HYPOCENTER DISTRIBUTION OF LOW-FREQUENCY EVENT AT PAPANDAYAN VOLCANO

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ABSTRACT

Papandayan volcano is a stratovolcano with irregular cone-shaped has eight craters around the peak. The most active crater in Papandayan is a Mas crater. Distribution of hypocenters calculated using Geiger Adaptive Damping Algorithm (GAD) shows that the epicenter of the event centered below Mas crater with maximum RMS 0.114. While the depth of the hypocenter range between 0-2 km and 5-6 km due to the activity of steam and gas.

Keywords: Papandayan; Geiger adaptive damping; low-frequency

Introduction

Papandayan volcano located at 7°19’00" S and 107°44’00" E with 2.665 m height. Papandayan was stratovolcano with classified A type.[1] The volcano shapeis irregular cone-like that cut on the top. This shape affected by composition of lava flow and debris avalanche.[2] There are eight craters on the Papandayan volcano, Bungbrung, Tegal Alun-alun, Parugpug, Papandayan, Mas crater, Baru crater, Nangklak crater and Manuk crater. After eruption on november 2002, it was formed 4 new craters (Figure 1). Only one crater was not filled with water, and the others were filled with water mixed by mud, bluish-green water and green water.[3]

Papandayan also an andesitic volcano which located on west java. Sunda magmatic was formed by the movement of Indo-Australia plate and Eurasia plate to the north. Hydrothermal is the most common activity at Papandayan volcano. It has crater whose horseshoe-like shape with diameter 1.6 km.[4] Volcanic structure composes with andesitic lava accumulated by pyroclastic deposit with the change between basalt and andesitic lava.[5]

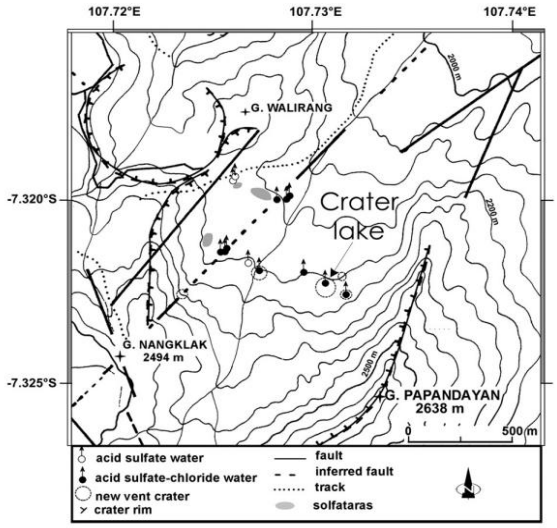

Figure 1. Location of fumarole at Papandayan volcano. Fault and crater arised after eruption on November 2002.[5]

Hydrothermal activity was shown by fumarole manifestation indicated gas emission, sulfate mud pool, and several

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opening at Mas crater, Manuk crater, Nangklak crater, and Baru crater. An Indication of water at Papandayan volcano (except magma) denotes dynamical activity at Papandayan. Therefore, Papandayanis well-known wet volcano.[4]

Figure 2. Instalation of seismometers CMG-40T at Sedep (SED).

Figure 3. Location of seismometers around Papandayan.

Methods

In this research, data recorded of Low-frequency events (LF) between 1 – 15 September 2015. Used 6 seismometers, Guralph CMG-40T and Guralph CMG-3T with sampling frequency100 sample/s (Figure 2). Installation of Seismometers located beneath surface with 80-100 cm depth.

Location of seismometers was (Table 1) Cileuleuy (CLL), Cisaruni (CSR), Gunung Jaya (GJY), Parkir (PAR), Sedep (SED) and Tegal Alun (TGL) (Figure 3).

The Hypocenter of LF events was calculated using Geiger Adaptive Damping (GAD) algorithm.[6] This method was a modification of Geiger with an automatic damping factor on its inversion in order to get solution convergence. The following equation of inversion,

$$m = (G^T G + \lambda I)^{-1} G^T d \quad (1)$$

Where G kernel matrice is the first order of partial differential of travel time equation with hypocenter parameter. λ is the damping factor, I is identity matrix and d is observation data. Flow chart of GAD algorithm was shown in Figure 4.

