

Multi-sensor satellite imagery analysis of the growth and collapse of a littoral lava dome during the 2018/19 eruption of Kadovar Volcano, Papua New Guinea

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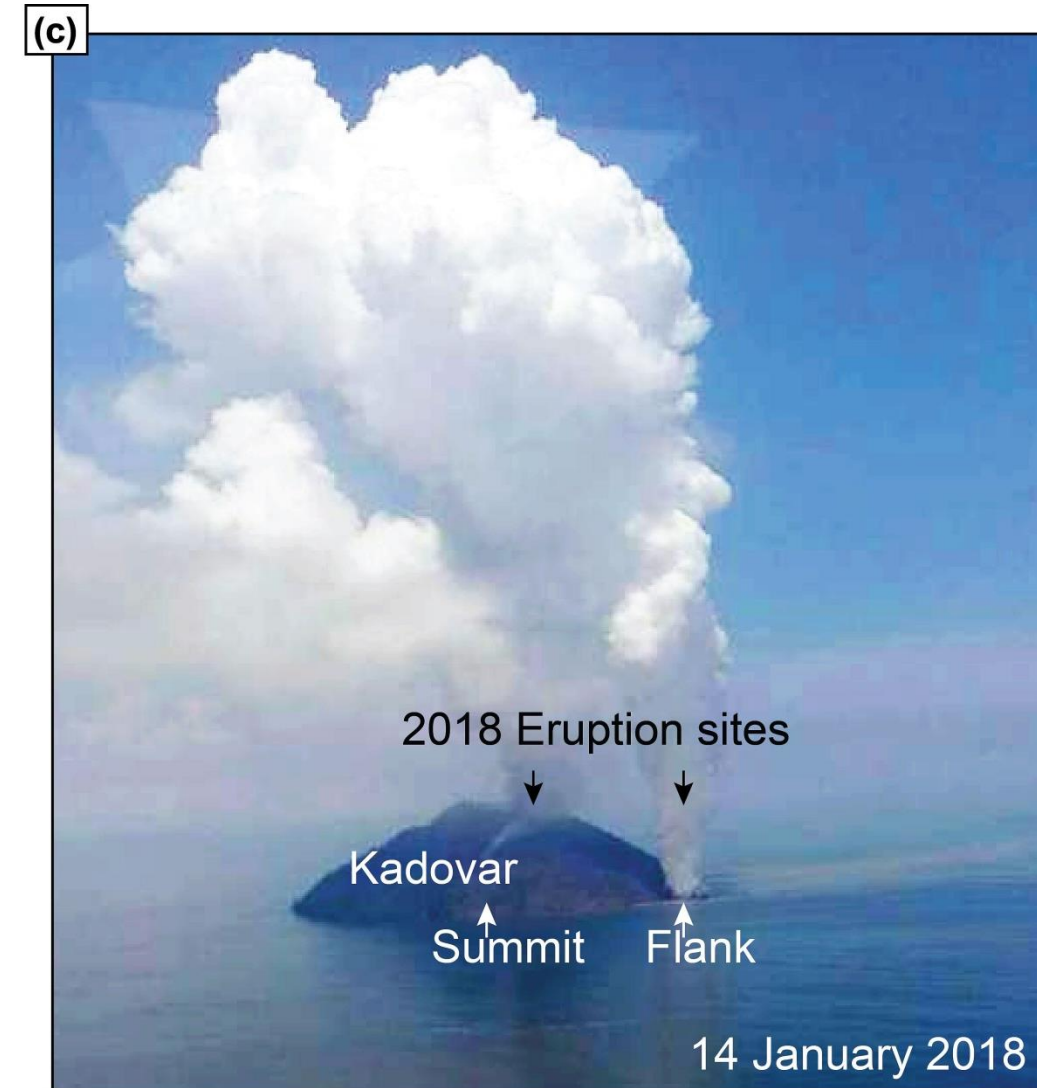
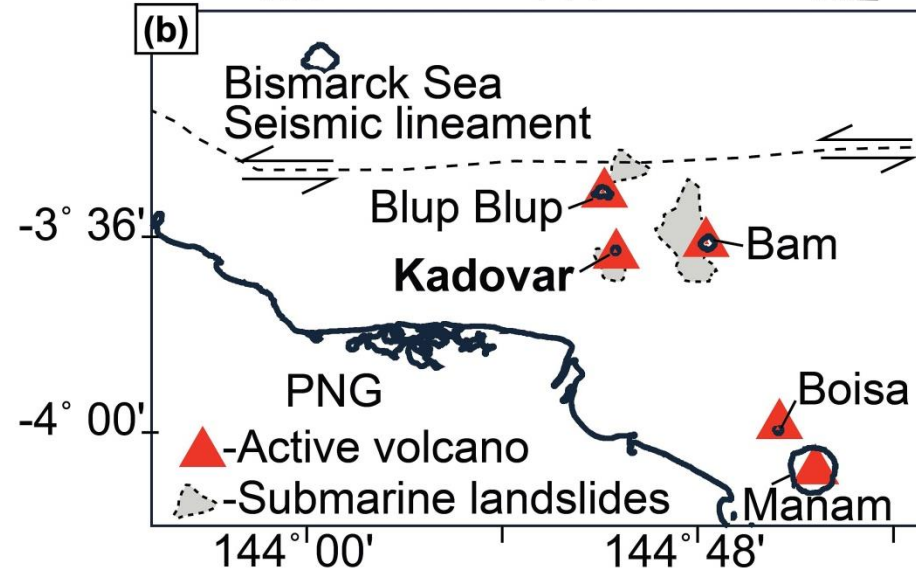
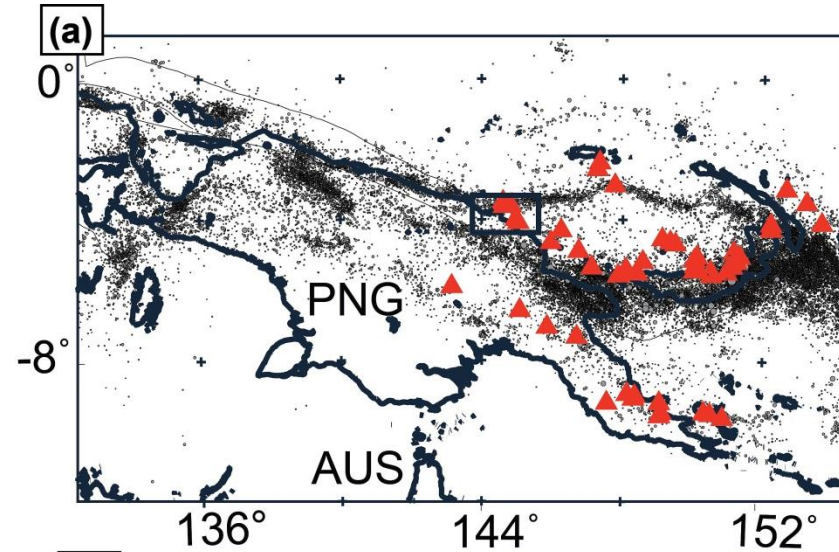


