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Hydrothermal activity in a lava dome detected by combined seismic and muon monitoring

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Muons can be used to study the density structure of large geological bodies





If continuous muon measurements for long periods —> density changes in the volcano

March 2017: anomalously calm weather led to coherent seismic noise observations with a small array of geophones.





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Muon flux increases only in the region where the source of the seismic noise is identified



An increase in the muon flux as represented by the red curve (1), indicates a decrease in the density. In the context of a Volcano Hydrothermal System, this is most likely due to a decrease in the amount of liquid in the lava dome, either by vaporisation or fluid redistribution due to pressure variations.



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Density changes in the Hydrothermal System are also coherent among different muon telescopes !



Remarks

- Muons are useful to study dynamic hydrothermal syste volcano from a single point of view.
- Coherence among different detectors is encouraging.
- Can the variations observed be correlated with other observations? Gravity, seismic interferometry?
- How can we combine different methods to have the full picture ? Need for models.

Thank you ! Questions, suggestions? —> rosas@ipgp.fr

References: - Le Gonidec *et al.*, 2019: <u>https://www.nature.com/articles/s41598-019-39606-3</u> - Rosas-Carbajal *et al.*, 2017: <u>https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017GL074285</u>

• Muons are useful to study dynamic hydrothermal systems ! Detectors are autonomous and scan large parts of the

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