Lesson learned from 2018 Eruption of Anak Krakatau & Future Monitoring Strategies

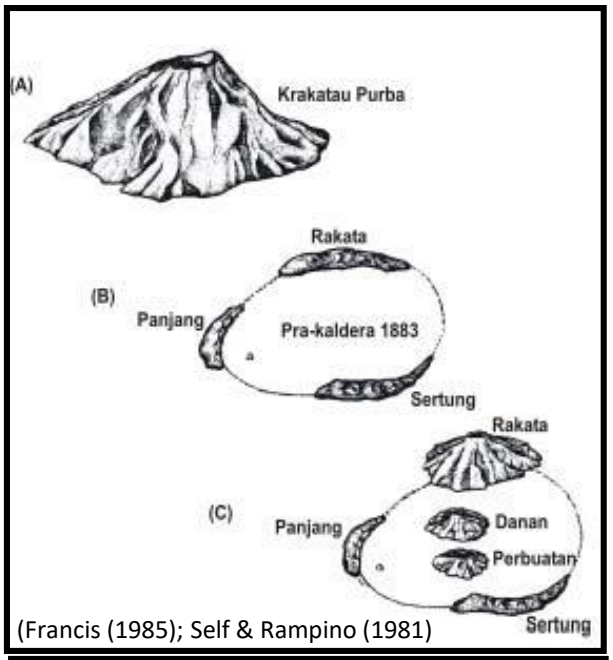
By : Hendra Gunawan

Center for Volcanology and Geological Hazard Mitigation

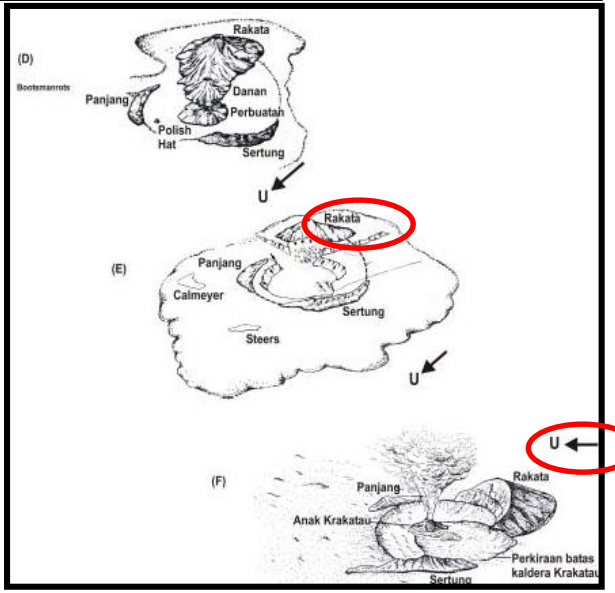
MINISTRY of ENERGY And MINERAL RESOURCES

Geological Agency

HISTORY of KRAKATAU



(Francis (1985); Self & Rampino (1981)



PREHISTORIC TIMES

(Escher, 1919; Francis,1985; Self & Rampino,1981; Simkin & Fiske, 1983)

1. **Prehistoric**
   - Composite type
   - First caldera 416 AD (from Indonesia ancient text)
2. **Rakata-Danan-Perbuwatan history**
3. **Catastropic Eruption in 1883**
   - Volume 18 km^3
   - Tsunami height ~ 30 m : Banten coast and south Lampung

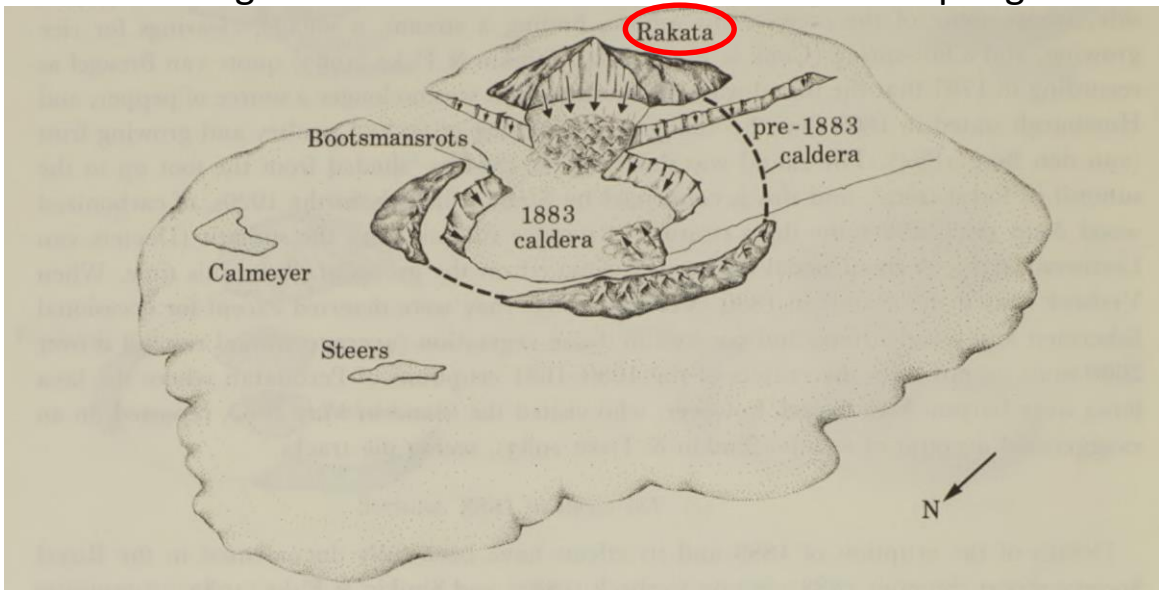
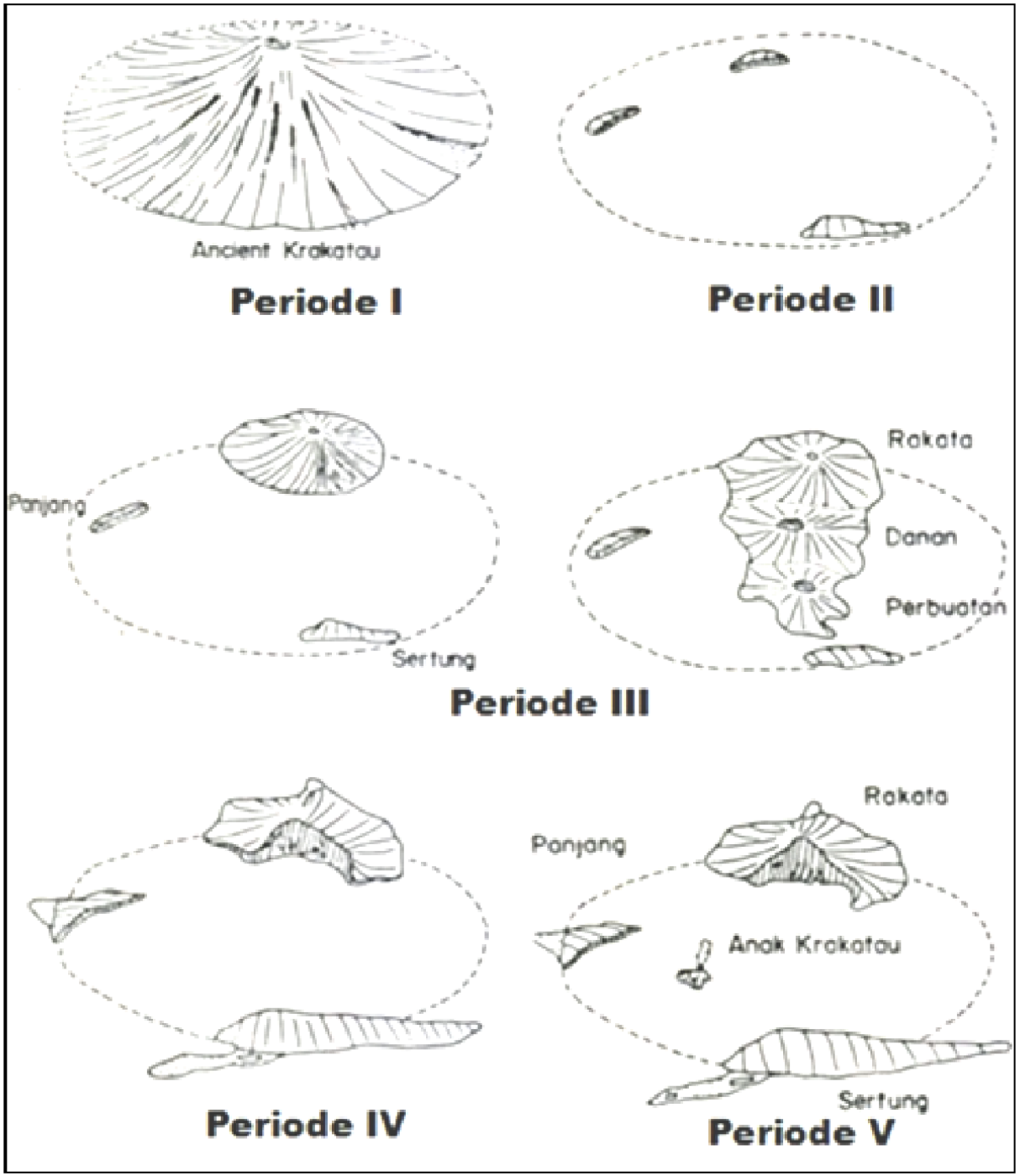


