MITIGASI ERUPSI GUNUNG API

Hendra Gunawan
Kepala Pusat Vulkanologi dan Mitigasi Bencana Geologi,
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KEMENTERIAN ENERGI DAN SUMBER DAYA MINERAL
Ministry of Energy and Mineral Resources

BADAN GEOLOGI
GEOLOGICAL AGENCY

PUSAT VULKANOLOGI DAN MITIGASI BENCANA GEOLOGI
Center for Volcanology and Geological Hazard Mitigation

Jalan Diponegoro, No. 57
Bandung 40122, Indonesia
+62 22 7271402; +62 22 7272606
+62 22 7202761
pvmbg@esdm.go.id
http://www.vsi.esdm.go.id/

RUANG LINGKUP

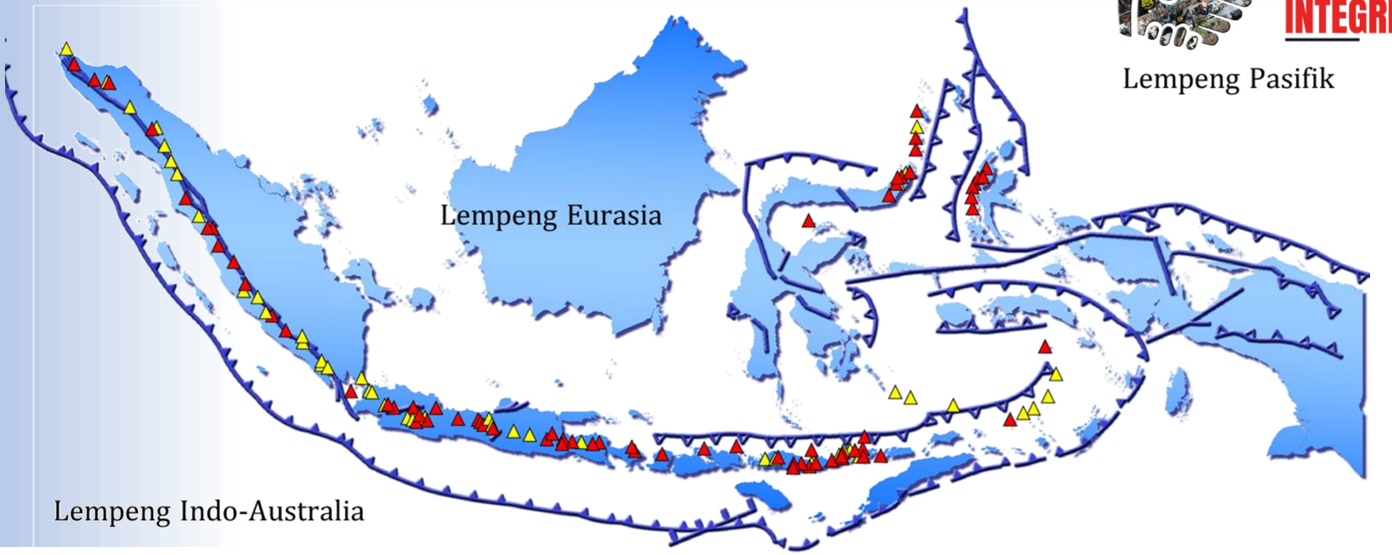
MITIGASI BENCANA GEOLOGI

POTENSI		DAMPAK
• 127 aktif • 20 Status di atas normal • 5 juta jiwa di dalam KRB	**Gunungapi**	Meninggal: • 200 ribu jiwa (<1980) • 450 jiwa (>1980) Diungsikan: • > 750 ribu jiwa (>1980)
•1300 kejadian 5 tahun terakhir •60 % rawan gerakan tanah •40,9 juta jiwa di wilayah rawan	**Gerakantanah**	200 jiwa meninggal /th 4 ribu bangunan rusak /th 400 Ha pertanian rusak / th
• 7000 km jalur subduksi • > 3000 km jalur sesar aktif • 150 juta penduduk terpapar • 5 juta jiwa terpapar tsunami	**Gempabumi dan Tsunami**	¼ juta jiwa meninggal (> th 2000)

MITIGASI BENCANA

BENCANA GEOLOGI DI INDONESIA

PEMBANGUNAN ZONA INTEGRITAS PVMBG



Gunungapi

- 127 gunungapi aktif dan 69 diantaranya dipantau secara menerus oleh PVMBG;
- 8 gunung api yang erupsi di tahun 2021 dengan jumlah jiwa yang terselamatkan ~3 juta jiwa

Gempa Bumi

- 12-15% gempa bumi di dunia terjadi di wilayah Indonesia;
- Dalam 31 tahun terakhir setidaknya telah terjadi 228 gempa bumi merusak, menyebabkan lebih dari 280 ribu korban jiwa.

Tsunami

- Probabilitas kejadian tsunami dengan ketinggian inundasi > 3 meter terjadi sekali dalam 10 – 50 tahun;
- Dalam 31 tahun terakhir telah terjadi 20 kejadian bencana tsunami.

Gerakan Tanah

- > 1000 kejadian gerakan tanah dalam satu tahun terjadi di Indonesia
- Gerakan tanah pada umumnya meningkat tiap musim penghujan
- Jumlah korban jiwa tidak berbanding lurus dengan jumlah kejadian

LAYANAN KEPADA MASYARAKAT MERUPAKAN HILIR MITIGASI

Berdasarkan **Peraturan Presiden Nomor 9 Tahun 2016 dan Peraturan Menteri Energi dan Sumber Daya Mineral Nomor 13 Tahun 2016:** Kewenangan dan tanggung jawab dalam penyusunan peta Kawasan rawan bencana gunung api, gempa bumi, tsunami dan longsor dilakukan oleh Badan Geologi Indonesia (PVMBG).

Data Dasar

Potensi Bahaya

Peta Bahaya

Penyiapan Data Dasar Bahaya Geologi; Pemetaan.

Pemantaua

Peringatan Dini
(Gunungapi dan Gerakan Tanah)

Penyusunan NSPK, rencana dan program mitigasi bencana geologi

Layanan PVMBG:

- Pendampingan & Rekomendasi Teknis
- Tanggap Darurat **& Pasca Bencana** / Kaji Cepat
- Pengurangan Risiko Bencana
- Acuan Tata Ruang
- Peningkatan Kapasitas
- Perpustakaan
- Web, MAGMA Indonesia – Android, Media Sosial
- Webinar PVMBG
- GeoShare

Pemangku Kepentingan

KENAPA INSTANSI PEMERINTAH ?

berAKHLAK

TANTANGAN KEBENCANAAN GEOLOGI

- Hidup berdampingan dengan bahaya geologi
  - Bertambahnya populasi manusia di Kawasan Rawan Bencana Geologi
  - Pemukiman dan infrastruktur vital dan strategis di KRB Geologi
  - Kebutuhan ruang yang semakin meningkat mengarah ke KRB Geologi
  - Rendahnya kapasitas masyarakat dalam pemahaman bahaya geologi

RISIKO BENCANA

STRATEGI MITIGASI BENCANA GEOLOGI

PENGURANGAN RISIKO BENCANA

UPAYA MITIGASI BENCANA GEOLOGI

PERSPEKTIF SUMBER

DARI MANA DATANGNYA?

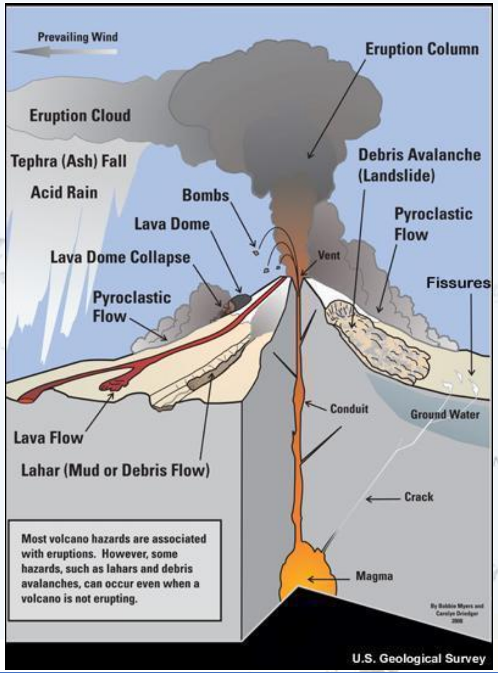
-PENELITIAN (IDENTIFIKASI SUMBER)
-PEMANTAUAN

PERSPEKTIF DAERAH TERDAMPAK

DAERAH MANA YANG PALING RAWAN?

- PERINGATAN DINI
- PEMETAAN KAWASAN RAWAN BENCANA

Peta Kawasan Rawan Bencana (KRB) Gunung Api



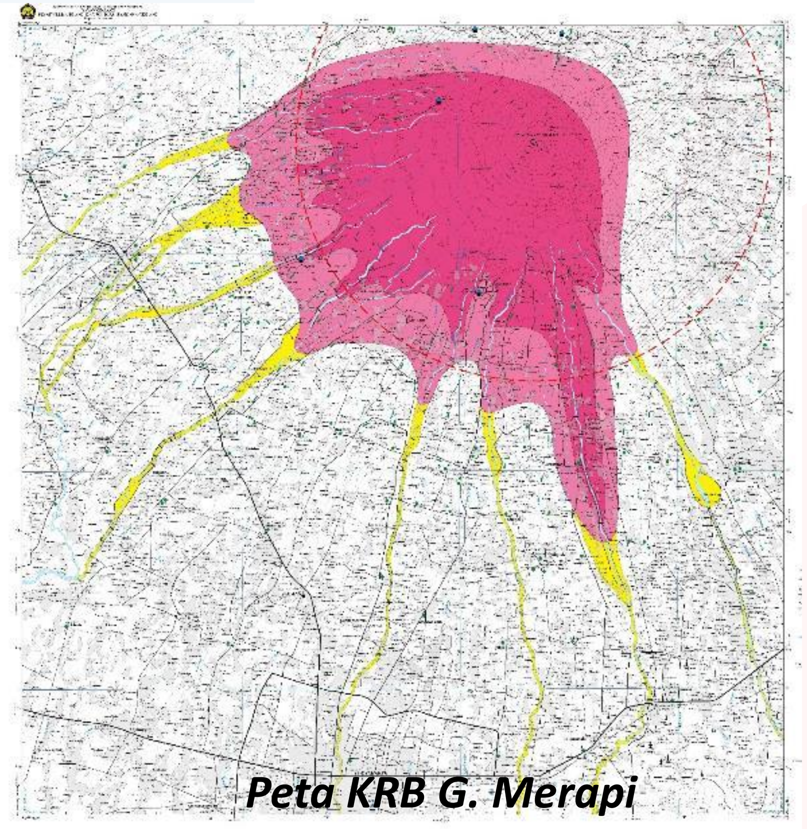
- Geomorfologi
- Geologi
- Sejarah Kegiatan
- Distribusi produk erupsi terdahulu
- Penelitian, Studi Lapangan & Pemodelan

Kawasan Rawan Bencana Gunungapi adalah kawasan yang *pernah terlanda atau diidentifikasikan berpotensi terancam bahaya erupsi gunungapi* baik secara langsung maupun tidak langsung. (*SNI KRB Gunungapi, 2011*)

Peta Kawasan Rawan Bencana Gunungapi adalah *peta petunjuk tingkat kerawanan yang berpotensi menimbulkan bencana* di suatu kawasan apabila terjadi erupsi gunungapi. (*SNI KRB Gunungapi, 2011*)

Analisis & Overlay

- KAWASAN RAWAN BENCANA GUNUNGAPI III
- KAWASAN RAWAN BENCANA GUNUNGAPI II
- KAWASAN RAWAN BENCANA GUNUNGAPI I



Peta KRB G. Merapi

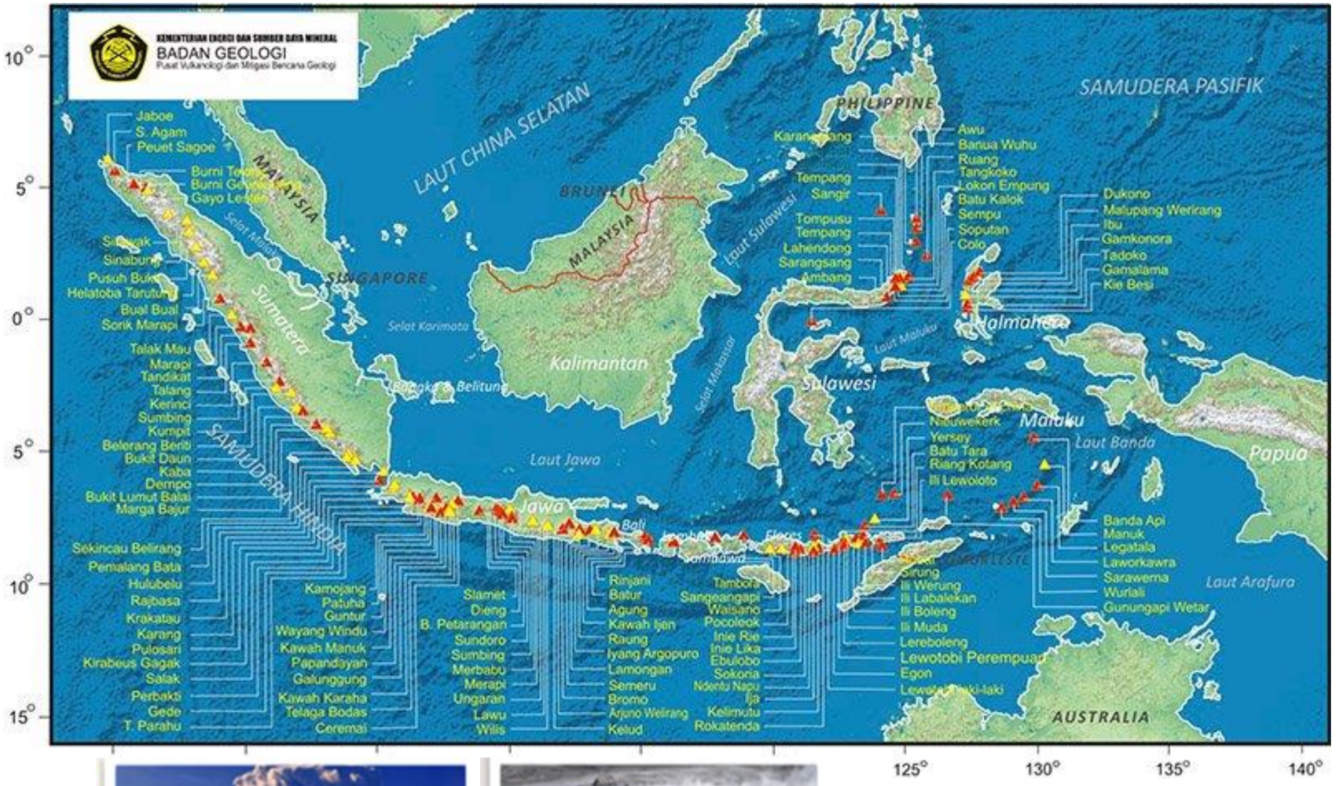
KOLABORASI LABORATORIUM : next STEP

ICP-MS

XRF

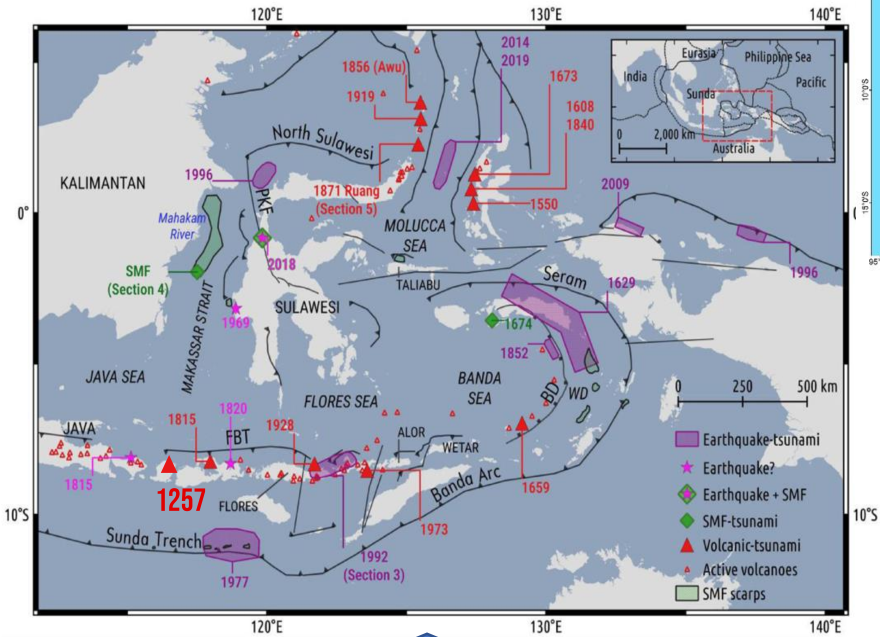
XRD

GUNUNG API DARAT



GUNUNG API LAUT

6 gunungapi bawah laut di Indonesia: Hobal, Yersey, Nieuwerkerk, Emperor of China, Banua Wuhu dan Sangir/Submarine1922.
Pernah memicu Tsunami: G. Hobal (NTT) dan G. Banua Wuhu (Sulawesi Utara).