Knowledge for Tomorrow

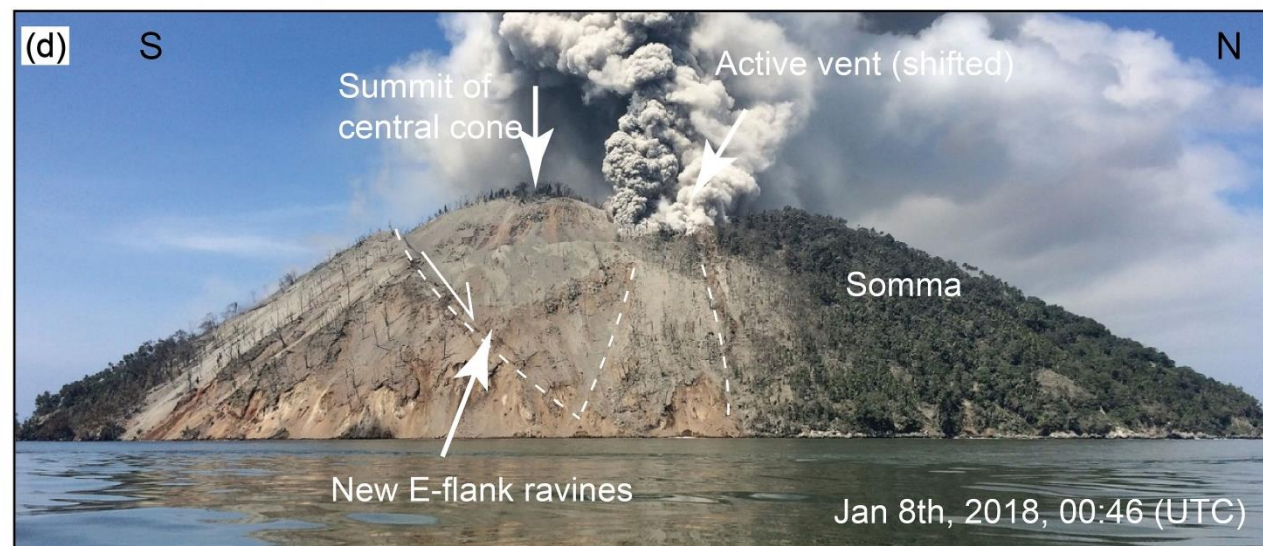
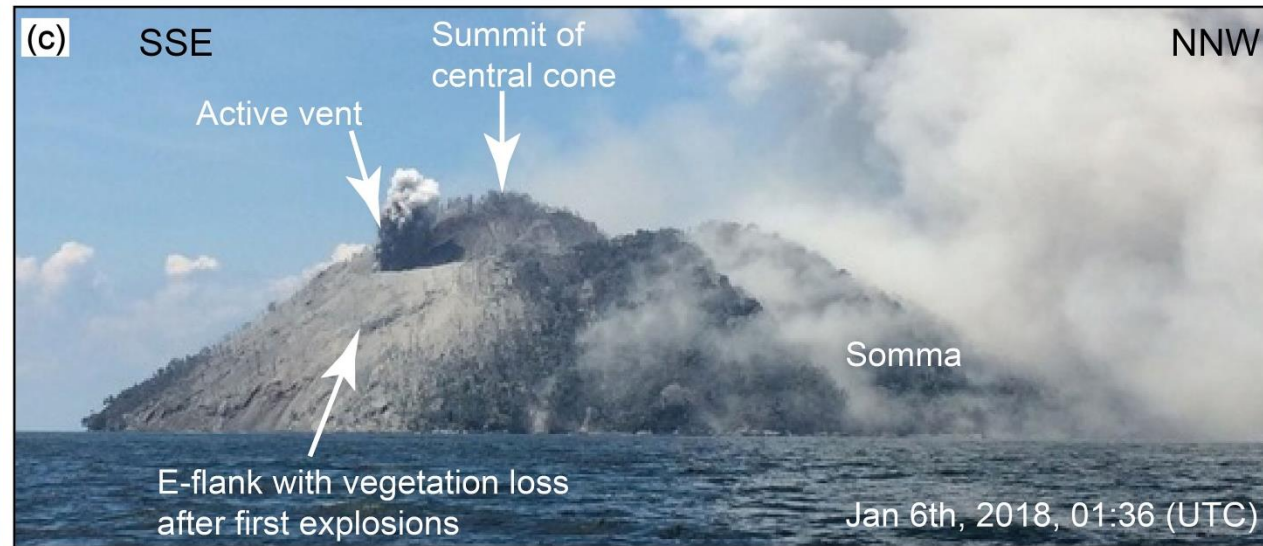
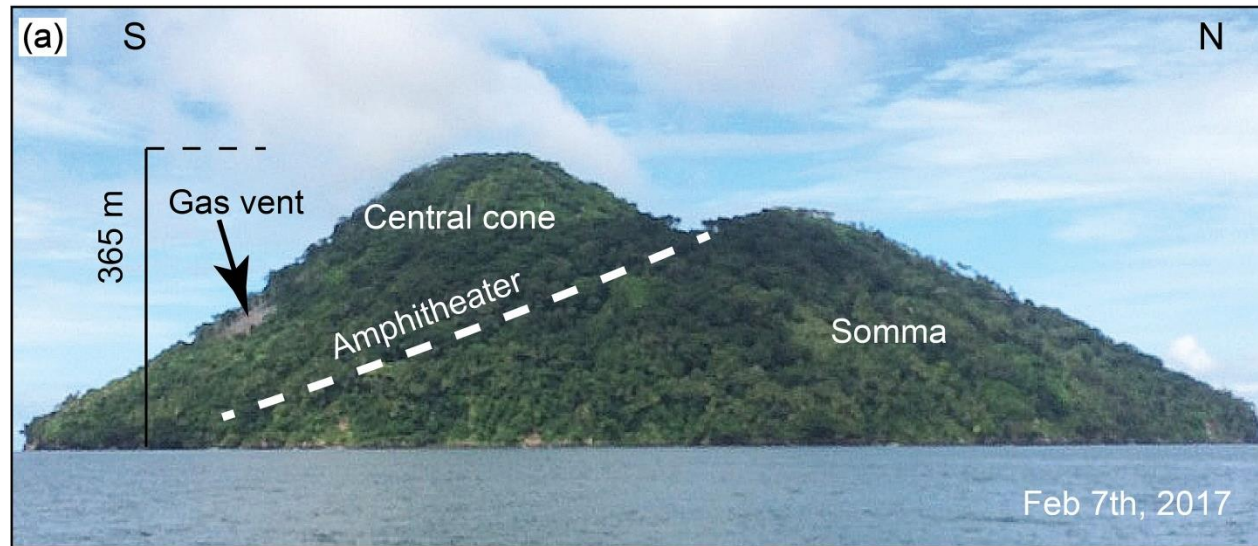