Determination of hypocenter was influenced by the accurate of arrival time picking on P and S wave also good velocity model beneath Papandayan volcano. Velocity model used in this work based on Kristianto[3] velocity model (Table 2).

Table 1. Seismometers around Papandayan

No	Seismometers	Lat	Lon
1	GJY	7,303	107,759
2	CSR	7,358	107,74
3	PAR	7,307	107,738
4	TGL	7,323	107,722
5	CLL	7,305	107,684
6	SED	7,261	107,661

Table 2. Velocity model beneath Papandayan volcano

V_p (km/s)	V_s (km/s)	h (km)
2.5	1.42	0.5
2.75	1.571	0.7
3.00	1.714	3
4.50	2.571	6
8.00	4.571	100

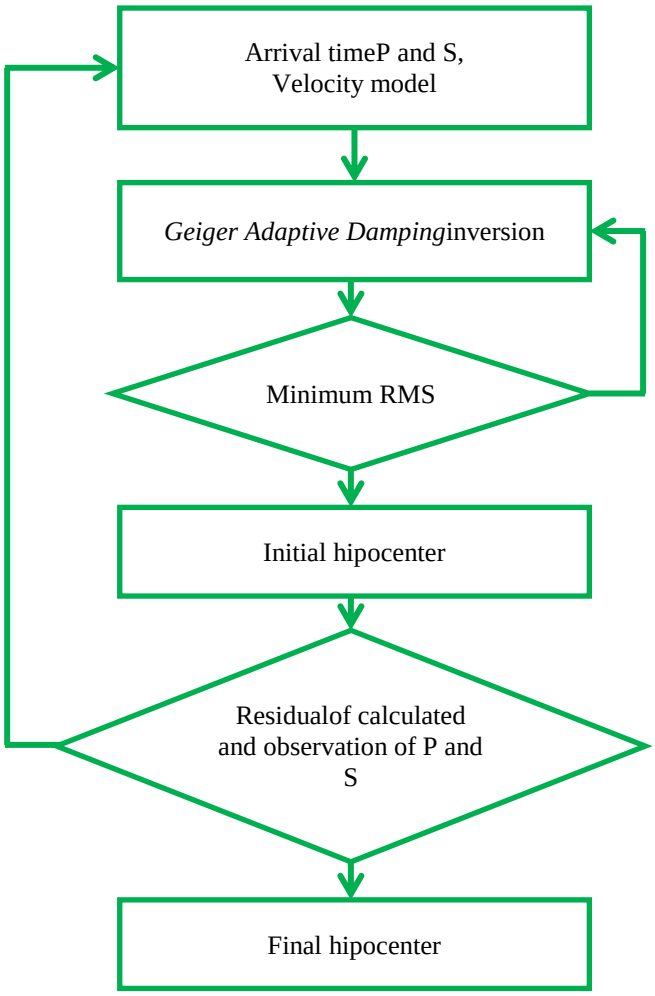

Figure 4. Flow chart of estimation hypocenter

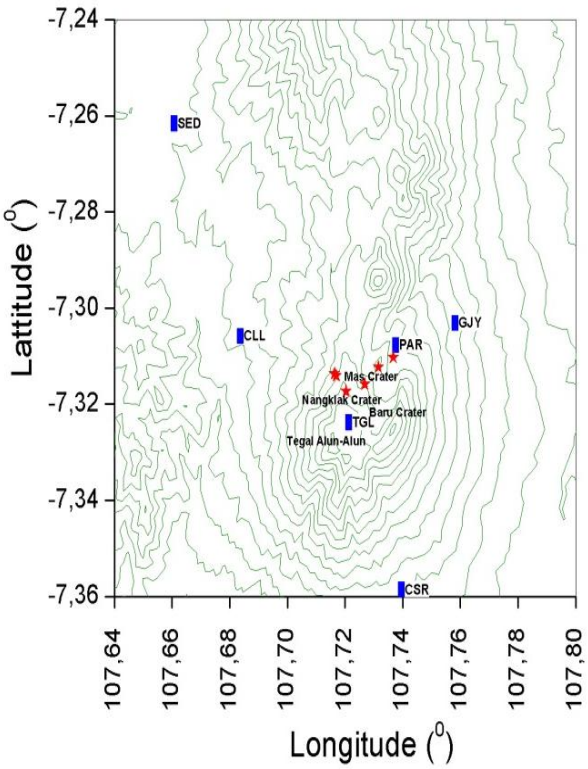

Figure 5. The epicenter of LF events at Papandayan.