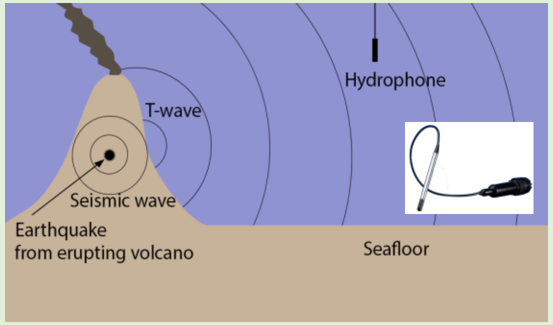


12 gunungapi di Indonesia memicu tsunami yaitu Anak Krakatau, Rinjani, Tambora, Rokatenda, Ile Werung-Hobal, Teon, Kie Besi, Gamalama, Gamkonora, Awu, Banua Wuhu dan Ruang.

Peralatan Survey Gunungapi Bawah Laut

Drone ROV: merekam visual aktivitas gunungapi bawah laut dangkal (< 500 m)

GPS: deformasi gunungapi (dipasang di pulau terdekat).



Hydrophone: aktivitas/erupsi gunungapi bawah laut melaui gelombang seismik & akustik (T-wave).

OBS

Seismometer: gelombang seismik aktivitas gunungapi. 2 opsi (darat:broadband seismometer) dan (dasar laut: ocean bottom seismometer/OBS).

POTENSI TSUNAMI YANG TERKAIT GUNUNG API

GUNUNGAPI YANG BERKORELASI DENGAN KEJADIAN TSUNAMI YANG MENGAKIBATKAN KORBAN JIWA

SELURUH GUNUNGAPI INI DIPANTAU 24 JAM OLEH PVMBG

ANAK KRAKATAU (1883 & 2018)

TAMBORA (1815)

ROKATENDA (1928)

ILE WERUNG-HOBAL (1973, 1979 & 1983)

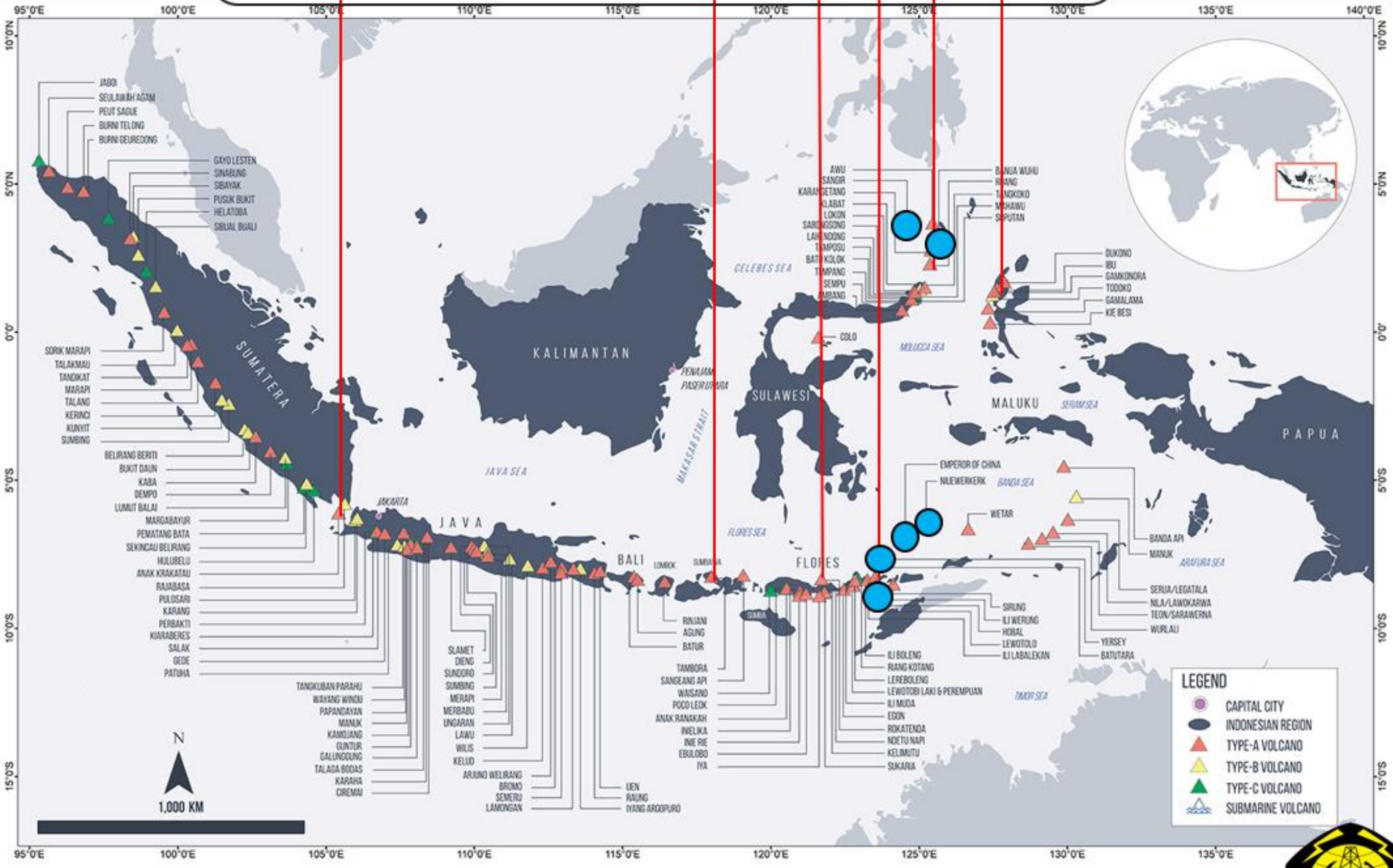
RUANG (1871)

GAMKONORA (1673)

GUNUNGAPI BAWAH LAUT DI INDONESIA:

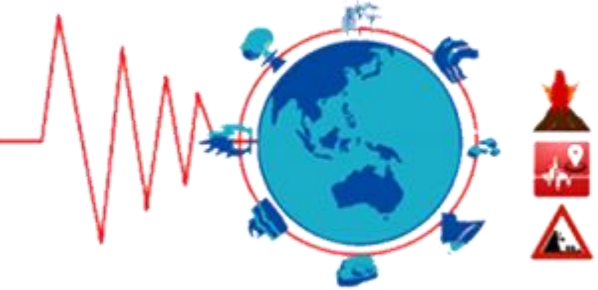
1. HOBAL (ILE WERUNG)
2. YERSEY
3. EMPEROR OF CHINA
4. NIEUWERKERK
5. BANUA WUHU
6. SANGIR

DARI GUNUNUNGAPI DI KOTAK INI, 2 DI ANTARANYA DILAPORKAN BERKORELASI DENGAN KEJADIAN TSUNAMI YAITU **HOBAL** & **BANUA WUHU**.



GUNUNGAPI BAWAH LAUT

PEMETAAN KAWASAN RAWAN BENCANA GEOLOGI



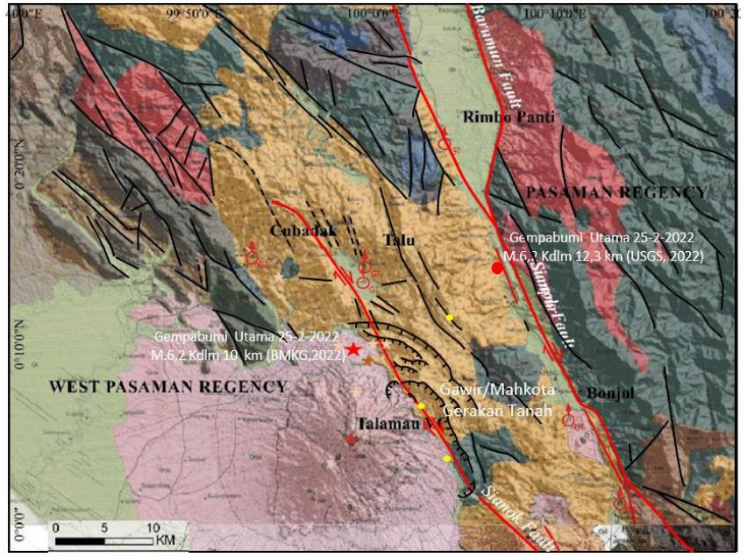
Bencana Geologi
- Letusan Gunungapi
- Gempabumi &Tsunami
- Gerakan Tanah

TAHUN 2021
20 PETA

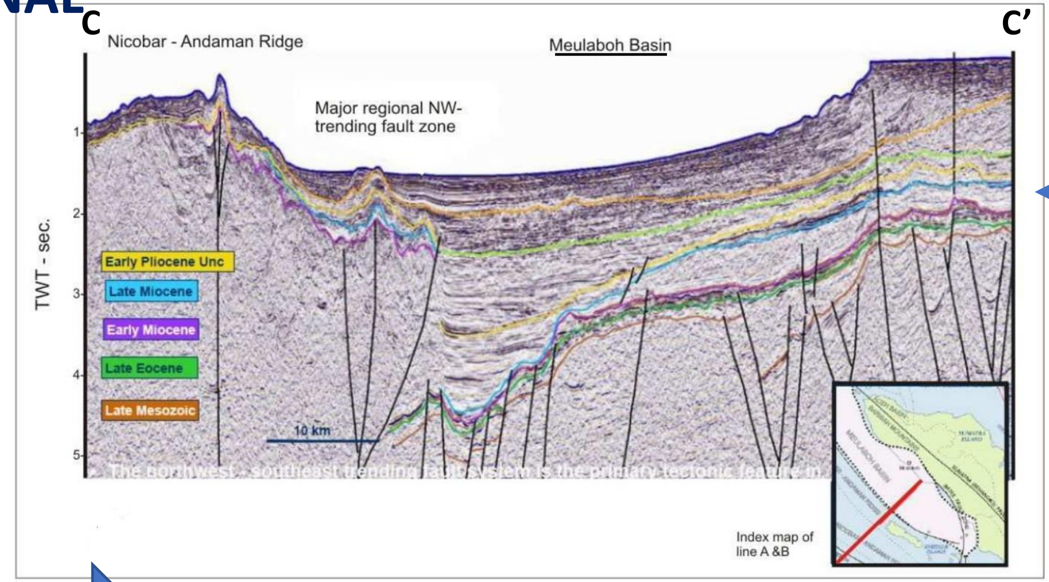
1. Aceh, Jawa Barat (2), NTT (2)
   (Pemetaan Geologi Gunungapi)
2. Aceh, Jawa Barat, NTT (2)
   (Pemetaan Kawasan Rawan Bencana Gunungapi)
3. Jawa Timur, Gorontalo
   (Pemetaan Kawasan Rawan Bencana Gempa Bumi)
4. Jawa Timur, Gorontalo
   (Pemetaan Kawasan Rawan Bencana Tsunami)
5. Sulawesi Selatan, Sumatera Barat, Sumatera Utara, Maluku Utara, Gorontalo, Aceh, Bali
   (Pemetaan Zona Kerentanan Gerakan Tanah)

LATAR KONDISI REGIONAL

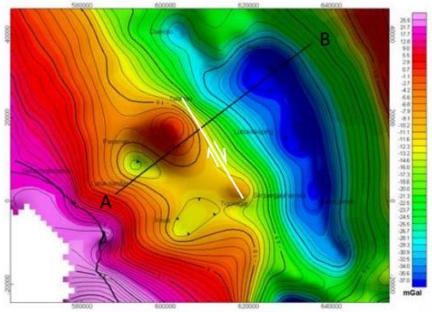
GUNUNG API DAN TEKTONIK REGIONAL

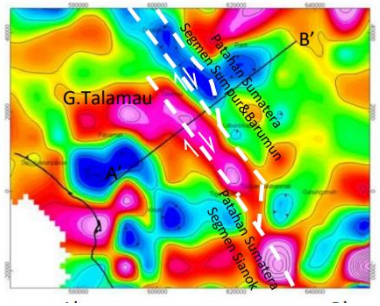


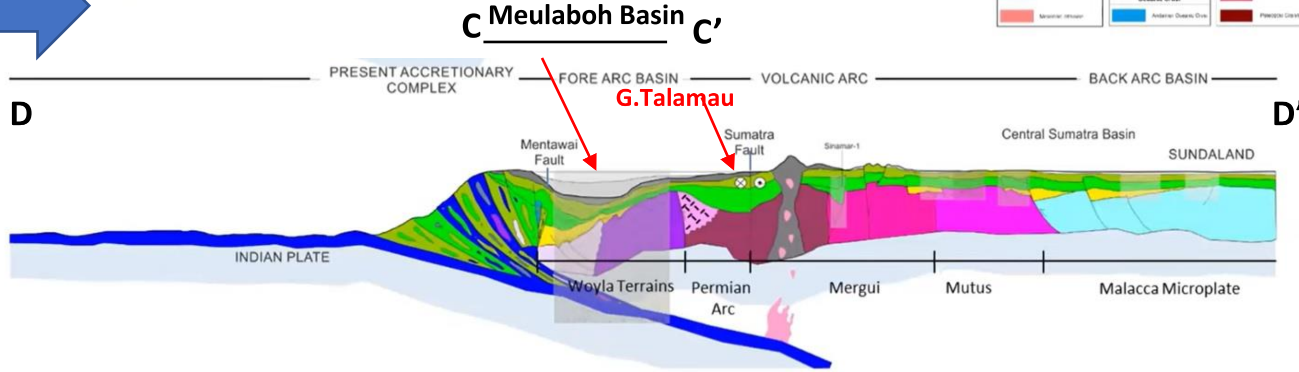
Gambar 4. Peta Geologi Patahan Aktif Daerah Lembah Talu dan sekitarnya, dengan pusat gempabumi BMKG dan USGS (Pusat Survei Geologi, 2022)