FIGURE 4. Aftermath of the 1883 eruption of Krakatau Is. (same view as figure 3) showing 1883 caldera within ancient caldera, undersea deposition of volcanic emissions, Calmeyer and Steers Islands (later eroded), enlargement of Sertung and Panjang, and remnant of Rakata volcano left as Rakata Is. (see text). Not to scale; modified from Francis & Self (1983).

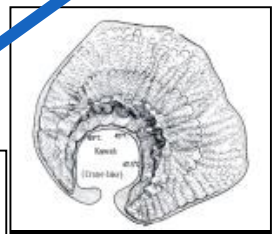

Ancient Krakatau
Periode I
Periode II
Panjang
Sertung
Rakata
Danan
Perbuatan
Periode III
Periode IV
Rakata
Panjang
Anak Krakatau
Sertung
Periode V

Phase Construction of Anak Krakatau

Konstruktif

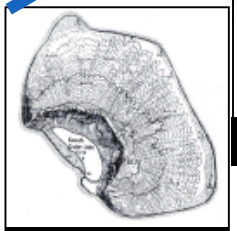

Jan

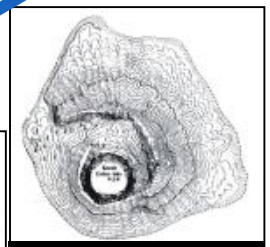

Feb 1929


Des 1940

Destruktif

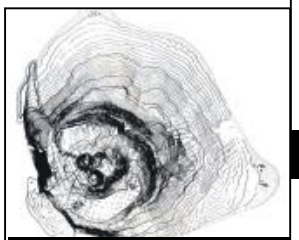
