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Abstract—Determination of onset time precursors of strong earthquakes for Padang 2009 and Mentawai 2010. We are using geomagnetic data from Geomagnetic station KTB, Sumatra and two station references DAV, Philippine and DAW, Australia. Separate techniques are required in its determination. Not the same as that recorded in the kinetic wave seismograms can be determined by direct time domain. Difficulties associated with electromagnetic waves seismogenic activities require analysis of the transformed signal in the frequency domain. Determination of the frequency spectrum will determine the frequency of emissions emitted from the earthquake source. We analyze signal ULF emission with associated strong earthquake in Sumatra period 2009 – 2010 for Padang earthquake 2009 and Mentawai earthquake 2010. The aim is to analyze the power amplitude of the ULF emissions in the horizontal component (H) and vertical component (Z). Polarization power ratio $S_Z/S_H$ is used for determining the sign of earthquake precursors controlled by the standard deviation. The pattern recognition polarization ratio should be obtained which can differentiate emissions from seismogenic effects and geomagnetic activity. ULF emission patterns generated that seismogenic effect has duration > 1 days before event. The dominance of emission intensity recorded at the Z component and for the dominance of the emission intensity of geomagnetic activity recorded in the component H. The result shows that the onset time is determined when the polarization power ratio $S_Z / S_H$ standard deviation over the limit ( $p \pm 2 \sigma$ ) which has a duration of > 1 days.

Keywords—component; Earthquake precursor, polarization ratio, Onset time, ULF emission and Sumatra Earthquake.

I. INTRODUCTION

Earthquake precursor studies using data geomagnetic has been widely reported by several researchers Hattori et al [1-4]. The result is still the problem of how to determine the signature and how the onset time precursor as anomaly earthquake associated with ULF emissions determined?. This study tried to answer the earlier problems by analyzing the pattern of earthquake precursor emissions associated with ULF $f = 0.023$ Hz, it is based on reports from Ismaguilov et al. [5 and 6] report is the seismogenic frequency spectrum $f = 0.02 - 0.05$ Hz, it has also been strengthened by Hattori et al. [2] using frequencies in the range $f = 0.01$ Hz. Yumoto et al. [7] also uses frequencies in the range $f = 0.01 - 0.022$ Hz. This spectrum used to investigate a strong earthquake Padang 2009 and Mentawai 2010. Result of the earthquake investigation eventually led to a question of how relations earthquake magnitude and distance to the length of ULF emissions recorded in the magnetogram.

II. DATA AND METHOD

These research is to analyze the data geomagnetic with associated strong earthquake Padang 2009 and Mentawai 2010 using BMKG catalog previously been conducted by Ibrahim et al. [8]. This research uses data during nighttime (23.00 – 04.00 local time) and an increase in the signal processing analysis. Data selection when a quiet day that the monitoring by geomagnetic index Dst (Dissurbence Storm time). We are using geomagnetic reference station DAV (Davao in
Our goal to observe the earthquake did not occur when storm or sub storm. In the same way we determine the precursor to a strong earthquake in Sumatra within ≤ 500 km from KTB. We also choose a quiet day at the station and for comparison the DAV (Davao, Philippines) in the north and DAW (Darwin, Australia) in our South also collected data on strong earthquake within ≤ 500 km from the station. And we selected earthquakes recorded at stations DAV does not occur simultaneously or ± 10 days when the earthquake occurred in Sumatra. From here we get an earthquake in Sumatra will be chosen completely clean of another earthquake disturbances in comparison with reference station.

The polarization ratio using power spectral analysis of the ULF emission is a collection contains variety of frequencies are presented in the frequency domain. It is clearly observed that polarization showed a remarkable pre-seismic enhancement [1], Previous research is a possible to determine the pattern of anomalies caused by magnetic disturbances from lithosphere [9-11], and polarization ratio (Z/H) gradual decrease about one month before the Earthquake and recover within 2 week after earthquake [12].

We have been done analyze the Power Spectral Density Spectral (PSD) used with the Welch method of dividing the length of the signal (N data) into several segments, overlapping 50% on each segment [8]. FFT performed on each segment called nFFT the use of type window and type Hamming window of length L = N + 1. Standard deviation need to control and determination onset time. We determination onset time if polarization power ratio Z/H cross moving average from standard deviation.

III. RESULT AND DISCUSSION

From the results of research that has been done by developing a technique polarization power ratio $S_Z/S_H$ to the timing of onset is still hard to do. But here we got a conviction in which each earthquake occurrence by using spectrum analysis on each component found an intensity anomaly where if there is interference with geomagnetic disturbances external to the component response intensity H has a higher frequency than the component Z. we using Dst Index for control geomagnetic activity in low latitude [8 and 12] in Fig. 2.

We showing response frequency if with associated seismogenic, Z comp. have intensity response more than H comp. This is The Padang earthquake September 30, 2009 with a quiet day (no geomagnetic activity) in Fig. 2. Analysis spectrum with polarization rasio $S_Z/S_H$ for determination onset time and lead time to Padang earthquake showing in fig.3.
Figure 4. Top panel (A) is Dst index (black line) (WDC-Kyoto Univ.[14]) in period August 21 – October 10, 2009 was quiet and the middle panel KTB (black line) shown information anomaly ULF emission with onset time September 06 – event (lead time) with shown crossed the line standard deviation ($p+\sigma$, $p-\sigma$). For below panel is station geomagnetic reference DAV and DAW shown not Information ULF emission all period.

Figure 5. Mentawai earthquake 25 October 2010 showing when event. Top Panel is Dst Index from WDC Kyoto University Japan dan Low panel are comp. H and Z for raw data, diff data and spectrogram.

In Fig.5 low panel in spectrogram showing frequency response in component H and Z. we selected spectrum frequency is $f = 0.022$ Hz and showing Polarization power ratio for mentawai Earthquake 2010.
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IV. CONCLUSIONS

We have found that electromagnetic frequencies generated from the earthquake source is in the range \( f = 0.02 \) to 0.06 Hz for frequencies below or above it is caused by disturbance from outside. Molchanov and Hayakawa [11] have modeled the effects of microfracturing which shows the angular frequency \( < 0.1 \) Hz. Frequency intensity response type effects occur seismogenic the Z component is more dominant than the components of H. we determination onset time using technic polarization ratio \( Z/H \) with using standard deviation \( (p \pm 2 \sigma) \) if the signal cross moving average standard deviation we determine as onset time.

Thus the confidence to build an earthquake early warning to the precursor of the ULF emission is in sight, although still far from the earthquake prediction. With the method carried out by previous researchers and the development of methods that we do so we add a new contribution which we can know the objective connection between ULF emission with the magnitude, epicenter distance so that with this method, at least we can know how big an earthquake will the earthquake occurred and the distance of the monitoring stations, even though we have not been able to find out where the fault position is going to happen. Further

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REFERENCES