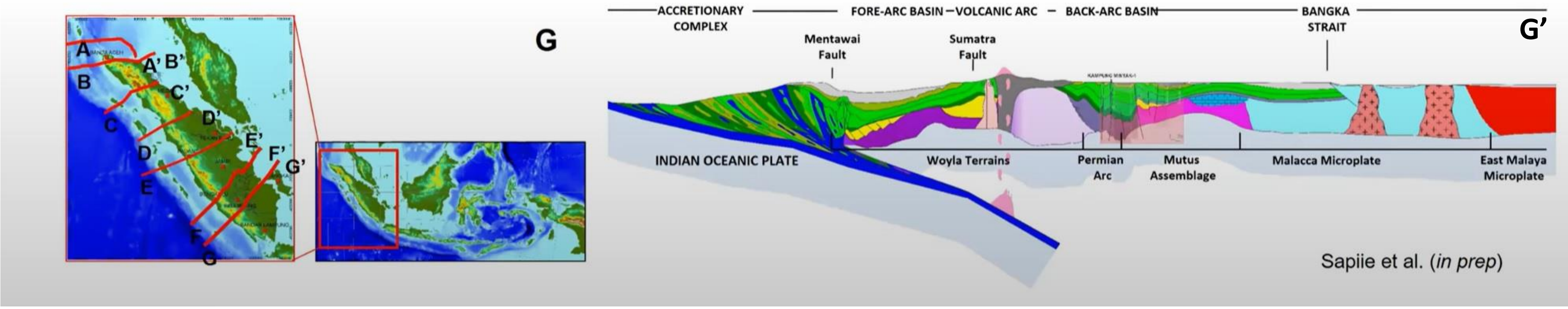


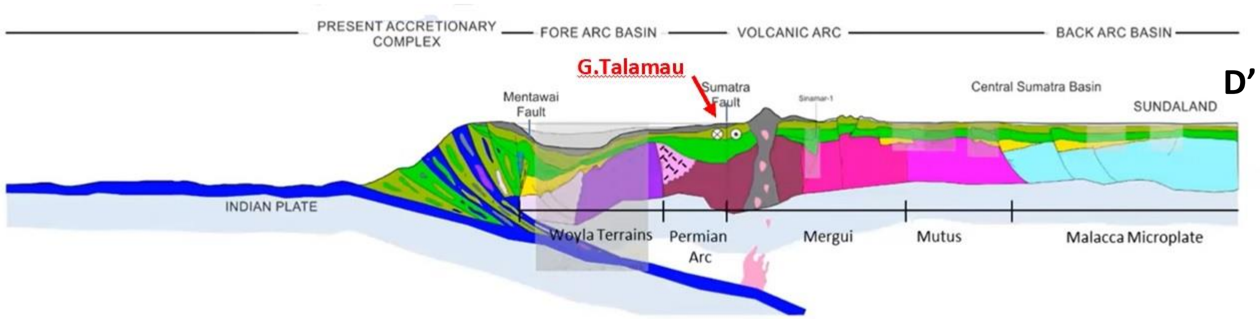
Miosen Awal

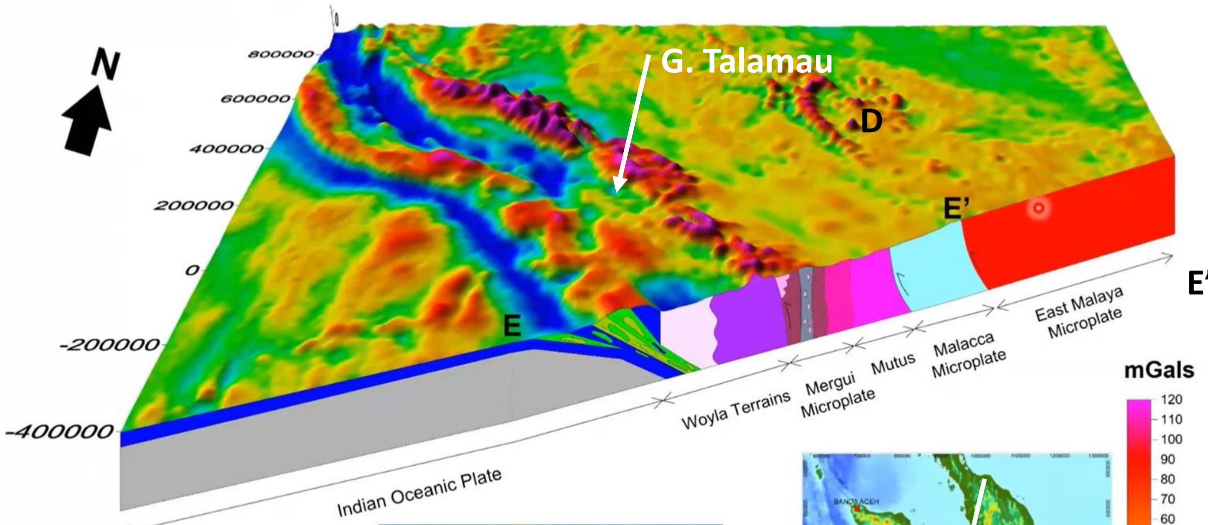


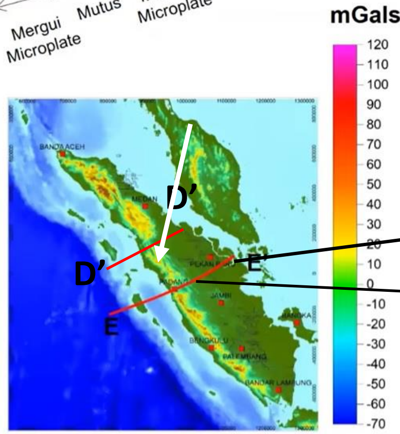






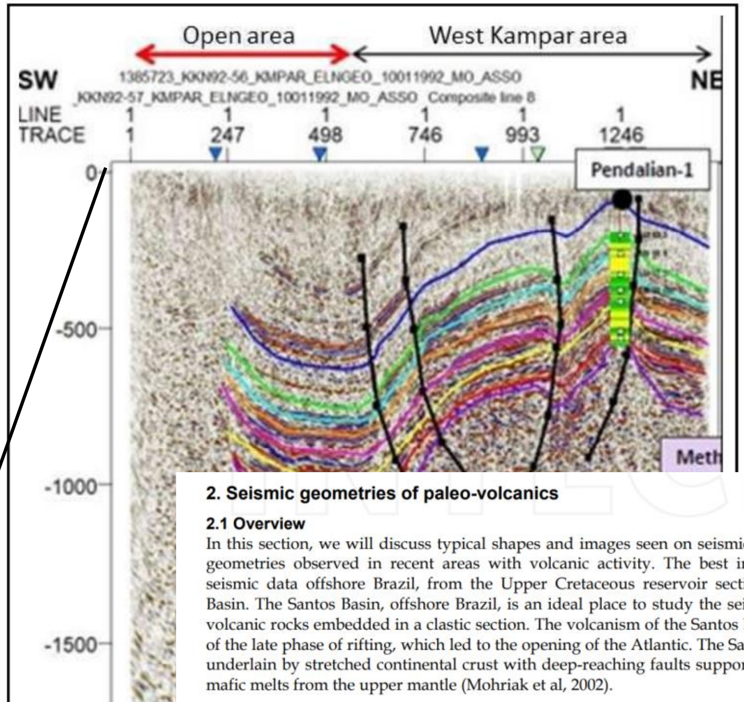






E

E’



Anticlinal

2. Seismic geometries of paleo-volcanics

2.1 Overview

In this section, we will discuss typical shapes and images seen on seismic data resembling geometries observed in recent areas with volcanic activity. The best images stem from seismic data offshore Brazil, from the Upper Cretaceous reservoir section in the Santos Basin. The Santos Basin, offshore Brazil, is an ideal place to study the seismic signature of volcanic rocks embedded in a clastic section. The volcanism of the Santos Basin is a product of the late phase of rifting, which led to the opening of the Atlantic. The Santos basin itself is underlain by stretched continental crust with deep-reaching faults supporting the ascent of mafic melts from the upper mantle (Mohriak et al, 2002).

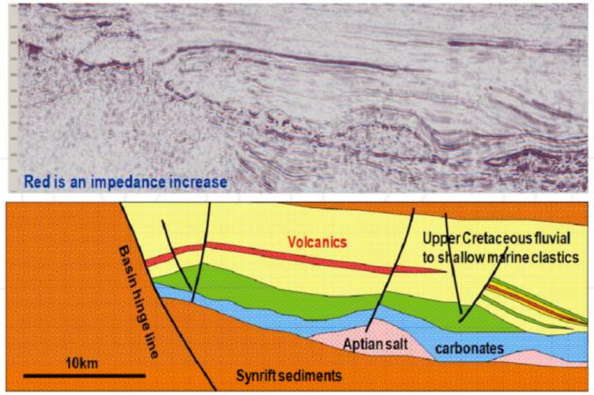


Fig. 1. Schematic interpretation of a NW-SE striking seismic section from the Santos Basin, crossing the basin hinge line

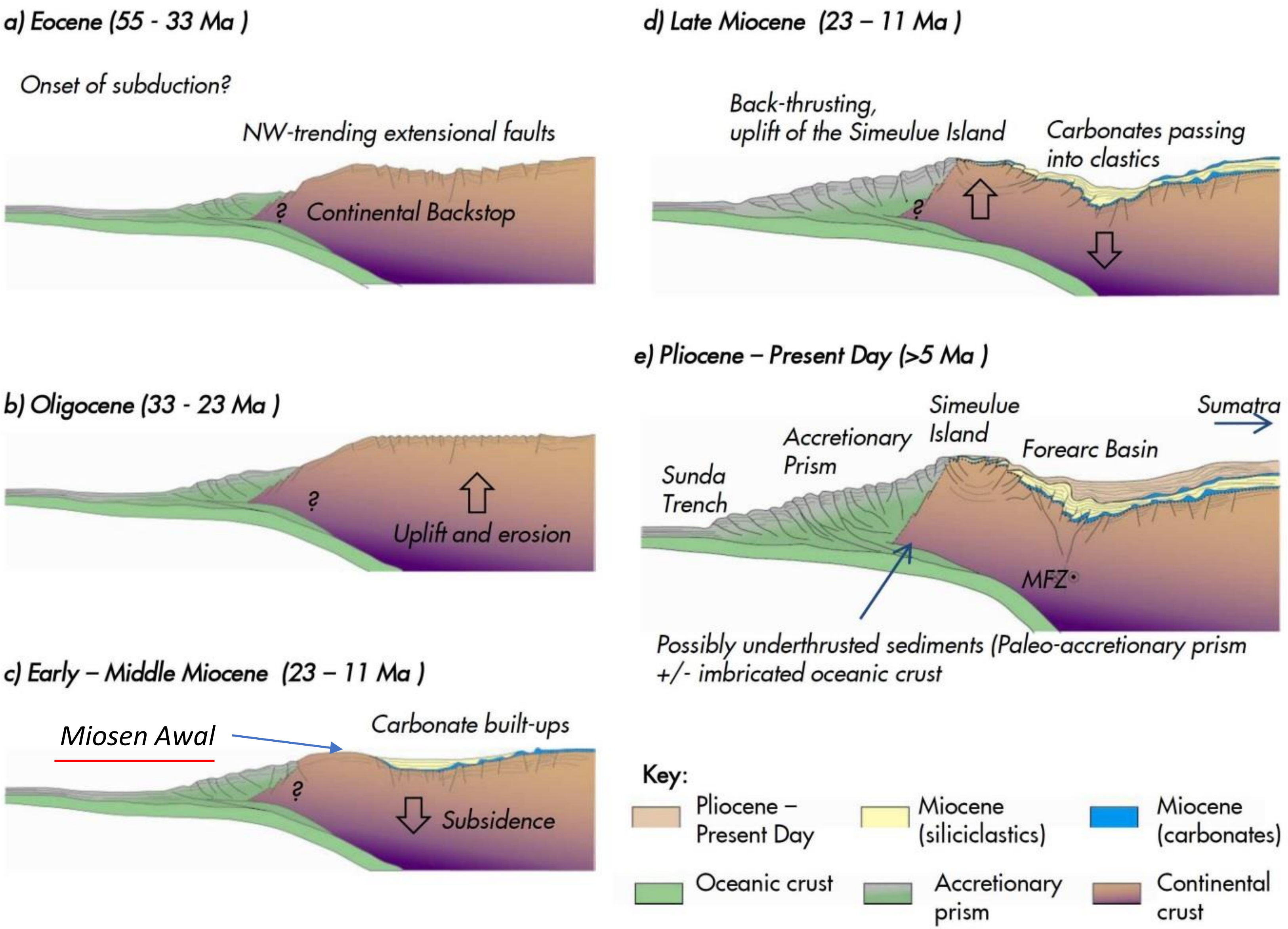
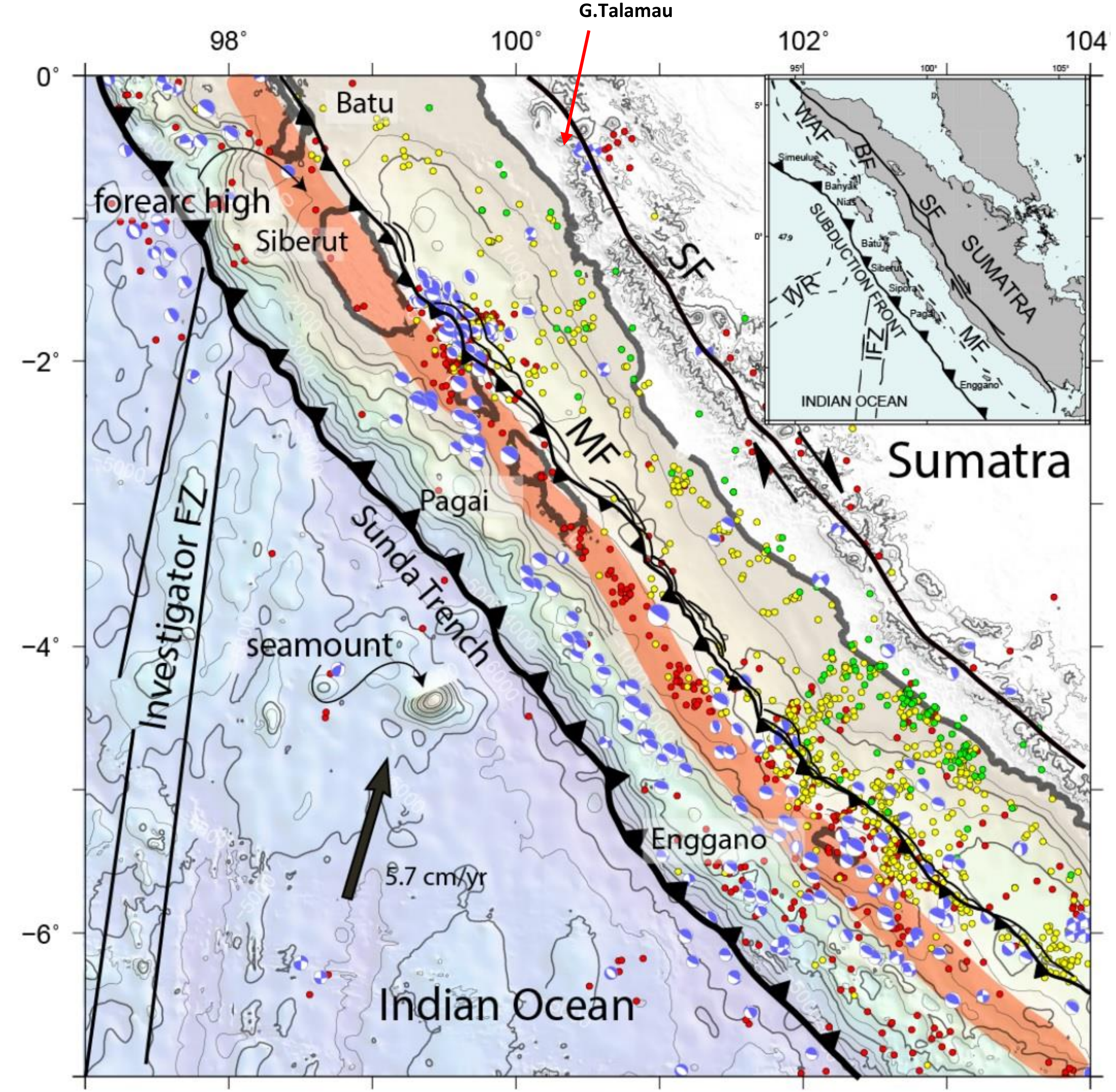
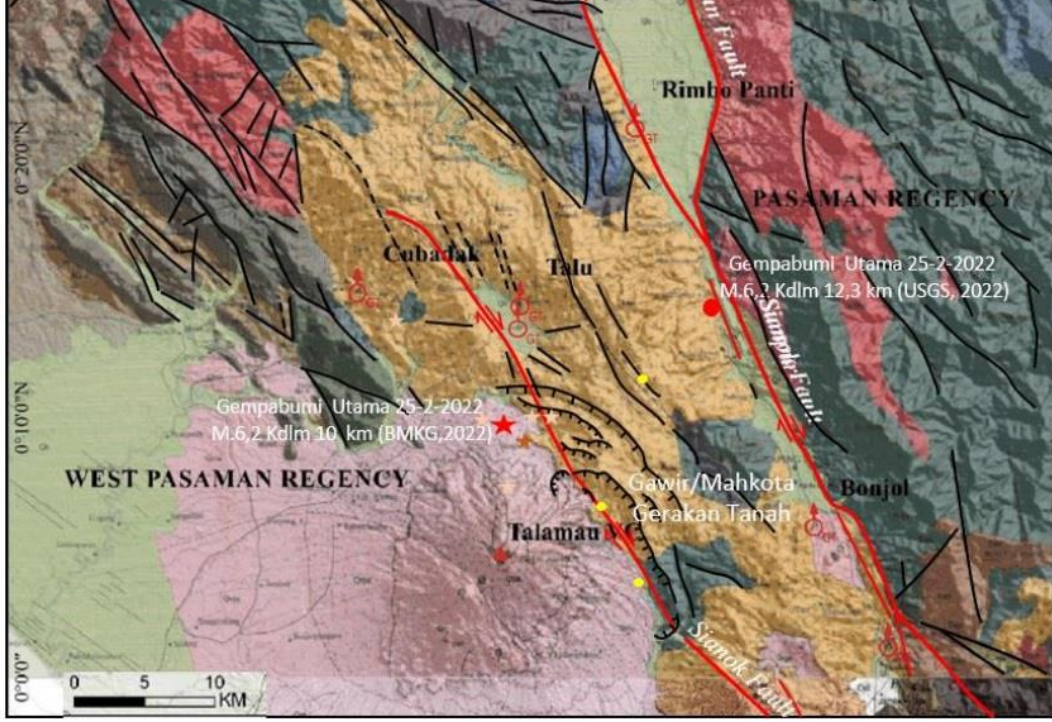
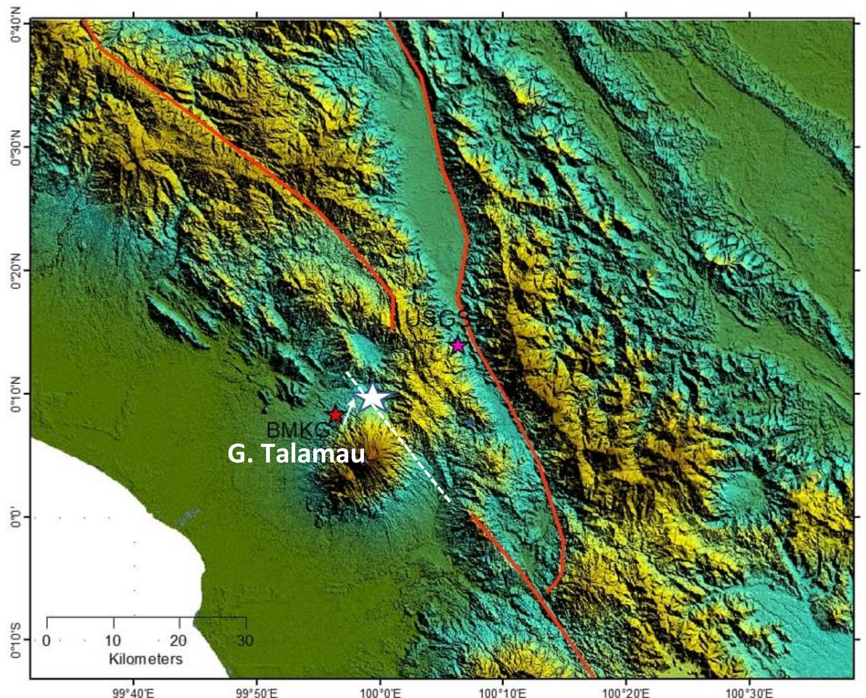


