

# Volcanic fluxes over the last millennium as recorded in the GV7 ice core (Northern Victoria Land, Antarctica)

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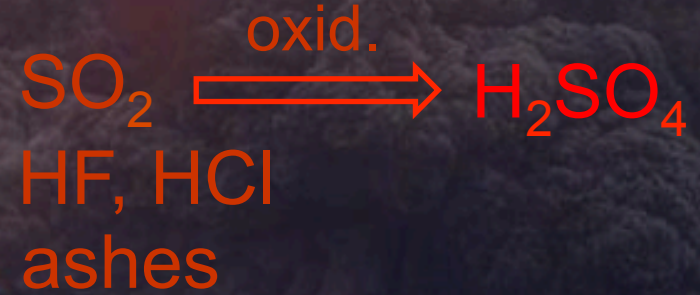
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# Ice core markers of VOLCANIC ERUPTIONS



Deposition onto ice sheet

**Sulphate**  
Acidity  
(electrical conductivity and dielectrical properties)

A white downward-pointing arrow is positioned above the text 'Sulphate Acidity'.

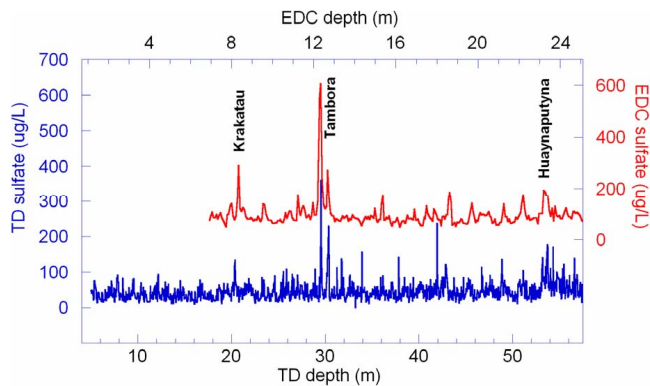
Mount Tambora (Indonesia)

# Volcanic $\text{SO}_4^{2-}$ peaks in ice cores useful to

## 1. DATING

both absolute and ice core  
synchronization

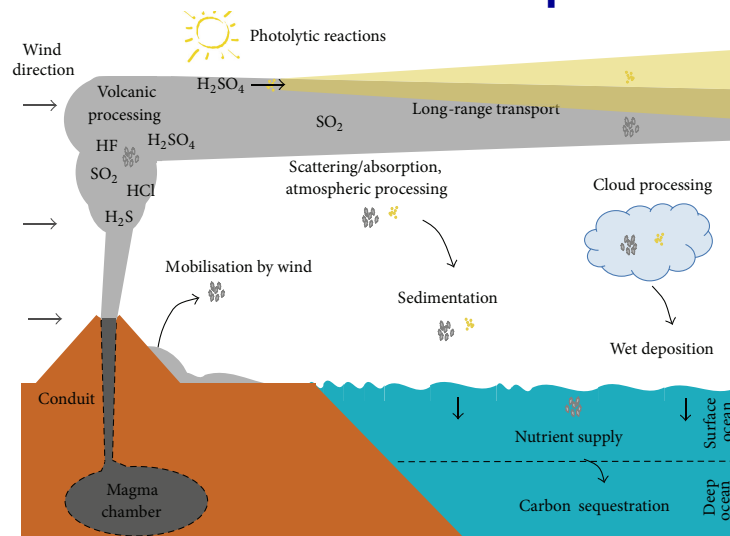
by volcanic **signature detection** and  
assignment to documented eruptions