Konstruktif

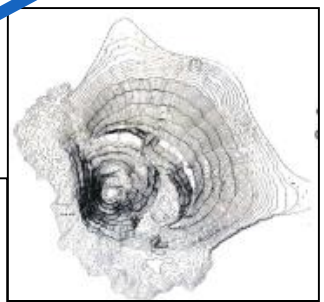

Juli 1950

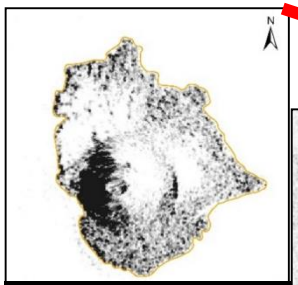

Okt 1952

Destruktif

Konstruktif

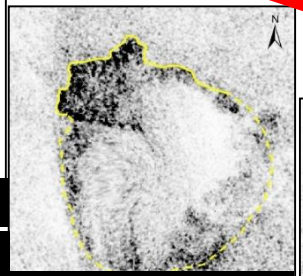

Des 1972

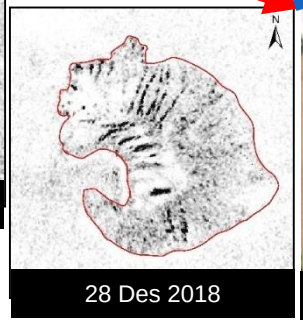

Juli 1981


19 Des 2018

- Luas 3 km2
- Volume ~ 5,5 km3

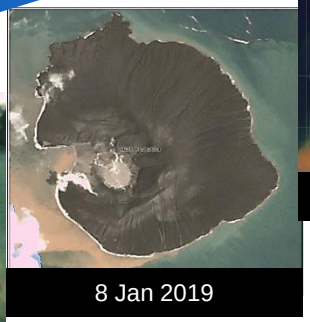
Destruktif

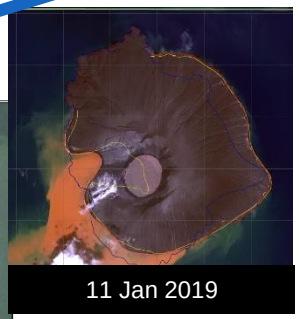

25 Des 2018


28 Des 2018

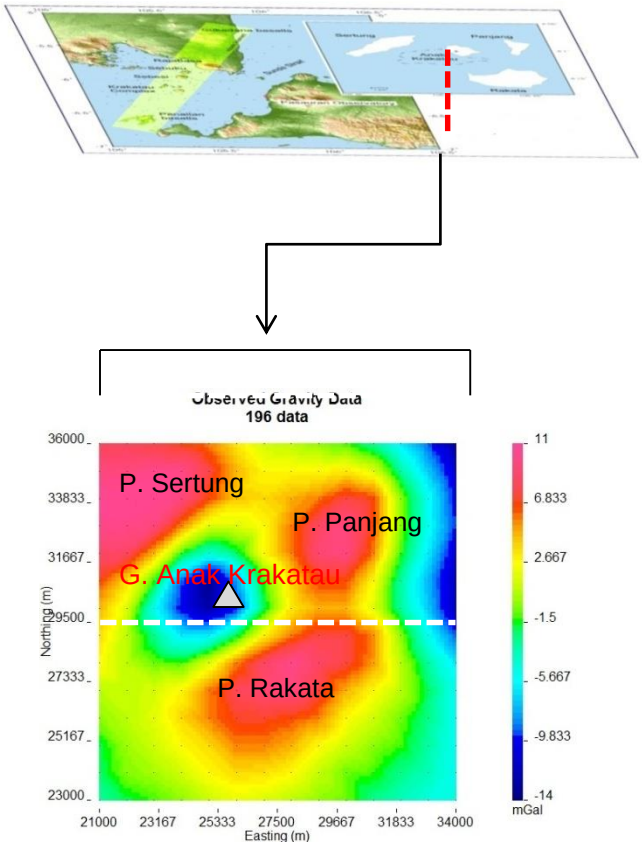
Konstruktif


1 Jan 2019


8 Jan 2019

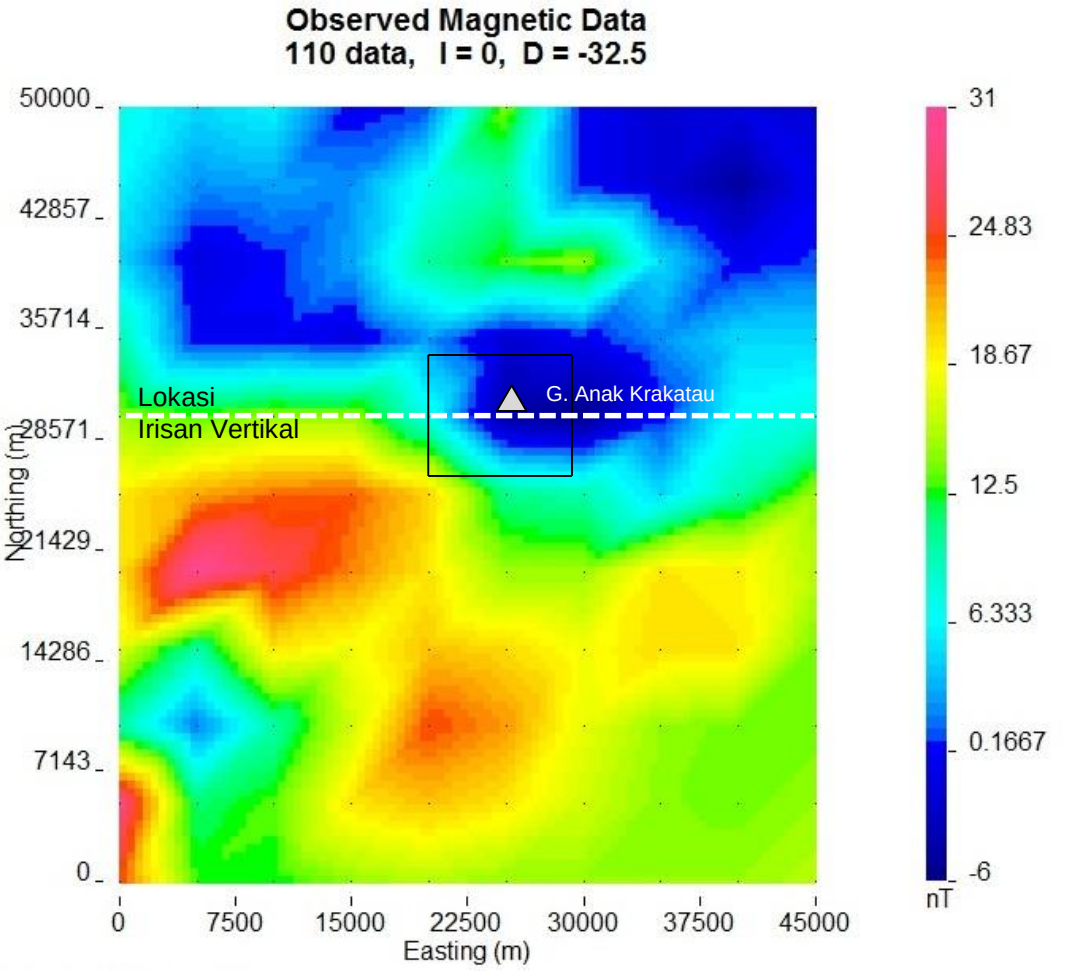

11 Jan 2019

BOUGER & MAGNETIC ANOMALY MAP
ANAK KRAKATAU
SURVEY IN 1980

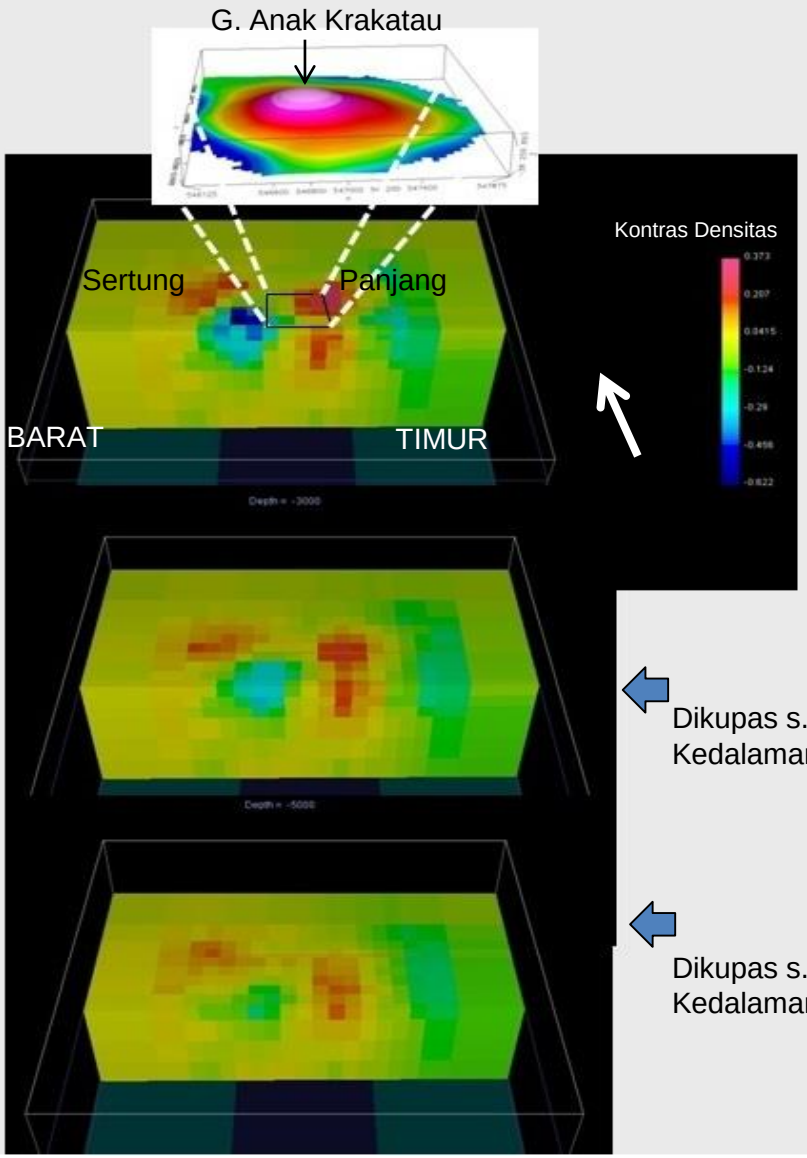


Bouguer Anomaly Map

Magnetic Anomaly Map

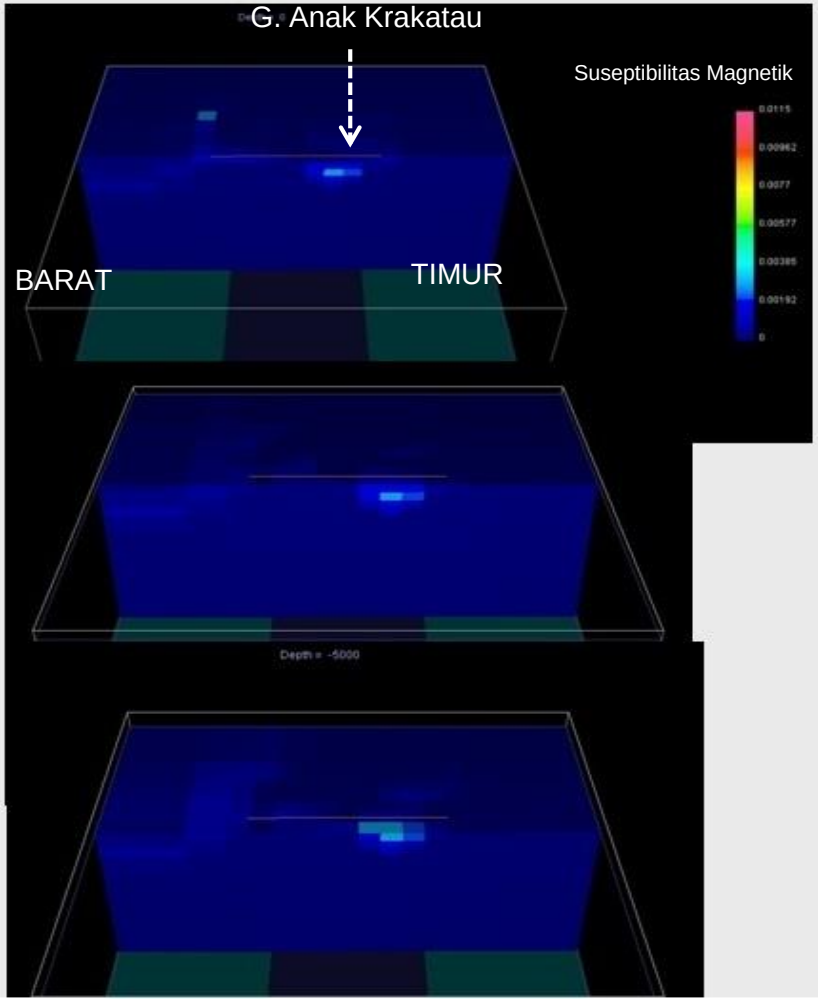


