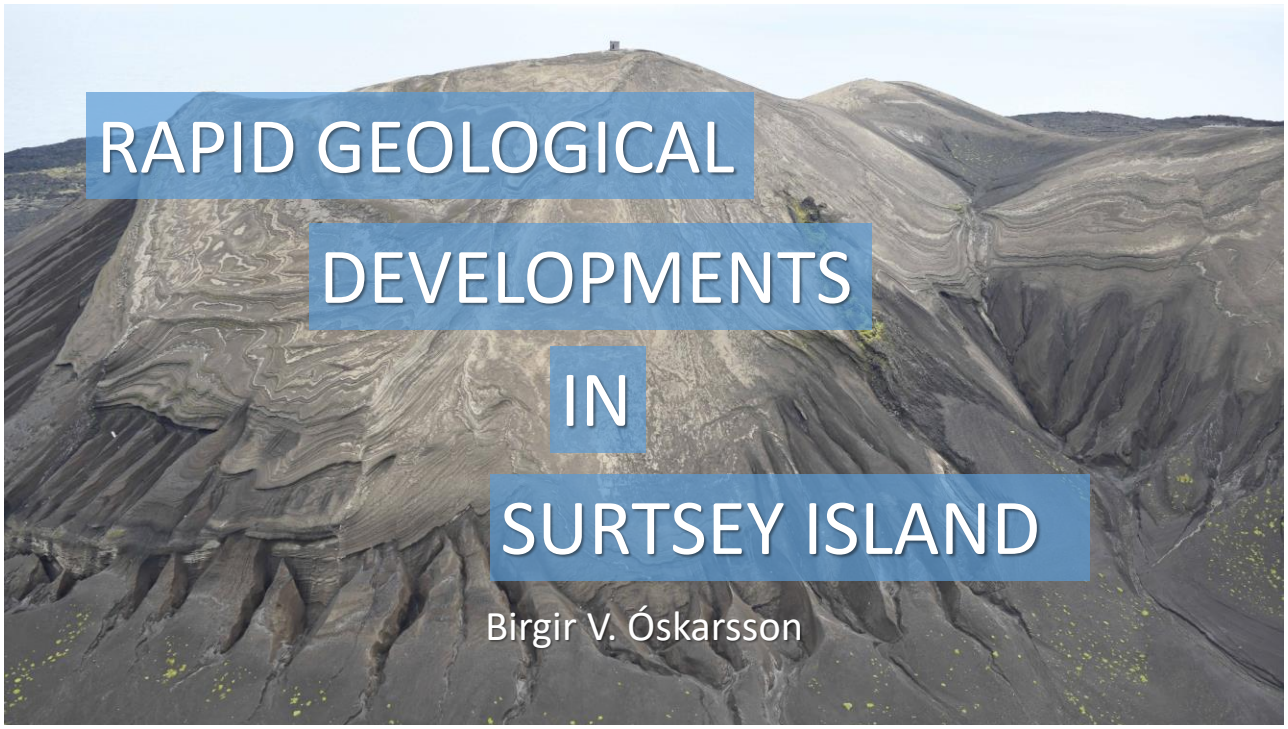
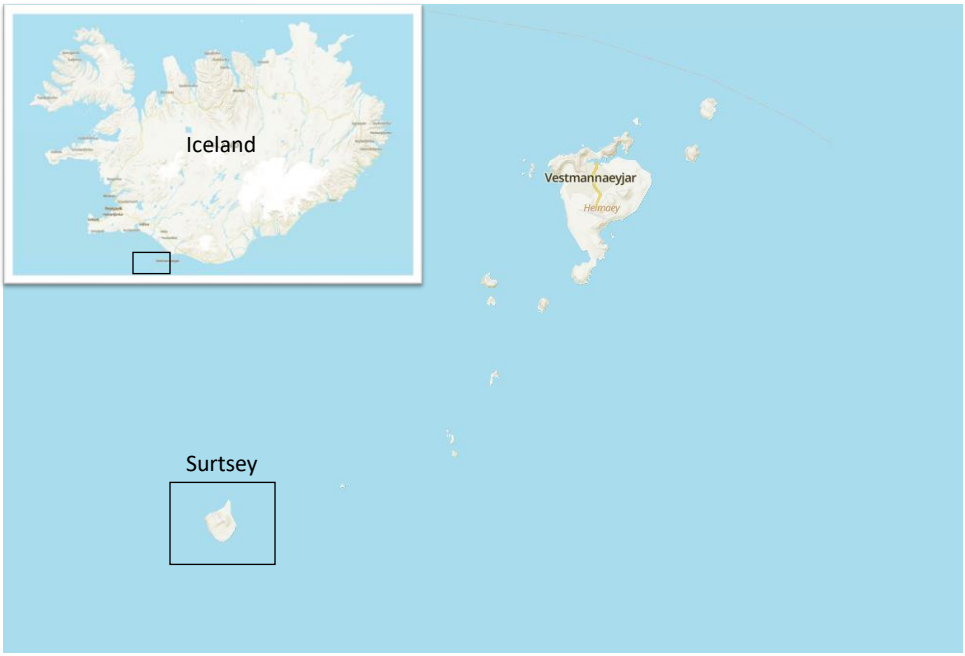


1

PARADIGM SHIFT

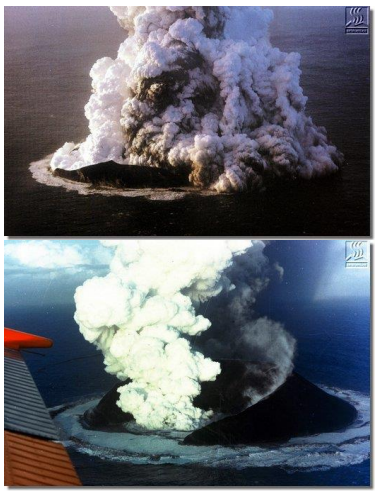
RAPID GEOLOGICAL PROCESSES

2



3

The Surtsey eruption



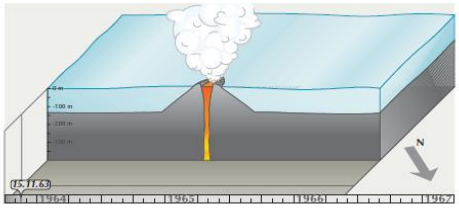
Eruption duration

- 15 Nov 1963 – 5 June 1967

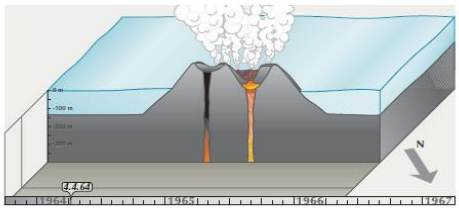
- Submarine phreatomagmatic phase 15 Nov – 4 April 1964
- Subaerial magmatic/effusive phase 4 April 1964 – 5 June 1967

4

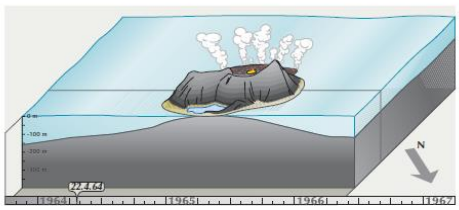
Sequence of events



(A) 15 November 1963: the island of Surtsey emerges.

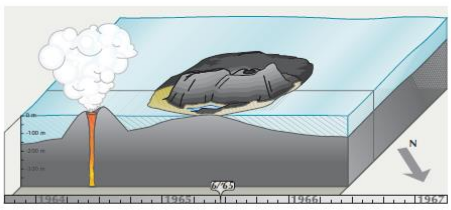


(B) 4 April 1964: the western crater (Surtungur) starts erupting lava.

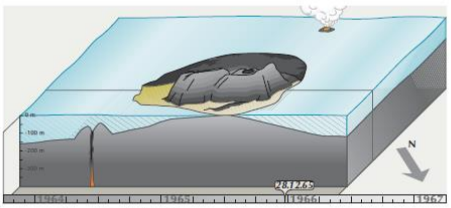


5

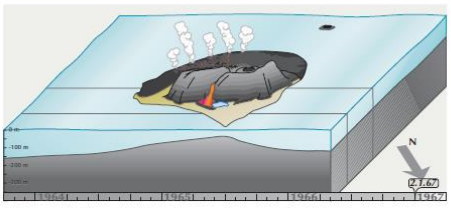
Sequence of events



(D) June 1965: activity on Surtsey has ceased temporarily and a new island, Syrtlingur, has emerged.

