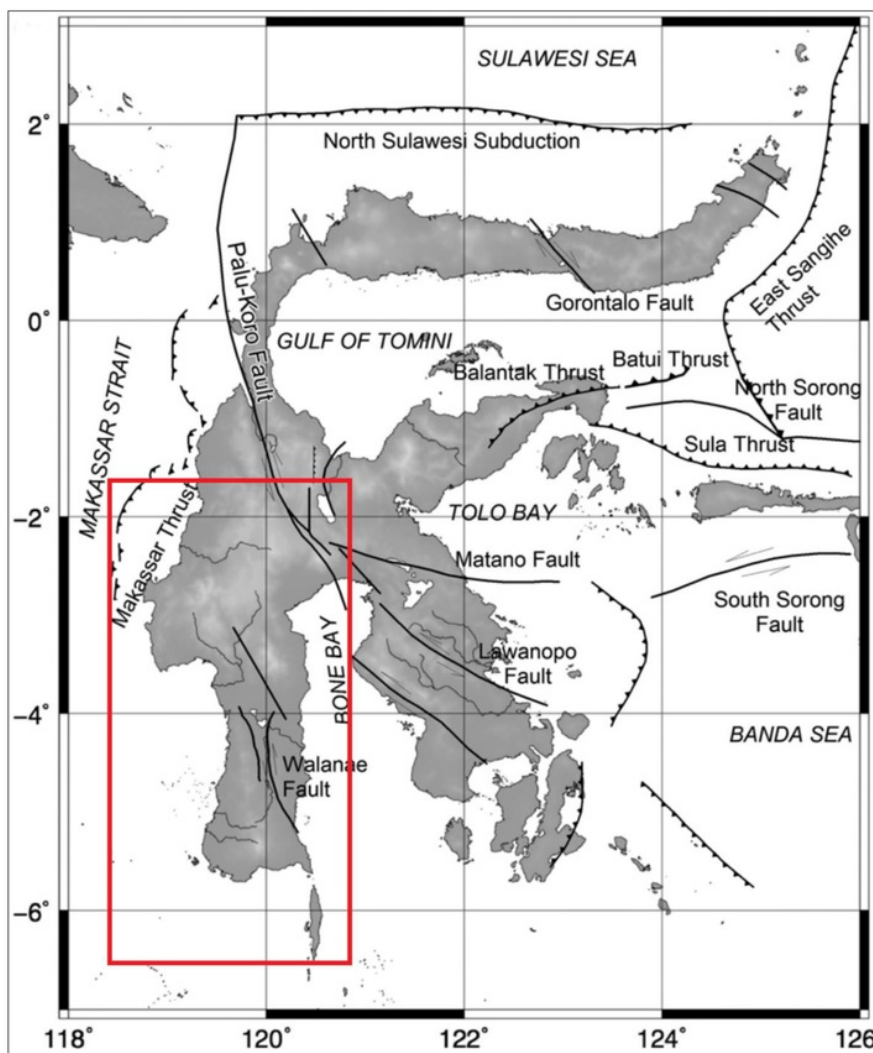


Figure 1. Several active fault in Sulawesi [7]. Red square is research area.

2. Methodology

Research location was conducted in Southern Sulawesi region which is located at the coordinates 2.38° - 5.69° S and 117.24° - 120.64° E.

Research data used were secondary data of earthquake events including origin time, hypocenter coordinates, depth, magnitude and seismogram of earthquake in the South Sulawesi region for the period 2010-2017 from BMKG catalogue.

Focal mechanism was determined using Azmtak [8] code. This code used amplitude polarity from first arrival P-wave. This information got by manual picking from seismogram (Fig. 2).

