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Evolution of the Volcano-Tectonic seismicity associated with Mayotte's active magmatic system

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INTRODUCTION

Mayotte

- ❖ Oldest island of the Comoros Archipelago (Fig. 1)
- ❖ Historically seismically quiet
- ❖ Onset of volcanic activity : onshore 11 Ma – submarine 20 Ma

Mayotte's recent submarine eruption

- ❖ Beginning of seismic activity in May 2018
- ❖ Large surface displacements (170 mm/yr subsidence & 240 mm/yr eastward)
- ❖ New volcanic edifice (820 m) discovered in May 2019 (MAYOBS1 cruise) (Fig. 1)
- ❖ At least 6.55 km³ of erupted lava in May 2020 (Fig. 1)
- ❖ Seismic and volcanic activity still on-going and monitored by the REVOSIMA

Need to understand the evolution of the seismicity to understand the structure's behavior and how it could evolve.

We re-analyze the **VT seismicity** from March 2019 to December 2021.

- ❖ **Automatic detection:** PhaseNet neural network (Retailleau et al., in prep) → increase considerably the number of detected earthquakes compared to manual detections (Fig. 2): 4,235 manual → 57,282 automatic
- ❖ **Land-stations only:** before the eruption, only 1 → 3 in February 2019 → now 9 deployed
- ❖ **Re-location:** catalog relocated with new 1D local velocity model (Lavayssière et al., in review) → lowering of the bias linked to the geometry of the network

We use the **39,154 best-constrained events** for our analysis.

- ❖ Proximal cluster: RMS < 0.13 s + longitude error < 8 km + latitude error < 7 km + depth error < 7 km
- ❖ Distal cluster: RMS < 0.1 s + longitude error < 11 km + latitude error < 14 km + depth error < 18 km