Result and Discussion

The results of inversion using GAD algorithm showed the variation of RMS between 0.020 and 0.114 (Table 3). Distribution of hypocenter based on depth divided into two groups. First, the depth between 0-2 km and second, 5-6 km.The following distribution of hypocenter is figure out in Figure 5 and Figure 6.

In Geiger method, a solution of inversion difficult to be convergent, although initial guess of hypocenter parameter has good accuration.[7] A solution of convergence problem using a damping parameter in inversion for minimizing instability of parameter solution and decreasing error in predicting data and inverting solution.[8]

Menke[9] suggested in providing a damping parameter must give full attention in order to obtain good inversion solution. Solving this problem, Nishi[9] proposed automatic damping parameter for decreasing RMS. It shows the maximum RMS of hypocenter attained only 0.114 (Table 3).

Table 3. Hipocenters of LF events.

No	Date	Magnitude	Lattitude	Longitude	Depth (km)	Origin Time (s)	RMS
1	01-09-2015 07:23	0.245	7.314	107.717	0.707	9.041	0.114
2	07-09-2015 08:56	0.245	7.310	107.737	6.054	24.417	0.123
3	10-09-2015 07:54	0.789	7.316	107.727	5.673	9.565	0.022

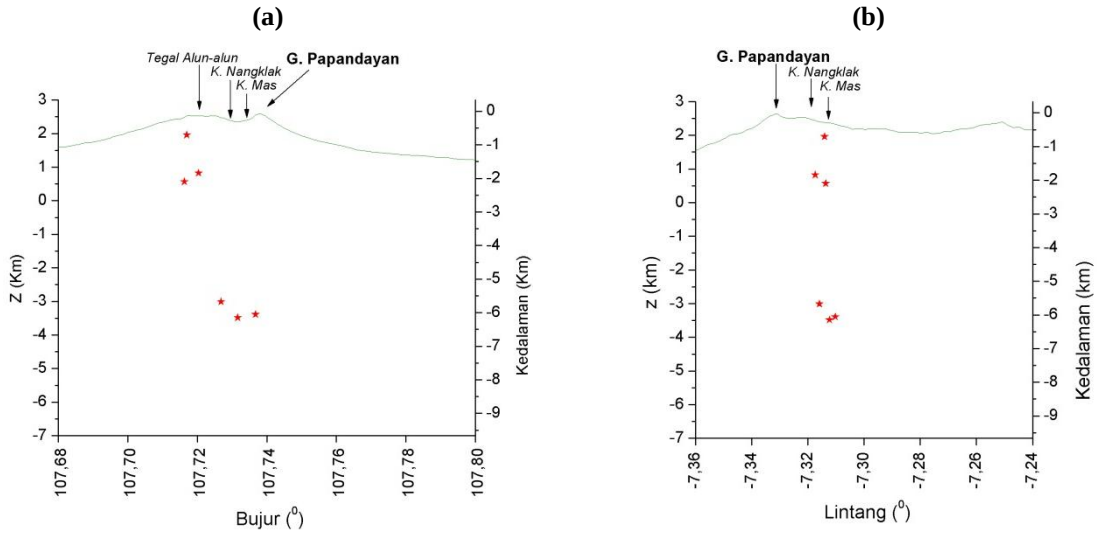

Figure 6. a. Cross-section profile of hypocenter east-west. **b.** Cross-section profile of hypocenter north-south.

Triastuty[11] mentioned that Mas crater is the most active crater with Nangklak inside it with LF events generated by steam and gas in the fracture zone (Figure 5). Depth of hypocenter divided into two groups, 0.5-2 km[4] and 2.5-4 km.[11] Figure 6 shows the depth of hypocenter between 0-2 km and 5-6 km. These are consistent with previous research although having different depth span. The differences were caused by interpretation in picking arrival time of P and S wave.[10]

Conclusion

LF events at Papandayan distributed beneath Mas crater and Nangklak crater with the depth between 0-2 km and 5-6 km. These occurence can be interpreted as the activity of water, steam, and gas.

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