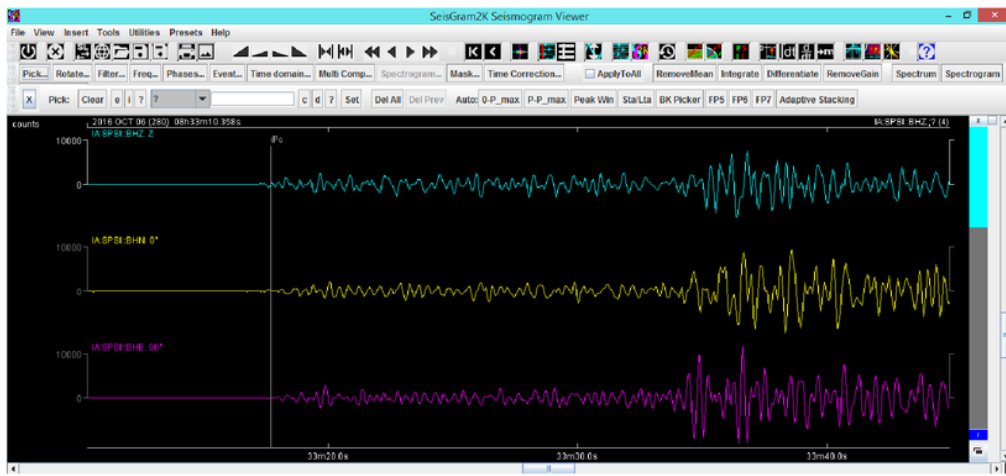


Figure 2. Example of seismogram manual picking which was recorded at SPSI station

Table 1. Example of manual picking result, as input to Azmtak code. + is amplitude have positive value and – is amplitude have negative value

Station	Amplitude
TTSI	+
SPSI	+
PMSI	+
BNSI	+
BKSI	+

Amplitude polarity value converted to numerical value as input to Azmtak code. + is 1 means compression and – is -1 means dilatation. Azmtak code will plot this information, with station coordinates, in spherical coordinate and give output such as strike, dip, rake and beachball diagram. This one result of this research (Fig. 3). In beachball diagram, red box is compression and empty box is dilatation. The validation of this diagram is given by consistent data. Consistent data show right amplitude polarity in right fault plane. If amplitude polarity is positive, so the station should be in the compression fault plane and vice versa. Compression fault plane is black area and white area is dilatation.

Normal, reverse/ thrust, strike-slip and oblique strike-slip fault have unique beachball diagram. Normal fault signed by dilatation fault plane in centroid and have only black-white-black pattern. Opposite with that pattern, white-black-white pattern sign compression fault plane in centroid and it is called reverse/ thrust fault. Strike-slip fault signed by no fault plane in centroid because is on line fault plane. It have four plane and have same wide on diagram. The last is oblique strike-slip fault, have same pattern with strike-slip fault and did not have same wide fault plane.

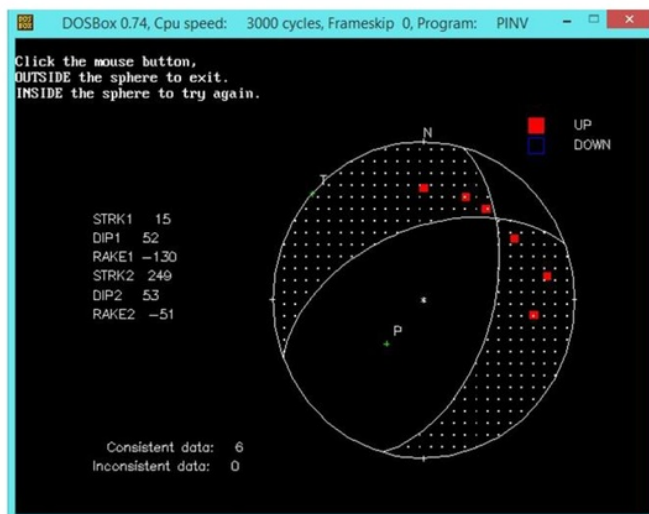


Figure 3. Azmtak code view beachball diagram. The diagram showed oblique strike-slip fault

