

# Imaging lava eruptions and crater morphology changes at a basaltic volcano using infrasound

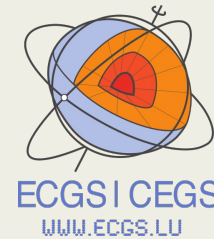
J. Barrière<sup>1</sup>, A. Oth<sup>1</sup>, J. Assink<sup>2</sup>, N. d'Oreye<sup>1,3</sup>, L. Evers<sup>2,4</sup>

<sup>1</sup> European Center for Geodynamics and Seismology, Luxembourg

<sup>2</sup> Royal Netherlands Meteorological Institute, The Netherlands

<sup>3</sup> National Museum of Natural History, Luxembourg

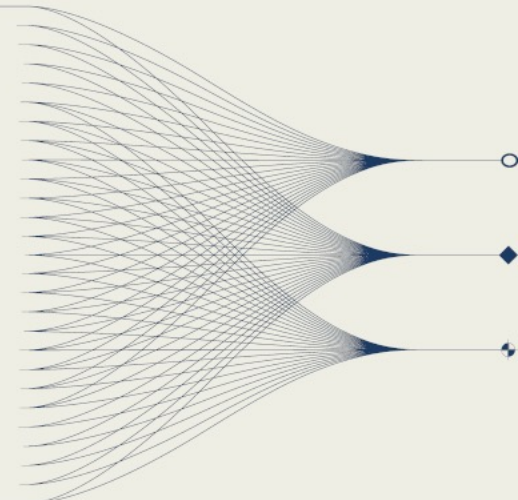
<sup>4</sup> Delft University of Technology, The Netherlands

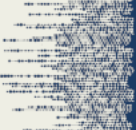


## INTRODUCTION AND MAIN RESULTS



- Aside from a few well-instrumented volcanoes worldwide, accurately reconstructing the precise eruptive mechanisms and chronology is hampered by the lack of detailed visual observations in space and time
- Because they emit infrasound (low-pitched sound  $< 20$  Hz), any changing and hazardous eruptive activity can be inferred with “specialised microphones”.
- Case study at Nyiragongo volcano located in the Kivu Rift, towering above the cities of Goma, D.R. Congo (~1 million inh.) and Gisenyi, Rwanda (~200 000)





## 1) Context : Nyiragongo volcano (D.R. Congo)

- The world's largest & persistent lava lake up to 2021, drained during its 3<sup>rd</sup> known (after 1977 and 2002) flank eruption on 22 May 2021
- The rupture of the edifice started around 15:57 UTC and initiated short-duration (~6 h) lava flows and a week-long magmatic intrusion (dyke)

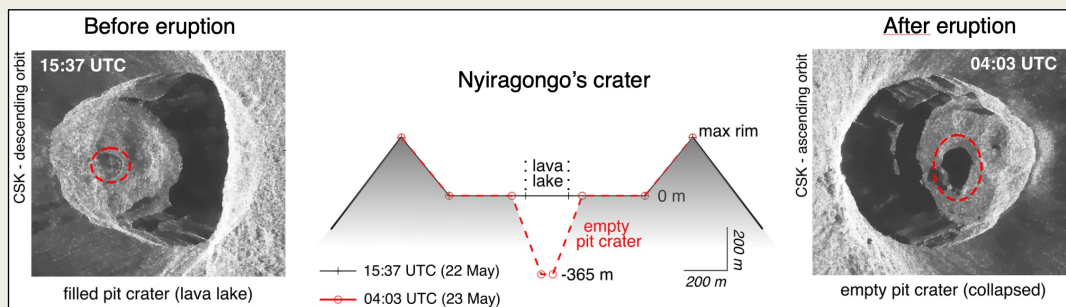


See also  
Smittarello et al.  
(2022, Nature)



