Monitoring passive degassing at the Azores archipelago

Fátima Viveiros, Catarina Silva, Lucia Moreno

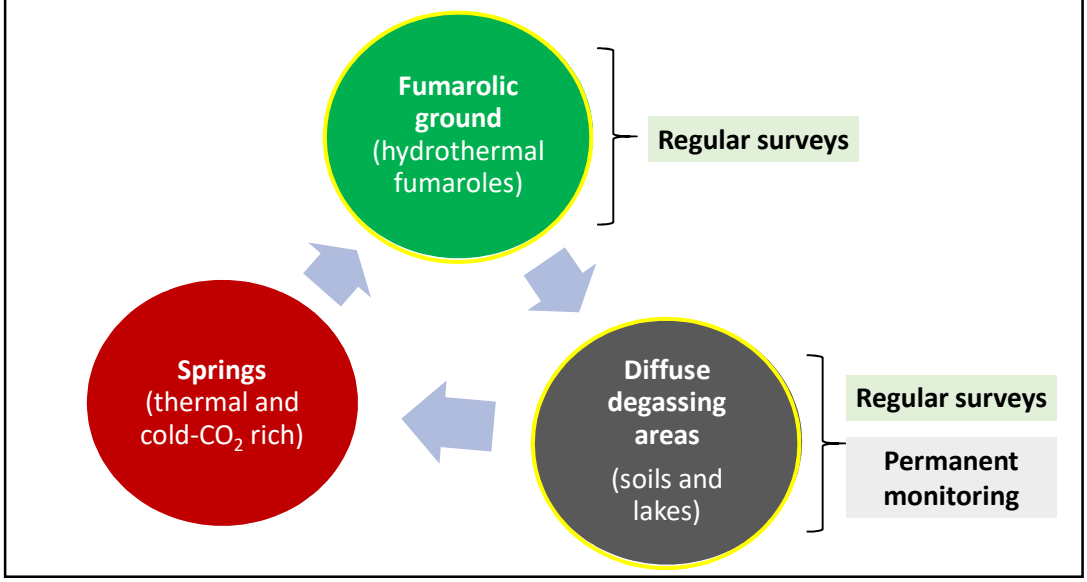
26th September 2024

UAc UNIVERSIDADE DOS AÇORES

CIVISA Centro de Informação e Vigilância Sismovulcânica dos Açores

Workshop on volcanic gas dispersal modelling and monitoring

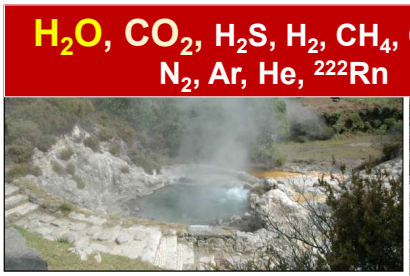
GAS MANIFESTATIONS IN THE AZORES ARCHIPELAGO