Figure 2. *Synoptic diagram showing tectonic evolution of the NW Sumatra forearc basin in the Cenozoic. MFZ – Mentawai Fault Zone.*


G.Talamau
98°
100°
102°
104°
0°
-2°
-4°
-6°
Batu
forearc high
Siberut
SF
MF
Sumatra
Pagai
Sunda Trench
Investigator FZ
seamount
5.7 cm/yr
Enggano
Indian Ocean
WAF
BF
SF
SUMATRA
Simeulue
Banyak
Nias
Batu
Siberut
Sipora
Pagai
Enggano
WR
SUBDUCTION FRONT
IFZ
MF
INDIAN OCEAN


Rimbo Panti
PASAMAN REGENCY
Cubadak
Talu
Gempabumi Utama 25-2-2022
M.6,2 Kdlm 12,3 km (USGS, 2022)
Sianok Fault
Gempabumi Utama 25-2-2022
M.6,2 Kdlm 10 km (BMKG,2022)
WEST PASAMAN REGENCY
Gawir/Mahkota
Gerakan Tanah
Bonjol
Talamau
Sianok Fault
0 5 10
KM


USGS
BMKG
G. Talamau
0 10 20 30
Kilometers
99°40'E
99°50'E
100°0'E
100°10'E
100°20'E
100°30'E
0°40'N
0°30'N
0°20'N
0°10'N
0°0'
0°10'S

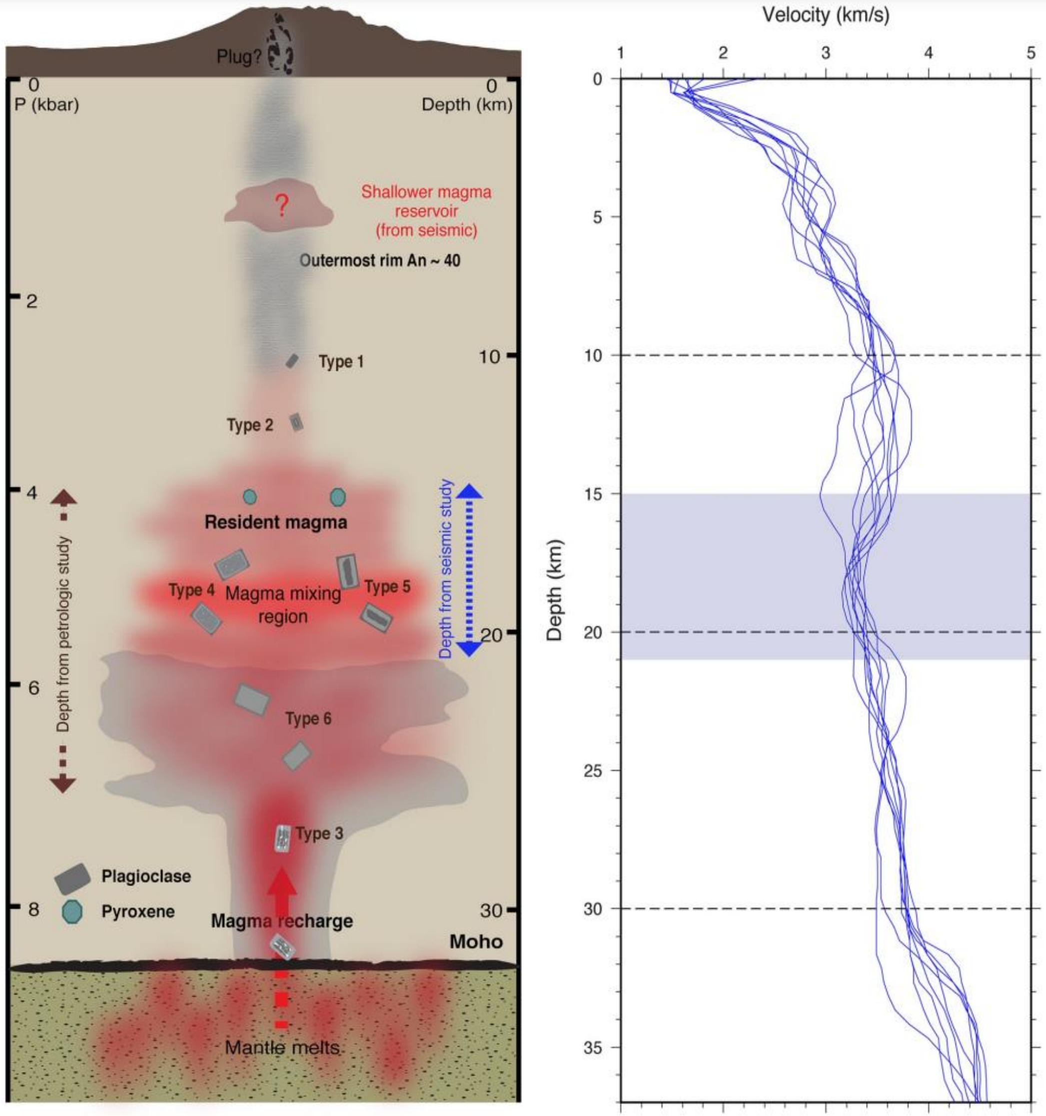


Figure 13. Schematic representation of Marapi's plumbing system. Two-pyroxene thermobarometry provides crystallization pressure estimates of 4–7 kbar (brown arrow). Shallower magma storage may exist as indicated by the lower crystallization pressures of MAR17 crystal rims (Figure 8 and S5). The Vs profiles combined from PCAK and GGSL seismic stations (all bins) on the right panel show the low velocity zone as highlighted by the blue-shaded rectangle. The depth range of the LVZ from the seismic study is depicted with the blue arrow. The lowest velocity zone (hotter red color) appears to be at a depth of ~18.5 km beneath the volcano. A deeper region of magma ponding just below the Moho is evidenced by differences in the velocity step at that depth. A shallower LVZ could potentially be located around 5 km depth according to some velocity models, but would need to be confirmed with other types of analyses. The magma recharge and magma mixing region as well as the origin of plagioclase types are proposed based on the joint interpretation of RF data and compositions and

Geochemistry, Geophysics, Geosystems

AGU ADVANCING EARTH AND SPACE SCIENCE

RESEARCH ARTICLE

10.1029/2020GC009524

Key Points:

- Combined petrologic and seismic studies constrain the magma plumbing system of Marapi
- Marapi magmas are stored in a highly crystalline state with low average melt fractions
- Plagioclase crystals record magma recharge, hybridization with the resident magma, and renewed crystallization before eruption

Supporting Information:

Supporting Information may be found in the online version of this article.

Correspondence to:

D. Nurfiani,
DININURF001@e.ntu.edu.sg

Citation:

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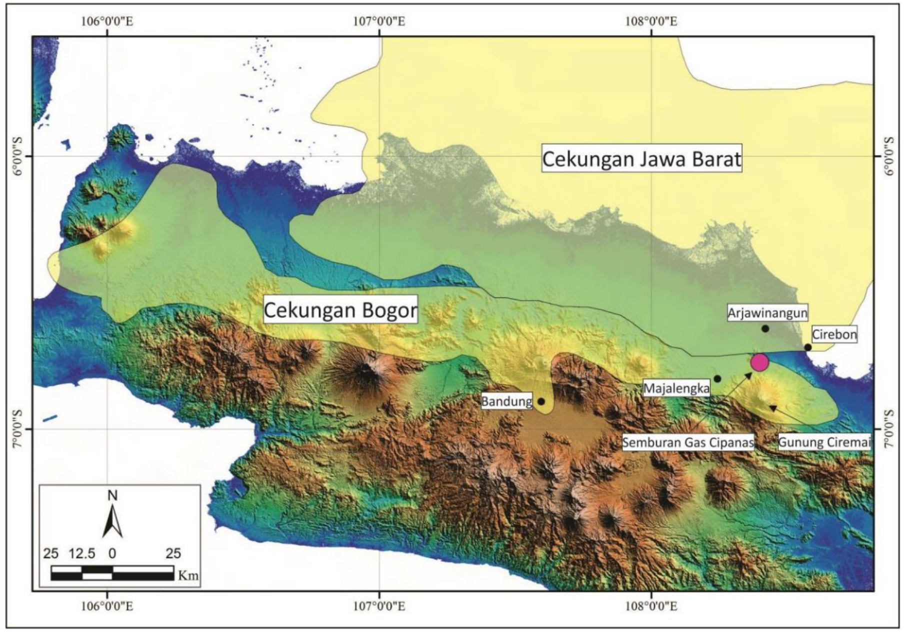
Combining Petrology and Seismology to Unravel the Plumbing System of a Typical Arc Volcano: An Example From Marapi, West Sumatra, Indonesia

D. Nurfiani[1], X. Wang[2,3], H. Gunawan[4], H. Triastuty[4], D. Hidayat[1], S. J. Wei[1], B. Taisne[1], and C. Bouvet de Maisonneuve[1]

[1]Earth Observatory of Singapore / Asian School of Environment, Nanyang Technological University, Singapore, [2]Key Laboratory of Earth and Planetary Physics, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing, China, [3]CAS Center for Excellence in Deep Earth Science, Guangzhou, China, [4]Center for Volcanology and Geological Hazard Mitigation (CVGHM), Indonesia

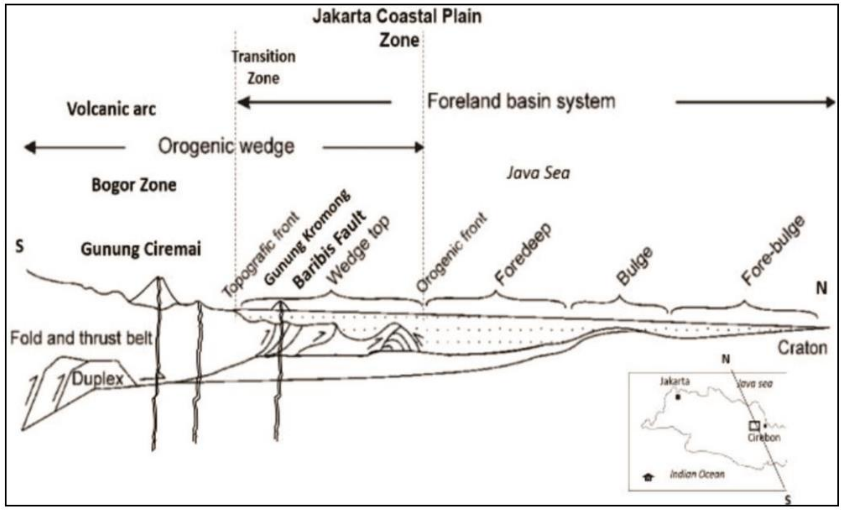
Abstract Marapi in Sumatra is characterized by frequent short-lived explosions and small eruptions (Volcanic Explosivity Index 1–2) and in the past 250 years, the volcano has erupted >60 times. Recent volcanic bombs and the presence of broadband seismic stations lead us to reconstruct the plumbing system of the volcano through an interdisciplinary study. A petrologic study of the summit bombs uses pyroxene, plagioclase and glass compositions to obtain pressures and temperatures of magma storage as well as identify pre-eruptive processes. Two-pyroxene geothermobarometry provides pre-eruptive crystallization pressure estimates of 4–7 kbar (~15–26 km). Compositional and textural analyses of plagioclase and pyroxene crystals indicate that mafic magma recharge was followed by mixing with the resident magma and renewed crystallization prior to eruption. In order to further image the magma reservoir, we performed a joint inversion of teleseismic receiver functions and surface waves (H/V ratio). The inversion reveals a low velocity zone (LVZ) at depths of 15–21 km that has 7 ± 3% shear velocity reduction, corresponding to an estimated melt fraction of 5 ± 2%. The depth of this LVZ overlaps with the depth of magma storage estimated from petrology, constraining it with high confidence. Such a combined interdisciplinary study provides valuable information for evaluating future periods of unrest, laying out a framework for the interpretation of incoming monitoring data and signals to look out for in order to improve eruption forecasts.

Plain Language Summary Magma plumbing systems (MPS) are the network of interconnected magma ponding regions beneath active volcanoes. The activities within the MPS involve processes such as crystallization of magma, injections of a new magma batch from a deeper source, mixing with the pre-existing magma, and magma transport to shallower depths or to the surface leading to an eruption. Understanding the processes in the MPS will provide information for interpretation of past and current eruption behavior for improved hazard assessments and eruption forecast. We study the MPS of Marapi (Sumatra) with the analysis of erupted rock samples and seismic waves propagating through the MPS. We find that the magma storage of Marapi is located at ~15–26 km beneath the volcano where magmas are stored in a state containing mostly solid crystals with low average melt (liquid phase) fractions. Crystals in the erupted rock samples record the injection of a new magma, its mixing with the pre-existing (resident) magma and renewed crystallization before eruption. This study will provide

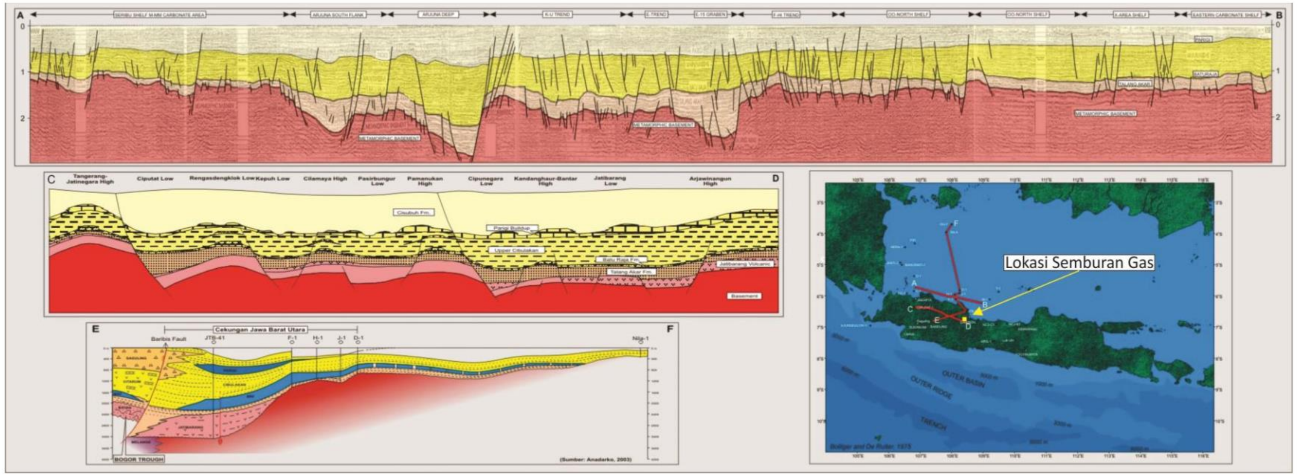


Gambar 1. Peta semburan gas di Desa Cipanas (Modifikasi Kementerian ESDM, 2020).

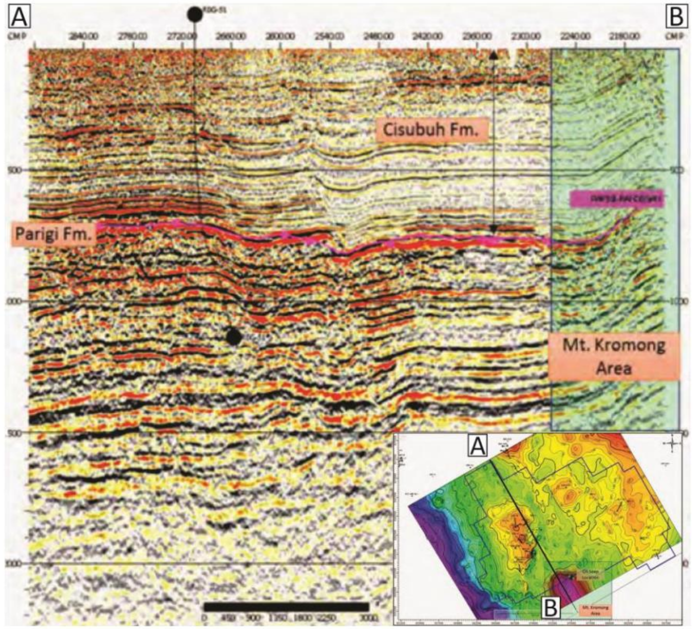
Gambar 4. Pengukuran komposisi kimia semburan gas menggunakan etektor gas drager xam 7000.