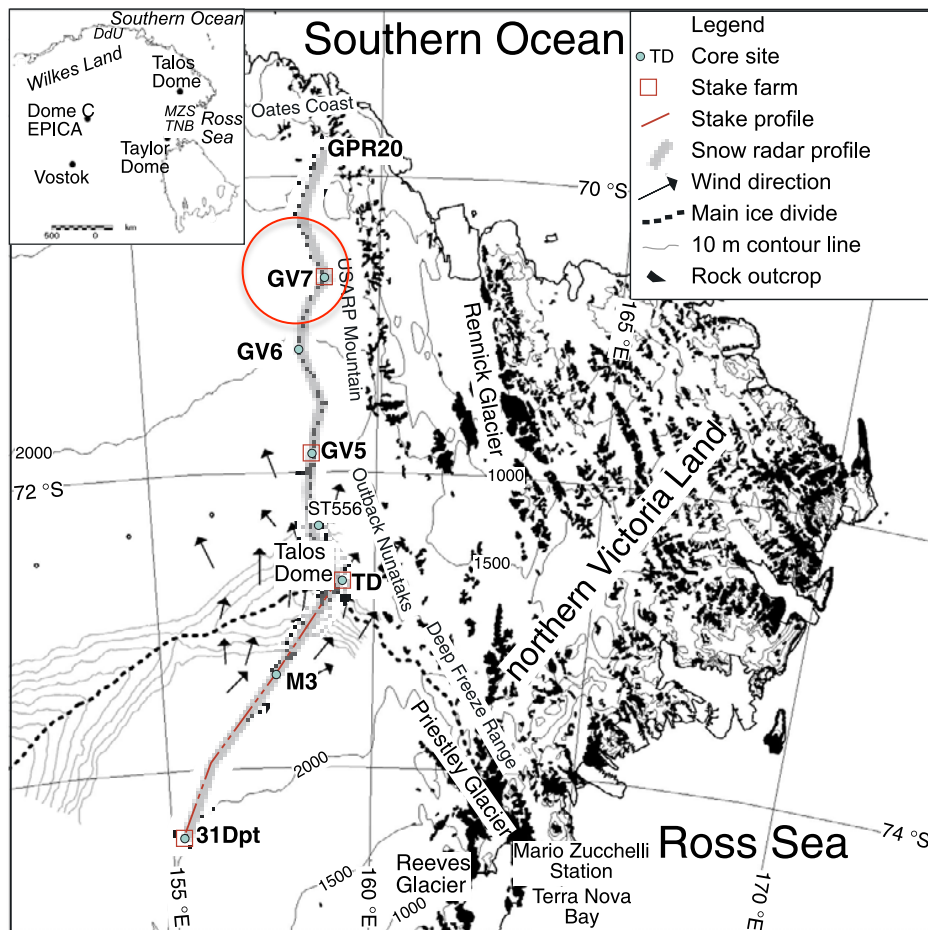
Sulphate profiles of the top parts of the EPICA Dome C and Talos Dome ice cores. Three known and well-dated volcanic events are shown: Krakatau (1884 AD), Tambora (1815 AD), Huaynaputyna (1600 AD) [Severi et al., 2007, Clim. Past]

## 2. VOLCANISM-CLIMATE CONNECTION

Assessment of volcanic radiative forcing  
by calculation of **volcanic deposition flux**



Climate effects of volcanic ashes (grey) and volcanic sulphate (yellow) [Langmann et al., 2014, Adv. Meteorol.]



Location map of the Talos Dome area showing **GV7** site along a north-south transect. [Frezzotti et al., 2007, J. Geophys. Res.]

## GV7 site (Northern Victoria Land)

Located on the ice divide between Oates Coast to Talos Dome ( $70^{\circ} 41' \text{ S}$ ,  $158^{\circ} 52' \text{ E}$ )

“Coastal” but high altitude site: about 95 km from Southern Ocean coast, 1950 m a.s.l.

Investigated during 2001/02 ITASE Traverse:

- Relatively high **accumulation rate** ( $241 \pm 13 \text{ mm w.e. yr}^{-1}$  in the last 50 yr), about 10-fold EPICA Dome C
- **Thickness** of the ice (approx. 1700 m)
- **Lack of post-depositional** processes



Ideal site to retrieve ice cores for studying the last millennium

- 250.7 m depth
- 5 cm analysis resol.