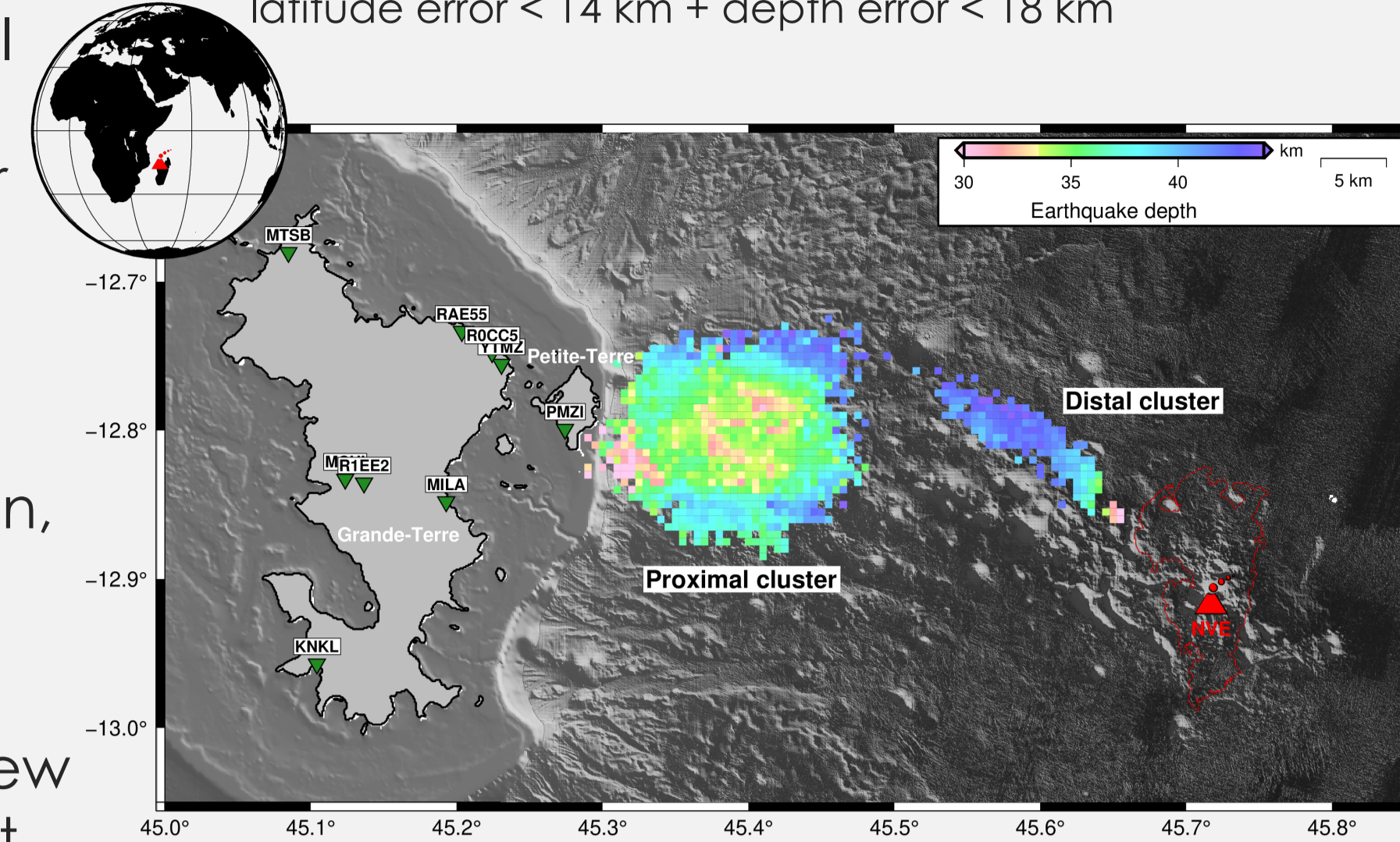


Figure 1: Map of Mayotte's seismicity. Each colored node represents the mean depth of the events located in the node, with a minimum of 2 events per node. Green inverted triangles are the land stations. The red volcano symbol is the location of the New Volcanic Edifice (NVE) and the red contour is the extent of new material from the eruption.