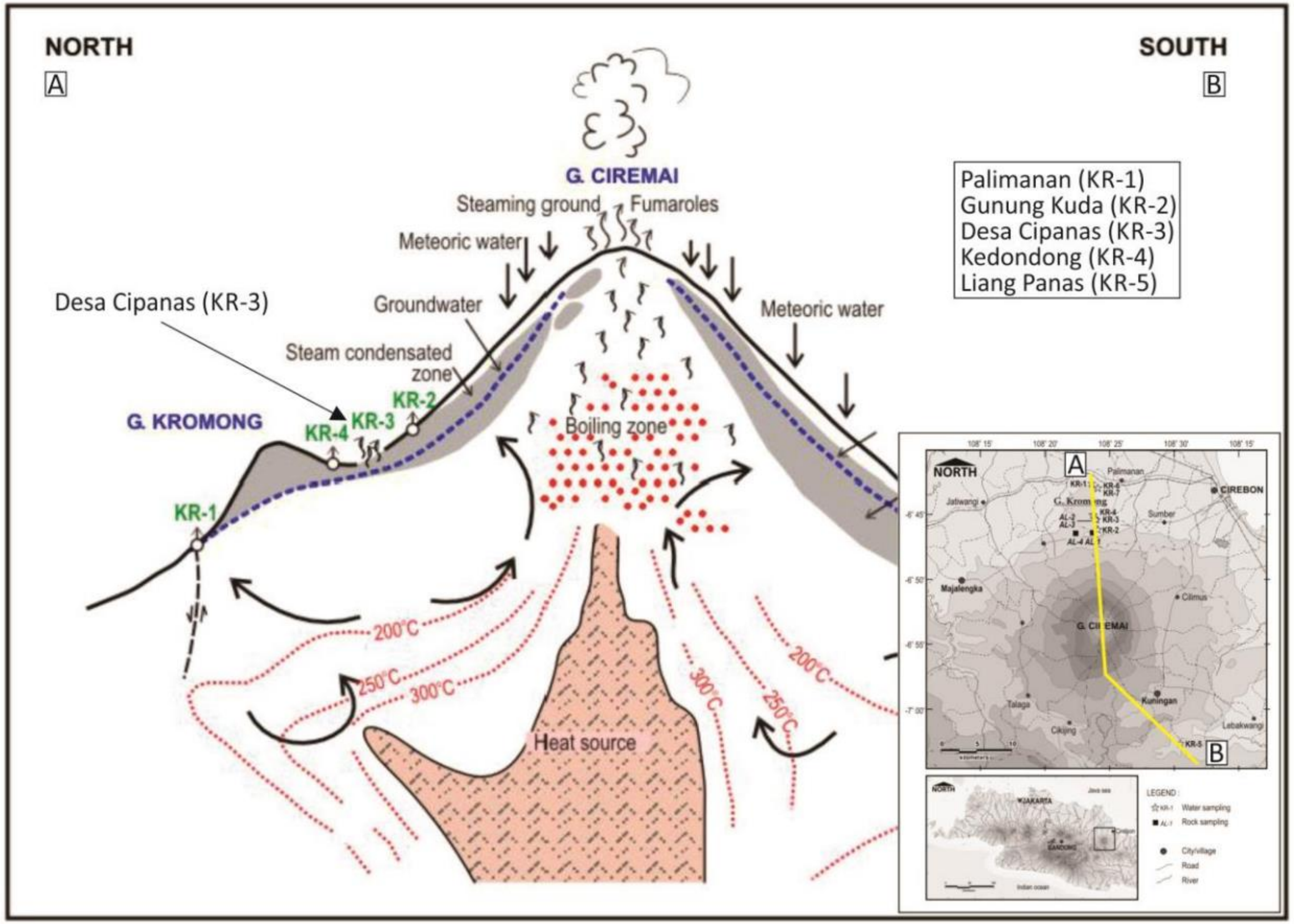
Gambar 7. Tektonik semburan gas Desa Cipanas yang merupakan bagian dari Gunung Kromong (Haryanto, dkk., 2020).



Gambar 8. Penampang tektonik regional yang menunjukkan adanya sesar normal pada penampang A – B dan C – D. Pada penampang E – F bagian selatan sesar Baribis di kontrol oleh sesar naik. (Pertamina-Beicip, 1992 dan Anadarko, 2003, dalam BP Migas dan Lapi ITB, 2008).

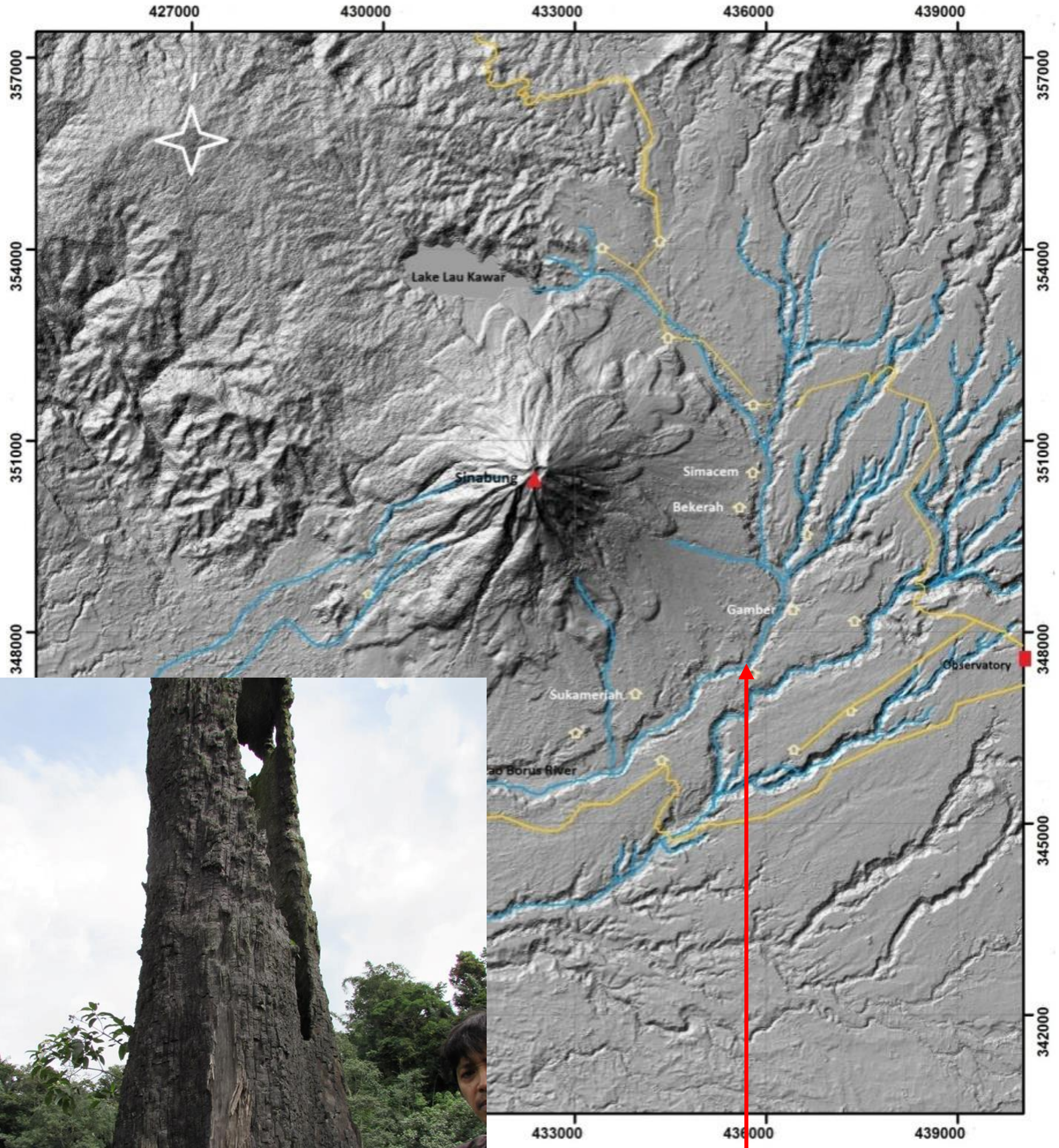


Gambar 9. Lintasan seismik menunjukkan tinggian pada Gunung Kromo (Ginanjar, dkk., 2019).



Gambar 11. Gunung Kromong adalah kerucut vulkanik dari Gunung Ciremai (Herdianita, dkk., 2010).

MENGAPA MITIGASI (I) ?:
DATA MASA LALU LONG-TERM



*Arang utk penentuan umur terjadinya awan panas: **letusan terakhir terjadi 1200 tahun yang lalu***

Lokasi:

Kabupaten Karo, Provinsi Sumatera Utara

Lokasi Geografis :

03° 10’ N dan 98° 23,5’ E

Elevasi 2460 m dml

- G. Sinabung pada awalnya merupakan tipe gunungapi B, yaitu gunung dengan tidak ada catatan pernah erupsi sejak 400 tahun yg lalu, sehingga banyak masyarakat sudah hidup dan berladang di lereng dan kaki G. Sinabung sejak lama tanpa antisipasi kemungkinan akan terjadi erupsi diwaktu kedepan.

- Pada tgl 27 Agustus 2010 G. Sinabung untuk pertama kali erupsi selama beberapa hari sehingga pada 29 Agustus 2010 G. Sinabung sudah diklasifikasikan menjadi tipe A (artinya gunung yg pernah eruspsi minimal 1 kali sejak 400 thn yg lalu) dan gunung telah dilengkapi sistem monitoring, hasil survei pemetaan geologi serta pos pengamatan gunungapi. Berdasar data monitoring dan data geologi, penyebaran endapan masa lalu awan panas termuda/1200 thn yg lalu terletak di sektor selatan-tenggara dlm radius 5 km, pada tgl 7 Oktober 2010 PVMBG telah merekomendasikan **relokasi** Desa Sukameriah, Bekerah dan Simacem (ketiga desa di sektor selatan-tenggara dan dlm radius 3 km).

- Selama periode non erupsi, yaitu Oktober 2010 - Agustus 2013, sistem monitoring G. Sinabung semakin diperkuat dgn 4 GPS kontinyu dan 11 stasiun seismik permanen-temporer.


a
b
c
d
11/24/2013 07 31

AWAN PANAS G. SINABUNG 2015 dan 2018

LETUSAN dan AWAN PANAS G. SINABUNG 2020

INFORMASI ERUPSI G. SINABUNGTelah terjadi erupsi G. Sinabung, Sumatera Utara pada tanggal 10 Agustus 2020 pukul 10:16 WIB dengan tinggi kolom abu teramati ± 5.000 m di atas puncak (± 7.460 m di atas permukaan laut). Kolom abu teramati berwarna kelabu dengan intensitas tebal condong ke arah timur dan tenggara.

Saat ini G. Sinabung berada pada Status Level III (Siaga) dengan rekomendasi:

1. Masyarakat dan pengunjung/wisatawan agar tidak melakukan aktivitas pada desa-desa yang sudah direlokasi, serta lokasi di dalam radius radial 3 km dari puncak G.Sinabung, serta radius sektoral 5 km untuk sektor selatan-timur, dan 4 km untuk sektor timur-utara.

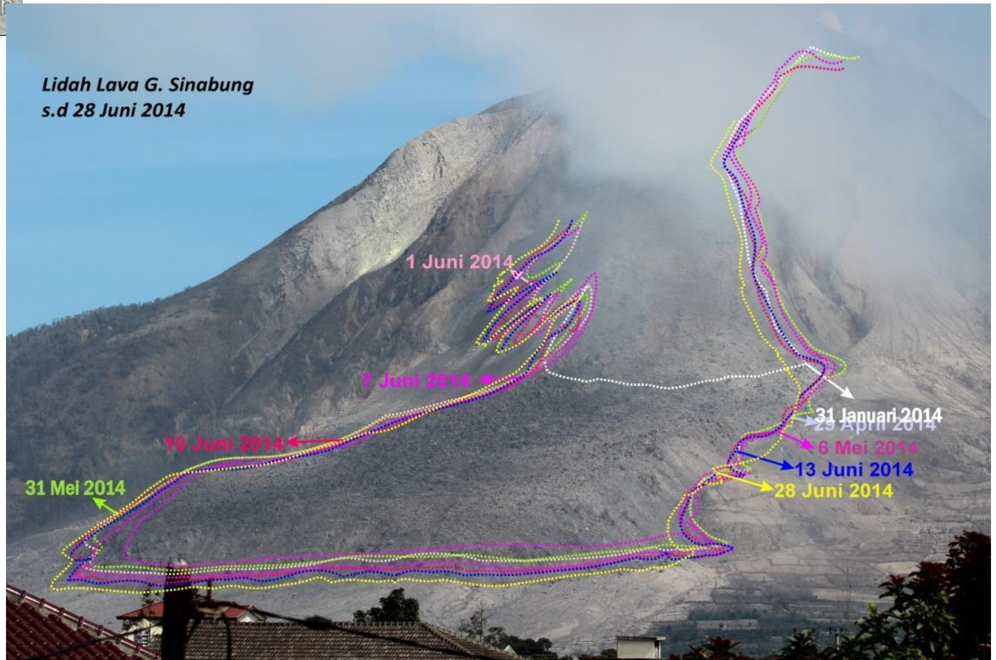
2. 2. Jika terjadi hujan abu, masyarakat dihimbau memakai masker bila keluar rumah untuk mengurangi dampak kesehatan dari abu vulkanik. Mengamankan sarana air bersih serta membersihkan atap rumah dari abu vulkanik yang lebat agar tidak roboh.3. Masyarakat yang berada dan bermukim di dekat sungai-sungai yang berhulu di G. Sinabung agar tetap waspada terhadap bahaya lahar.