Introduction

- Last historic activity: maybe 1700
- Fumarole activity: 1900s & 1976, 1981
- **First recorded eruption: 5 January 2018**



Observations in the field – beginning of the eruption



Investigated data

• Thermal

- daily *MODIS*
- daily *VIIRS*

• Optical

- 3 x *Landsat-8*
- 26 x *Sentinel-2*

• SAR

- 32 x *Sentinel-1*
- 7 x *ALOS-2*
- 2 x *TerraSAR-X*
- 1 x *Kompsat-5*

• Seismic data

• Field Photographs

Satellite imagery analyzed.

Acquisition date	Sensor	Acquisition date	Sensor	Acquisition date	Sensor
31 Dec. 2017 –	MODIS	10 May 2018	S2	2 Oct. 2018	L8 & S2
30 Apr. 2019		14 May 2018	S1	5 Oct. 2018	S1
31 Dec 2017 –	VIIRS	15 May 2018	S2	17 Oct. 2018	S1
30 Apr. 2019		25 May 2018	S2	27 Oct. 2018	S2
24 Sept. 2017	ALOS-2 ^a	26 May 2018	S1	29 Oct. 2018	S1
26 Dec. 2017	S2	07 Jun. 2018	S1	1 Nov. 2018	S2
2 Jan. 2018	S1 ^{b)}	14 Jun. 2018	S2	11 Nov. 2018	S2
10 Jan. 2018	ALOS-2	19 Jun. 2018	S1	22 Nov. 2018	S1
14 Jan. 2018	S1	1 Jul. 2018	S1	26 Nov. 2018	S2
23 Jan. 2018	TSX ^{c)}	13 Jul. 2018	S1	11 Dec. 2018	S2
24 Jan. 2018	ALOS-2	24 Jul. 2018	S2	16 Dec. 2018	S1 & S2
26 Jan. 2018	S1	25 Jul. 2018	S1	5 Jan. 2019	S2
5 Feb. 2018	K5 ^{d)}	29 Jul. 2018	S2	9 Jan. 2019	S1
7 Feb. 2018	S1	30 Jul. 2018	L8	21 Jan. 2019	S1
19 Feb. 2018	S1	6 Aug. 2018	S1	22 Jan. 2019	L8
21 Feb. 2018	ALOS-2	8 Aug. 2018	ALOS-2 & S2	30 Jan. 2019	S2
3 Mar. 2018	S1	18 Aug. 2018	S1	2 Feb. 2019	S1
21 Mar. 2018	ALOS-2 & S2	28 Aug. 2018	S2	7 Feb. 2019	L8
24 Mar. 2018	L8	30 Aug. 2018	S1	14 Feb. 2019	S2
27 Mar. 2018	S1	7 Sept. 2018	S2	26 Feb. 2019	S1
8 Apr. 2018	S1	11 Sept. 2018	S1	1 Mar. 2019	S2
10 Apr. 2018	S2	12 Sept. 2018	S2	22 Mar. 2019	S1
15 Apr. 2018	S2	16 Sept. 2018	L8	27 Mar. 2019	L8
20 Apr. 2018	S1	22 Sept. 2018	S2	15 Apr. 2019	S1 & S2
25 Apr. 2018	S2	23 Sept. 2018	S1	30 Apr. 2019	TSX
2 May 2018	ALOS-2 & S1	27 Sept. 2018	S2		

^a ALOS-2: HH/HV polarization, orbit ascending 113; ^{b)} S1: VV/VH, descending 133; ^{c)} TSX: HH, ascending 49; ^{d)} K5: HH, descending.

Methods

- **Thermal**

- Detection of thermal hotspots → Derivation of the volcanic radiant power

- **Optical**

- Visual analysis of the SWIR/NIR/Green bands
- Location of volcanic activity → at the **central crater** and / or at the **coastal vents**

- **SAR**

- Co-registration of the data stacks
- Terrain correction and map projection
- Two-layer composite maps of consecutive SAR images
- Measurement of the spatial-temporal evolution of the area of the newly created peninsula