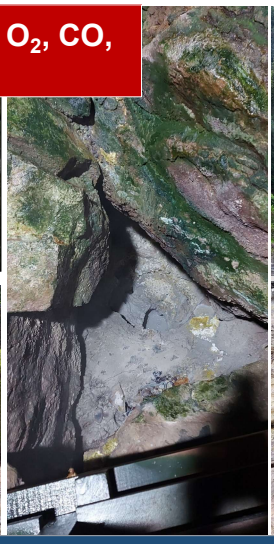


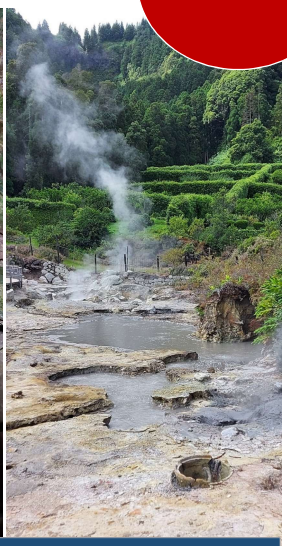
FUMAROLIC EMISSIONS

Fumaroles

H_2O, CO_2, H_2S, H_2, CH_4, O_2, CO, N_2, Ar, He, ^{222}Rn



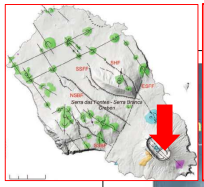


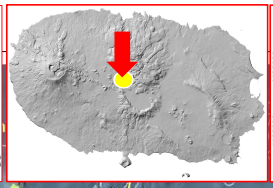


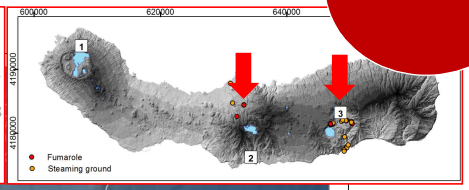
Low temperature fumaroles (maximum temperature around 100ºC)

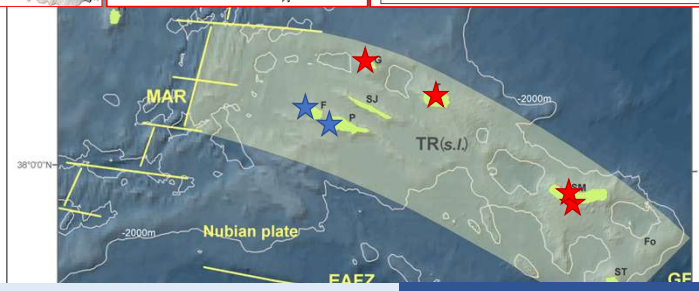
SUBAERIAL MANIFESTATIONS

Fumaroles









-São Miguel Island (*Furnas and Fogo volcanoes*)

-Terceira Island (*Pico Alto Volcano*)

-Graciosa Island (*Caldeira Volcano*)

Steam emissions:

-Pico Island (*Pico Volcano*)

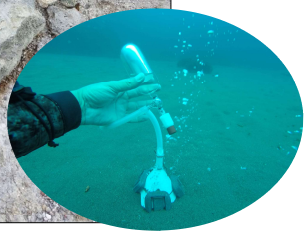
-Faial Island (*Capelinhos Volcano*)

REGULAR MONITORING - DIRECT SAMPLING

Fumaroles

Regular surveys in the Azores fumarolic fields since 2001

Giggenbach method



MultiGAS

Since 2018

DIRECT SAMPLING - GAS COMPOSITION

Fumaroles

IVAR – CIVISA laboratorial facilities

Titration (CO_2, H_2S)

Gas chromatography (H_2, He, N_2, O_2, Ar, CH_4)

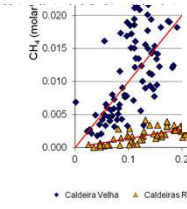
Ion chromatography (Sulphur and halogens)

FUMAROLIC EMISSIONS – some results

Fumaroles

Available online at www.sciencedirect.com
ScienceDirect
Geochimica et Cosmochimica Acta xxx (2015) xxx–xxx
Geochimica et Cosmochimica Acta
www.elsevier.com/locate/gca

Gas geochemistry
and
Stefano Caliro[a,*], Fátin



Contents lists available at ScienceDirect
Journal of Volcanology and Geothermal Research
journal homepage: www.elsevier.com/locate/jvolgeores

Deep CO_2 emitted at Furnas do En
Azores archipelago). An approach
emissions using carbon isotopic d
Fátima Viveiros[a,b,*], Giovanni Chiodini[c], Ca
Andrea Luca Rizzo[g], Ana Hipólito[a,b], Lucia

Contents lists available at ScienceDirect
Geothermics
journal homepage: www.elsevier.com/locate/geothermics

The contribution of hydrothermal mineral alteration analysis and gas geothermometry for understanding high-temperature geothermal fields – The case of Ribeira Grande geothermal field, Azores

Journal of Volcanology and Geothermal Research 450 (2024) 108076

M.L. Pereira[a,b,*], D.