Non-sea salt sulphate conc. and thresholds used for detection of volcanic signatures

RMN: running mean; RMA: running median, MAD: median absolute deviation

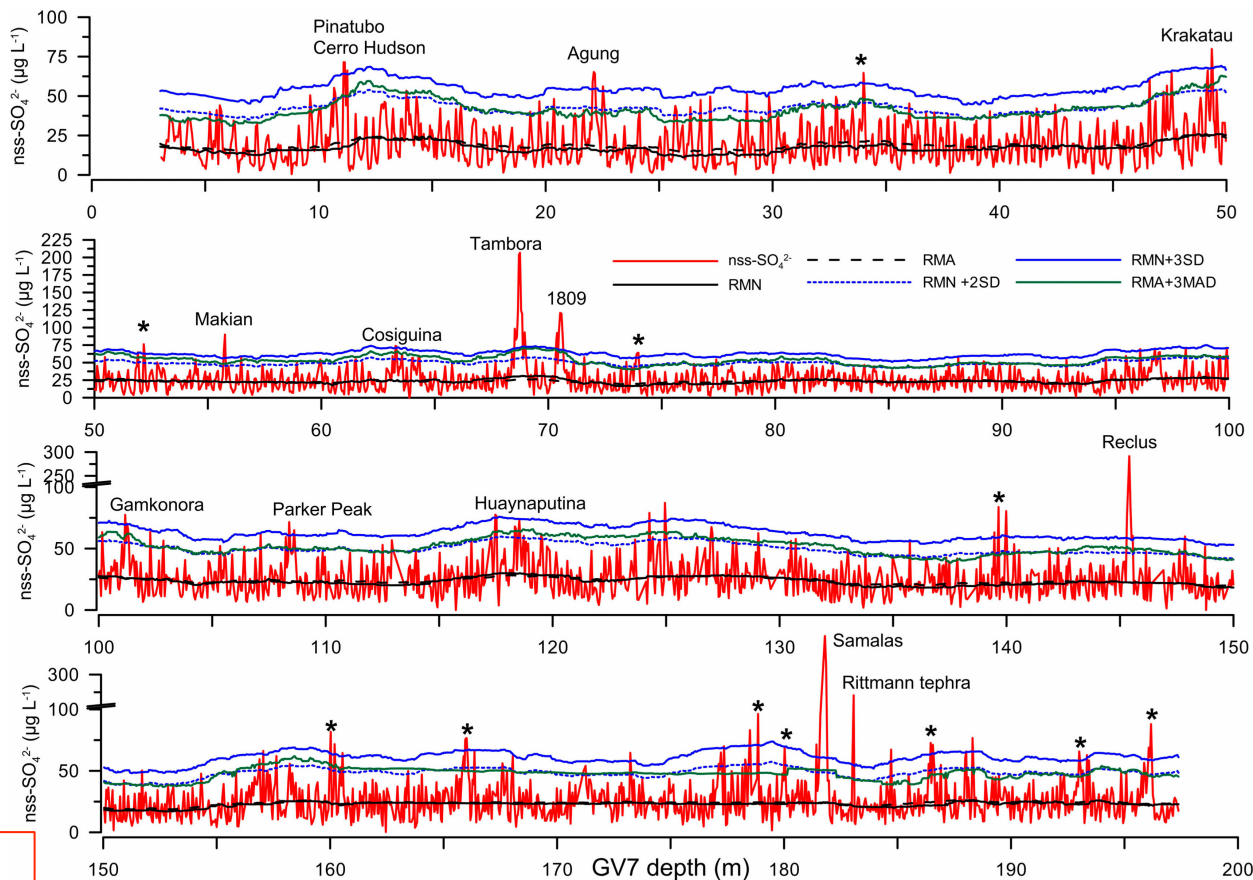


24 major volcanic eruptions identified, dated, and ascribed to a volcano in the **last millennium**