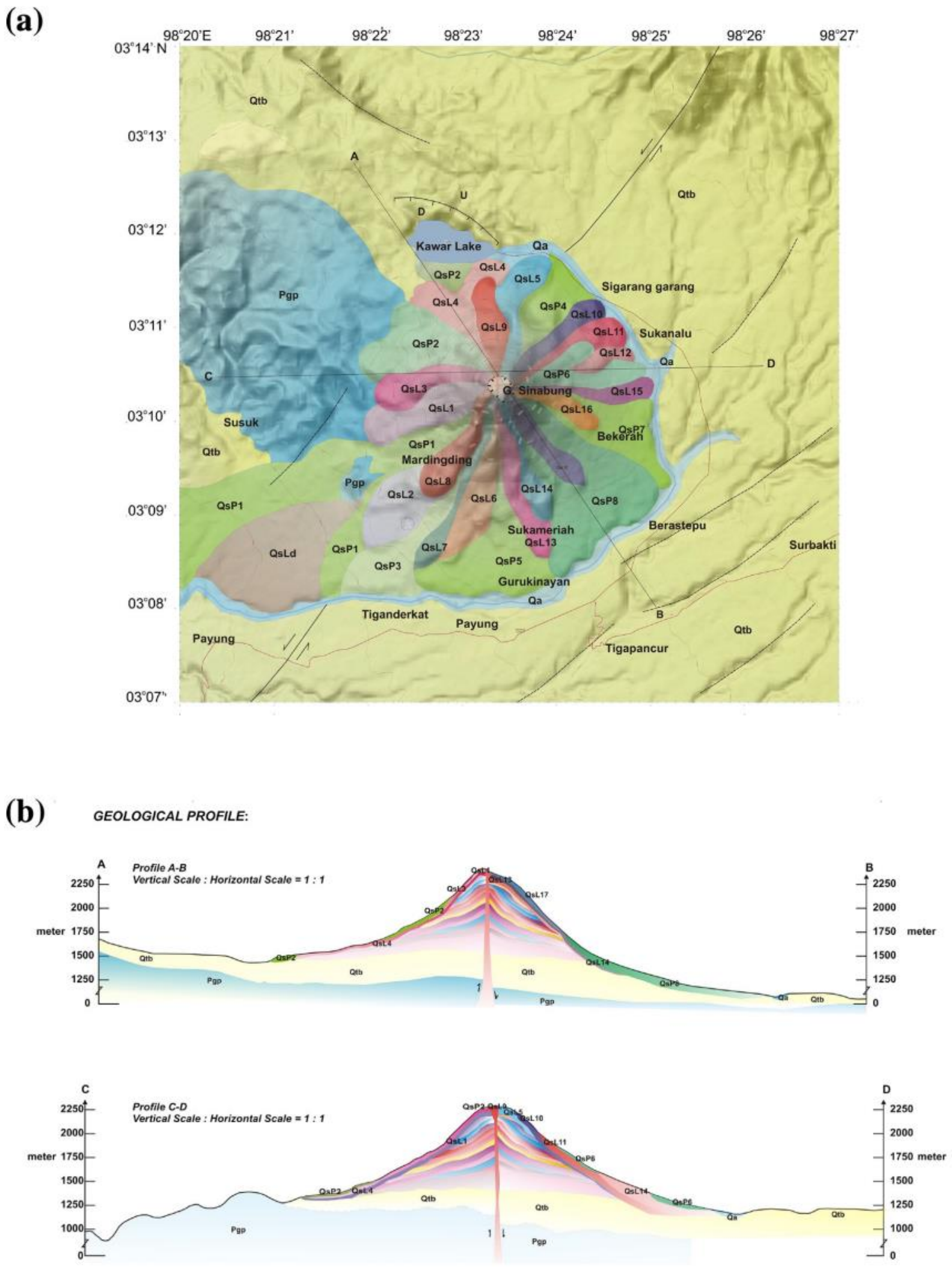
KUBAH LAVA G. SINABUNG

Sebelum dan Sesudah Erupsi
tanggal 11 Januari 2014

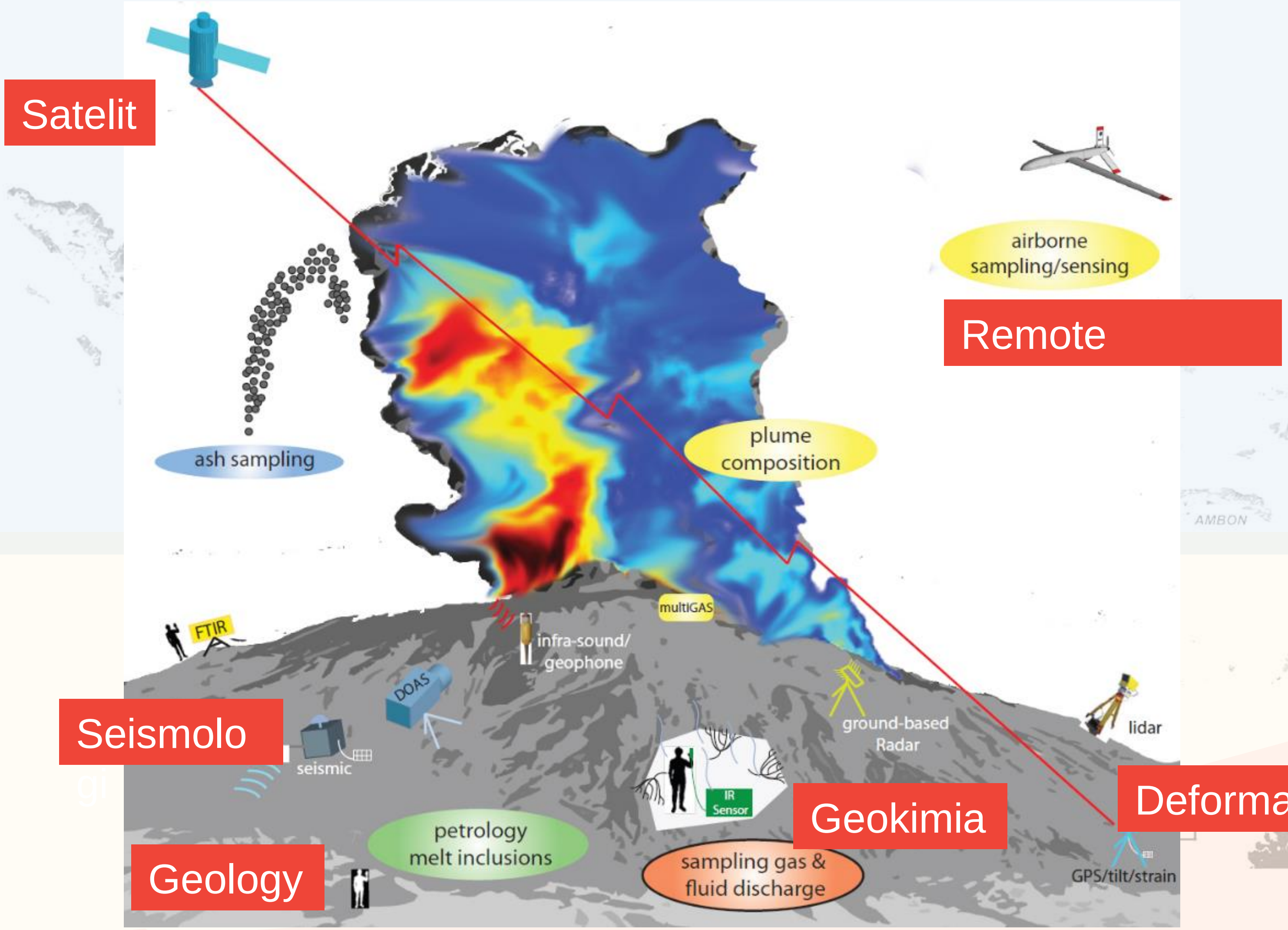
KUBAH LAVA BERKEMBANG MENJADI LIDAH LAVA

(Februari 2014 dan Juni 2014)




(a)
98°20'E
98°21'
98°22'
98°23'
98°24'
98°25'
98°26'
98°27'
03°14' N
03°13'
03°12'
03°11'
03°10'
03°09'
03°08'
03°07'
Qtb
A
U
D
Kawar Lake
Qa
Pgp
QsP2
QsL4
QsL5
Sigarang garang
QsP4
QsL10
QsL9
QsL11
Sukanalu
QsL12
C
QsP6
D
QsL3
G. Sinabung
QsL15
QsL1
QsL16
Susuk
Bekerah
QsP7
QsP1
Mardingding
QsL8
QsL14
QsL2
QsL6
QsP8
Berastepu
Sukameriah
QsL13
Surbakti
QsLd
QsP3
QsL7
QsP5
Gurukinayan
Tiganderkat
Payung
B
Tigapancur
(b)
GEOLOGICAL PROFILE:
Profile A-B
Vertical Scale : Horizontal Scale = 1 : 1
meter
2250
2000
1750
1500
1250
0
QsL17
QsL14
QsP8
Profile C-D
Vertical Scale : Horizontal Scale = 1 : 1
1000
QsL10
QsL11
QsP6
Qtb
Pgp
Qa

Mitigasi Gunung Api : Monitoring Kegempaan



Contoh G. Merapi dan Jaringan Peralatan Monitoring

Foto dari arah Tenggara

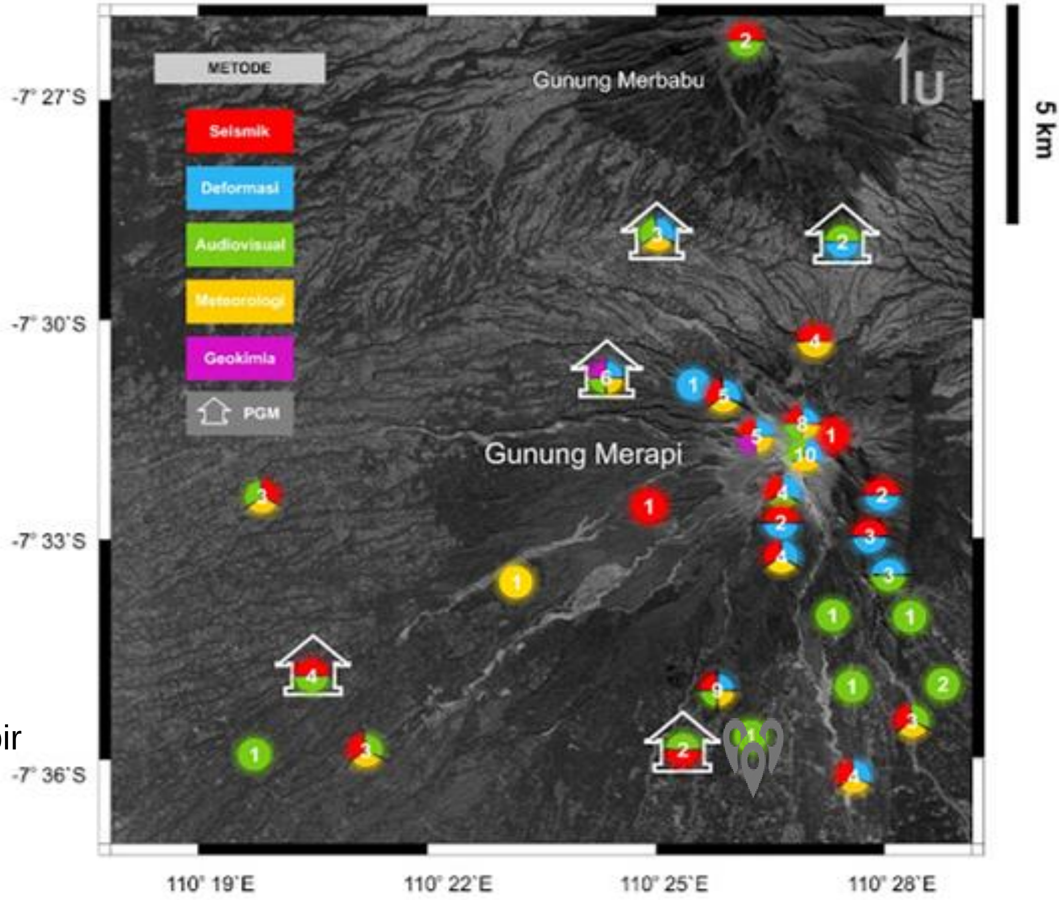
Ketinggian: 2968 m

Letak:
Perbatasan Propinsi Jawa Tengah dan D.I. Yogyakarta

Kabupaten:
Kab. Sleman, D.I. Yogyakarta
Kab. Magelang, Jawa Tengah
Kab. Boyolali, Jawa Tengah
Kab. Klaten, Jawa Tengah

Sejarah dan Karakter Erupsi Merapi:
➔Waktu rata-rata 4 tahun
➔Index erupsi (VEI) rata-rata VEI 2, erupsi besar VEI 4 2010, 1872.
➔Erupsi eksplosif dengan VEI 4 tahun 2010 menghasilkan kawah dengan diameter hampir 400 m dengan kedalaman 100-150 m.
➔Secara umum sekitar 84 % erupsi bersifat efusif ditandai dengan pertumbuhan kubah lava dan menghasilkan Awan Panas.

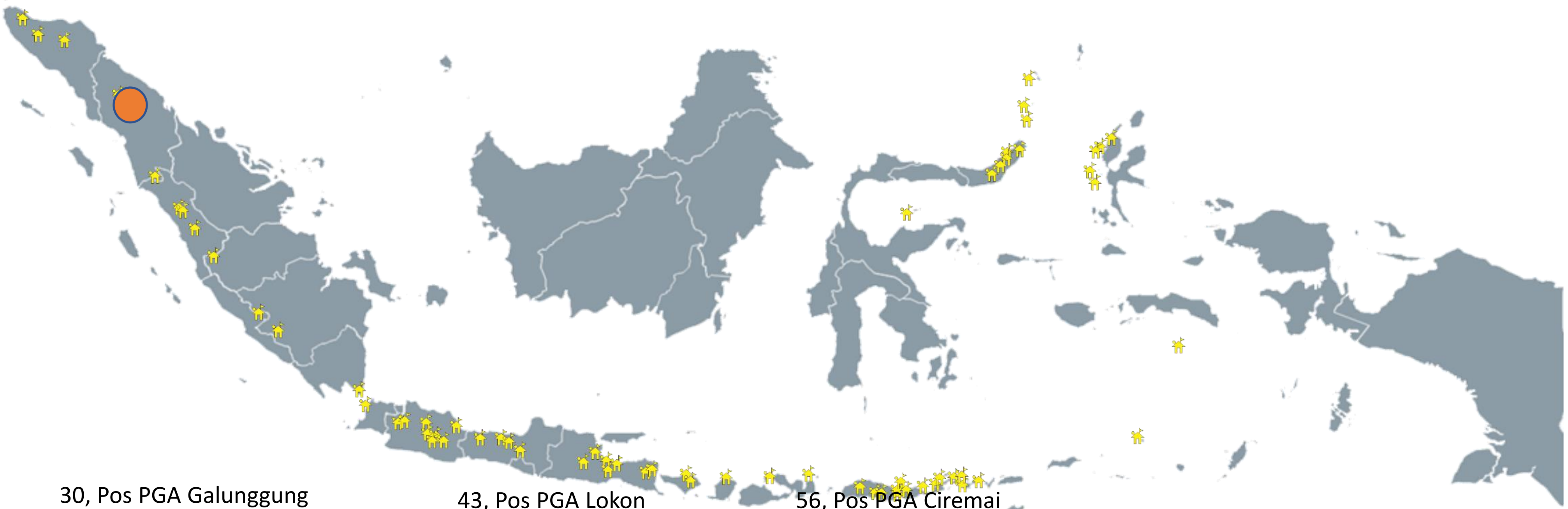
STATUS : WASPADA



147 sistem

74 lokasi

Pengamatan Gunung Api Indonesia



1, Pos PGA Peut Sague
2, Pos PGA Bur Ni Telong
3, Pos PGA Seulawah Agam
4, Pos PGA Sinabung
5, Pos PGA Batur
6, Pos PGA Sorik Marapi
7, Pos PGA Agung
8, Pos PGA Marapi
9, Pos PGA Rinjani
10, Pos PGA Tandikat
11, Pos PGA Tambora
12, Pos PGA Sangeangapi
13, Pos PGA Anak Ranakah
14, Pos PGA Inelika
15, Pos PGA Inerie
16, Pos PGA Talang
17, Pos PGA Ebulobo
18, Pos PGA Kerinci
19, Pos PGA Iya
20, Pos PGA Kaba
21, Pos PGA Dempo
22, Pos PGA Rokatenda
23, Pos PGA Krakatau (Kalianda)
24, Pos PGA Krakatau (Pasauran)
25, Pos PGA Salak
26, Pos PGA Gede
27, Pos PGA Tangkuban Parahu
28, Pos PGA Papandayan
29, Pos PGA Guntur
30, Pos PGA Galunggung
31, Pos PGA Kelimutu
32, Pos PGA Egon
33, Pos PGA Lewotobi Laki Laki
34, Pos PGA Lewotobi Perempuan
35, Pos PGA Lereboleng
36, Pos PGA Ili Boleng
37, Pos PGA Ile Lewotolok
38, Pos PGA Ile Werung
39, Pos PGA Sirung
40, Pos PGA Colo
41, Pos PGA Ambang
42, Pos PGA Soputan
43, Pos PGA Lokon
44, Pos PGA Mahawu
45, Pos PGA Tangkoko
46, Pos PGA Ruang
47, Pos PGA Karangetang
48, Pos PGA Awu
49, Pos PGA Banda Api
50, Pos PGA Kie Besi
51, Pos PGA Gamalama
52, Pos PGA Gamkonora
53, Pos PGA Ibu
54, Pos PGA Dukono
55, Pos PGA Wurlali
56, Pos PGA Ciremai
57, Pos PGA Slamet
58, Pos PGA Dieng
59, Pos PGA Sundoro
60, Pos PGA Sumbing
61, Pos PGA Merapi (Babadan)
62, Pos PGA Kelud
63, Pos PGA Arjuno Welirang
64, Pos PGA Bromo
65, Pos PGA Sawur PGA Semeru
66, Pos PGA Lamongan
67, Pos PGA Raung
68, Pos PGA Kawah Ijen

Pos Pengamatan G. Bromo

PENGEMBANGAN POS PENGAMATAN GUNUNGAPI

- **Pos Pengamatan Gunungapi sebagai representasi Kementerian Energi dan Sumber Daya Mineral di daerah dan merupakan garda terdepan dalam pelayanan publik.**
- **Banyak Pos Gunungapi yang kondisinya masih memprihatinkan.**
- **Pengembangan Pos Pengamatan Gunungapi bertujuan supaya Pos Pengamatan Gunungapi menjadi pusat pengamatan dan penelitian gunungapi yang nyaman dan representatif serta berfungsi sebagai Pusat Pelayanan Informasi Publik maupun wisata di daerah.**

Dari 74 Pos Pengamatan Gunungapi di seluruh Indonesia, sampai dengan tahun 2020, sebanyak 19 Pos Pengamatan Gunungapi sudah dikembangkan.