[a] StoneCITE Instituto Superior Técnic
[b] Instituto de Investigação em Vulcan
[c] Centro de Informação e Vigilância
[d] Faculdade de Ciências e Tecnologia

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Journal of Volcanology and Geothermal Research
journal homepage: www.journals.elsevier.com/journal-of-volcanology-and-geothermal-research

Monitoring hydrothermal fumaroles in the Azores archipelago - Applications and sources of analytical uncertainties

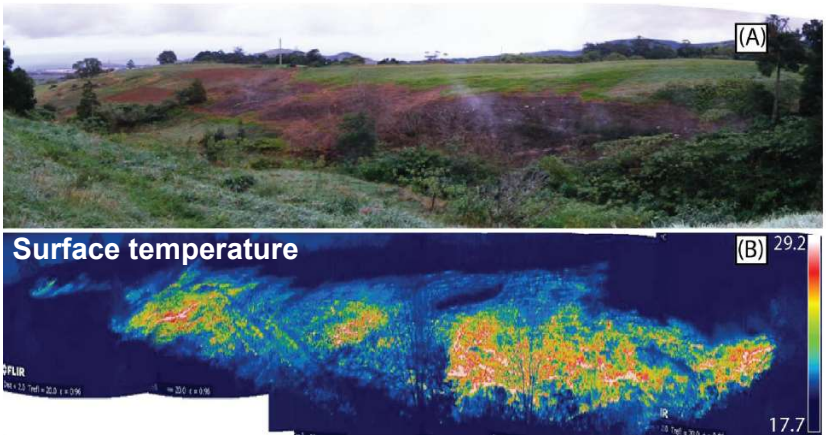
D. Matias[a], M. Antlauf[b,c], F. Viveiros[a,d,*], L. Moreno[a,b], C. Silva[a,b], S. Oliveira[a,b]

- ►Volcano monitoring
- ► Geoindicators
- ► Geodynamic setting

FUMAROLIC EMISSIONS - REMOTE SENSING

Fumaroles

IR cameras



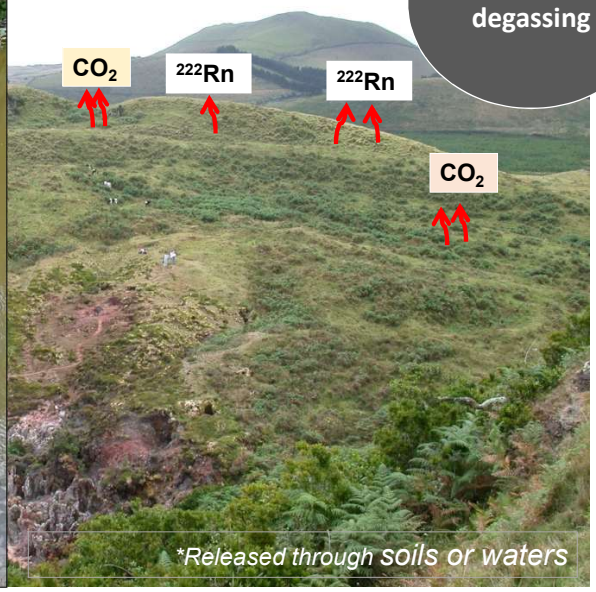
OTHER FACILITIES - REMOTE SENSING

Fumaroles

Mobile DOAS

DIFFUSE DEGASSING

Diffuse degassing



DIRECT SAMPLING

Diffuse degassing

Spatial surveys




Permanent stations

- CO_2 (H_2S) detector

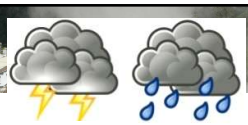
- Soil temperature
-Soil water content

-Rainfall
-Air temperature
-Air relative humidity
-Barometric pressure
-Wind speed
-Wind direction

Permanent monitoring program started in October 2001


SOME RESULTS

Diffuse degassing



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ELSEVIER

Environmental ir
(São Miguel Islan

F. Viveiros [a,*], T. Ferre

AGU PUBLICATIONS

JGR

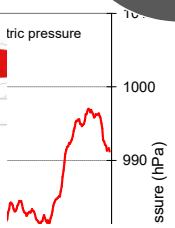
Journal of Geophysical Research: Solid Earth