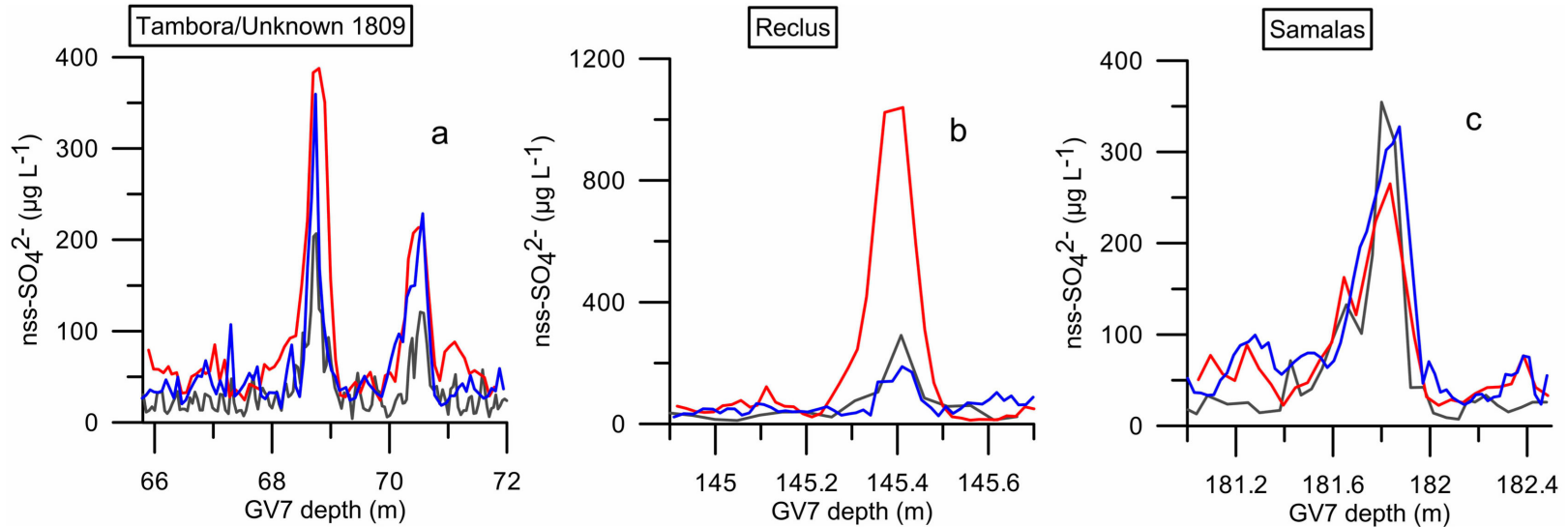
milestone for building an accurate age-scale for GV7

## Non sea salt sulphate in 2013/14 GV7 ice core





## Non sea salt sulphate: close-up on three major events in the last millennium



$\text{nssSO}_4^{2-}$  profiles as recorded at the time of three major volcanic eruptions: (a) Tambora/Unknown 1809, (b) Reclus, and (c) Samalas in GV7 ice core – grey line and in the “nearby” Talos Dome cores (TD96 – red line and TALDICE – blue line)

# Volcanic fluxes in 2013/14 GV7 ice core

## Comparison at regional scale

Volcanic signatures and volcanic fluxes (in kg/km<sup>2</sup>) found in GV7, **GV7 (ITASE)**, and **Talos Dome ice cores**, and comparison with the Volcanic Explosive Index (VEI) of the volcanic eruption.

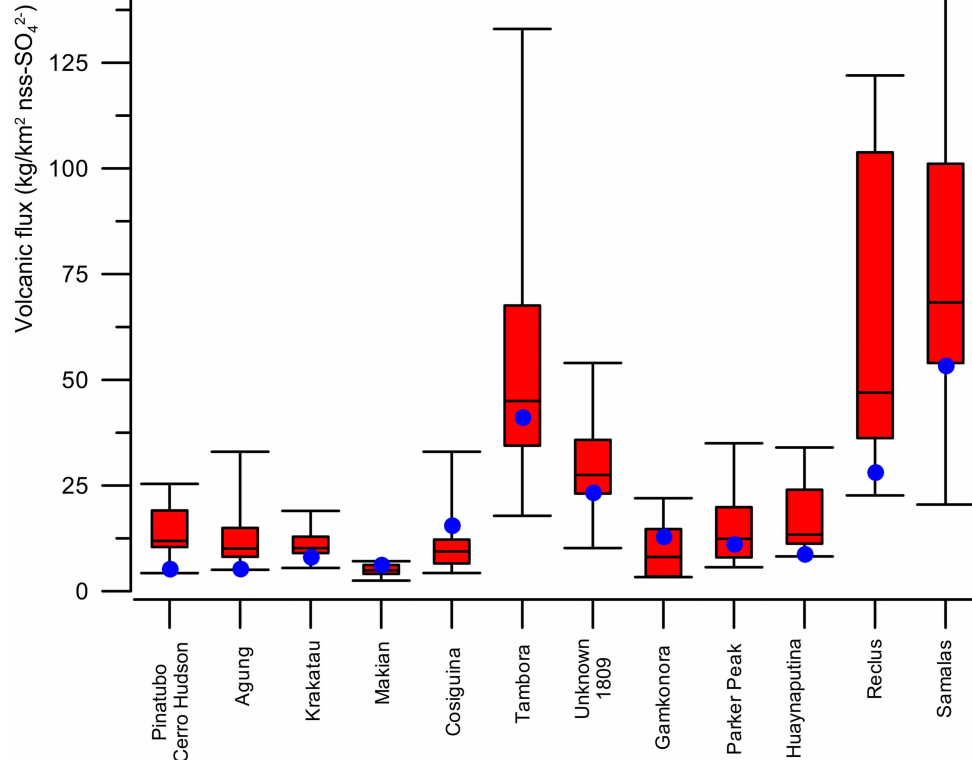
The uncertainty of flux ( $\sigma$ ) in GV7 core is calculated as the std dev. of the biogenic flux evaluated by MAD.