3. Methodology

3.1 Distribution of Earthquakes that occurred in 2010-2017 period in Southern Sulawesi Region

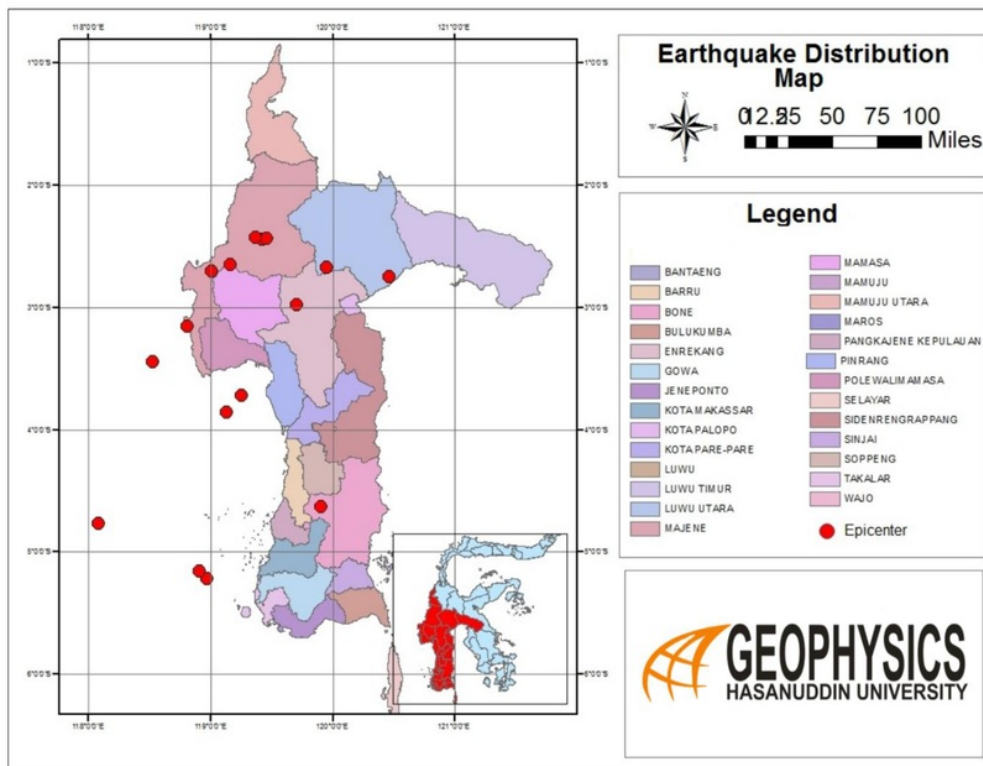


Figure 4. Map of Distribution of Earthquakes in Southern Sulawesi region 2010-2017 period

An earthquake distribution map in the South Sulawesi region obtained the distribution of earthquakes originating on land and ocean as in Fig. 4. There are 16 earthquake events which were shallow earthquakes with depth off to < 80 km in the Southern Sulawesi region. While based on the magnitude or strength of the earthquake is dominated by moderate earthquakes. Condition of seismicity it proves that this research area had characteristics of seismicity approached high frequency at shallow depths that are dominated by moderate earthquakes.

3.2 Distribution of Earthquake Focus Mechanisms in the Southern Sulawesi Region (Period 2010-2017)

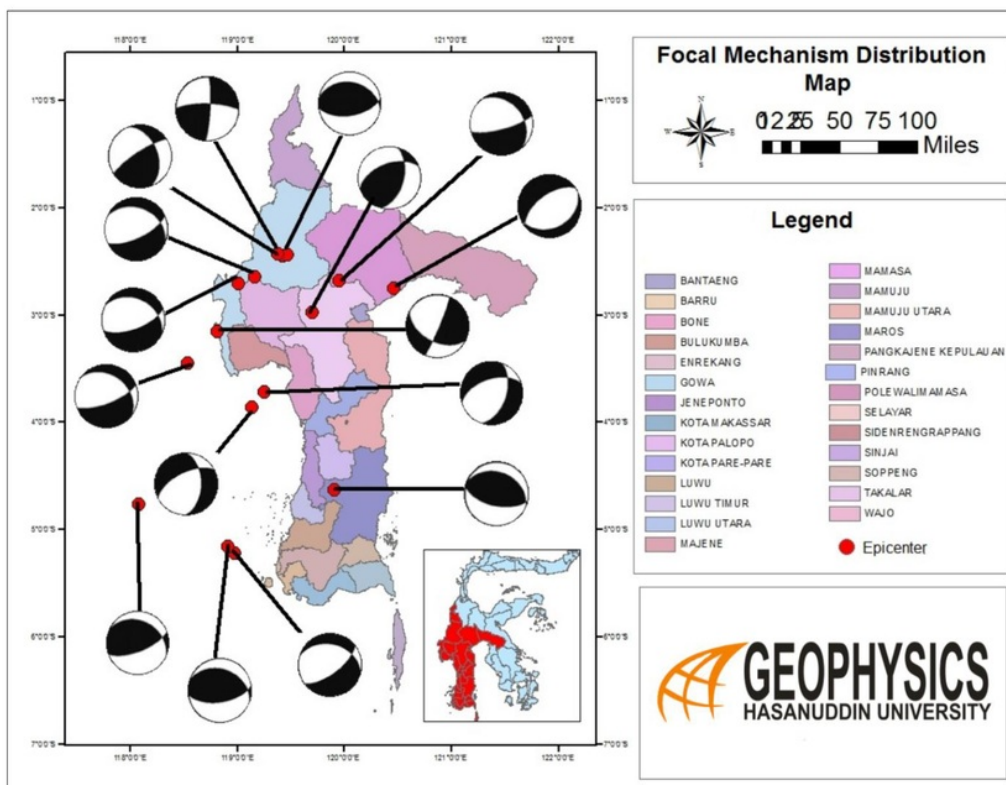


Figure 5. Distribution of Earthquake Focus Mechanisms in the Southern Sulawesi Region Period 2010-2017.