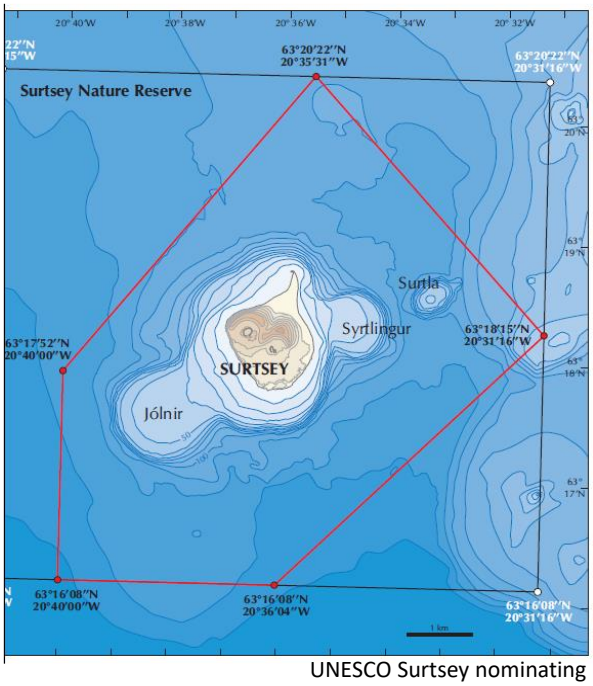


(E) 28 December 1965: the island of Jólnir emerges.



(F) 2 January 1967: Surtsey's last lava crater opens, after a renewal of activity on the island.

6



UNESCO Surtsey nominating report 2007

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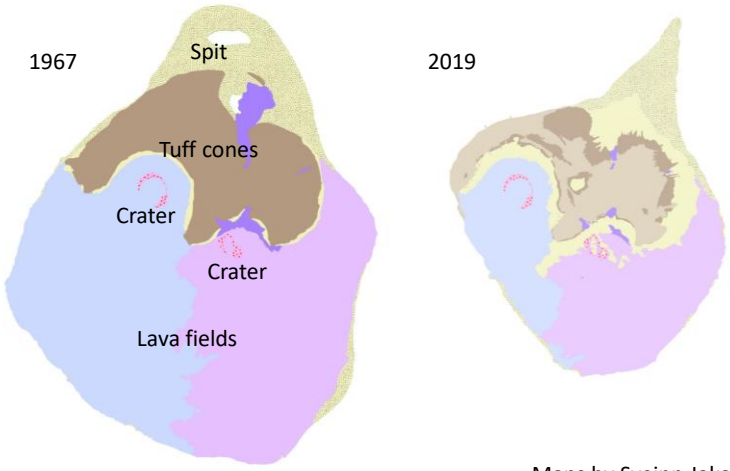
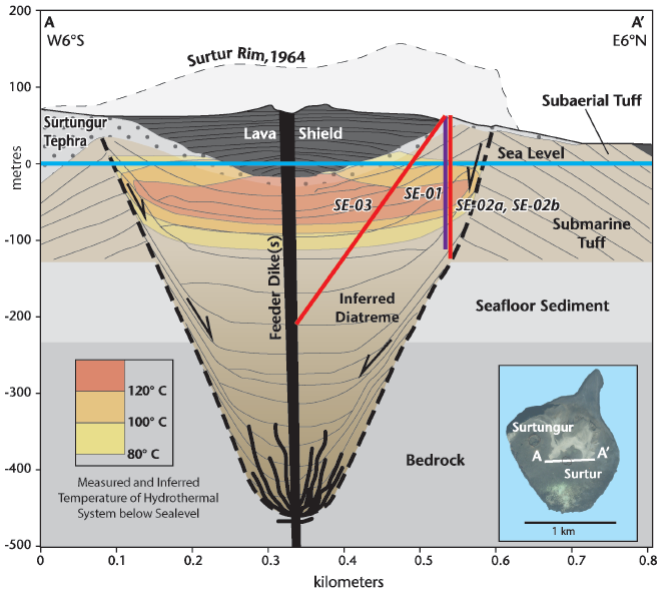
Geological map of Surtsey



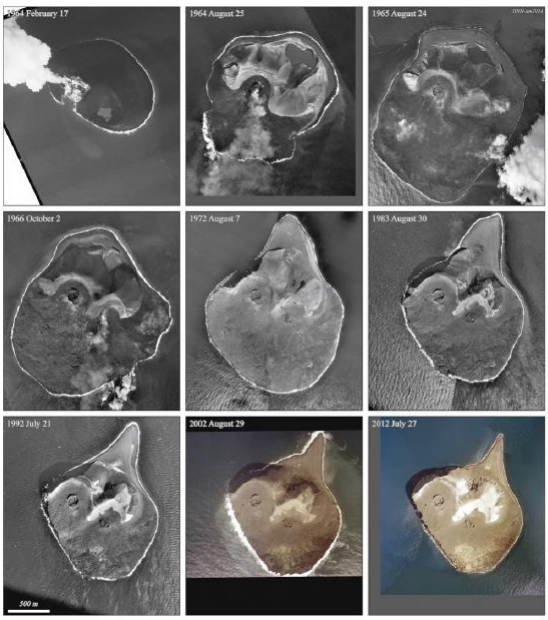
Maps by Sveinn Jakobsson

8



Moore and Jackson 2020

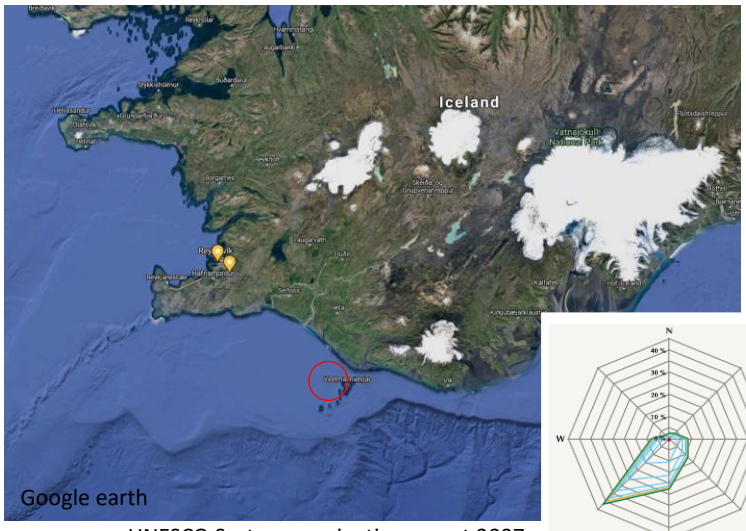
9



Ramagnoli and Jakobsson 2015

10

Offshore wave statistics



UNESCO Surtsey nominating report 2007

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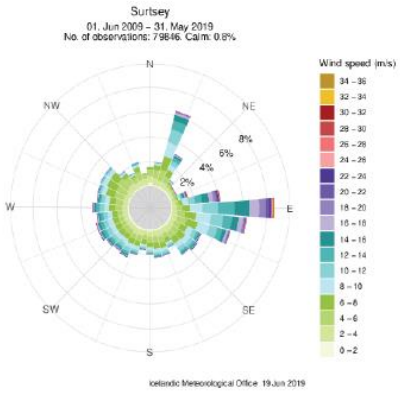
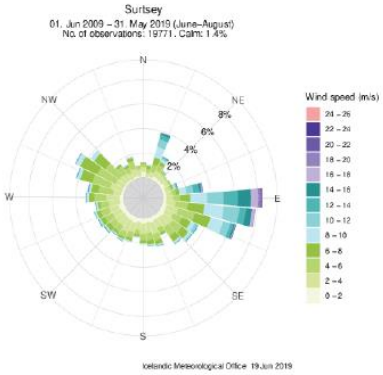
Predominant wind direction



Whole year



Summer months

Petersen and Jónsson 2020

12

Bird and plant colonization

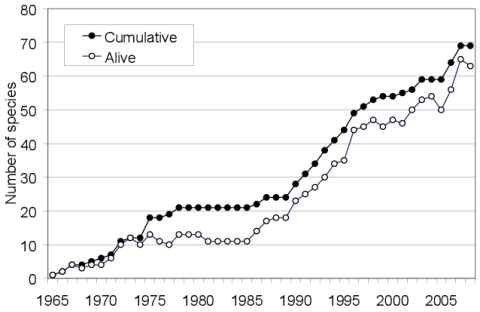


Figure 3. Number of vascular plant species found on Surtsey during 1965–2008.

