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Evaluation of flow and emplacement temperatures reached by PDCs using charred wood analysis

EGU European Geosciences Union

Research Motivation

Aims

- Pyroclastic density currents (PDCs) are among the most hazardous of all volcanic processes in terms of potential damages due to their **concentration** and **velocity** (dynamic pressure) and **temperature**.
- how physical properties interact among each other and with the topography during flow is still matter of debate and study
- Using Charcoal Reflectance analysis for:
  - PDCs **emplacement temperature** evaluation
  - PDCs **flow temperature** variation assessment
- Lab work: pyrolysis experiments to simulate the charring events at different Temperature and Time

Image from web

Image from web

Images from web

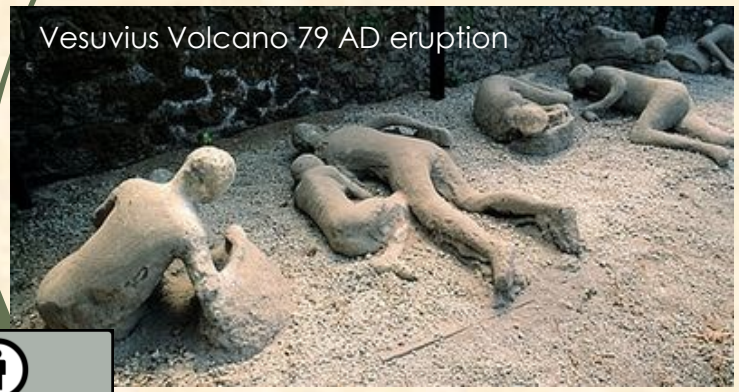


Image from web

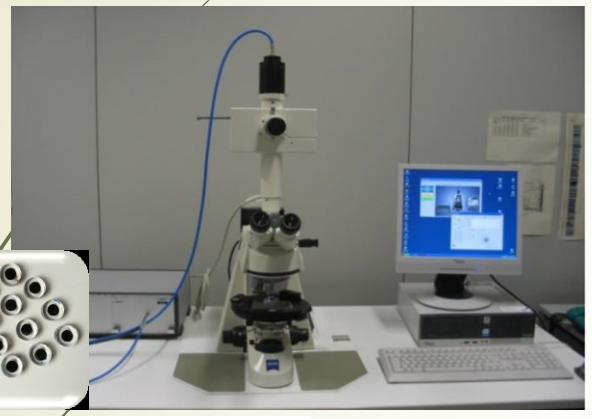
Images from web

Temperature evaluation of PDCs has been recently performed using optical analysis of charred wood (Reflectance analysis - Ro%) embedded within the pyroclastic deposits.

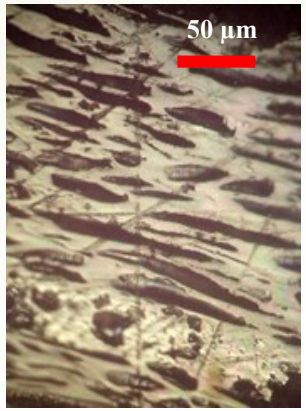
State of the art

Field sample

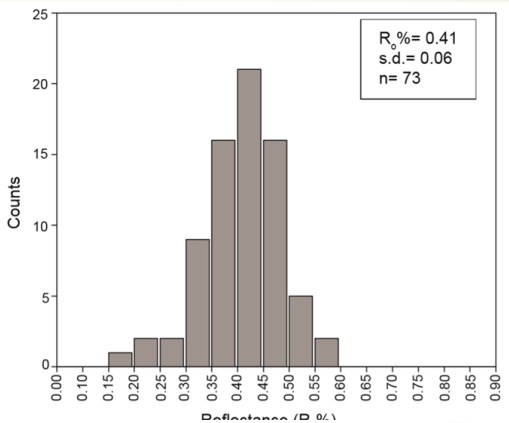
Organic Petrography Equipment ALBA Lab (Roma Tre Univ.)