In Fig. 5 there are 16 earthquake focus mechanisms. Each focus mechanism of the earthquake shows that there are four forces that are perpendicular and as large as each earthquake. The black colour of the earthquake focus mechanism shows that ground motion causes the earthquake to be polarized as repulsive or compressed, while the white color on the focus mechanism shows ground motion causing the earthquake to be polarized as an attractive or dilated motion.

Based on 16 earthquakes there were 3 strike - slip faults, 2 reverse faults, 1 normal fault, 7 oblique faults and 3 oblique faults. It can be seen that this earthquake is dominated by oblique faults. The analysis obtained from these 16 focals was that Southern Sulawesi was affected by oblique fault patterns, although there are other fault patterns obtained.

It can be seen in Figure 5 that the northside there are three earthquake points of the upper right are the reverse oblique fault, in addition normal oblique fault, and the normal fault affected by Palu - Koro

Fault which spread from Palu through northside of South Sulawesi to South Bone until Banda Sea. Whereas, the 7 upper left side earthquake points are reverse faults, 2 strike - slip faults, 4 normal oblique faults which are affected by Makassar Thrust (Makassar Strait) striped from coast of Mamuju beach, West Sulawesi diagonal cut across middle of South Sulawesi region then Southern South Sulawesi, namely Bulukumba City to the eastern area of Selayar Island and 1 point in central earthquake point, as a reverse fault affected by Walanae Fault. Then 2 earthquake point in the central, namely each normal oblique fault and 3 earthquake point on lower, namely a reverse oblique fault, reverse oblique fault and a normal oblique fault which is affected by Parangloe fault.

4. Conclusion

Based on the results and discussion of this research it can be concluded that:

1. The earthquake that occurred in the Southern Sulawesi region in the period 2010-2017 was dominated by the type of moderate and shallow earthquakes with a high level of seismicity in the study area.
2. Fault types that occur in earthquakes in the South Sulawesi region in the period 2010-2017 are generally oblique fault pattern which is affected by Palu - Koro Fault, Makassar Strait, Walanae Fault and Parangloe Fault.

References

- [1] Massinai M A and Nakir M N 2009 *Proc. PIT HAGI* p.12 – 15.
- [2] Massinai M A, Sudrajat A, Lantu 2013 *Journal of Engineering and Technology* **3** 945 – 948.
- [3] Massinai M F I, Lantu, Aswad S, Massinai M A 2015 *AIP Conference Proceedings* **1658** 030013-1 – 030013-10.
- [4] Surono and Hartono U 2015 *Geologi Sulawesi* LIPI Press: Jakarta.
- [5] Okal E A 2011 *Earthquake, Focal Mechanism* USA Springer Science+Business Media B. V. Evanston, II. 60208.
- [6] Santoso D 2002 *Pengantar Teknik Geofisika* Bandung: Penerbit ITB.
- [7] Cipta A, Robiana R, Griffin D, Horspool N, Hidayati S, Cummins P 2016 *Geol Soc London Spec Publ* **441** <http://doi.org/10.1144/SP441.6>
- [8] Suetgusu D 1997 *Source Mechanism Practice Lecture notes International Institute of Seismology and Earthquake Engineering* Tsukuba Japan.

Present-day Tectonic Regime from Focal Mechanism Data in South Sulawesi

ORIGINALITY REPORT

1 %	0 %	1 %	0 %
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Steven C. Bergman, Dana Q. Coffield, James P. Talbot, Richard A. Garrard. "Tertiary Tectonic and magmatic evolution of western Sulawesi and the Makassar Strait, Indonesia: evidence for a Miocene continent-continent collision", Geological Society, London, Special Publications, 1996	1 %
	Publication	

Exclude quotes On
Exclude bibliography On

Exclude matches < 5 words