Magnússon et al 2009

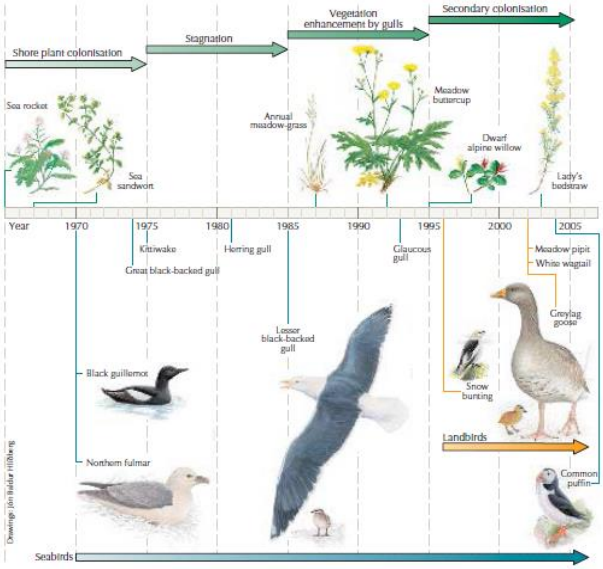


Fig. 2.28. Main steps in species colonisation and ecosystem development of plant communities and birdlife on Surtsey. A large increase in the number of breeding seagulls on the island after 1985 improved its nutrient status and enhanced development of its vegetation and invertebrate communities, enabling the first landbirds to settle on the island ten years later.

UNESCO Surtsey nominating report 2007

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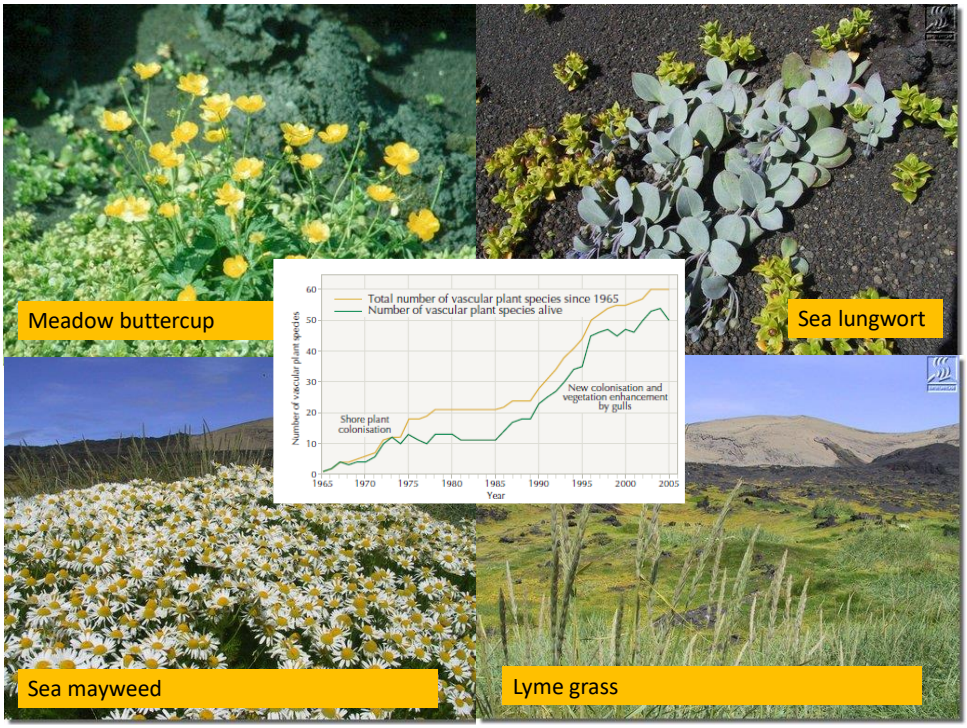

15

Quantifying the erosion and sedimentation

Article:
Óskarsson et al 2020, Erosion and sedimentation in Surtsey island quantified from new DEMs, Surtsey Research 14, pp. 63-77.
Visit: www.surtsey.is

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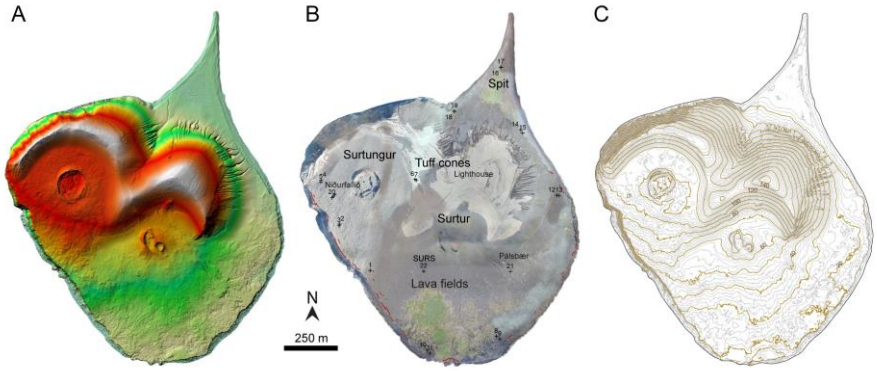
Photogrammetry surveys

18



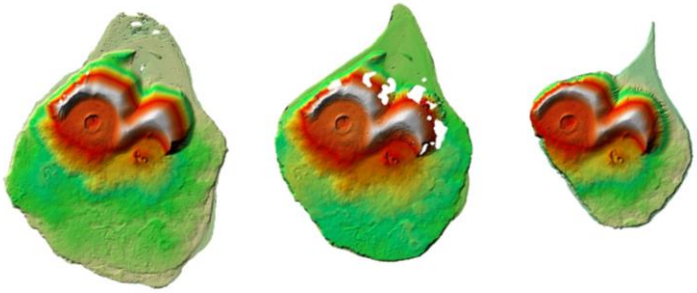
Digital elevation model (DEM)
Resolution 20x20 cm