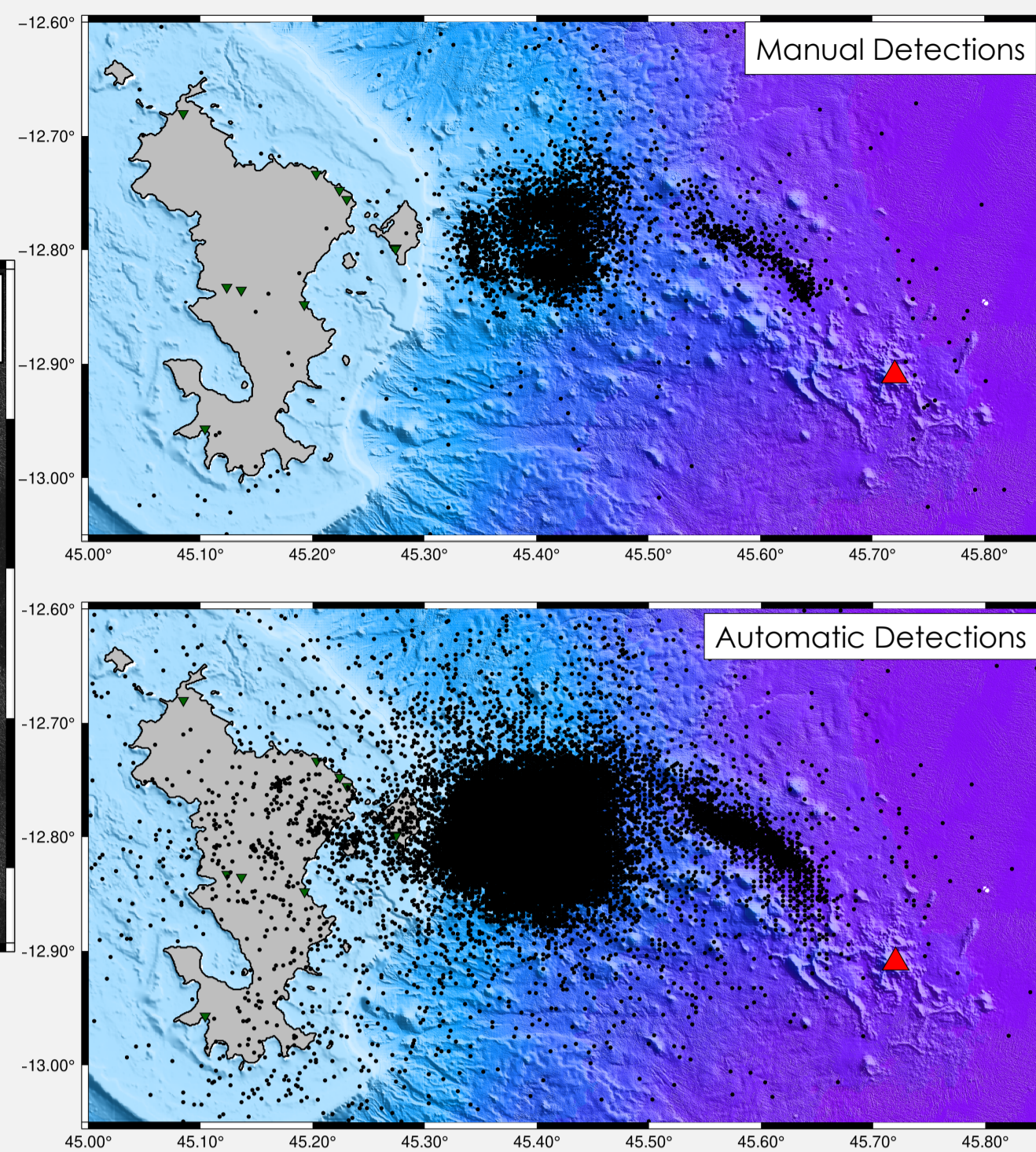


Figure 2: Earthquakes detected manually compared to events detected with PhaseNet neural network

EVOLUTION OF THE PROXIMAL CLUSTER

- ❖ Cluster in place since 2018
- ❖ **Seismicity is decreasing with time** (Fig. 3 and 4)
- ❖ Activity started in the center and moved to the edges of the cluster (Fig. 3 and 4)
- ❖ Events highlight different structures (Fig. 3)
- ❖ At depths, events are shallower in the center than at the edges (Fig. 3)
- ❖ Events further from center generally deeper (Fig. 5)
- ❖ **Aseismic circular region** in the top center (Fig. 3)
- ❖ **Aseismic vertical zone** along the center (Fig. 3)
- ❖ On the cross-section at 45°, we can distinguish two linear aseismic zones
- ❖ The linear aseismic zones all converge to the aseismic top center (Fig. 3)

- ❖ Recent (end of 2020) seismicity is deep (> 30km) (Fig. 3 and 4)
- ❖ Mainly to the West-South West and to the South East (Fig. 3 and 4)

Zones of interest:

- ❖ Sub-cluster 1 (black) = linear almost-vertical structure that slowly dissipates through time
- ❖ Sub-cluster 2 (red) = linear structure that slowly dissipates through time
- ❖ Sub-cluster 3 (green) = continuous activity – slight increase with time in the West
- ❖ Sub-cluster 4 et 4' (brown & purple) = deep activity; slightly dissipates but still active
- ❖ Sub-cluster 5 (cyan) = very small cluster but shallower than the rest; appears slowly over time