3-D MODEL of ANAK KRAKATAU SUBSURFACE
From GRAVITY-MAGNETIC DATA

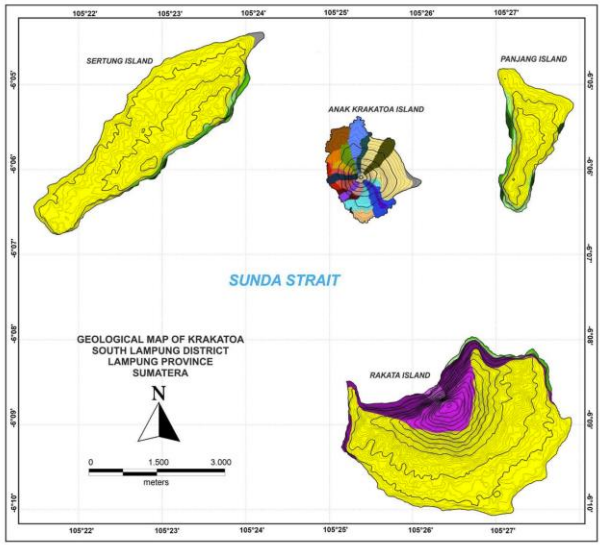


Dikupas s.d
Kedalaman = 3 km

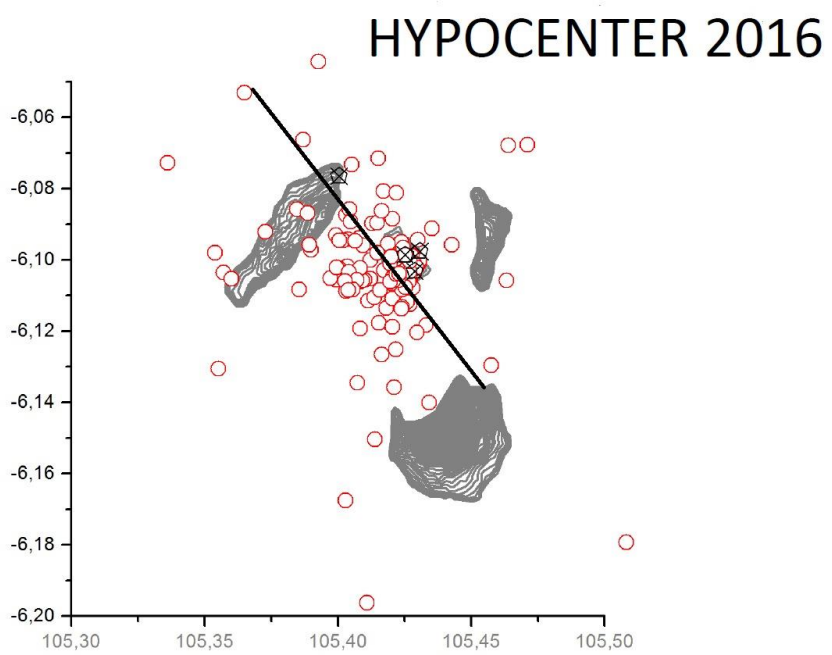
Dikupas s.d
Kedalaman = 5 km

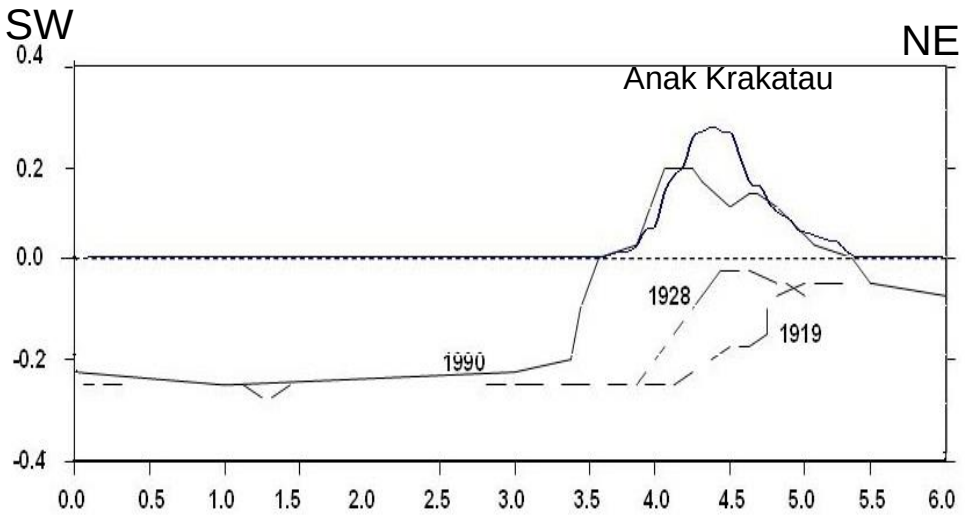


GEOLOGICAL MAP and SEISMIC DATA of ANAK KRAKATAU

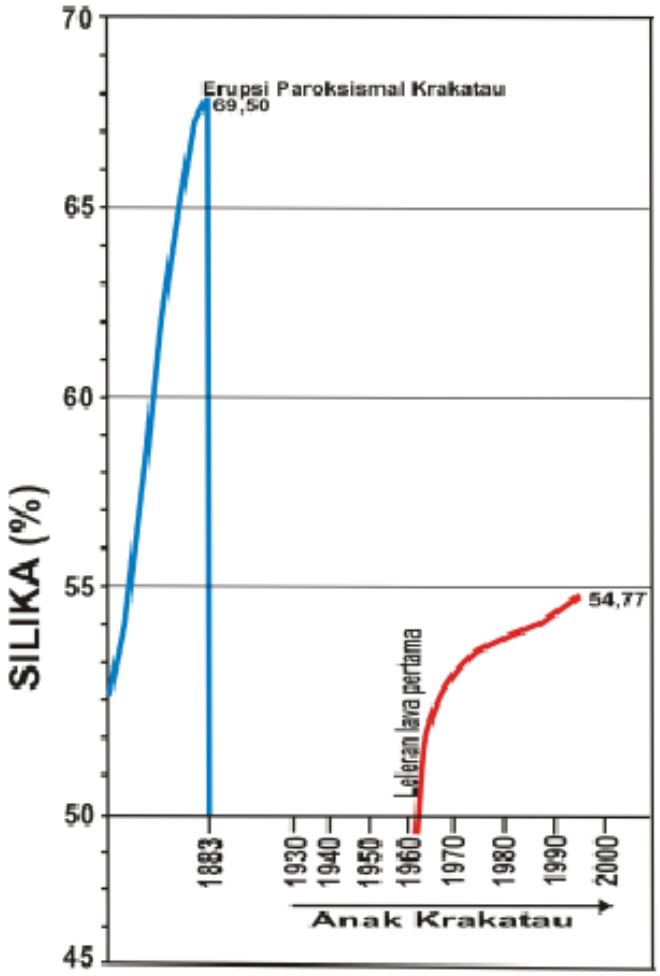


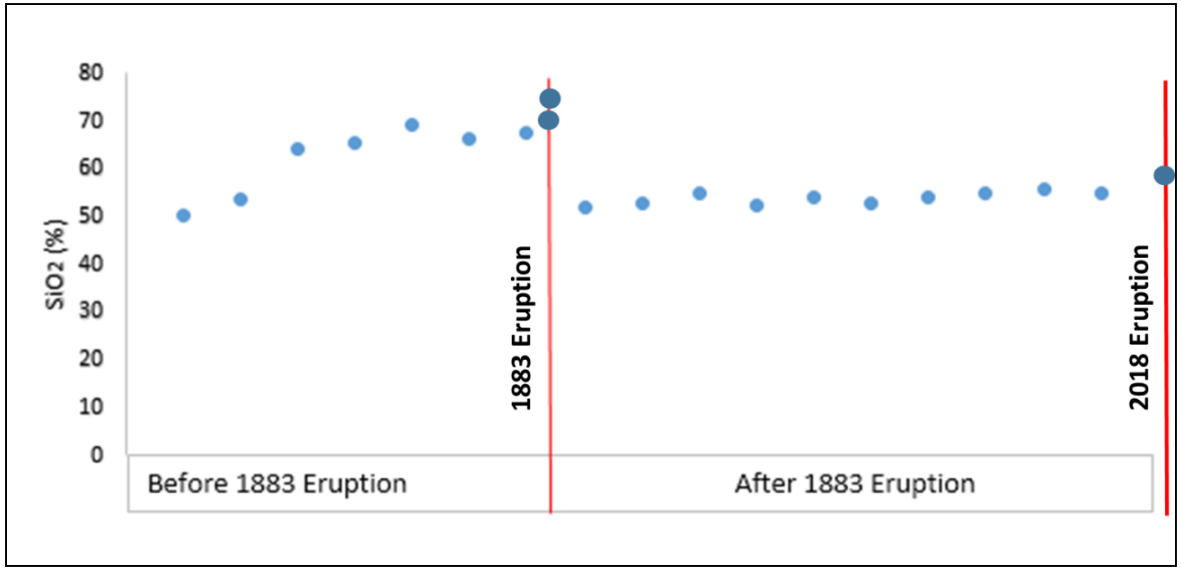
Sutawijaya, 2006





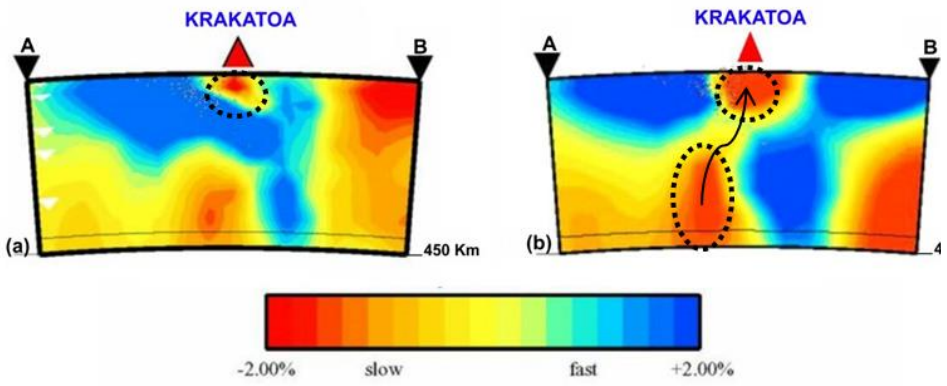
SILICA CONTENT TIME SERIES

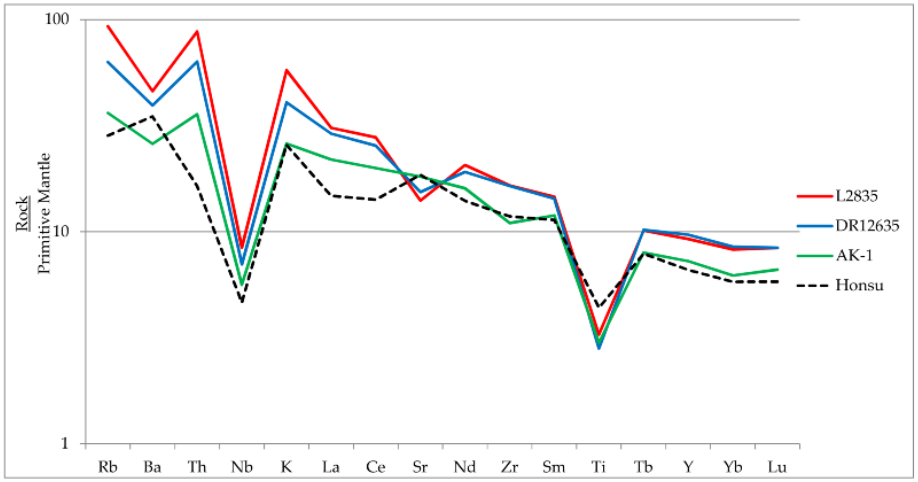


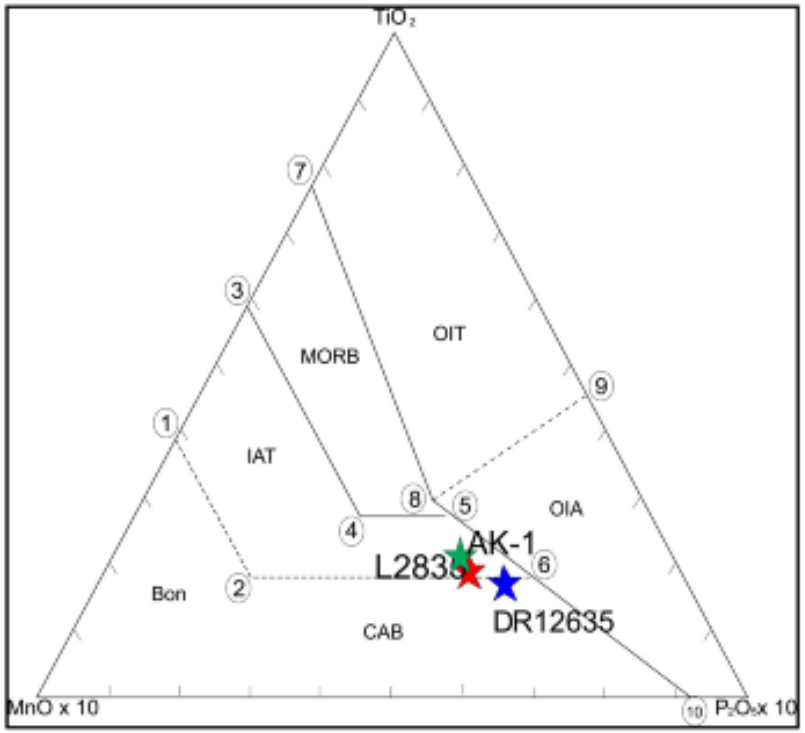


- ✓ No significant changes Silica content after 1883 caldera formation
- ✓ The 2018 eruption is not due to changes of SiO2 content but more likely to high magma discharge rate throughout 2018 activity