Orthoimage
GSD 5 cm

Contour map

19

Digital elevation models



1967
Area: 2.67 km^2
Volume: 0.996 km^3

1974
Area: 2.12 km^2
Volume: 0.907 km^3

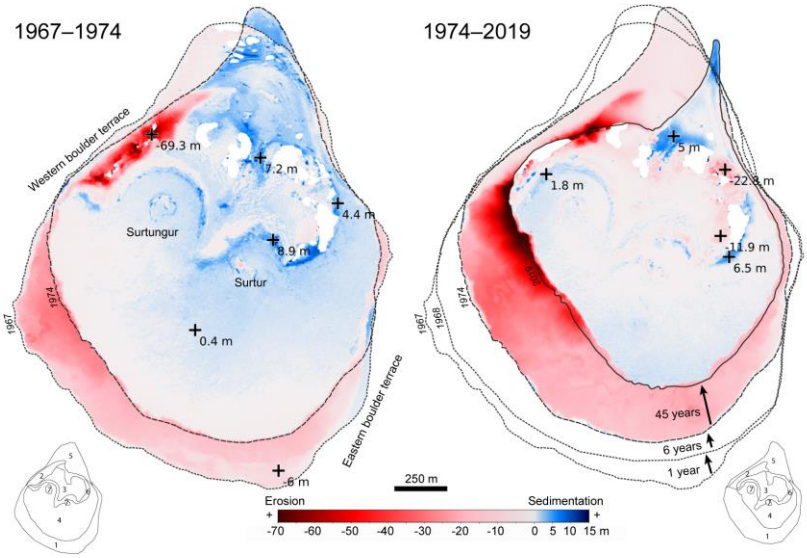
2019
Area: 1.25 km2
Volume: 0.707 km^3

Area change: 53%

Volume change: 29%

20

DEM differencing



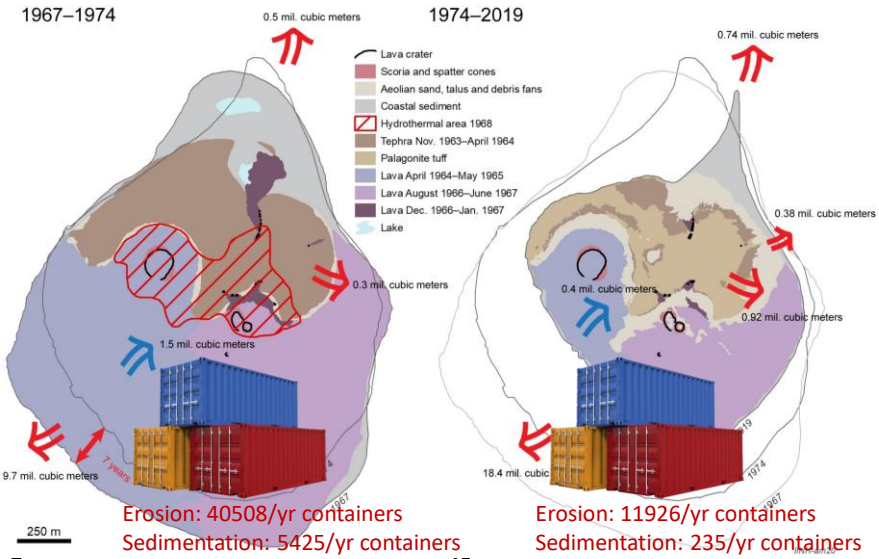
21

DEM differencing

Volume change 1967–1974				
	Area m²	Volume (x 10⁶ m³)		Avg./yr (x 10⁶ m³) loss
		Positive	Negative	
1-Cliff lava	491435	0.026±0.036	-6.999±0.553	-0.999±0.079
2-Cliff tephra/tuff	121284	0.011±0.009	-2.658±0.113	-0.380±0.016
3-Tephra/tuff cones	408544	0.336±0.117	-0.248±0.088	-0.035±0.013
4-Lava fields	1122572	0.430±0.280	-0.417±0.281	-0.060±0.04
5-Spit sediment	—	0.181±0.048	-0.507±0.244	-0.072±0.035
6-Sediment	216916	0.447±0.091	-0.091±0.018	-0.013±0.003
7-Scoria cones	32928	0.033±0.014	-0.011±0.002	-0.0016±0.0003
Total		1.464±0.595		
Total			-10.931±1.299	-1.562±0.186
Net loss			-9.467±1.894	-1.352±0.271
Volume change 1974–2019				
1-Cliff lava	615928	0.031±0.035	-15.484±0.693	-0.344±0.015
2-Cliff tuff	112809	0.003±0.001	-2.931±0.113	-0.065±0.003
3-Tuff cones	287104	0.011±0.005	-0.922±0.276	-0.020±0.004
4-Lava fields	535010	0.055±0.078	-0.199±0.188	-0.004±0.004
5-Spit sediment	—	0.051±0.027	-0.735±0.214	-0.016±0.005
6-Sediment	191071	0.257±0.046	-0.384±0.063	-0.009±0.001
7-Scoria cones	31953	0.003±0.003	-0.034±0.014	-0.0008±0.0003
Total		0.409±0.193		
Total			-20.689±1.422	-0.459±0.032
Net loss			-20.280±1.615	-0.451±0.036

* Sediments around the tuff cones included in area.

22



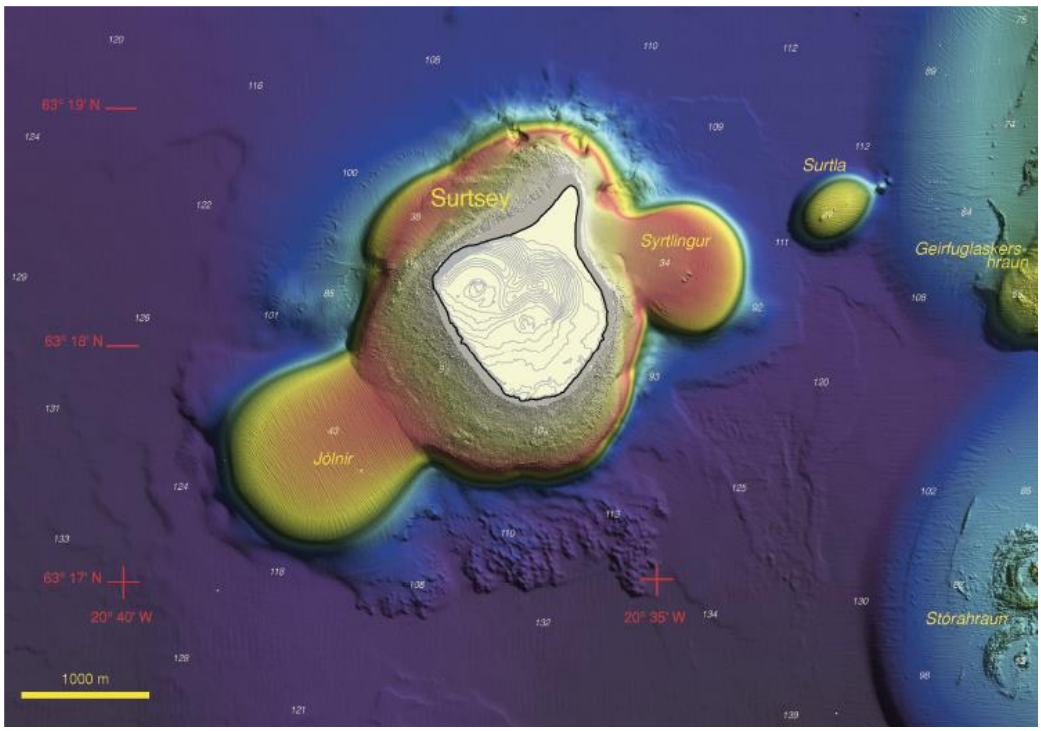
Erosion: 40508/yr containers
Sedimentation: 5425/yr containers

7 years
Coastal erosion (South): 1379000 m^3/yr
Wind/Runoff erosion: 35000 m^3/yr
Spit erosion: 72000 m^3/yr

Erosion: 11926/yr containers
Sedimentation: 235/yr containers

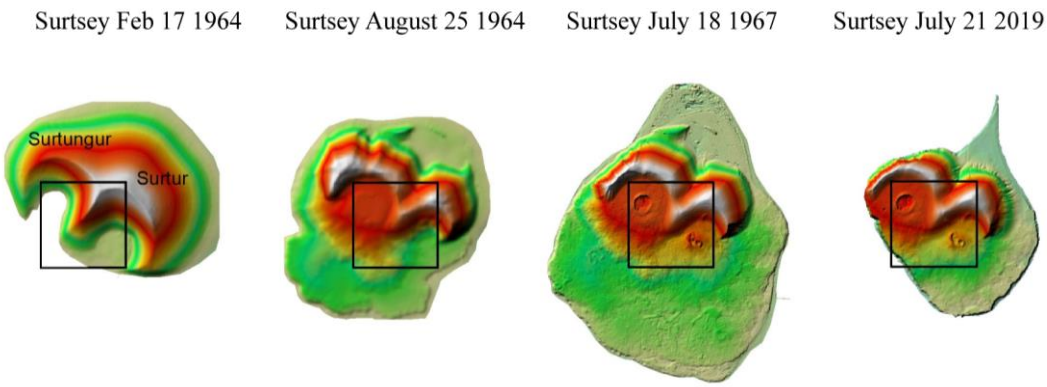
45 years
Coastal erosion (South) 409000 m^3/yr
Wind/Runoff erosion: 20000 m^3/yr
Spit erosion: 16000 m^3/yr