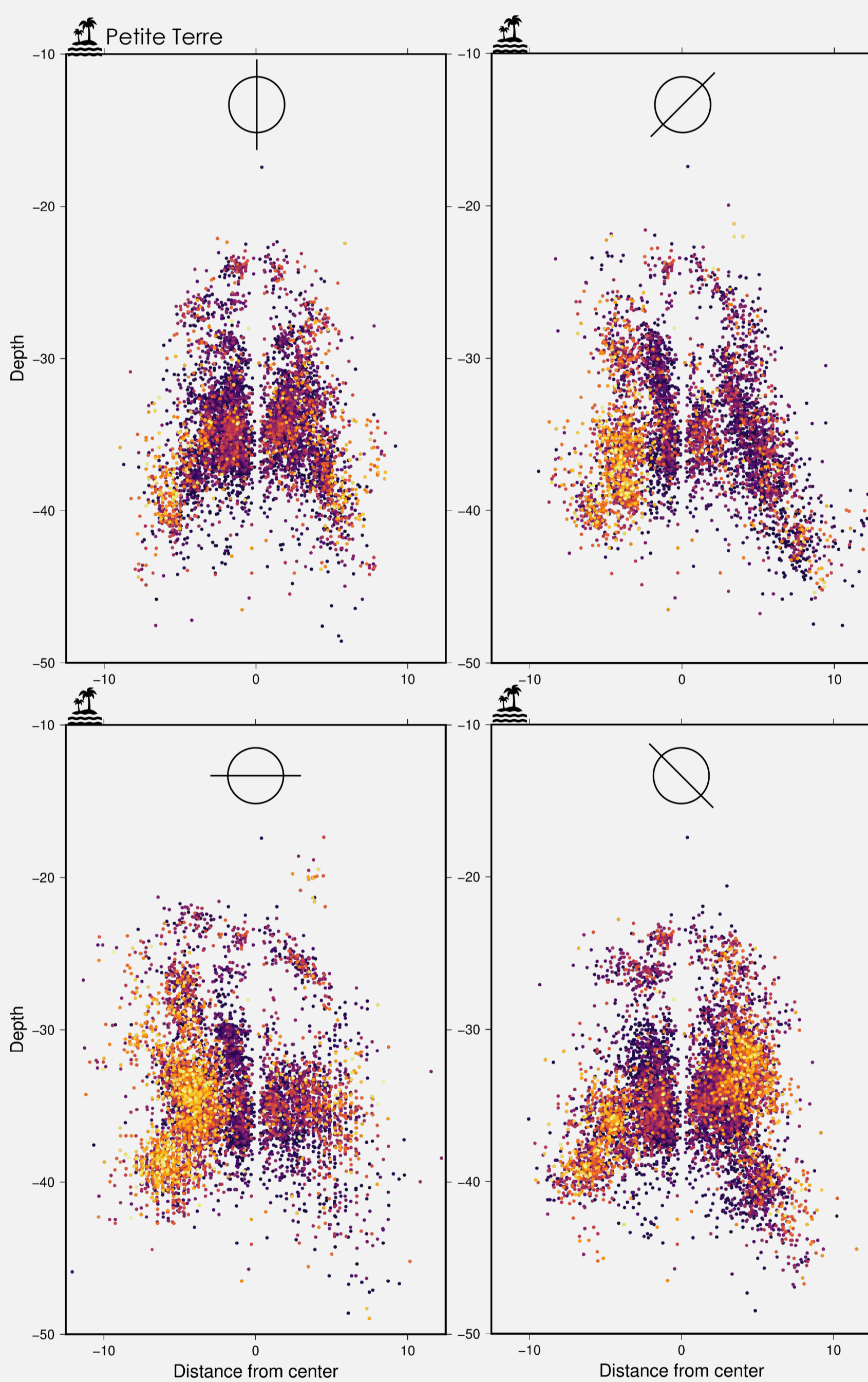


Figure 3: Cross-sections of the seismicity color-coded by time. Symbol at the top of each subplot represents the cross-sections trace.