Magmatic Origin of Anak Krakatau Volcano



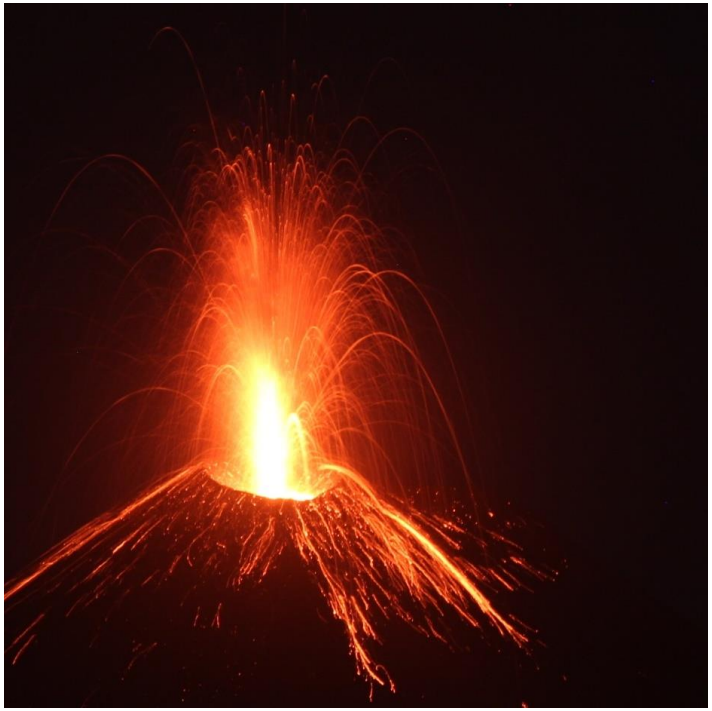


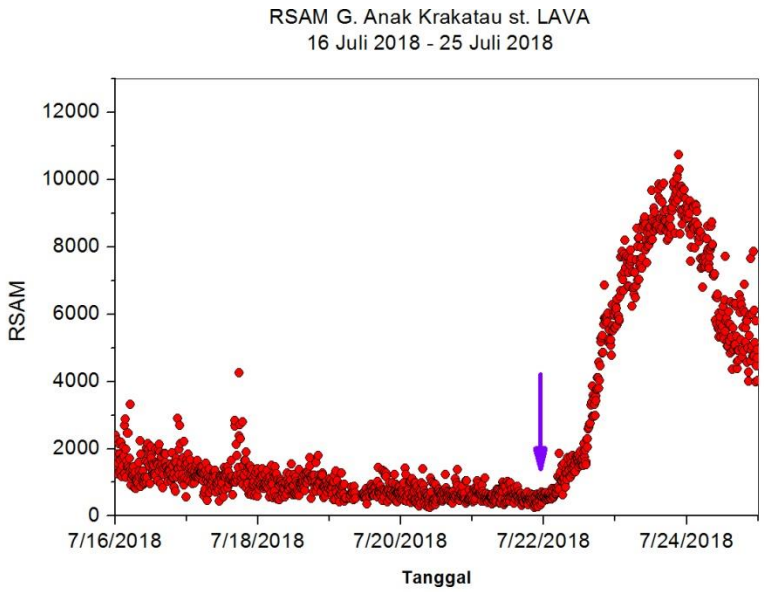


- ✓ Seismic Tomography shows two different magma source (**Partial Melting due to subduction** i.e dehidration of subducted slab, **Upper Mantle Upwelling** i.e magma rising due to slab thinning.
- ✓ Trace element normalized to primitive mantle showing depleted Nb & Ti elements indicating magma generated from subduction environtment.
- ✓ Ternary diagram of TiO_2 –MnO x10-P_2O_5 x10 of Krakatau Rocks reveals that magma belong to Island Arc Thoellitic series.

Erution Phase in July 2018

- **Visual and seismic observation**
  - **strombolian type (cont.)**
  - **lava flow reach island coast**
- **tremor amplitude : 31 mm**





Peningkatan amplitudo kegempaan
Pada tanggal 22 Juli 2018

Eruption Pahes in September 2018

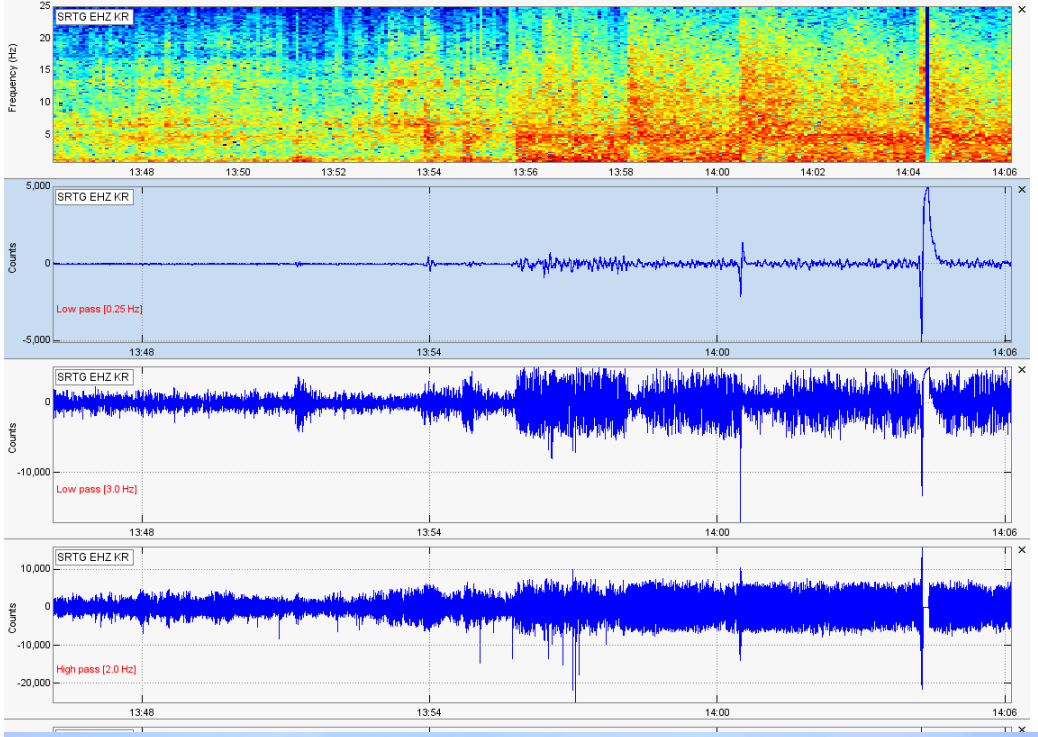
- **Visual observation and tremor amplitude : 51 mm**

Aliran lava ke arah selatan P. Anak Krakatau dan mencapai laut pada tanggal 16 September 2018

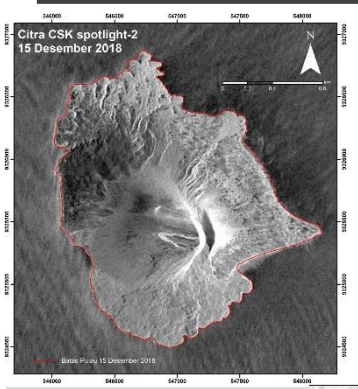
Seismic Waveform on 22 December 2018

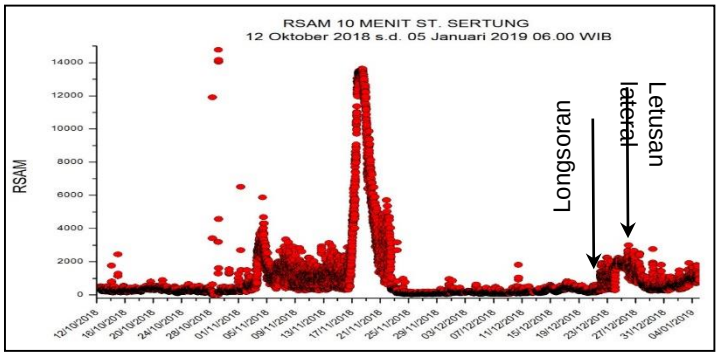
Sertung seismic station :

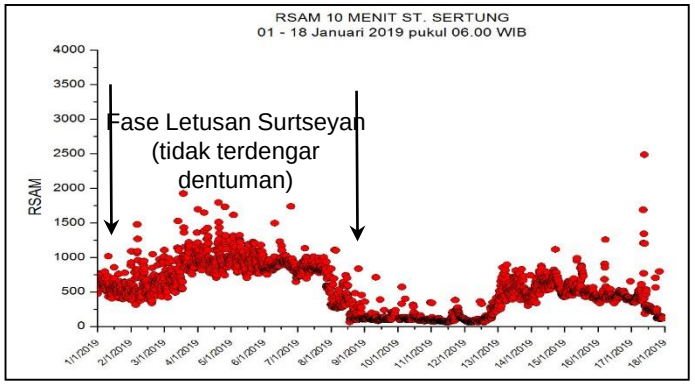
1. **On 22 Desember 2018 at 20:55:43.3 LT, spectrogram changed.**
2. **This type spectrogram is repeated with same interval, at 20:58, 21:00, 21:02,dan 21:04.**