23



24

Rapid geomorphologic changes



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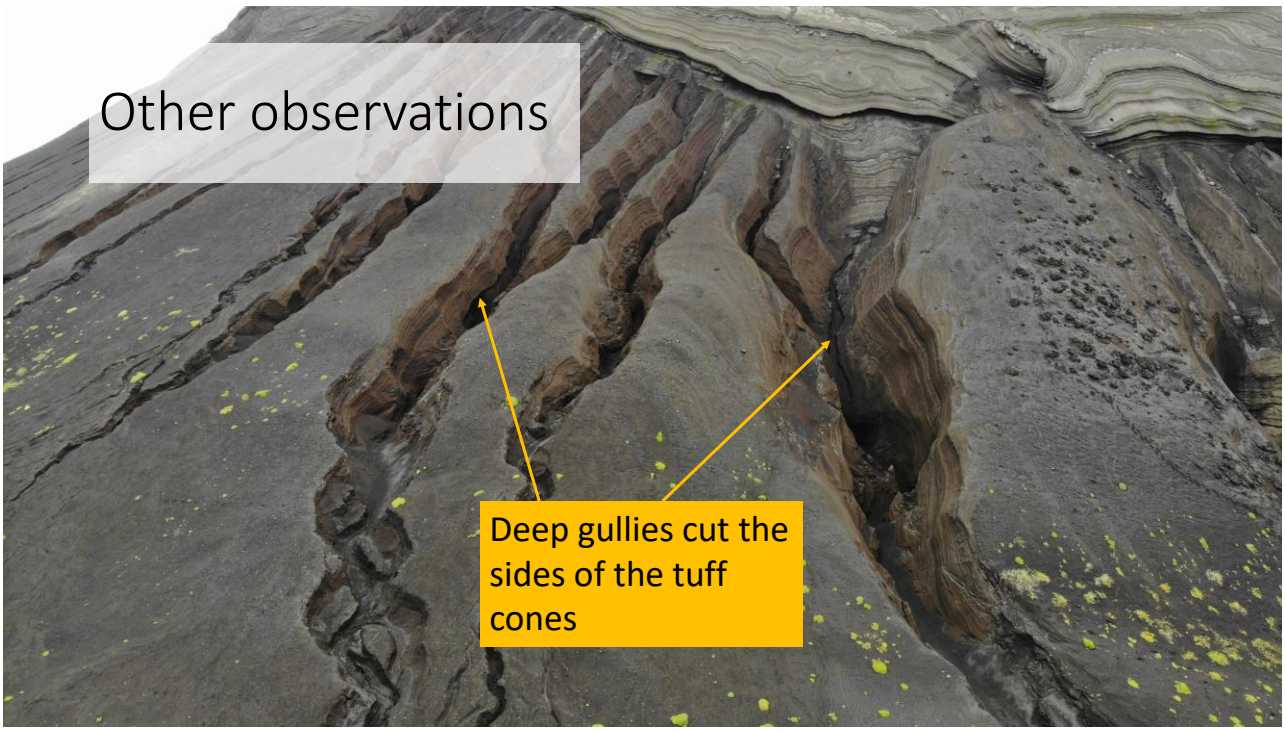
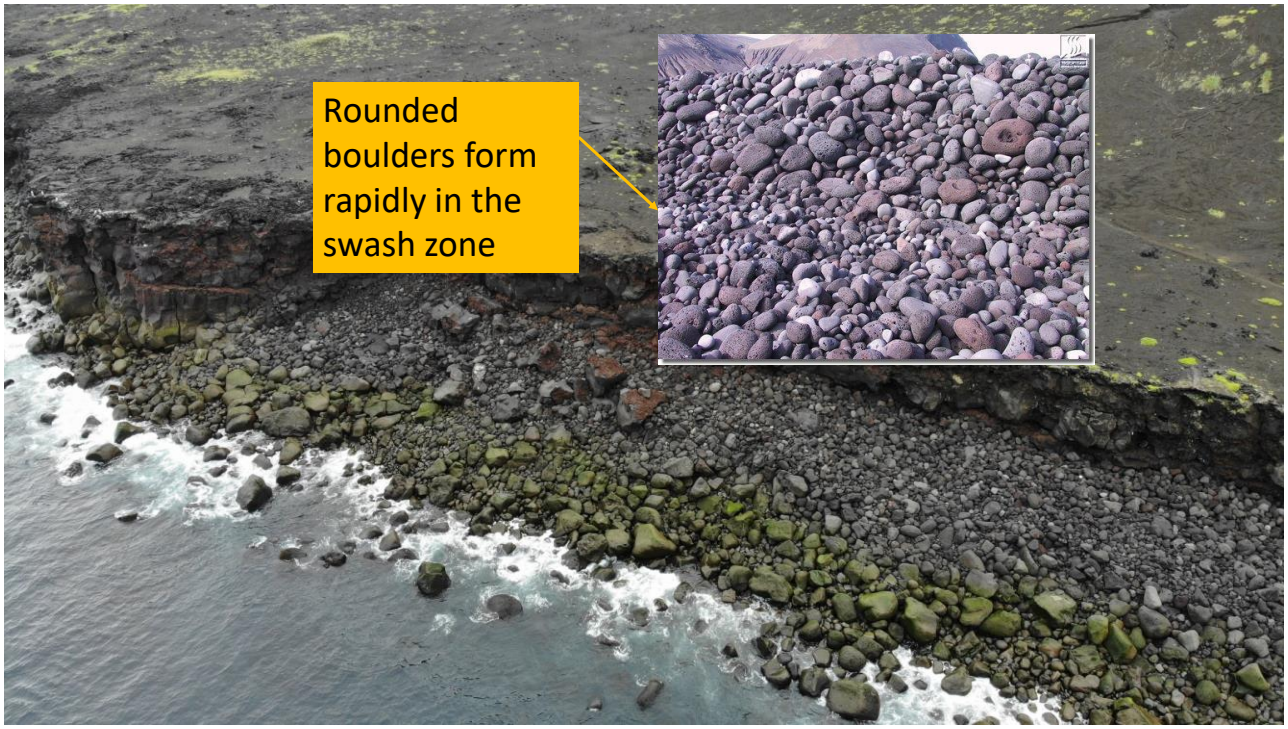
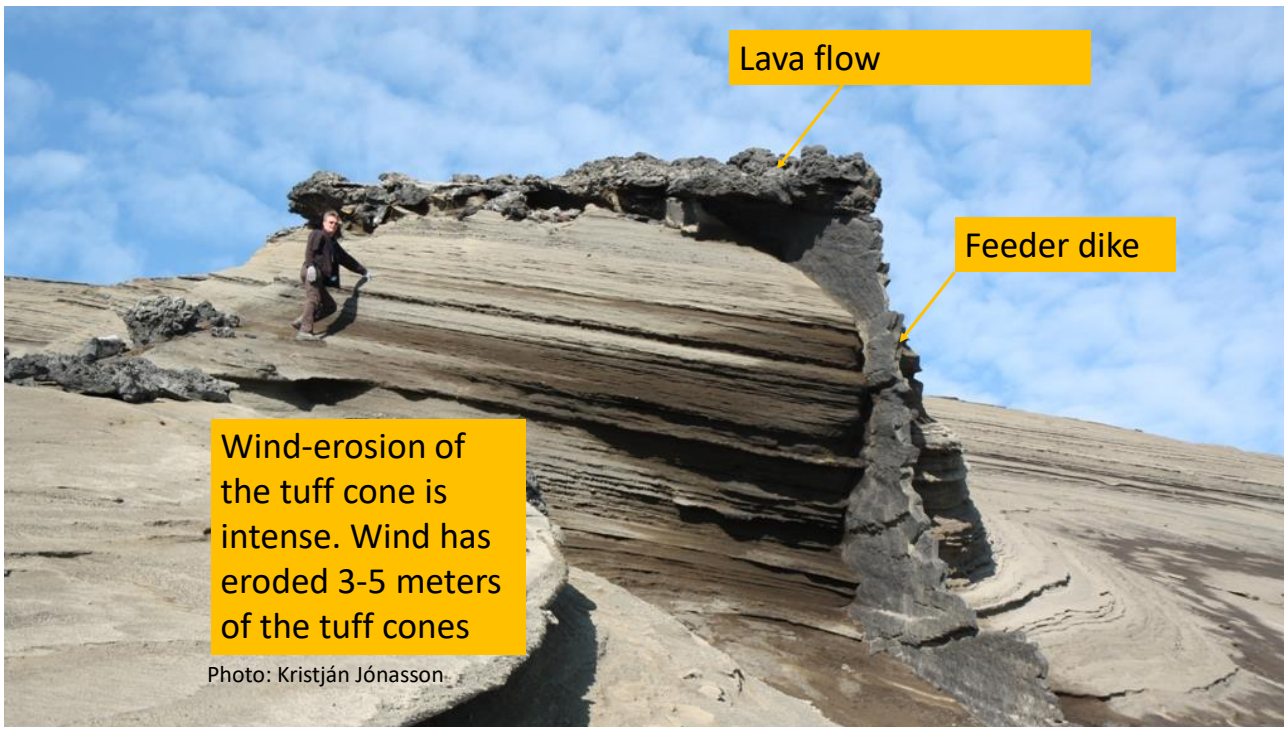
Other observations