- **Seismic data**

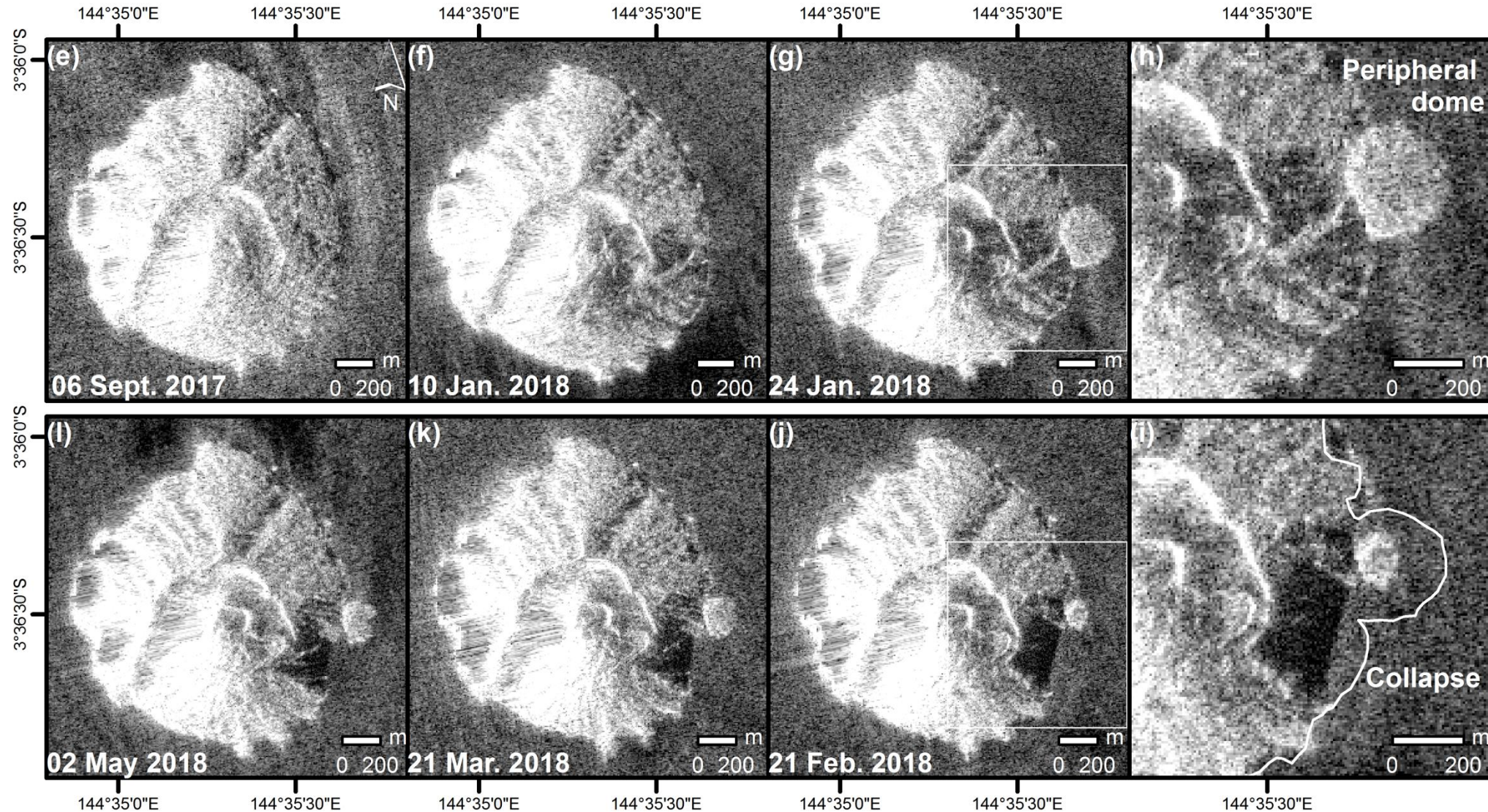
- Analysis of global seismic catalogs and reprocessing of data from 4 broadband station next to Kadovar