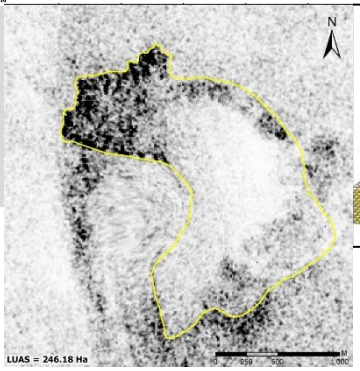
2018 ERUPTION

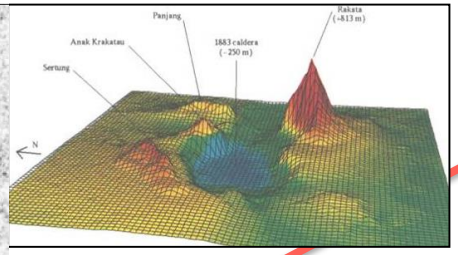






- Longsoran ~ 0.08 km3
- Tsunami 21.05 WIB



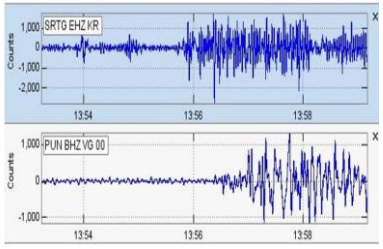


Earthquake
20.55 LT

Eruption Phase

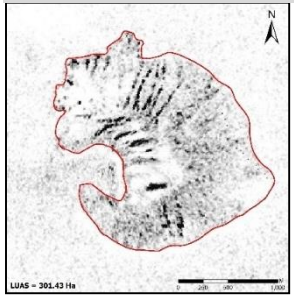
29 June 2018

22 Dec 2018



26 Dec 2018

- Lateral blast
- Kawah tapal kuda (KTK)
- Landslide ~ 0.005 km3
- No tsunami

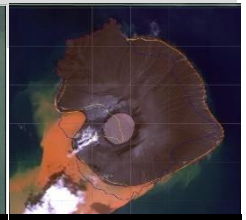


1 – 18 Jan 2019

- After 26 Dec, center of eruption under the sea
- Surtseyan type
- 1 Jan terlihat endapan letusan di dasar KTK
- 8 Jan emerged cone shape
- 11 Jan terlihat kawah terisolasi dan berair
  - ✓ Diamter 400 m


Situasi 1 Jan


Situasi 8 Jan


Situasi 11 Jan

Future Monitoring Strategy

Seismic Equipment

FIELD

OBSERVATORY

Analog signal (VHF/UHF)

Transmiiter (UHF/VHF)

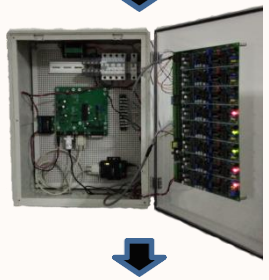
Receiver (UHF/VHF)

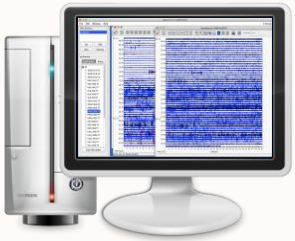
McVCO

Gain : 60 – 66 dB
Att : 5dB
Low-pass filter 30Hz, 4 poles

Discriminator (Mc8)

Low-pass filter 20Hz, 4 poles





Earthworm

PSN ADC

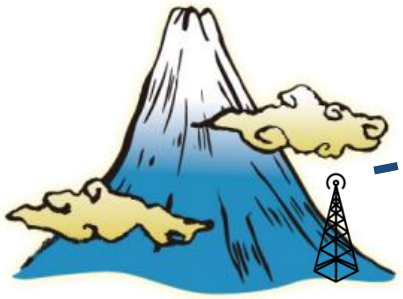
LSB/media gain:
6558 count/V

Sercel L4-C

Sensitivity 275 V/m/s

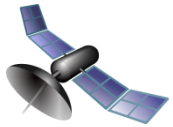
Tiltmeter Equipment

- Sensor Jewel 701-2
- Logger mini-PC (assembled, embedded Arm TS-4200)
- Software TiltTemp
- Communication using wifi and VSAT