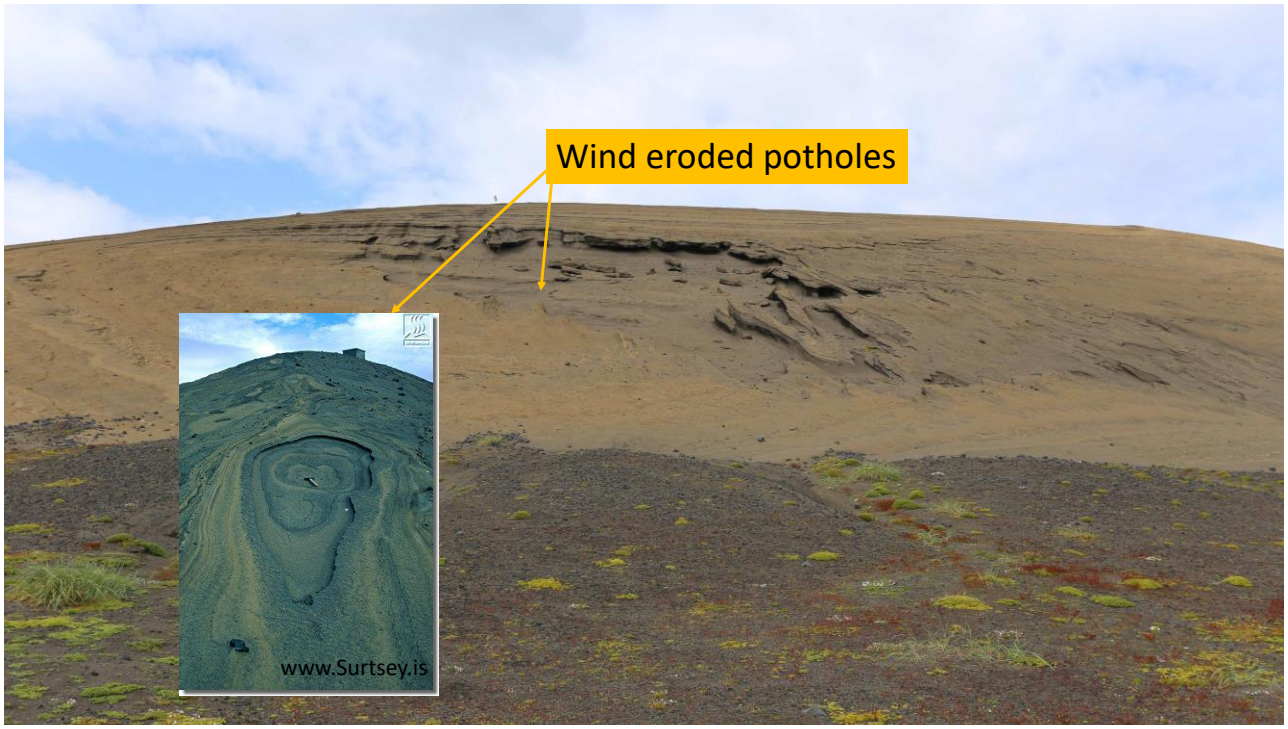
26


Rounded boulders form rapidly in the swash zone

27


Lava flow
Feeder dike
Wind-erosion of the tuff cone is intense. Wind has eroded 3-5 meters of the tuff cones
Photo: Kristján Jónasson

28


Wind eroded potholes
www.Surtsey.is

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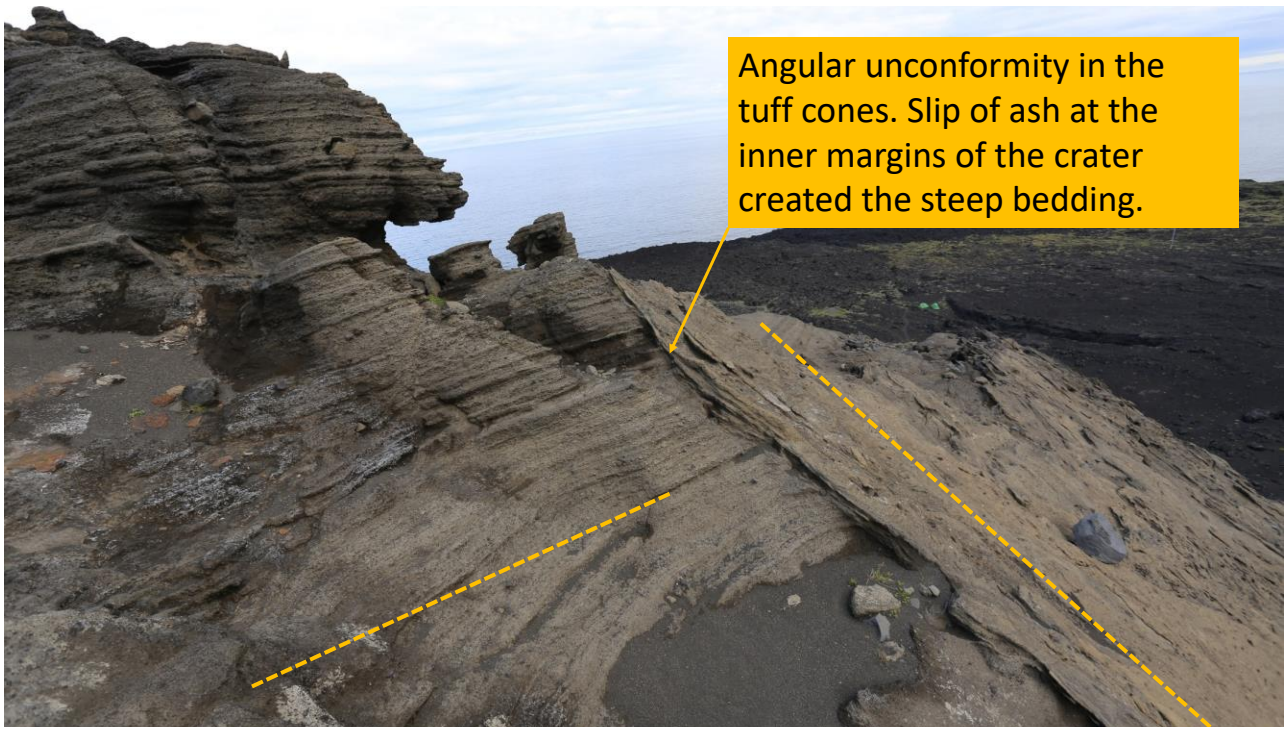
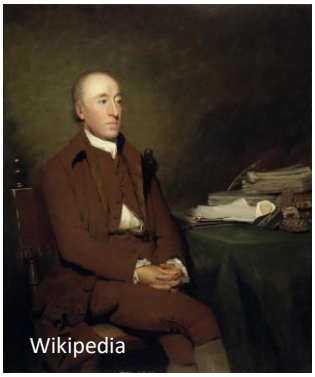

Angular unconformity in the tuff cones. Slip of ash at the inner margins of the crater created the steep bedding.

30



James Hutton 1726-1797

"Continuing along the coast, they made more discoveries including sections of the vertical beds showing strong ripple marks which gave Hutton "great satisfaction" as a confirmation of his supposition that these beds had been laid horizontally in water."