- **Field Photographs**



Results

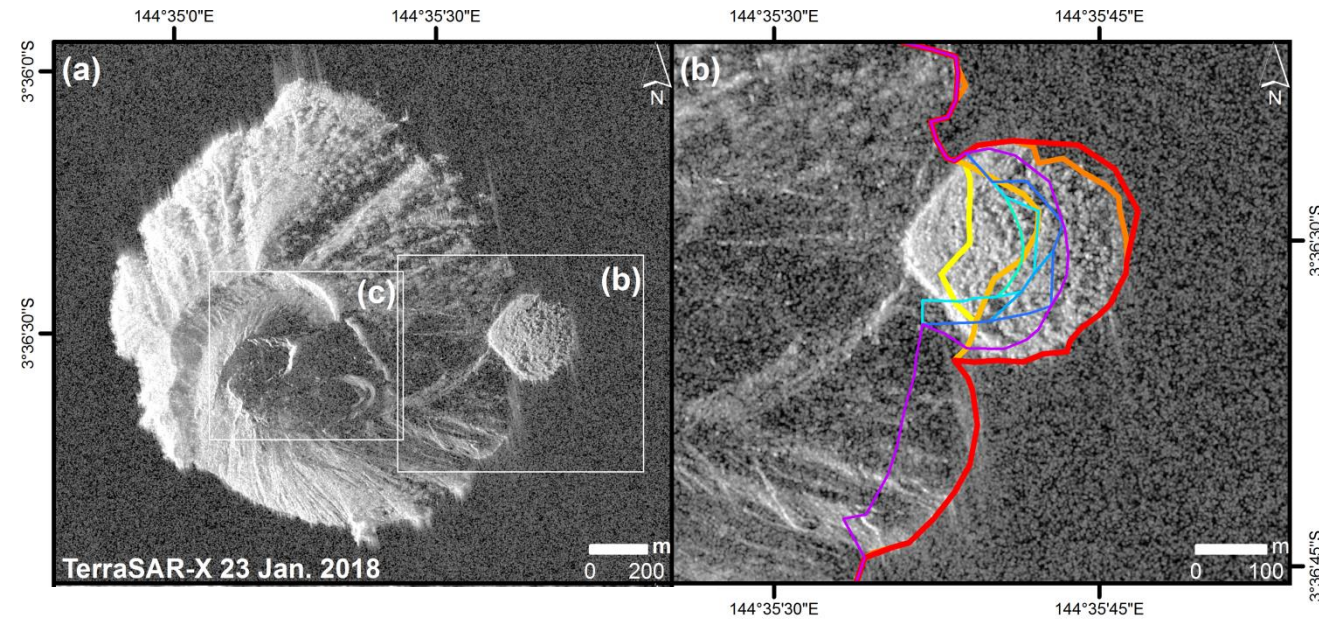
- **SAR: ALOS-2**
Evolution of the
littoral lava dome



Results

- **SAR:**
Evolution of the
littoral lava dome

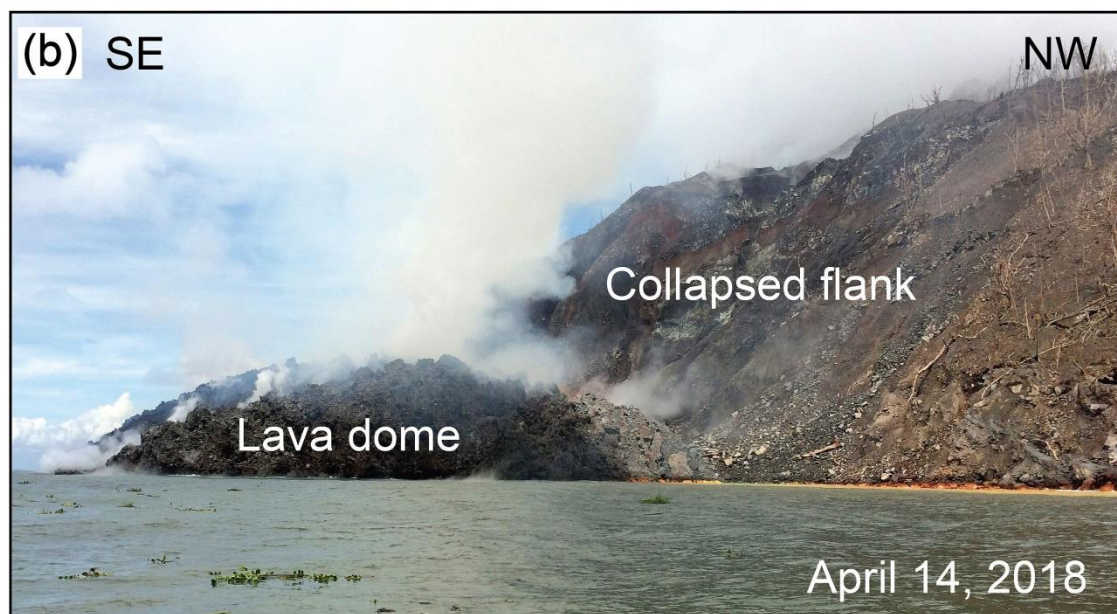
**Dome collapse on
9 Feb. 2018**



Growth	Re-growth
10.01.2018	19.02.2018
14.01.2018	03.03.2018
23.01.2018	08.04.2018
07.02.2018	20.04.2018
	02.05.2018