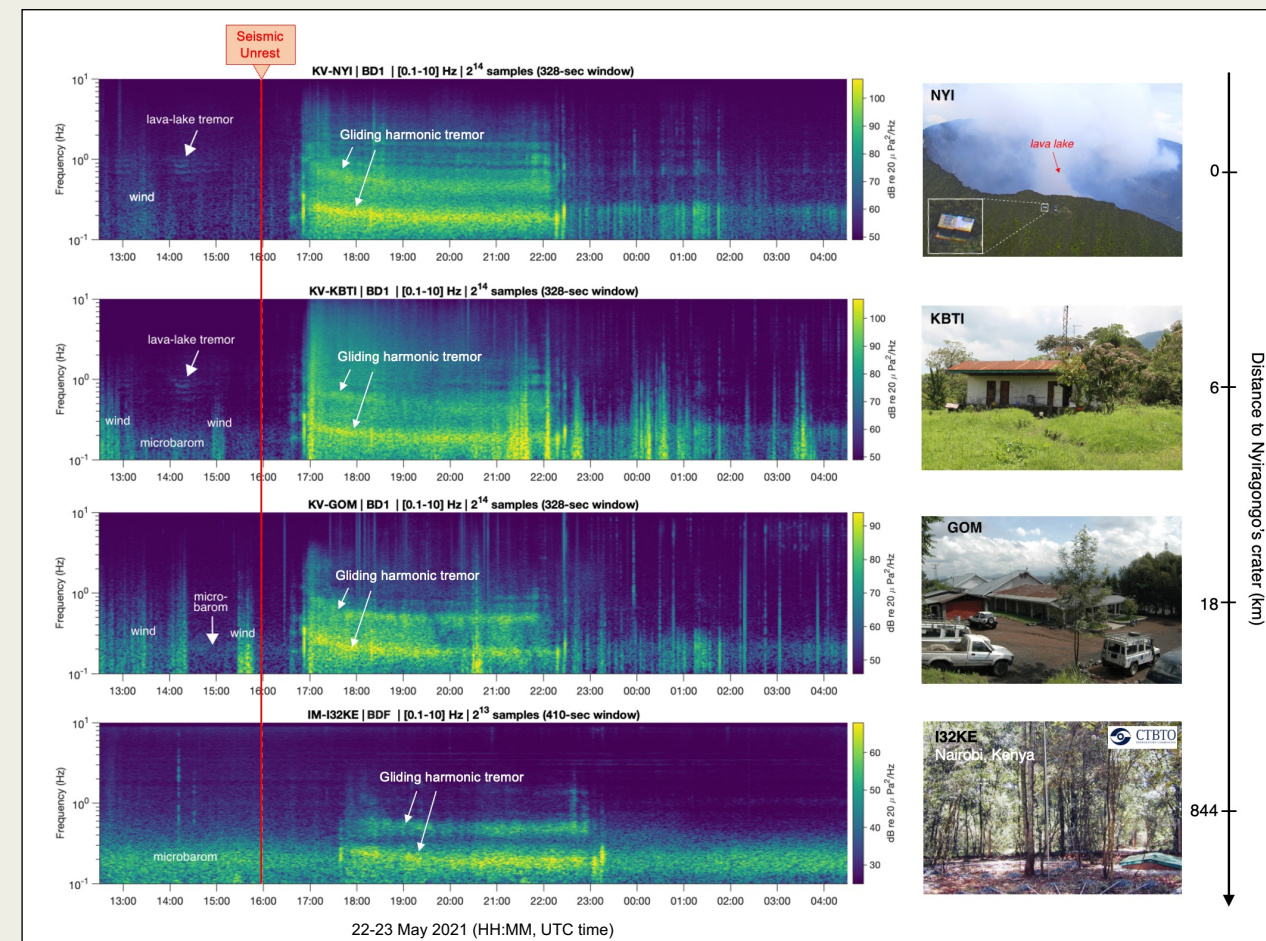
## 2) What we know from space-based (SAR) observations ?

- SAR = Synthetic-Aperture Radar
- Two amplitude images before/after

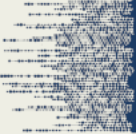


## 3) 22 May 2021 eruption : A long-range infrasonic tremor below 1 Hz

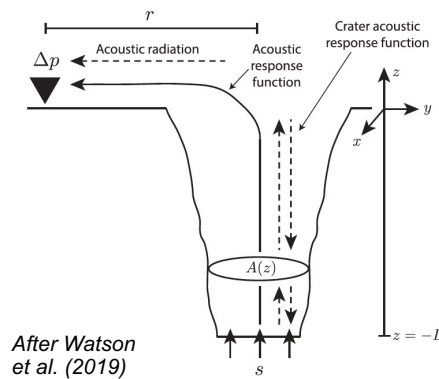
- Infrasound records close to the edifice (<20 km) up to Kenya (~800 km)
- Stations NYI, KBTI, GOM from KivuSNet network and station I32KE from IMS