NO	NAMA POS PGA
1	Pos PGA Anak Krakatau-Pasauran, Propinsi Banten
2	Pos PGA Anak Ijen, Propinsi Jawa Timur
3	Pos PGA Agung dan Mess Agung, Propinsi Bali
4	Pos PGA Bromo, Propinsi Jawa Timur
5	Pos PGA Semeru (Sawur), Propinsi Jawa Timur
6	Pos PGA Burnitelong, Propinsi Aceh
7	Pos PGA Dempo, Propinsi Sumatera Selatan
8	Pos PGA Raung, Propinsi Jawa Timur
9	Pos PGA Sangeangapi, Propinsi NTB
10	Pos PGA Kelud, Propinsi Jawa Timur
11	Pos PGA Ililewotolok, Propinsi NTT
12	Pos PGA Iliwerung, Propinsi NTT
13	Pos PGA Mahawu, Propinsi Sulawesi Utara
14	Pos PGA Rinjani, Propinsi NTB
15	Pos PGA Marapi - Bukittinggi, Propinsi Sumatera Barat
16	Pos PGA Guntur, Propinsi Jawa Barat
17	Pos PGA Slamet, Propinsi Jawa Tengah
18	Pos PGA Dieng, Propinsi Jawa Tengah
19	Pos PGA Batur, Propinsi Bali

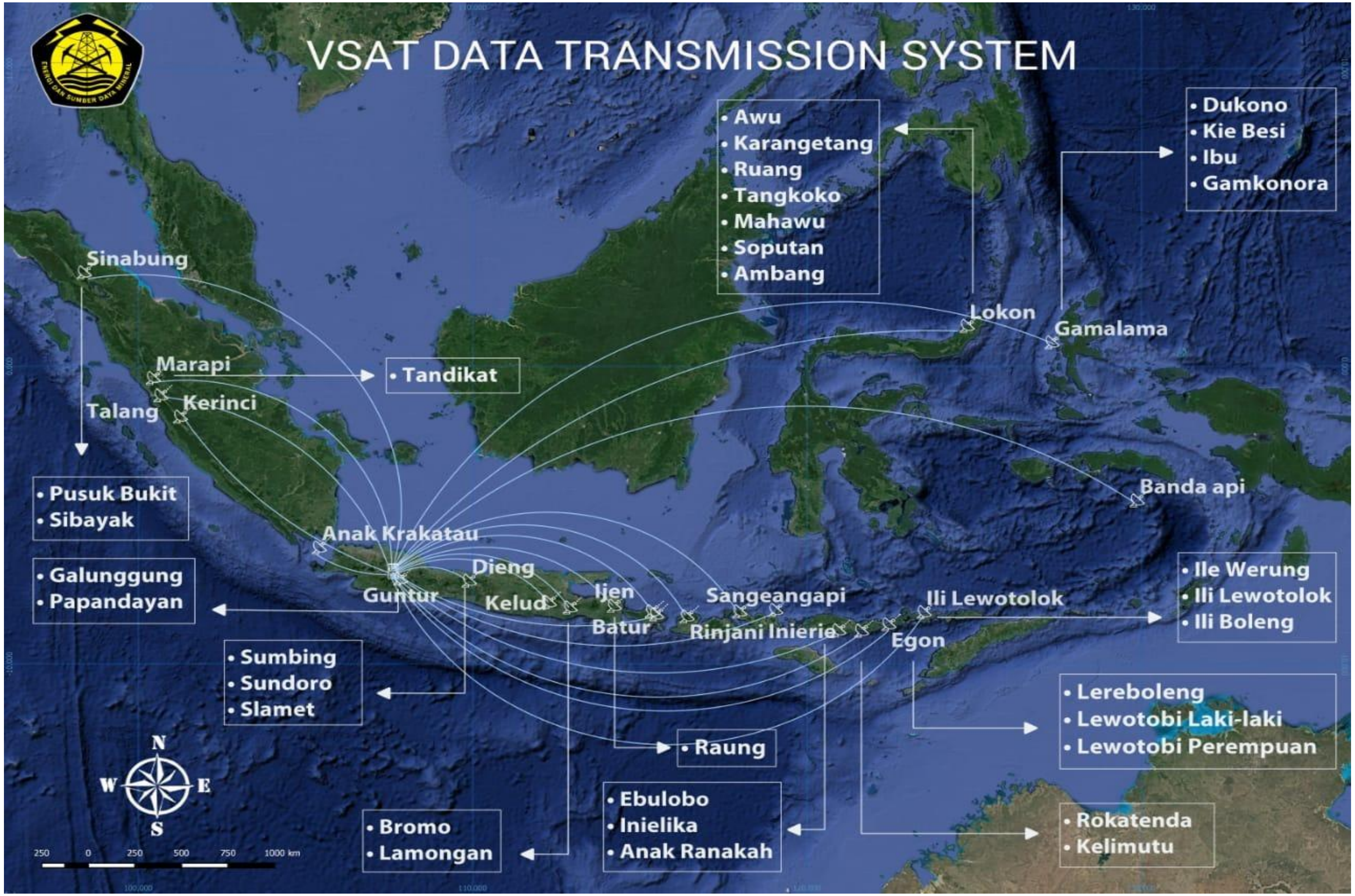
Rencana TA. 2021

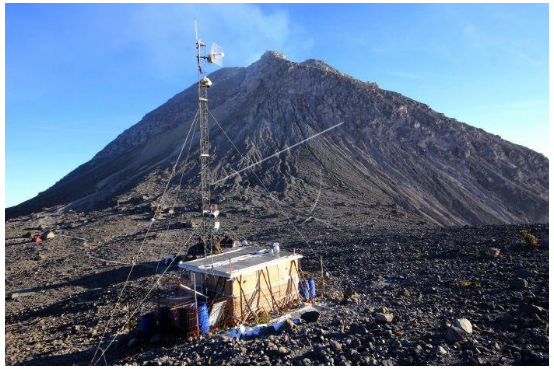
Tahun 2021 Akan dilakukan pengembangan Pos Pengamatan Gunungapi sebanyak 5 Pos PGA.

NO	NAMA POS PGA
1	Pos PGA Ciremai, Jawa Barat
2	Pos PGA Karangetang, Sulawesi Utara
3	Pos PGA Soputan, Sulawesi Utara
4	Pos PGA Egon, NTT
5	Pengadaan Tanah Pos PGA Tangkuban Parahu, Jawa Barat

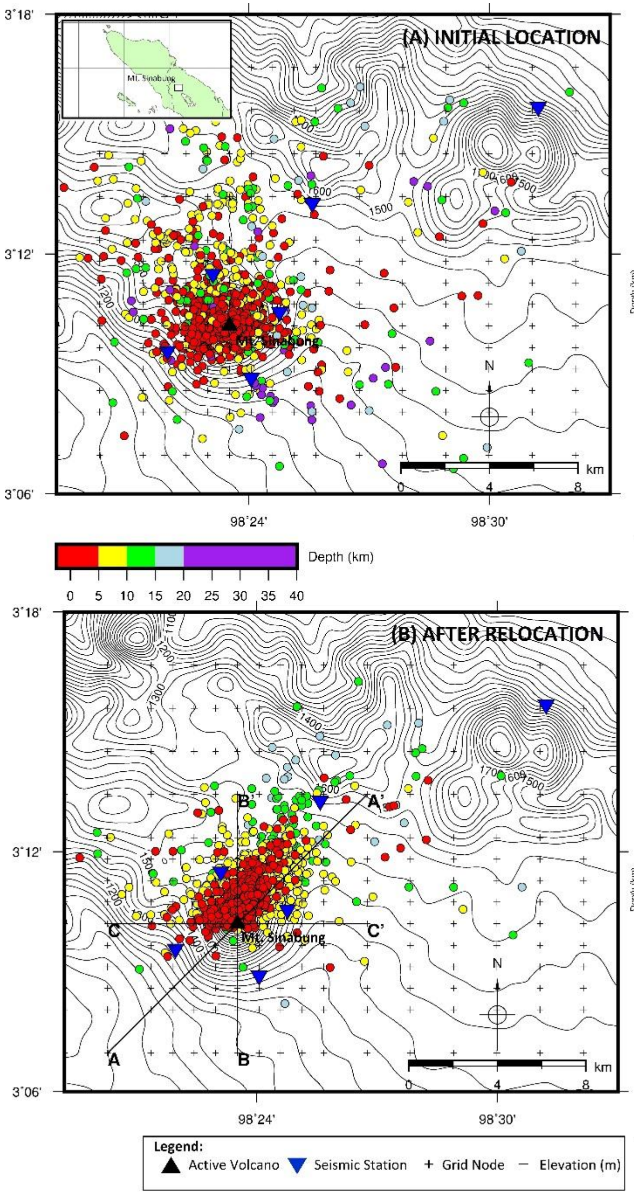


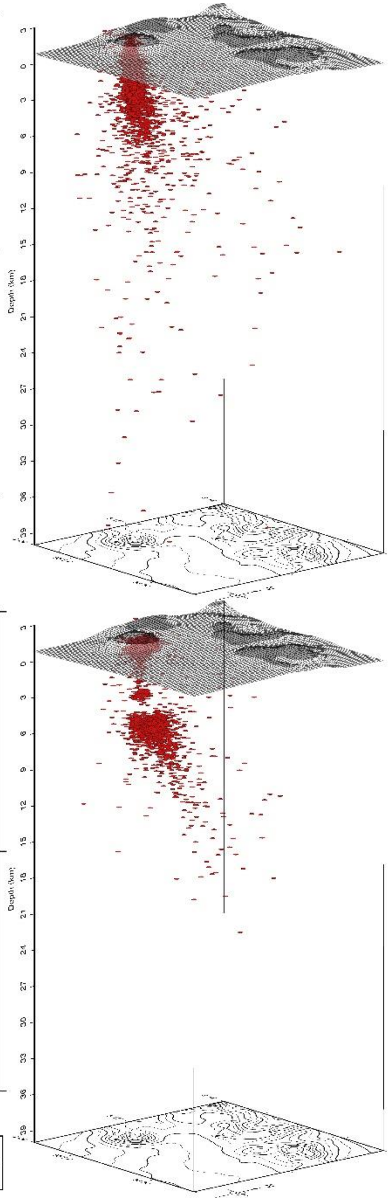
Jaringan Peralatan Monitoring Kegempaan





Investigasi Tomografi Seismik pada Zona Gunungapi di bawah Gunung Sinabung, Sumatera Utara





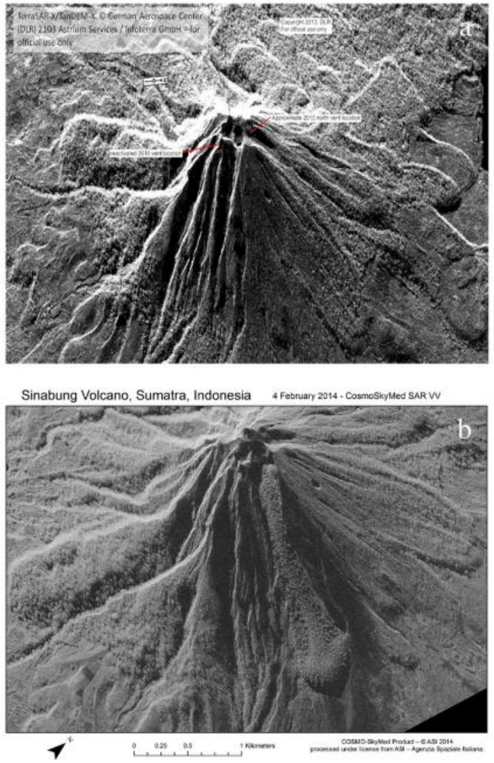


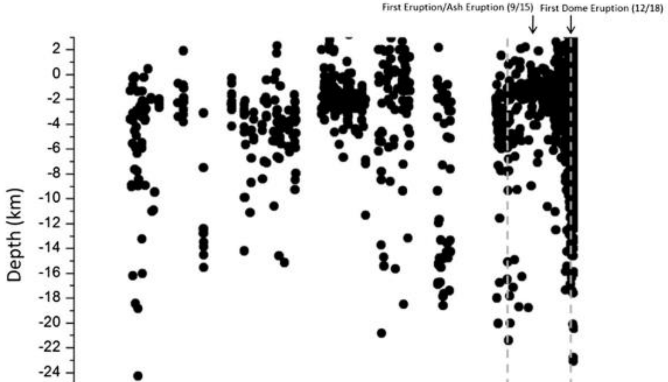
Fig. 10. CosmoSkyMed radar image of Sinabung volcano on November 2013 (a) and 4 February 2014 (b). (b) showing the lava flow that had descended the southeast side of the volcano and the inflation of the flow terminus on the lower slope flank of the volcano. Collapses from the flow-front and from the steep upper west side of the flow produced multiple PDCs.

This was followed by a period of relatively low emission rates a
aging about 250 tons/day prior to the first dome and colla
phase. In October and November 2013, SiO2 fluxes fluctuated u
reaching maximum values of more than 4000 tons/day and ave
ing 1500 t/d during first dome growth and collapse phase in Dec
ber 2013.

6. Conclusions

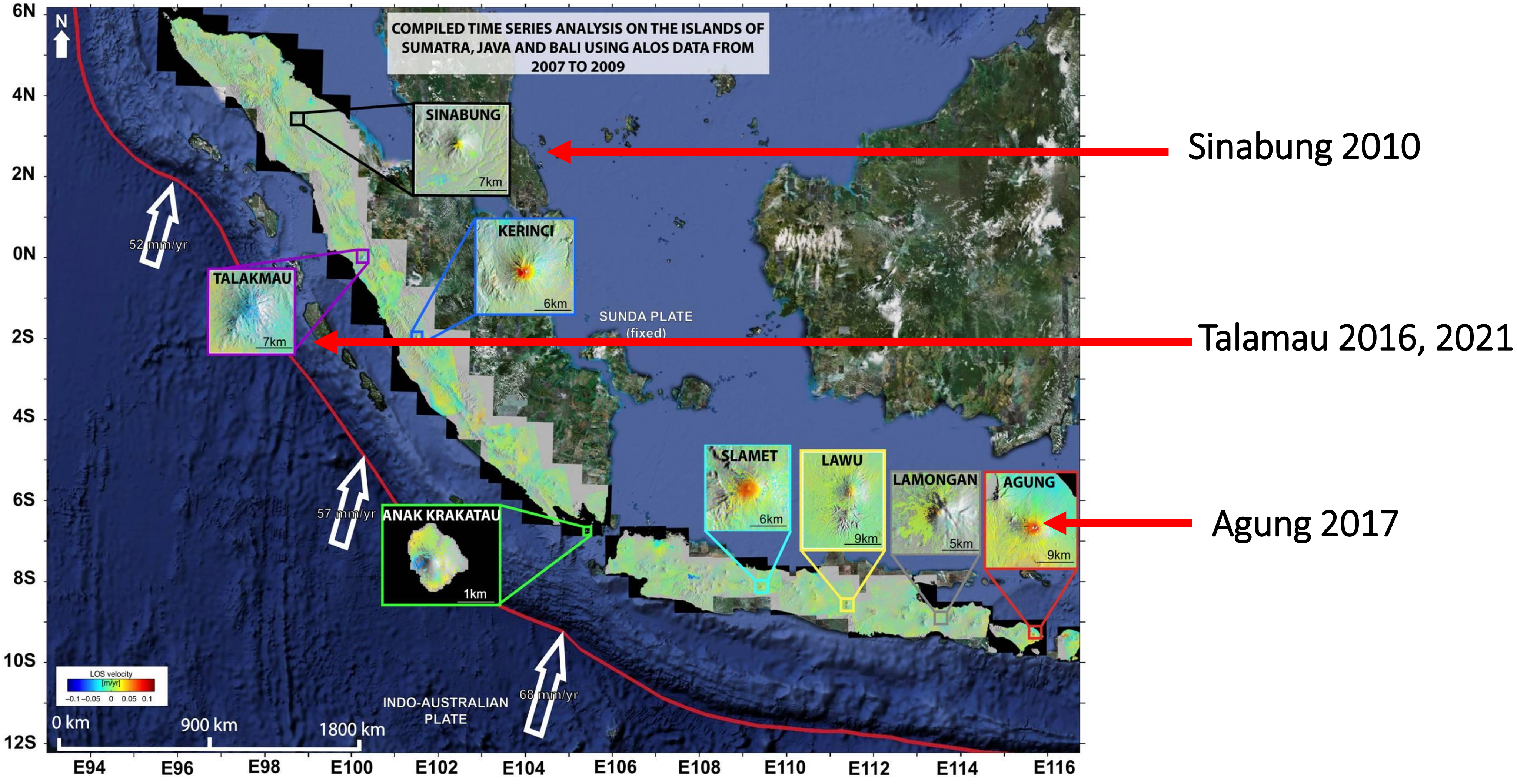
The ongoing eruption and monitoring of Sinabung volcano is
viding new insights into the volcanology of andesitic arc volcan
We and the other contributors to this special issue show how
long-dormant volcano renewed activity in 2010 with a short-li
phreatic phase, followed by three years of relative quiescence du
which VT swarms and slow uplift marked continued magma asc
before phreatomagmatic then magmatic eruptions began ag
(Fig. 16). A transition to hybrid and self-similar earthquake swa
accompanied magma ascent that preceded lava dome extrusion
seen at many other volcanoes (e.g., White and McCausland, 20
Another remarkable volcanologic phenomena witnessed during
Sinabung eruption was the transition from a lava dome to a
flow, and the collapse of lava flow-front and flow margins.
those of summit domes, collapses from the lava flow front and r
gins, produced PDCs at Sinabung, including both block-and-ash
roclastic flows as well as dilute surges and at least one small lat
blast (Pallister et al., this issue).

The location and extent of PDC hazards at Sinabung has varied
the course of the eruption, depending on the location of the ac
vent(s), with PDCs impacting areas initially to the south and south
then shifting more to the east (Andreastuti et al., this issue). Over
course of the eruption, careful monitoring of the volcano using bot
situ remote geophysical techniques, combined with probabilistic e
tree analysis (Wright et al., this issue) has proven effective in issu
warnings and mitigating risk and saving hundreds to thousand
lives. Tragically, in spite of these warnings and restricting access to
ger zones, several dozen lives have been lost to PDCs associated
eruptions in 2014 and 2016.