7 Feb. 2018: Maximum of dome growth
area: ~71,800 m² | volume: ~ 726,000 m³

Observations in the field – after growth/collapse/re-growth of the littoral dome

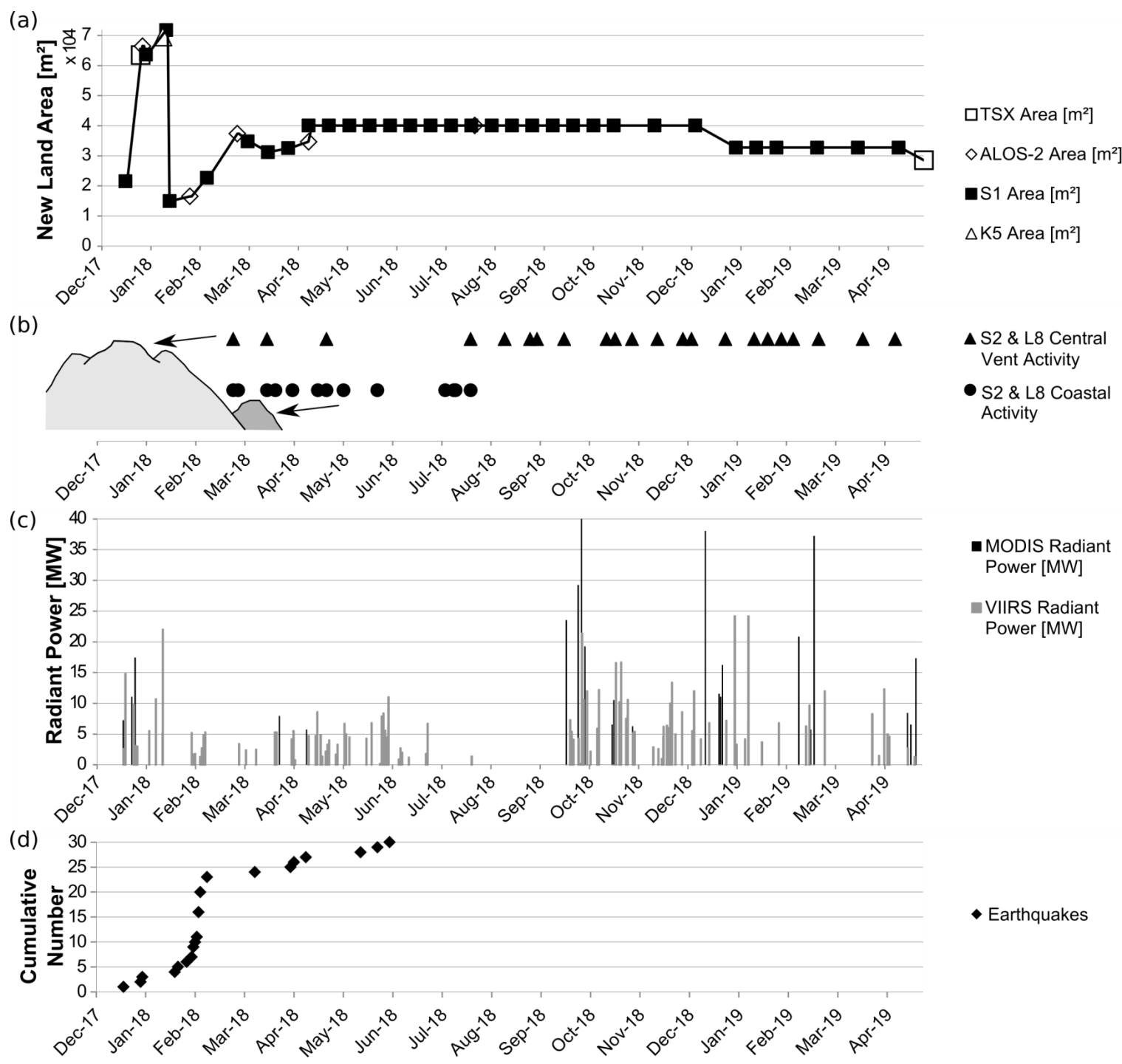


**Estimated volume of littoral lava dome (14.04.2018):
~400,000 m³**

Synopsis of the evolution over time

Growth of the littoral lava dome:

- First episode: ~20,000 m² / per week
- **9 Feb. 2018: Collapse of ~80% of the lava dome and parts of the island**
- Second episode: ~2,850 m² / per week