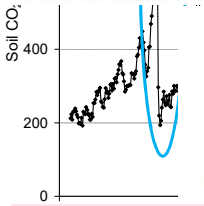
RESEARCH ARTICLE
10.1002/2014JB011118

Key Points:
- Daily and seasonal cycles are identified in CO_2 efflux in volcanic areas
- Water table and thermal amplitudes are explicative factors of diurnal cycles

Periodic behavior of soil CO_2 emissions in diffuse degassing areas of the Azores archipelago: Application to seismovolcanic monitoring

Fátima Viveiros[1], Jean
Catarina Silva[1], and Jc





frontiers in Earth Science

ORIGINAL RESEARCH
published: 20 November 2018
doi: 10.3389/feart.2018.00208

Permanent

F. VIVEIROS[1,2]*,

Increase 5 times the ave

Automatic Filtering of Soil CO_2 Flux Data; Different Statistical Approaches Applied to Long Time Series

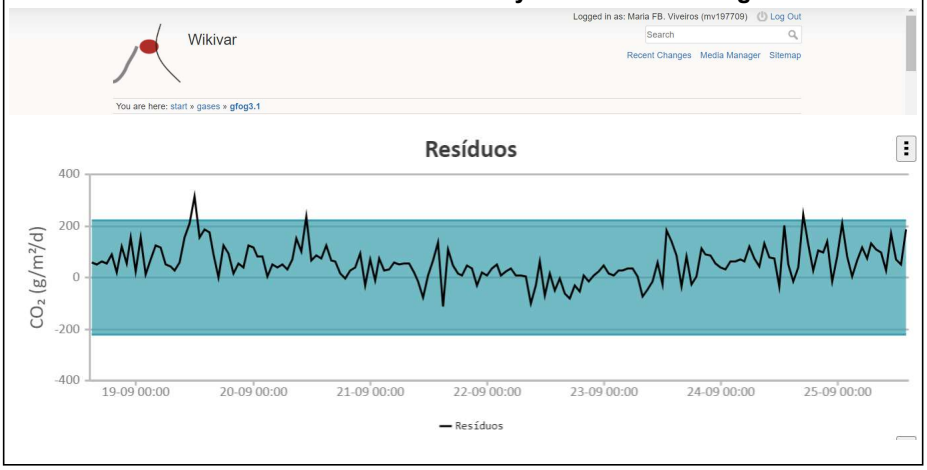
Sérgio Oliveira[1], Fátima Viveiros[1], Catarina Silva[1,2] and Joana E. Pacheco[1,2]*

[1] Instituto de Investigação em Vulcanologia e Avaliação de Riscos (IVAR), Universidade dos Açores, Ponta Delgada, Portugal,
[2] Centro de Informação e Vigilância Sismovulcânica dos Açores, Ponta Delgada, Portugal

SOIL CO_2 PERMANENT MONITORING

Diffuse degassing

In the IVAR-CIVISA Observatory: automatic filtering:



Residuals correspond to the time series that best represent deep processes

HAZARD ASSESSMENT

Diffuse degassing

Volcanic gases have claimed directly the lives of >2000 people over the past 600 years (Auker *et al*. 2013).

About 70% of the deaths during **quiescent periods**

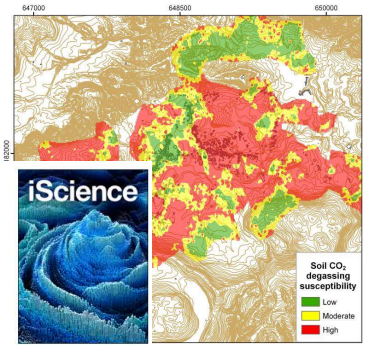
CO_2, H_2S, ^{222}Rn

Lake Nyos, Cameroon (1986), *1746 deaths*
Lake Monoun, Cameroon (1984), *37 deaths*
Dieng Plateau, Indonesia (1979), *149 deaths*