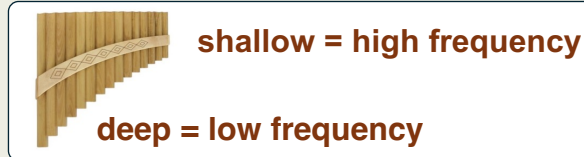


## 4) Nyiragongo's crater, a gigantic acoustic resonator

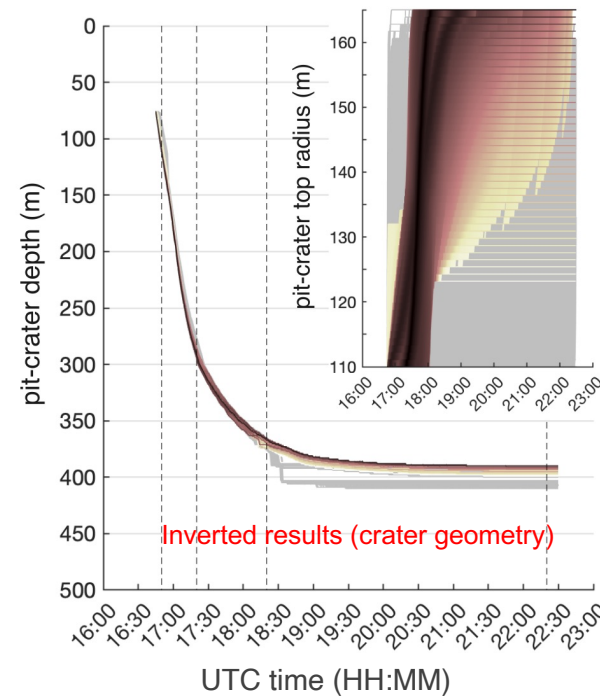
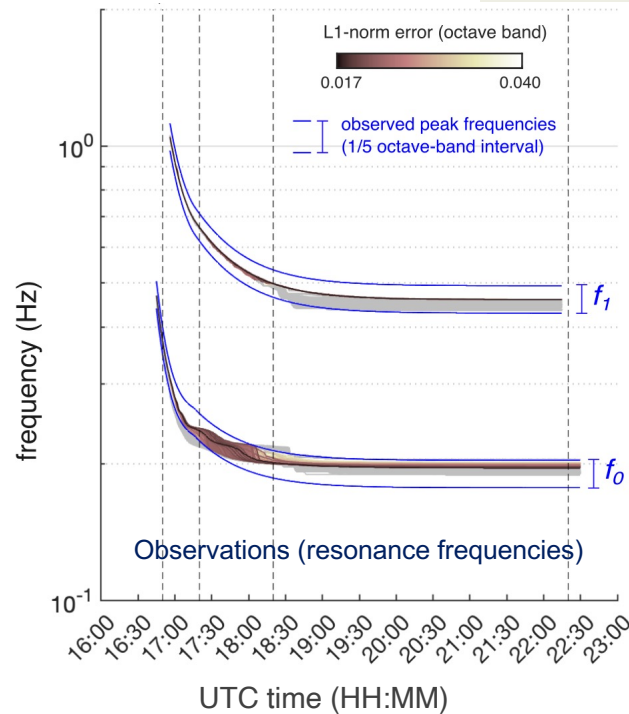


After Watson et al. (2019)

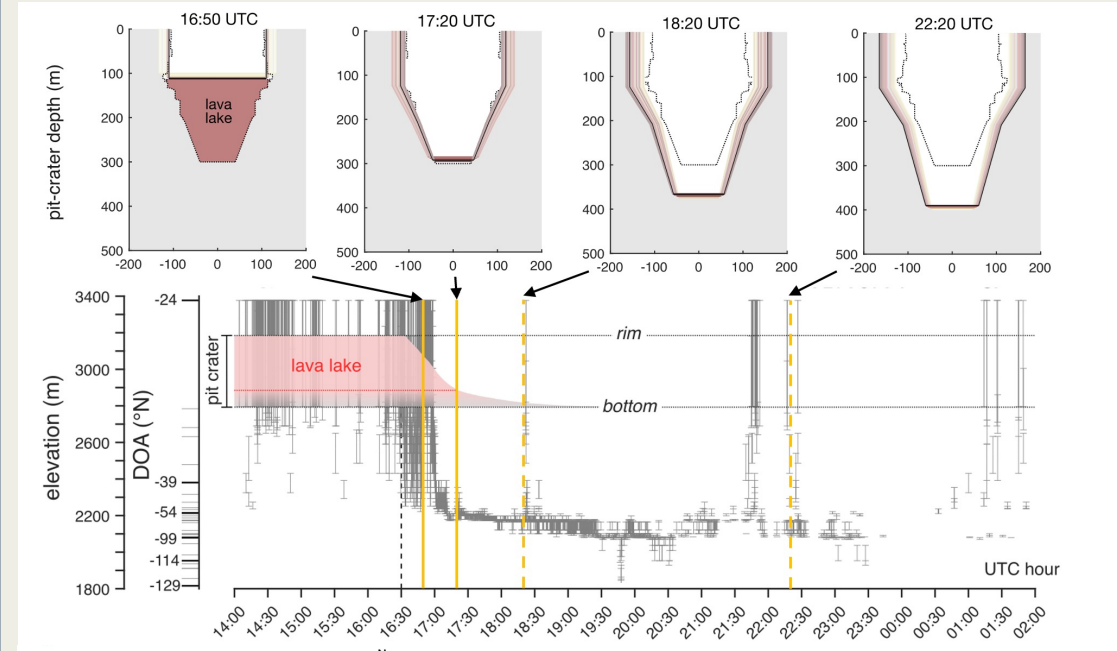
- This tremor is the signature of Nyiragongo's crater acoustic resonance during the lava-lake drainage



- We use the numerical code *CRes* for simulating quasi-1D wave propagation along depth inside an axisymmetric crater (<https://github.com/leighton-watson/CRes>)



## 5) The eruption scenario : crater + fissures



- Complementary result using 3-sensor array on the flank (KBTI)
- Higher frequency band [1-8] Hz
- Potential sources (fissures) in line-of-sight with angles  $< 15^\circ$
- Grid-search of DOA (Direction of Arrival)  $\rightarrow$  Fissures opening