Wi-fi

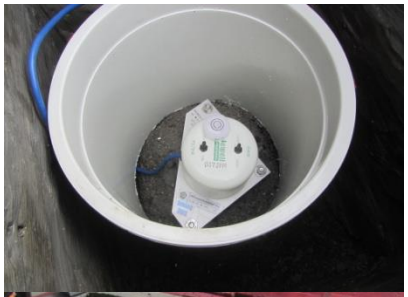
VSAT

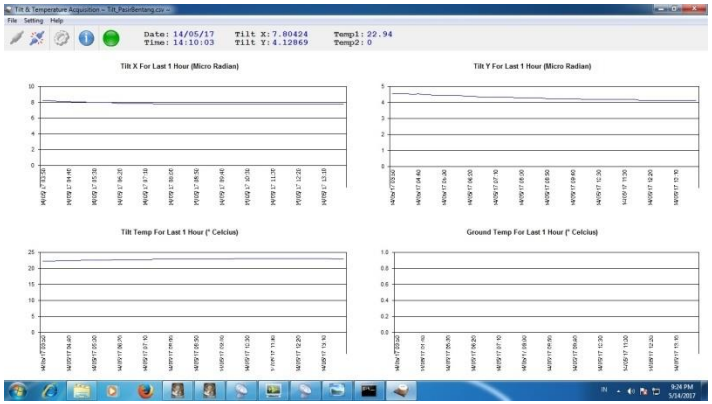


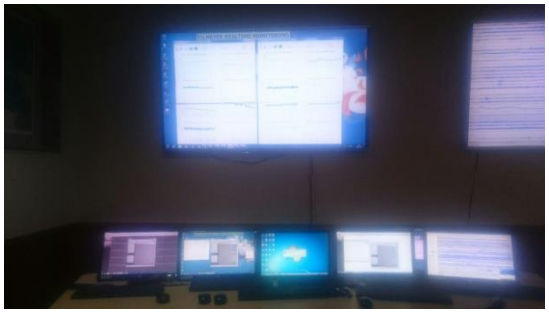
Sensor and logger at field

Realtime monitoring at Obervatory

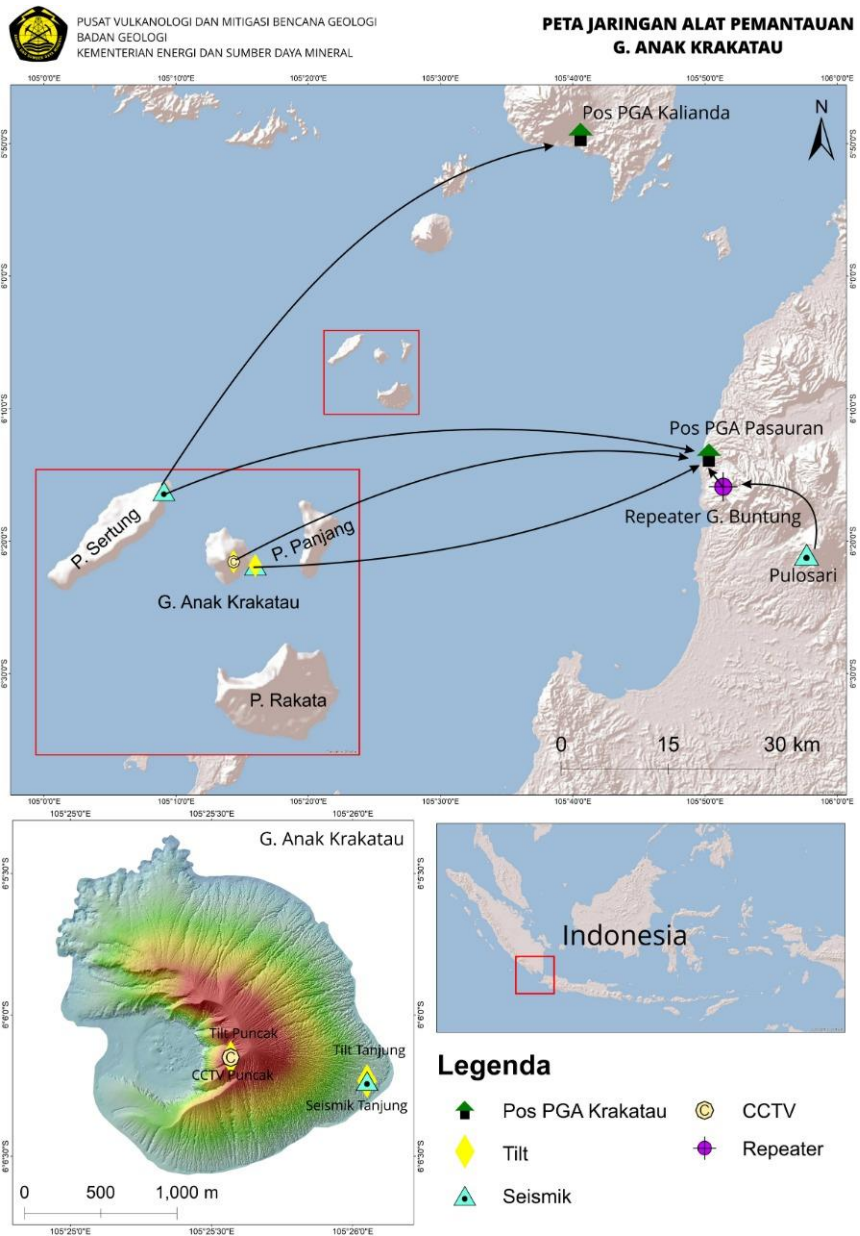
Realtime monitoring at Main Office



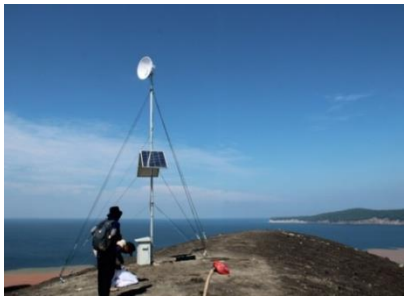


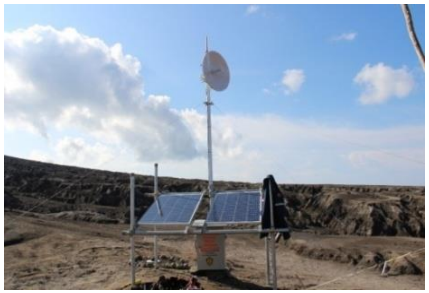


EARLY WARNING SYSTEMS AFTER 2018 ERUPTION



Instalasi seismometer St. Tanjung

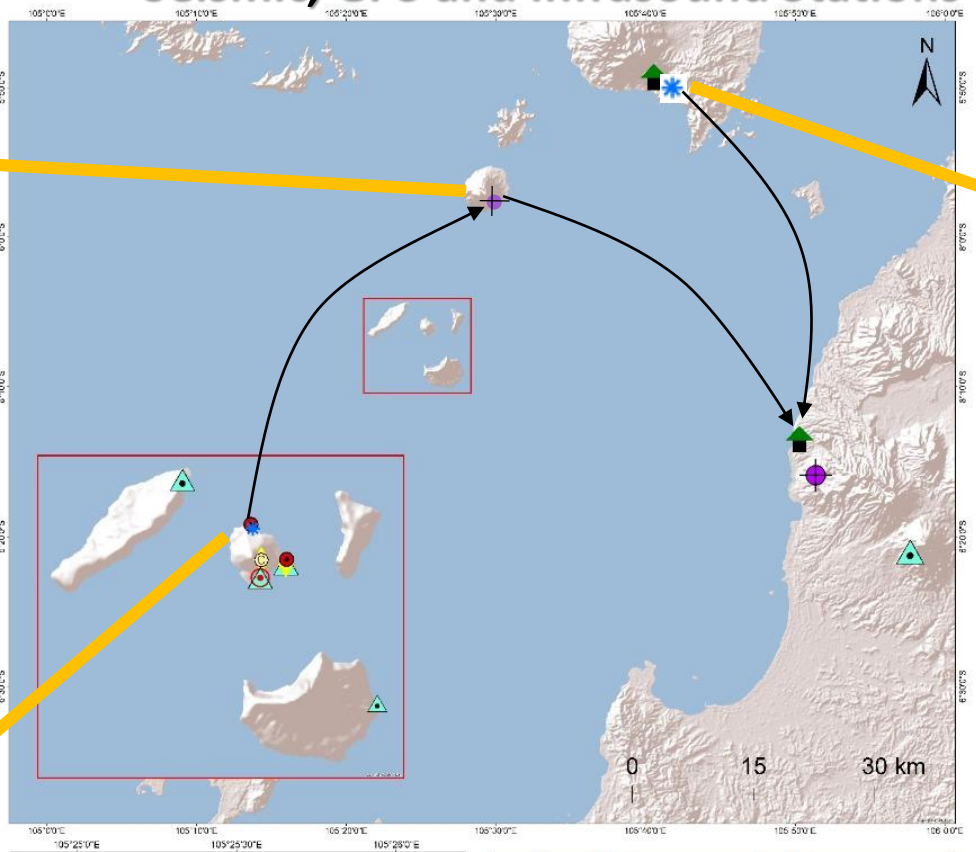


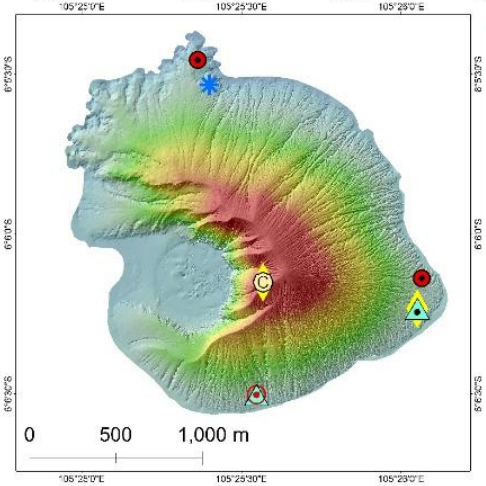


Instalasi tiltmometer St. Puncak dan St. Tanjung

Rekaman CCTV Letusan GAK 22 Agustus 2019