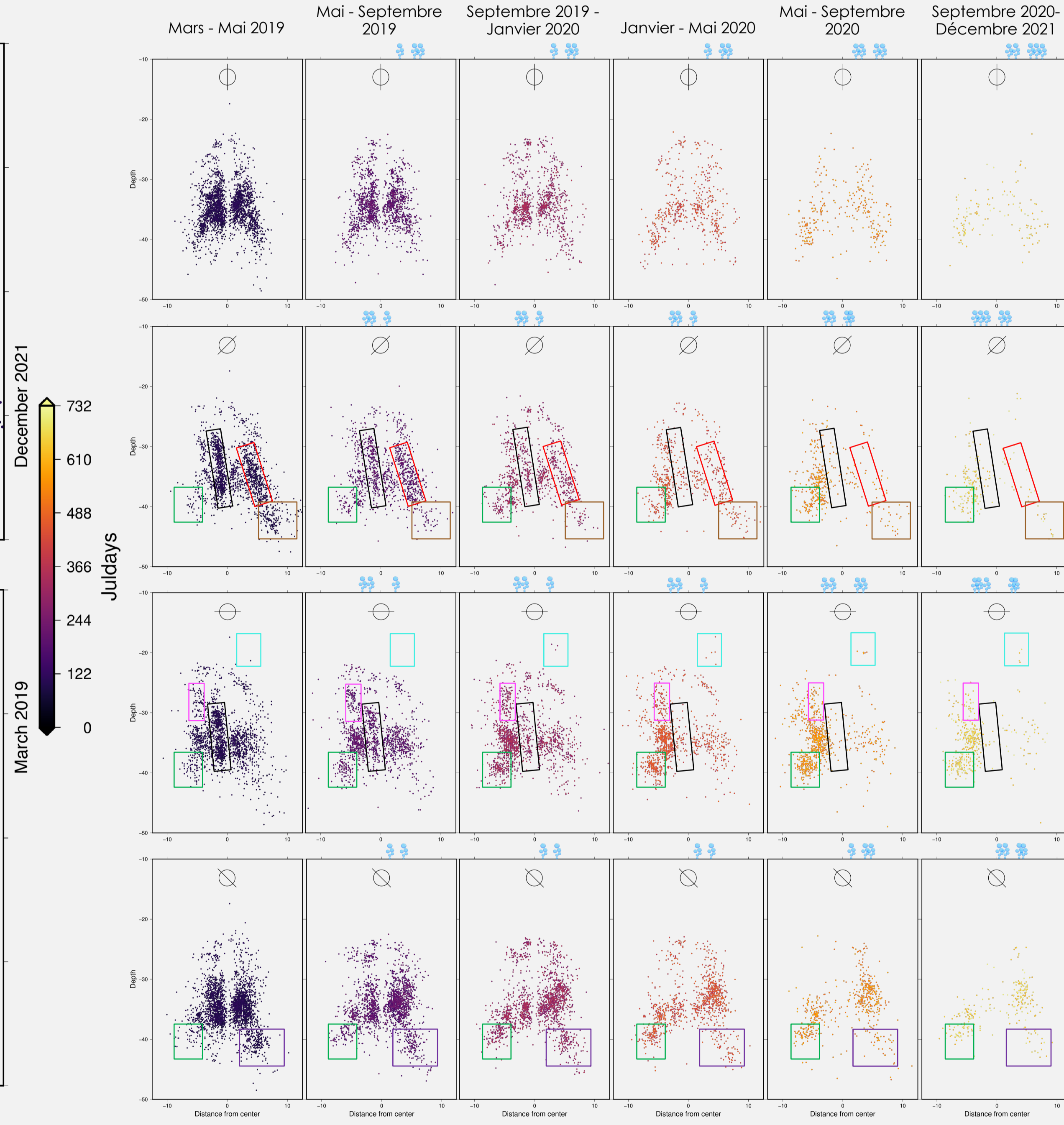


Figure 4: Evolution of the seismicity through time. Each line of graphs represents the evolution on each traces (see Fig. 3). Information on the location and evolution of surface degassing is indicated.