Journal Pre-proof

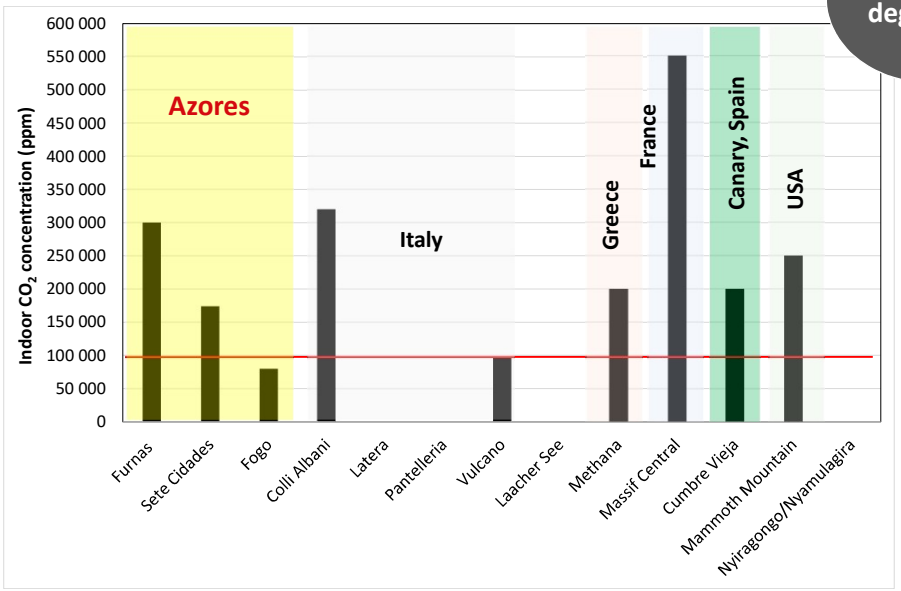
Hazardous volcanic CO_2 diffuse degassing areas – a systematic review on environmental impacts, health and mitigation strategies

Fátima Viveiros, Catarina Silva



HAZARD ASSESSMENT

Diffuse degassing



HAZARD ASSESSMENT

Furna do Enxofre lava cave (Graciosa Island)

Installed since December 2002

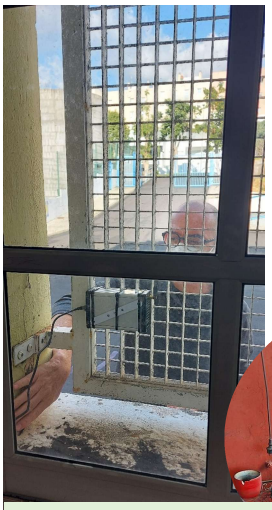
Caldeiras da Ribeira Grande site (São Miguel Island)

Installed since November 2012

Indoor radon
(São Jorge, Terceira and São Miguel islands)