Seismic, GPS and Infrasound Stations

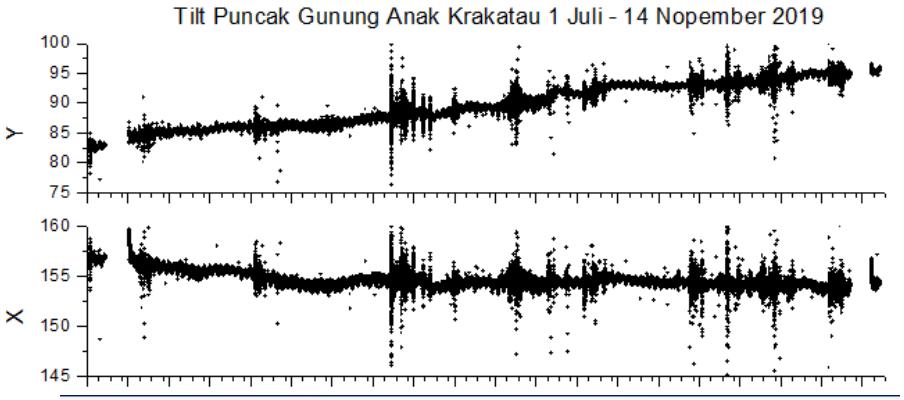




Legenda

- Pos PGA Krakatau
- Seismic
- Tilt
- CCTV
- Repeater
- GPS Temporer
- INFRASONIK
- SEISMIK & GPS

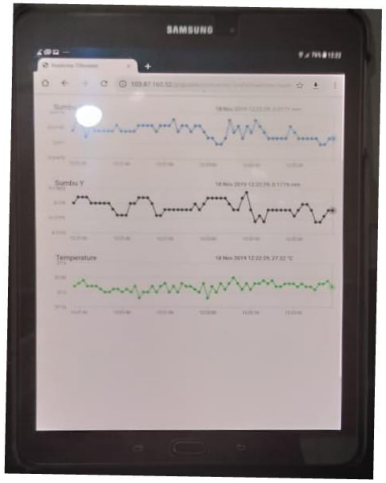
Deformation Monitoring (Tiltmeter)



CCTV di monitor dari HP Realtime

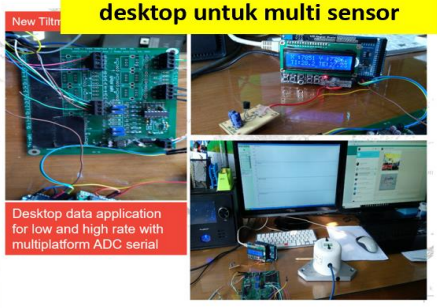
Penguatan Sistem Monitoring

Suhu, Tilt di monitor dari HP Realtime



Suhu, Tilt di monitor di POS Realtime

Rancang bangun : aplikasi desktop untuk multi sensor



12 Oktober 2019 pkl 12:27 WIB

13 September 2019 pkl 10:56 WIB


Terima kasih