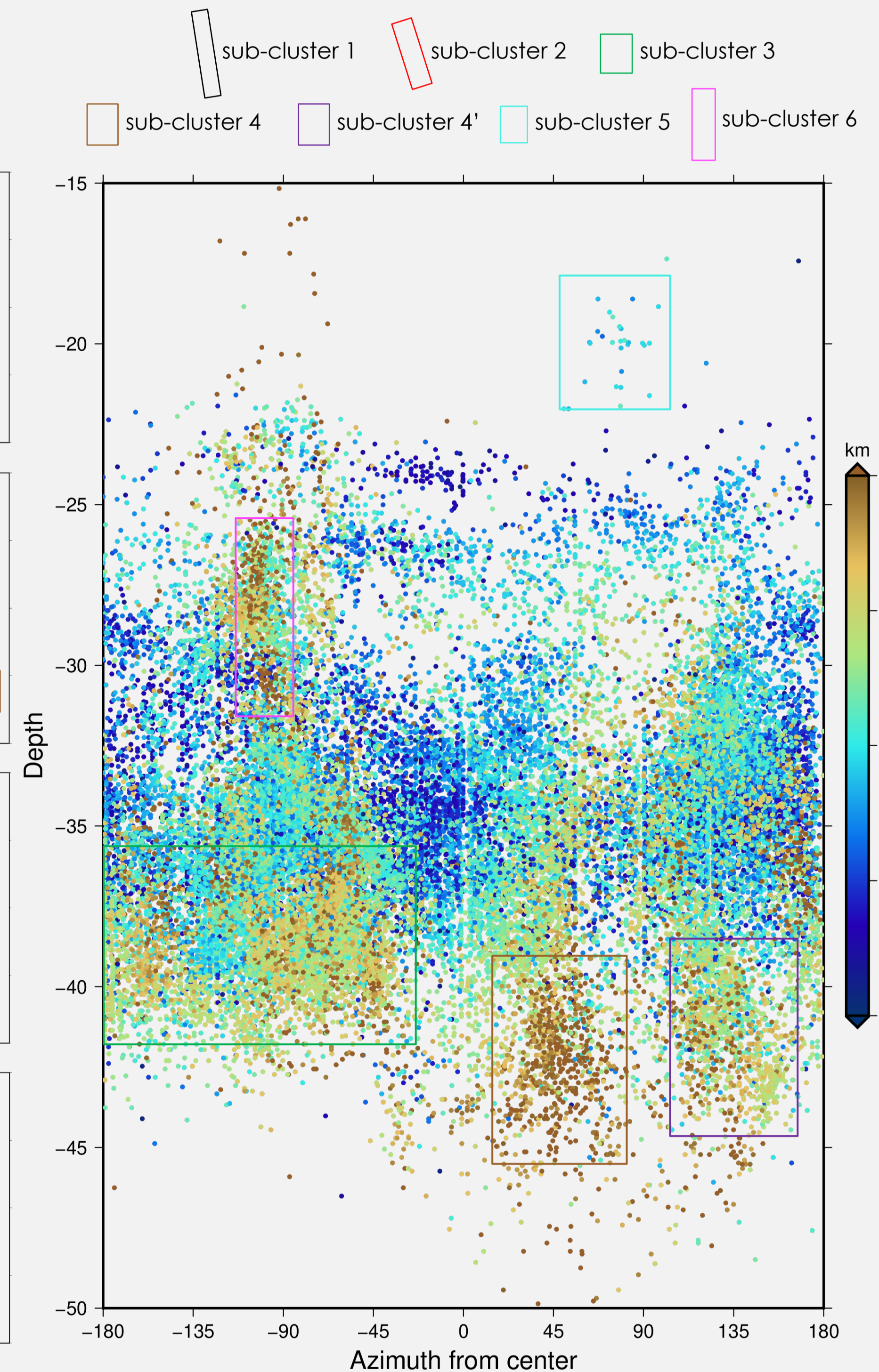


Figure 5: Events in the proximal cluster represented by its depth and its azimuth compared to the center of the cluster, and color-coded by its distance to the center.

EVOLUTION OF THE DISTAL CLUSTER

- ❖ **Seismicity relatively stable with time** but has moved (Fig. 6 and 7)
- ❖ 2 main sub-clusters: sub-cluster 1 disappears – sub-cluster 2 increases in activity (Fig. 6 and 7)

Sub-cluster 1

- ❖ Activity slowly decreases (Fig. 7)
- ❖ A slight shift to the East can be noticed (Fig. 8)

Sub-cluster 2

- ❖ Appears mainly in September 2019 and **events are getting shallower with time** (Fig. 7)
- ❖ Peak of activity in April 2020 - coincides with observation of lava flow on the seafloor NW of NVE in May (MAYOBS13-2) (Fig. 8)
- ❖ Lava flow still observed in October 2020 (MAYOBS15) = sub-cluster still active (Fig. 8)
- ❖ Activity decreases significantly around December 2020 = lava activity in January/February (SISMAORE) - no lava activity in April 2021 (MAYOBS18/GEOFLAMME)