From this he deduced that the land was a composition which had been formed by the operation of second causes in an earlier world composed of sea and land, with tides, currents, and "such operations at the bottom of the sea as now take place" Hutton, 1788

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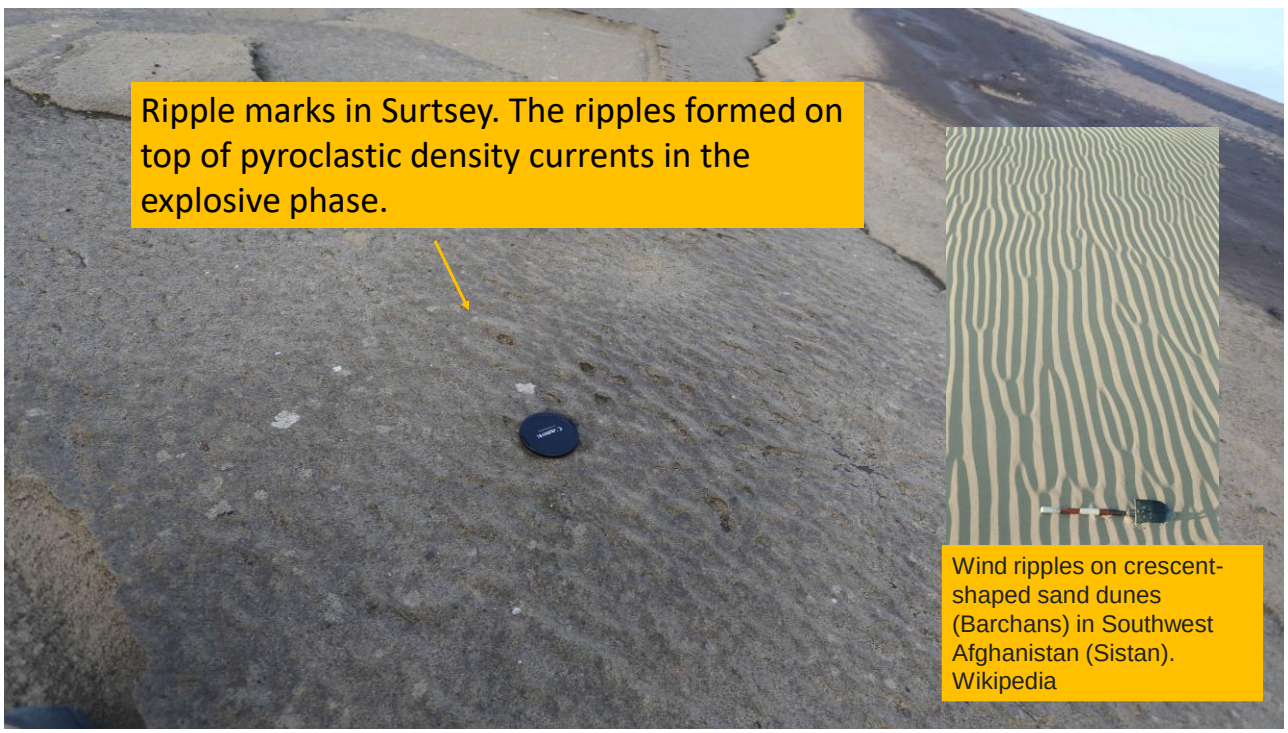

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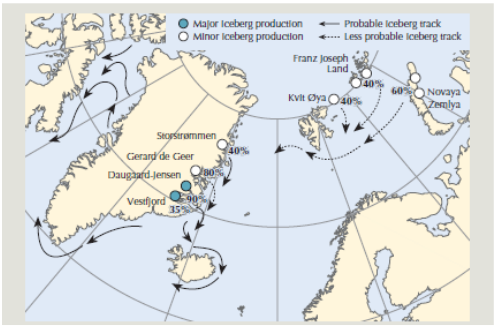
Xenoliths from Greenland in Surtsey



Reynisson and Jakobsson 2009

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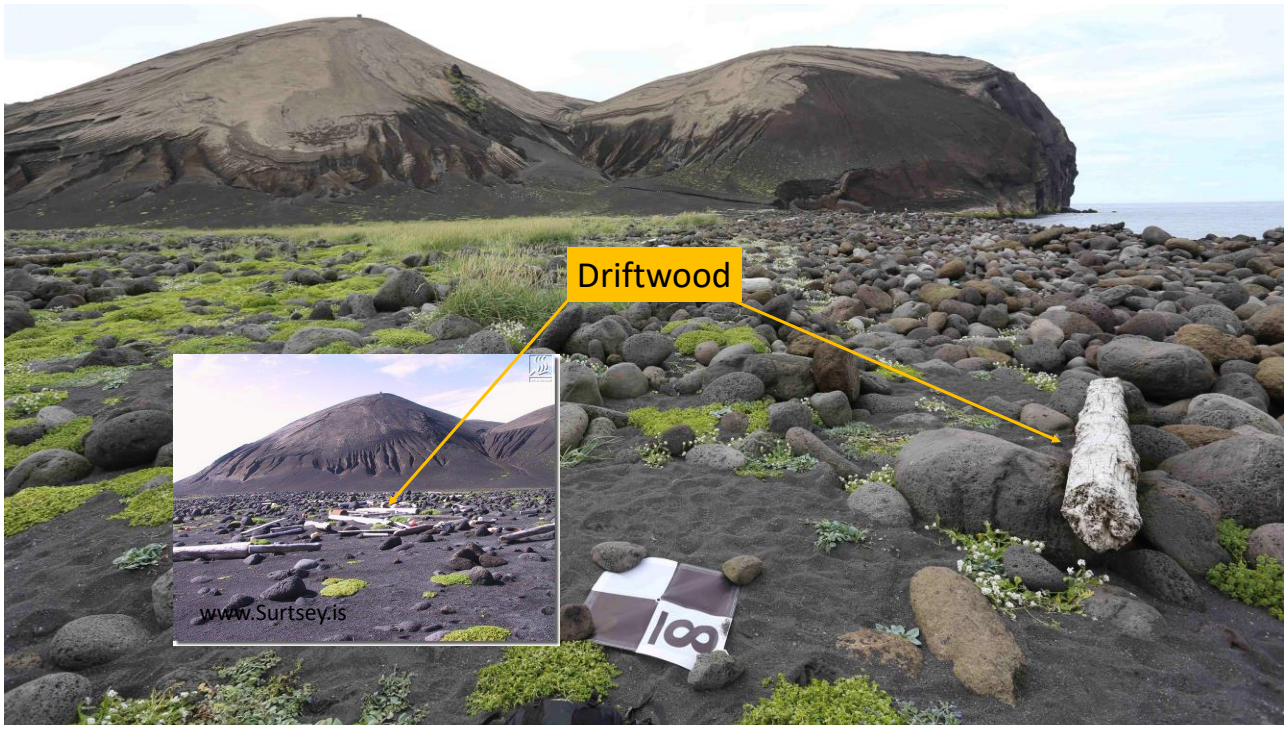
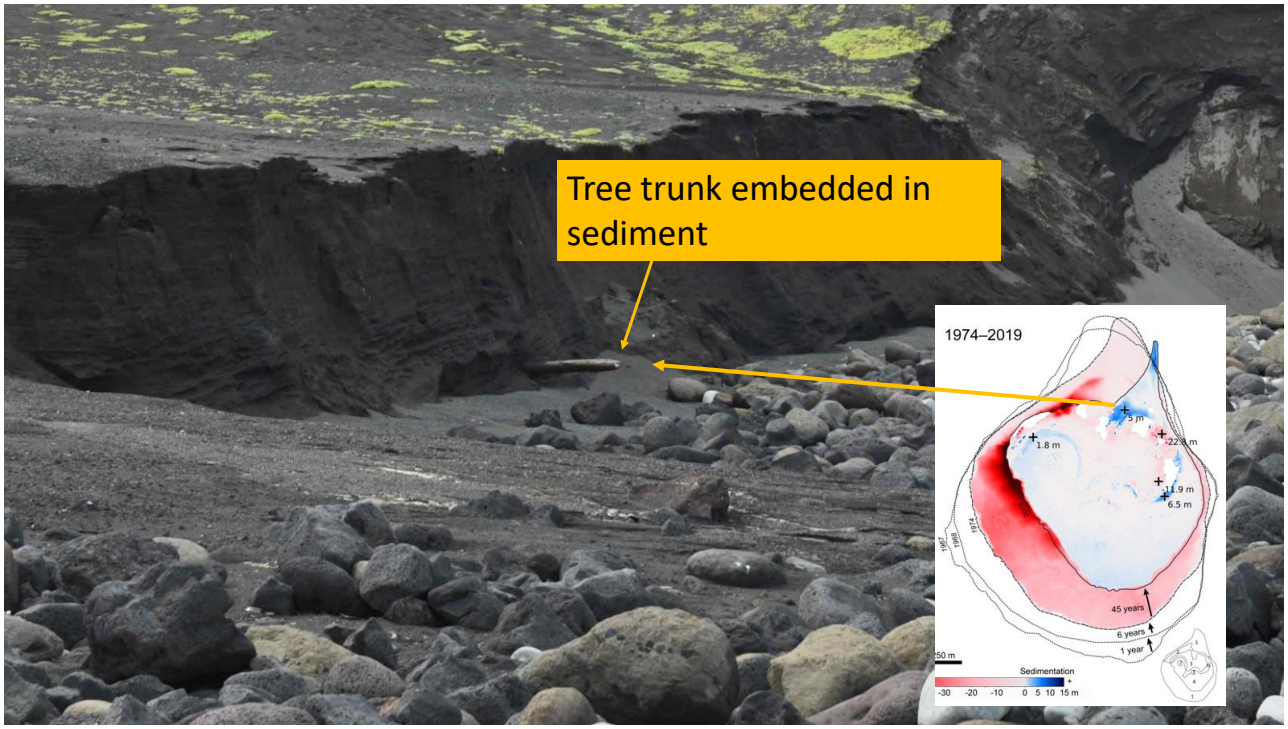