“x” marks the signatures showing two consecutive data points of non-sea salt sulphate concentration values above the corresponding threshold.

Depth (m)	Volcano	2 $\sigma$	3 $\sigma$	3MAD	Volcanic Fluxes					VEI
					GV7 ITASE	TD96	TALDICE	GV7	$\sigma$	
11.10	Pinatubo	x	x	x	10.46	4.28	-	5.28	2.88	6
	Cerro Hudson									
22.12	Agung	x	x	x	8.15	5.07	*	5.29	0.61	4
34.01	Unknown	x		x	2.03	<2	-	3.47	0.49	
49.35	Krakatau	x		x	11.51	7.99	10.20	8.06	0.56	6
52.17	Unknown	x		x	<2	-	-	6.58	0.62	
55.75	Makian	x	x	x	<2	5.51	2.51	6.21	0.50	4
63.27	Cosiguina	x	x	x		11.90	6.39	15.55	0.47	5
68.75	Tambora	x	x	x		42.31	34.44	41.12	0.97	7
70.53	Unknown	x	x	x		44.46	38.32	23.32	1.66	?
	1809									
73.97	Unknown	x	x	x		8.52	5.08	6.09	0.75	
101.25	Gamkonora	x		x		Missing data	-	12.91	0.48	5
108.39	Parker Peak	x		x		6.43	8.56	11.14	0.58	?
117.48	Huaynaputina	x	x	x		11.25	8.23	8.77	0.94	6
139.99	Unknown	x		x		-	2.26	5.30	0.28	
145.41	Reclus	x	x	x		119.7	22.66	28.13	0.42	6
160.25	Unknown	x	x	x		16.43	13.27	12.12	0.69	
166.01	Unknown	x	x	x		15.22	13.71	16.69	0.09	
178.73	Unknown	x	x	x		3.55	41.51	38.84	0.14	
180.03	Unknown	x	x			10.23	9.38	8.09	0.11	
181.86	Samalas	x	x	x		21.72	121.51	53.36	1.01	7
186.60	Unknown	x	x	x		12.68	23.06	10.98	0.67	
188.03	Unknown	x		x		<2	<2	<2	0.40	
193.07	Unknown	x	x	x			10.86	10.99	0.66	
196.17	Unknown	x	x	x			8.95	8.15	0.29	

Volcanic fluxes of different known volcanic eruptions. Blue dots refer to GV7 ice core.

Besides single drilling sites, a composite of multiple ice cores (“Ant. comp.”) is taken into account.



## Comparison of GV7 volcanic fluxes at Antarctic scale

The comparison of volcanic fluxes with all the available data sets from **Antarctica** shows that the GV7 values are not significantly different.

At **regional scale** inter-site variability is of the same order of magnitude of the intra-site variability.



The obtained data set appears to be consistent with available data and can be used to increase the statistical significance of data sets for predictive modelling