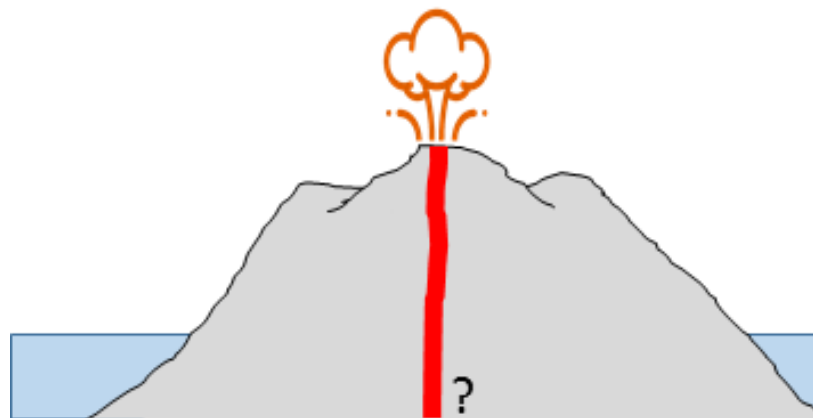


Plank, S., Walter, T.R., Martinis, S., Cesca, S. (2019): Growth and collapse of a littoral lava dome during the 2018/19 eruption of Kadovar Volcano, Papua New Guinea, analyzed by Multi-Sensor Satellite Imagery. *Journal of Volcanology and Geothermal Research*, 388(106704).

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Theoretical Model

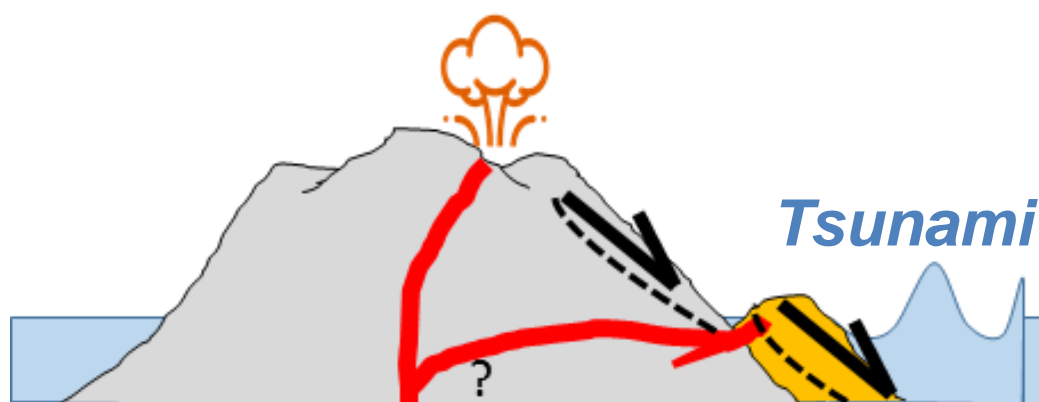
(a) Crater rim eruption



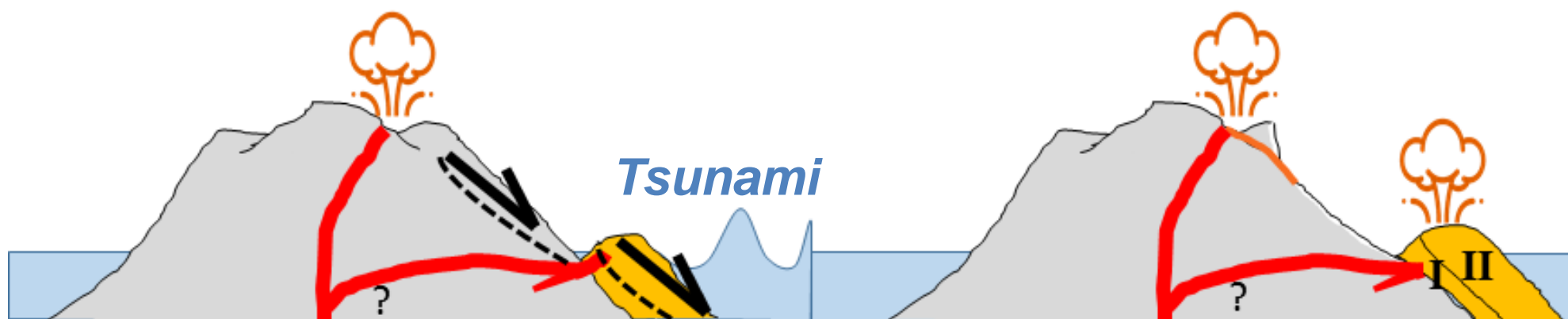
(b) Periphery dome growth, vent migration



(c) Sliding



(d) New dome growth



9 February 2018:
Dome & flank
collapse
→ Tsunami that hit
the neighboring
islands

Conclusions

- The **2018/19** eruption of **Kadovar Volcano**:
 - rare case of a growing, collapsing and re-growing littoral lava dome
 - Tsunami caused by dome collapse
 - This was the **first ever observed dome collapse in shallow waters**
 - More information:

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