HAZARD ASSESSMENT

LOW COST GAS AND PARTICLE SENSORS

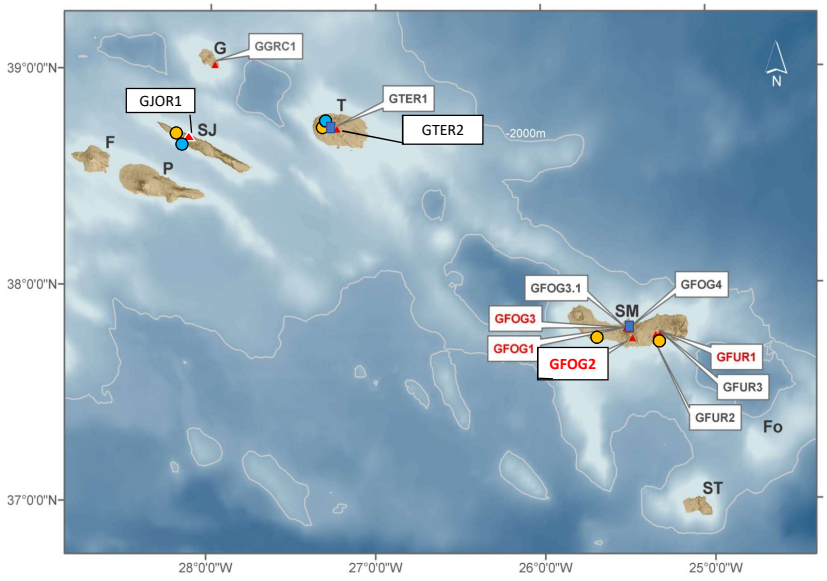


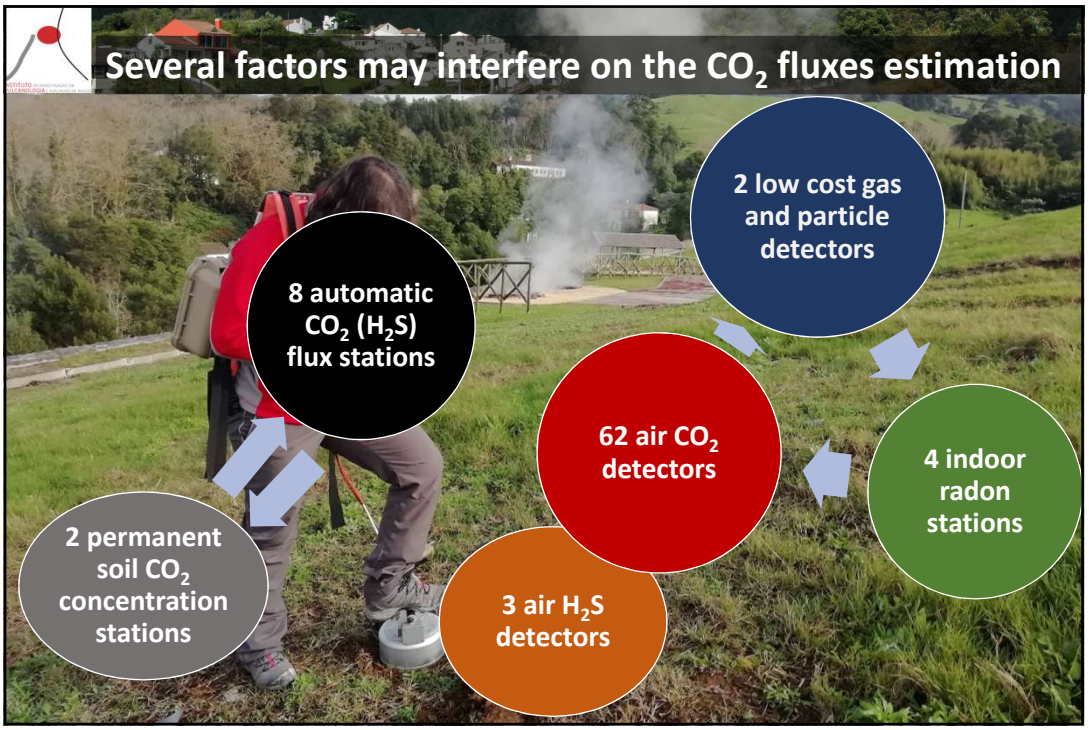
São Jorge Island – 1 sensor installed since March 2023.

Terceira Island – 1 sensor installed since August 2024

Tested during the 2021 La Palma eruption

GAS GEOCHEMISTRY PERMANENT NETWORKS




Several factors may interfere on the CO_2 fluxes estimation
2 low cost gas and particle detectors
8 automatic CO_2 (H_2S) flux stations
62 air CO_2 detectors
4 indoor radon stations
2 permanent soil CO_2 concentration stations
3 air H_2S detectors


INSTITUTO DE INVESTIGAÇÃO
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Thank you!
Obrigado!
maria.fb.viveiros@azores.gov.pt
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Reference: PTDC/EME-SIS/1960/2020