





# Seismicity in Kerguelen and melting of the Cook icecap

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# Kerguelen



- In the oceanic domain of the Antarctic plate
- Third largest oceanic archipelago after Iceland et Hawaii.
- Hotspot : 110 90 Ma
- Around 45 Ma : Northern plateau linked to the South East Indian rift activity
- Active volcanism at decreasing rate in the last 40 Ma
- Last eruption ~ several thousand years
- Reported fumarolic activity

### Kerguelen



Verfaillie et al. (2021)

### Kerguelen earthquakes

Time	Lat S	Lon E	${f Depth}\ ({ m km})$	Mb	Source
18:13:25	57.82	83.59	33	5.2	ISC
23:11:06	46.14	73.22	18	5.5	ISC
	46.15	53.63	33	-	ISC
	48.78	69.24	10	4.6	ISC
	48.72	69.17	10	4.7	ISC
	48.56	69.47	10	4.9	ISC
	57.99	82.50	0	4.7	ISC
15:32:50	49.16	68.92	4	$5.3^{*}$	ISC
17:54:03	49.30	69.62	19	4.5	NEIC
18:15:11	49.32	69.55	20	4.9	NEIC
14:00:13	49.17	69.51	10	4.3	NEIC
14:20:59	49.35	69.45	10	4.6	NEIC
14:57:01	49.22	69.57	16	4.7	NEIC
15:42:47	49.40	69.58	10	4.3	NEIC
15:48:08	48.97	69.69	10	4.4	NEIC
04:39:24	49.66	69.73	10	4.7	NEIC
03:12:29	49.33	69.75	10	4.7	NEIC
18:43:44	49.22	68.949	14	4.7	NEIC
22:21:31	49.104	68.991	15	4.6	NEIC
	Time $18:13:25$ 23:11:06 15:32:50 17:54:03 18:15:11 14:00:13 14:20:59 14:57:01 15:42:47 15:42:47 15:48:08 04:39:24 03:12:29 18:43:44 22:21:31	$\begin{array}{c c} {\rm Time} & {\rm Lat\ S} \\ \hline \\ 18:13:25 & 57.82 \\ 23:11:06 & 46.14 \\ & 46.15 \\ & 48.78 \\ & 48.72 \\ & 48.56 \\ & 57.99 \\ \hline \\ 15:32:50 & 49.16 \\ 17:54:03 & 49.30 \\ 18:15:11 & 49.32 \\ 14:00:13 & 49.17 \\ 14:20:59 & 49.35 \\ 14:57:01 & 49.22 \\ 15:42:47 & 49.40 \\ 15:48:08 & 48.97 \\ 04:39:24 & 49.66 \\ 03:12:29 & 49.33 \\ 18:43:44 & 49.22 \\ 22:21:31 & 49.104 \\ \hline \end{array}$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$

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1973-03-20	18:13:25	57.82	83.59	33	5.2	ISC
1973-05-03	23:11:06	46.14	73.22	18	5.5	ISC
1974-09-21		46.15	53.63	33	-	ISC
1980-04-24		48.78	69.24	10	4.6	ISC
1980-04-25		48.72	69.17	10	4.7	ISC
1980-04-25		48.56	69.47	10	4.9	ISC
1981-04-06		57.99	82.50	0	4.7	ISC
2007-07-28	15:32:50	49.16	68.92	4	$5.3^{*}$	ISC
2014-03-12	17:54:03	49.30	69.62	19	4.5	NEIC
2014-03-12	18:15:11	Most	lv Offs	hore	4.9	NEIC
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2014-03-21	04:39:24	49.66	69.73	10	4.7	NEIC
2015-06-10	03:12:29	49.33	69.75	10	4.7	NEIC
2017-10-06	18:43:44	49.22	68.949	14	4.7	NEIC
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- Installed in 1984
- Continuous data since 1986
- HF data since 1999





# Data mining



# Data mining



## Building an automatic earthquake catalog

- Data : 20 years of continuous seismic signal at station PAF (GEOSCOPE)
- Algorithm :
  - EQTransformer algorithm : neural network (detection & picking)

- Results :
  - 6826 P-wave picks
  - 6864 S-wave picks
  - 6591 events with both S-P < 20s









#### Single station localisation



- Distance to earthquake : S-P time
- Azimuth : P-wave polarization
- Removing signal originating from the scientific base
- 6591 detected events => 3271 located earthquakes







- 4 main seismicity clusters
- 2 small clusters in SW
- Cluster East of Cook : most of the activity in 2014
- Cluster West of Cook : 1406 earthquakes (largest ones) with discontinuous activity







Nasa Earth Observatory



Cook ice cap is the the largest French glacier, it had an area of around 500 km2 in 1963. Over the last 40 years, the Cook ice cap has thinned by around 1.5 meters per year, its area has decreased by 20%, and retreat has been twice as rapid since 1991 (Favier et al. 2016).

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#### Fast retreat of the ice-cap decrease of the vertical stress

Elastic rebound and activation of faults

Unloading induce:

- magmatic pressure change
- variation of the threshold pressure required for dyke initiation
- Melt generation
- Elastic rebound



Sigmundson et al., 2010

# Perspectives



- 2 stations installed in december 2021

**Project IPEV LISISKER** 



#### Installation of 10 stations for 4 years