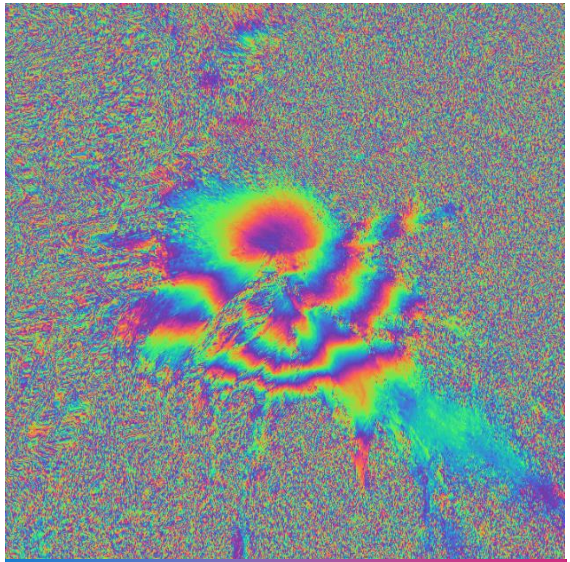
MENGAPA MITIGASI (II) ?:

DATA MASA LALU MEDIUM-TERM

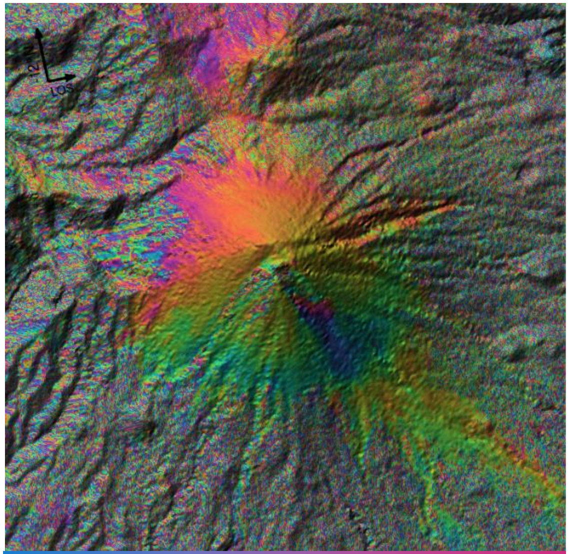


Pemantauan deformasi gunungapi di Indonesia menggunakan data SAR ALOS periode 2007-2009 (Estelle Chaussard and Falk Amelung, 2010)

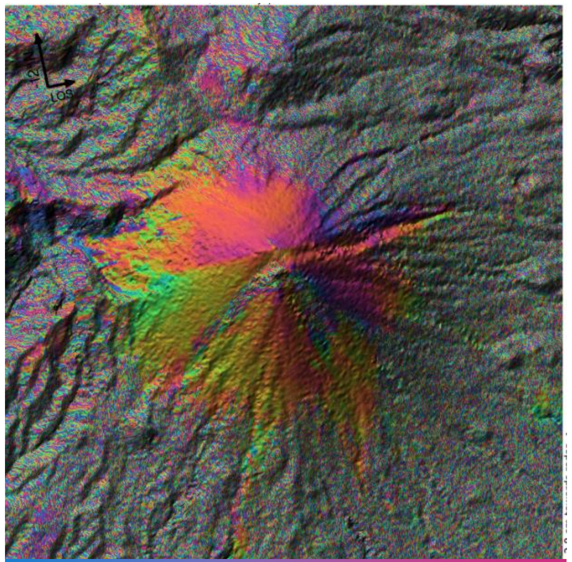
INSAR 2 SEPTEMBER – 19 DESEMBER 2021



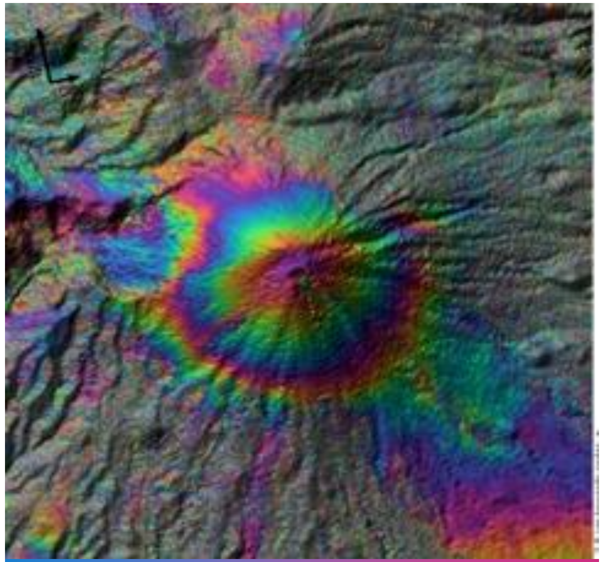
Sentinel 1-A periode
2 September 2021 - 14 September 2021
terdeteksi inflasi di bagian puncak.



Sentinel 1-A periode
13 November 2021 - 25 November 2021
terdeteksi inflasi di bagian puncak.



Sentinel 1-A periode
25 November 2021 - 7 Desember 2021
terdeteksi inflasi di bagian puncak.



Sentinel 1-A periode
7 Desember 2021 - 19 Desember 2021
terdeteksi inflasi di bagian puncak.

MENGAPA MITIGASI (III) ?:
DATA MASA LALU SHORT-TERM

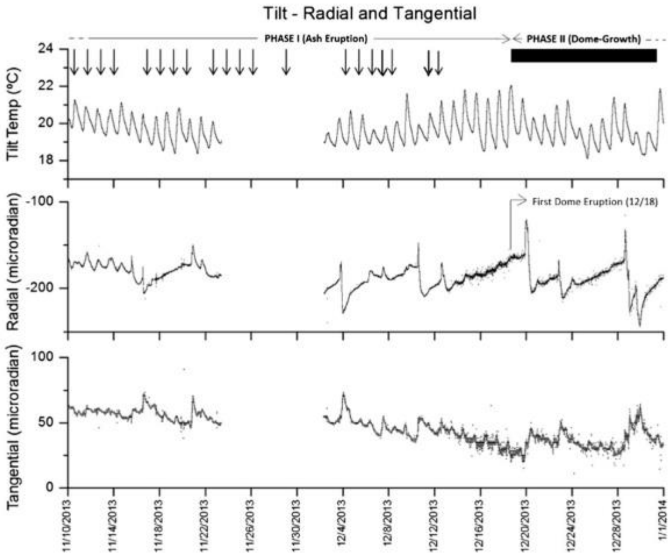
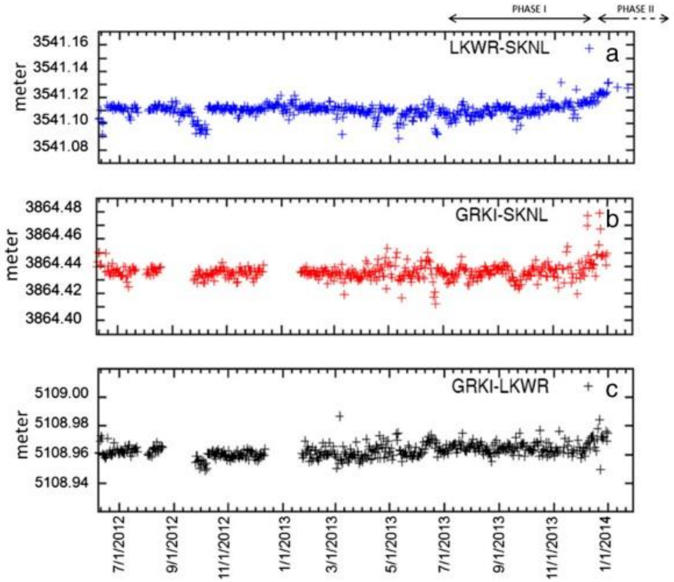


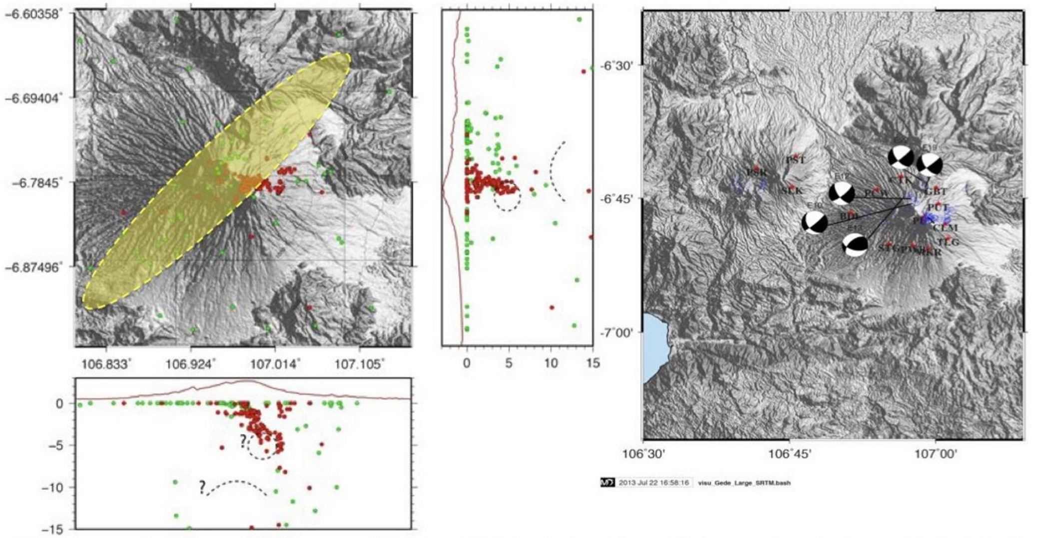
Fig. 13. Temperature, radial and tangential component of the station SKN tiltmeter data during the period between 10 November and 31 December 2013.

Please cite this article as: Gunawan, H., et al., Overview of the eruptions of Sinabung eruption, 2010 and 2013–present and details of the 2013 phreatomagmatic phase, J. Volcanol. Geotherm. Res. (2017), http://dx.doi.org/10.1016/j.jvolgeores.2017.08.005

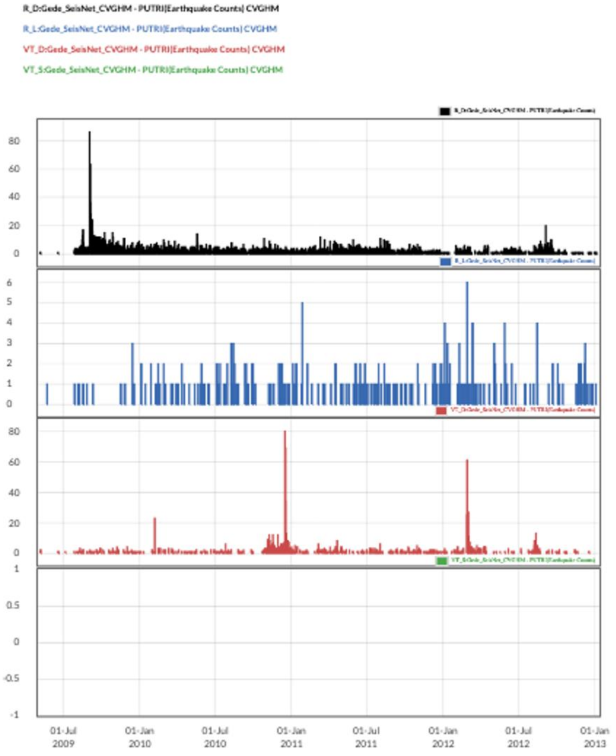


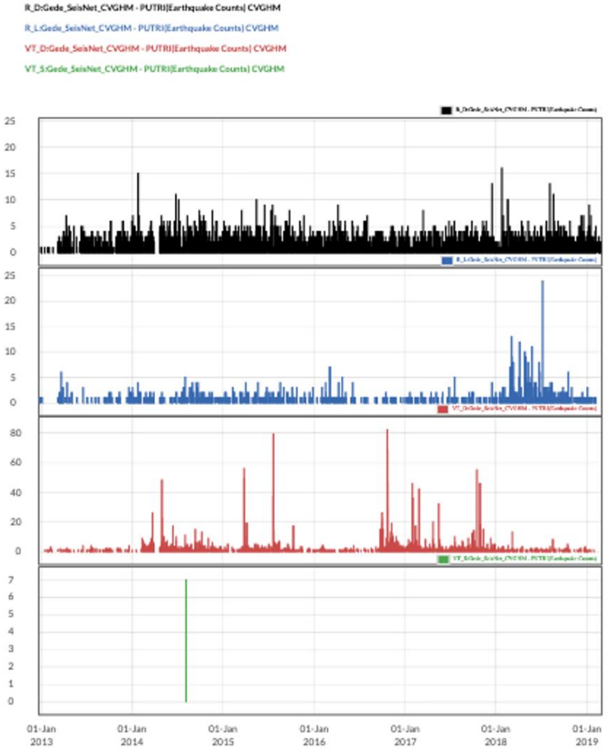
2012-2013

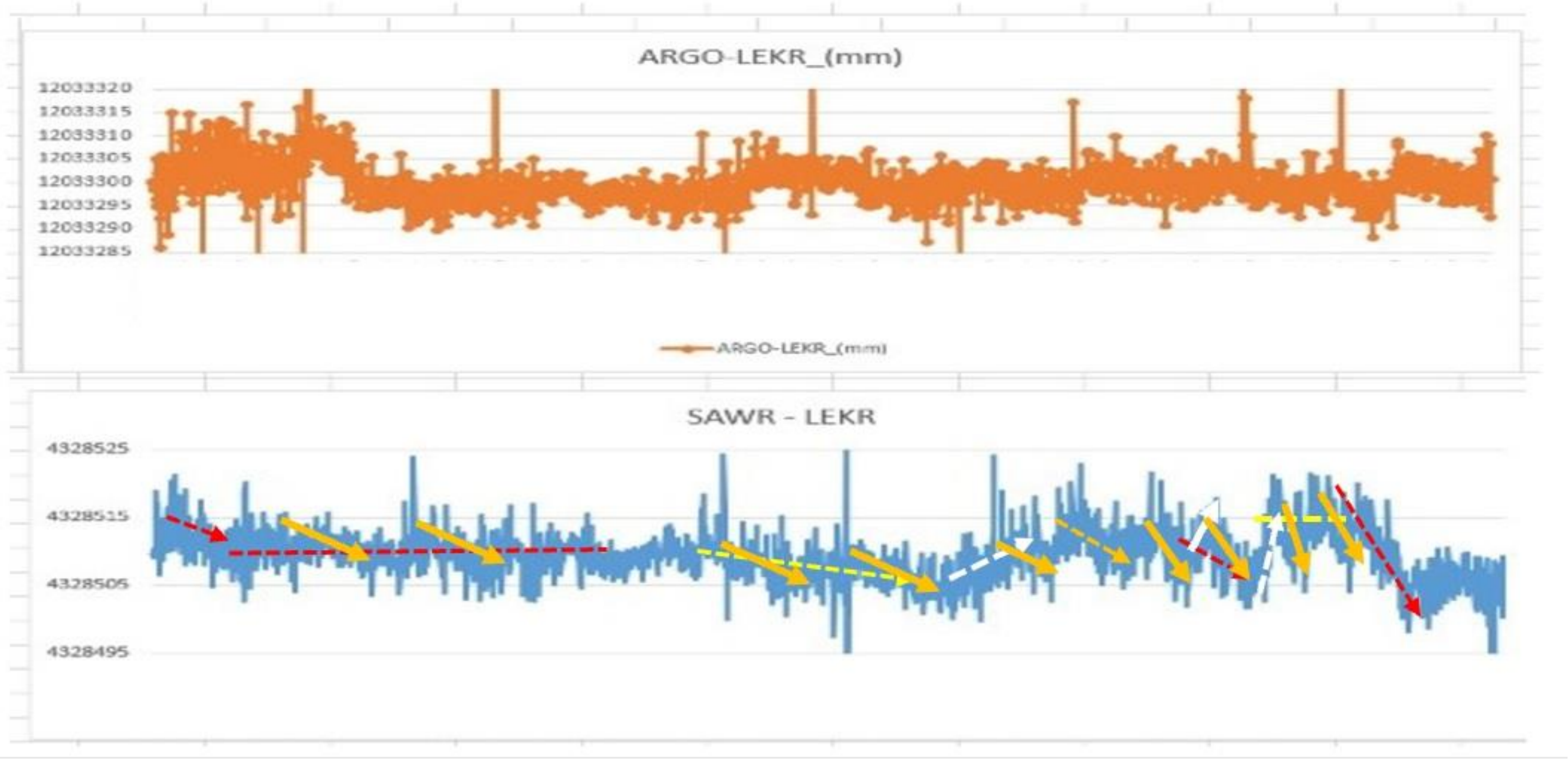
Seismic experiment: April – October 2013



Hypocenters during period of swarm of Feb-Apr 2012 (red), together with hypocenters between Mar 2011 – Sep 2012 (green). Our receiver function study suggests 2 low velocity zones at about 5 and 10-15 km depth; zones






ARGO-LEKR_(mm)
12033320
12033315
12033310
12033305
12033300
12033295
12033290
12033285
ARGO-LEKR_(mm)
SAWR - LEKR
4328525
4328515
4328505
4328495

Modernisasi peralatan pemantauan : next Step

No.	Gunungapi	Peralatan yang dibutuhkan
1	Ili Lewotolok	3 Seismometer, 4 GPS, 2 Tiltmeter, 2 CCTV, 1 Kamera infra merah
2	Gamalama	3 Seismometer, 4 GPS, 2 Tiltmeter, 2 CCTV, 1 Kamera infra merah
3	Semeru	3 Seismometer, 4 GPS, 2 Tiltmeter, 2 CCTV, 1 Kamera infra merah
4	Bromo	3 Seismometer, 4 GPS, 2 Tiltmeter, 2 CCTV, 1 Kamera infra merah
5	Lamongan	3 Seismometer, 4 GPS, 2 Tiltmeter, 2 CCTV, 1 Kamera infra merah
6	Dempo	3 Seismometer,
7	Papandayan	3 Seismometer,
8	Kelimutu	3 Seismometer,

Terima Kasih