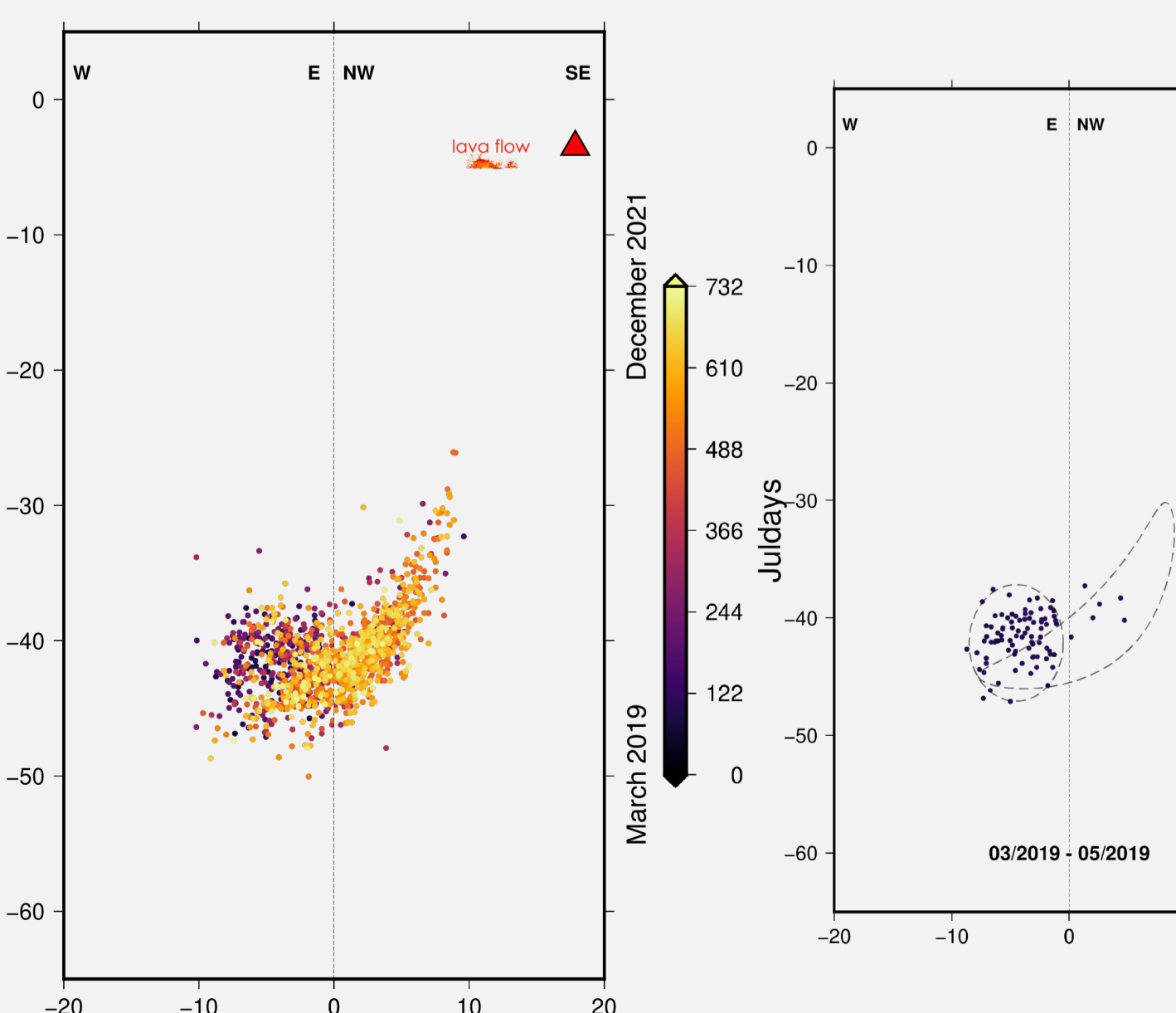


Figure 6: Cross-sections of the seismicity color-coded by time.

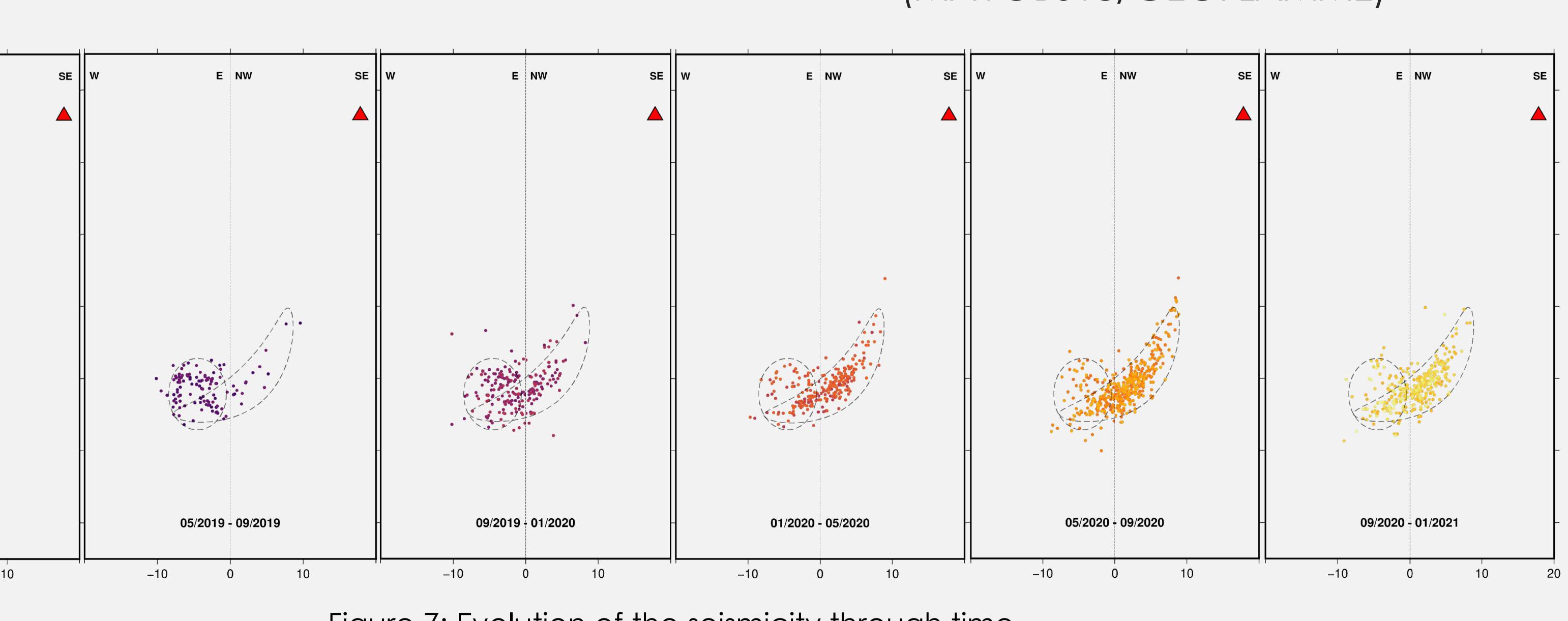


Figure 7: Evolution of the seismicity through time.