36



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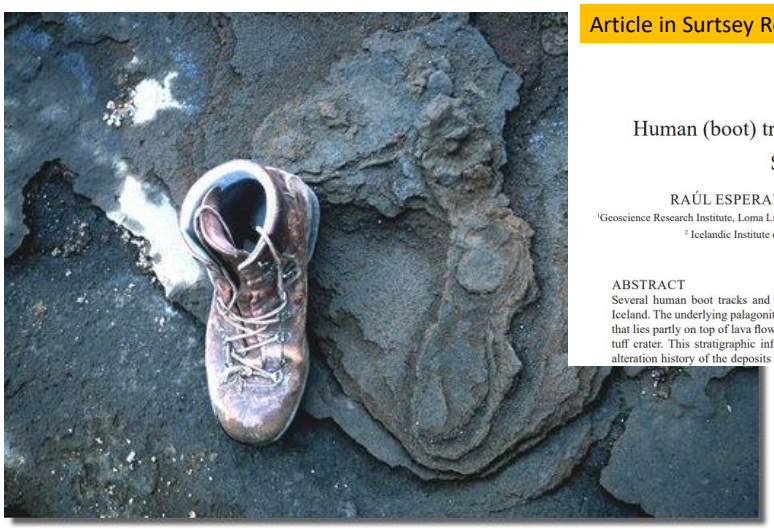
Footprints (boot prints)



Article in Surtsey Research on the boot tracks

www.surtsey.is

Human (boot) tracks preserved in volcanic deposits of Surtsey Island, Iceland

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[1]Geoscience Research Institute, Loma Linda University, California, 92350, USA, resperante@llu.edu (corresponding author)
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ABSTRACT
Several human boot tracks and trackways are preserved in palagonitized tuff in Surtsey Island, south Iceland. The underlying palagonitized substrate is made of reworked tephra debris talus and slump material that lies partly on top of lava flows erupted in 1964–1965 in Surtungur tuff crater and 1966–1967 in Surtur tuff crater. This stratigraphic information along with other evidence from the nature of the sediments, alteration history of the deposits and the record of human presence on the island indicate the tracks were

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Footprints (boot prints)

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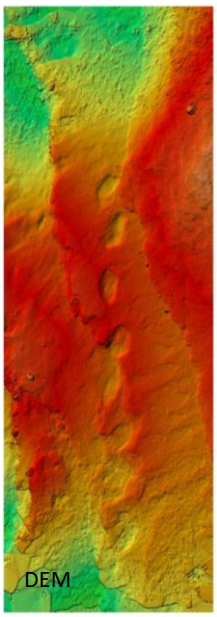
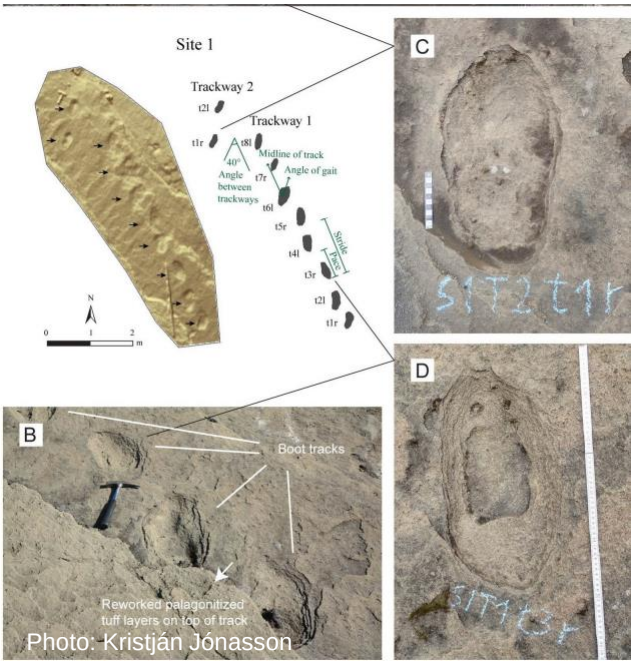
Footprints

The boot tracks were laid in between 1967 and 1970 and are today fossilized in the altered tuff cones.





40

Sigurður Þórarinsson

Sigurður Þ. was a geologist and is one of the potential owner of the boot tracks

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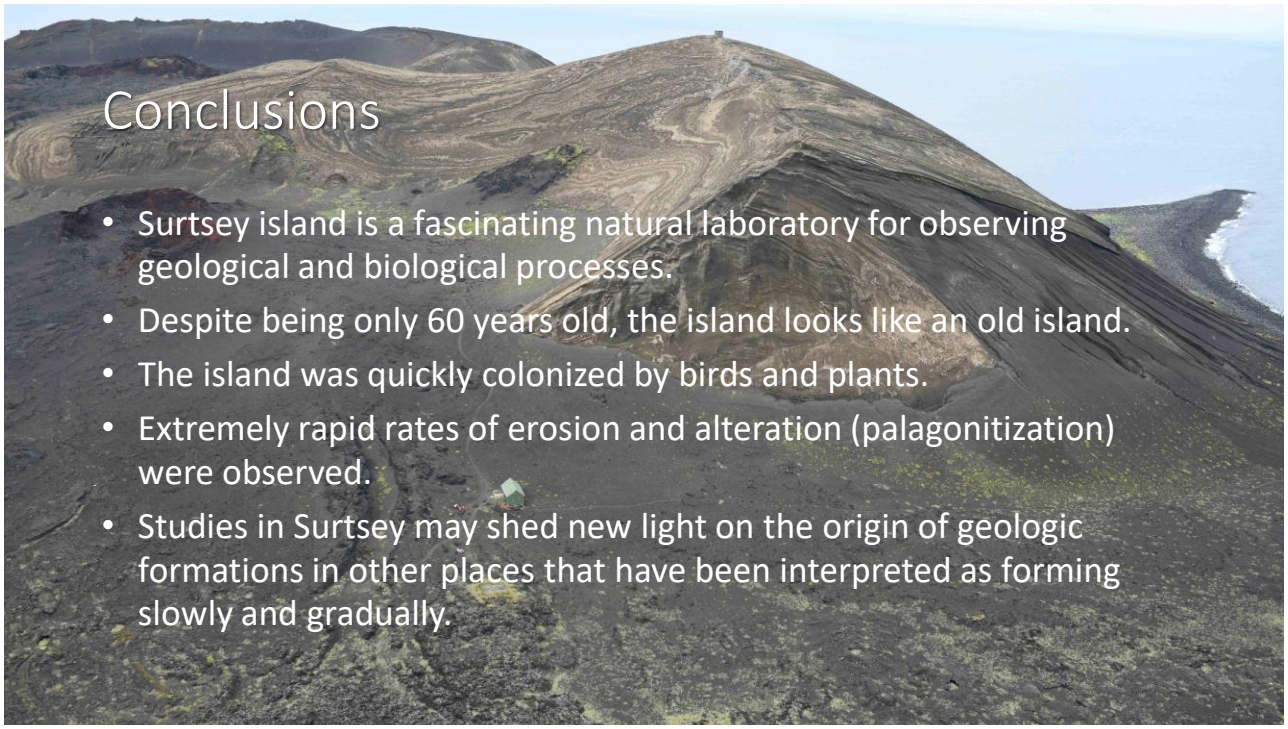

Conclusions

- Surtsey island is a fascinating natural laboratory for observing geological and biological processes.
- Despite being only 60 years old, the island looks like an old island.
- The island was quickly colonized by birds and plants.
- Extremely rapid rates of erosion and alteration (palagonitization) were observed.
- Studies in Surtsey may shed new light on the origin of geologic formations in other places that have been interpreted as forming slowly and gradually.

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