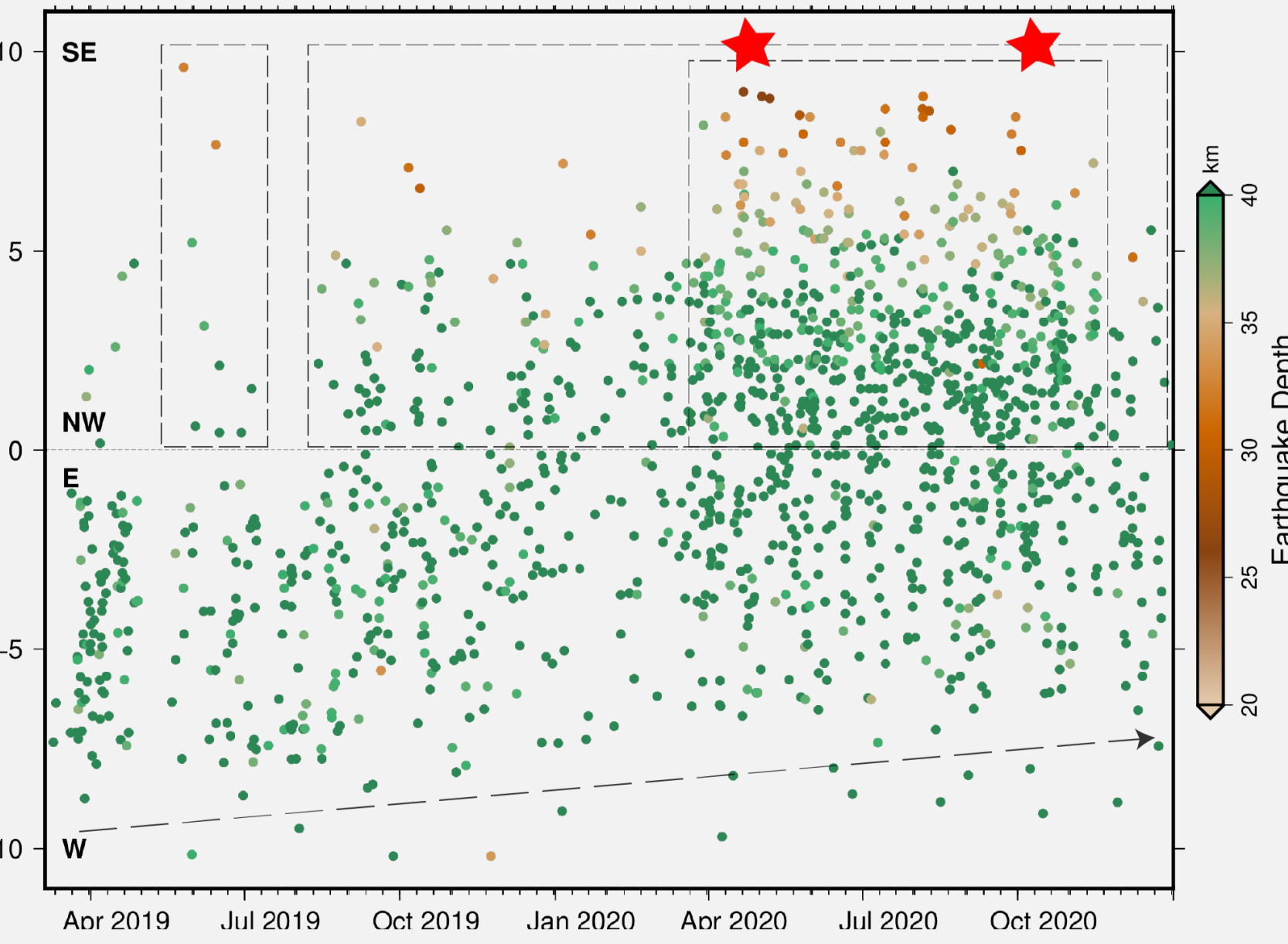


Figure 8: Events in the distal cluster represented by its position along the cross-section trace through time, and color-coded by its depth.