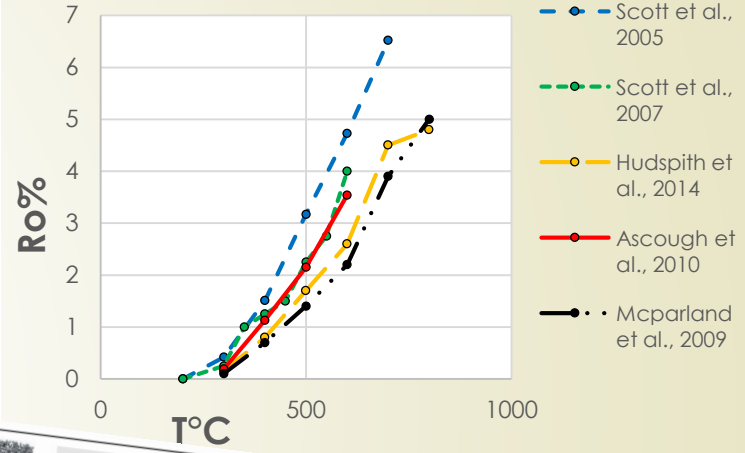
Charcoal micro-texture

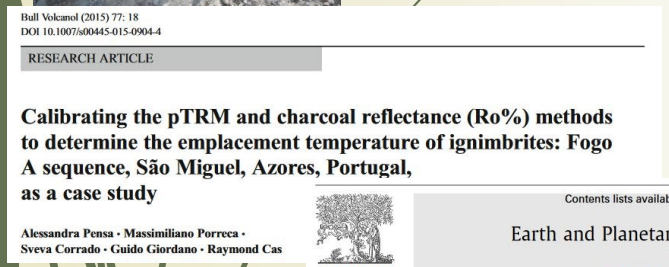


Charcoal Reflectance histogram



Reflectance vs. Temperature°C





Bull Volcanol (2015) 77: 18
DOI 10.1007/s00445-015-0904-4

RESEARCH ARTICLE

Calibrating the pTRM and charcoal reflectance (Ro%) methods to determine the emplacement temperature of ignimbrites: Fogo A sequence, São Miguel, Azores, Portugal, as a case study

Alessandra Pensa · Massimiliano Porreca · Sveva Corrado · Guido Giordano · Raymond Cas

Contents lists available at ScienceDirect

Earth and Planetary Science Letters

www.elsevier.com/locate/epsl

Thermal interactions of the AD79 Vesuvius pyroclastic density currents and their deposits at Villa dei Papiri (Herculaneum archaeological site, Italy)

G. Giordano [a,*], E. Zanella [b], M. Trolese [a], C. Baffioni [a], A. Vona [a], C. Caricchi [c], A.A. De Benedetti [a], S. Corrado [a], C. Romano [a], R. Sulpizio [d], N. Geshi [e]

Contents lists available at ScienceDirect

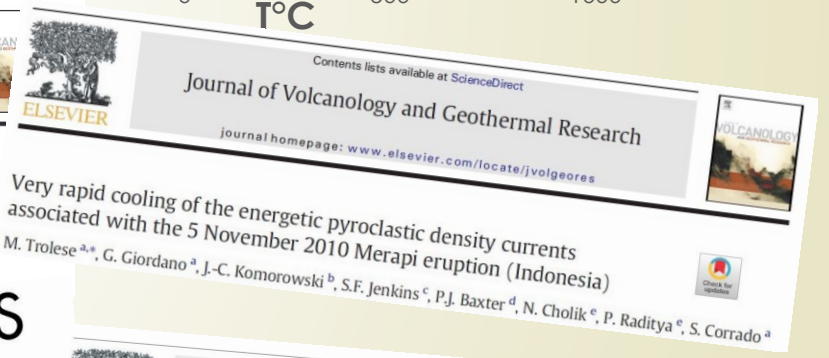
Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

79 AD Vesuvius PDC deposits' temperatures inferred from optical analysis on woods charred in-situ in the *Villa dei Papiri* at Herculaneum (Italy)

C. Caricchi *, A. Vona, S. Corrado, G. Giordano, C. Romano

Dipartimento di Scienze, Sezione di Scienze Geologiche, Università "Roma Tre", Largo San Leonardo Murialdo 1, 00146 Roma, Italy



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Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

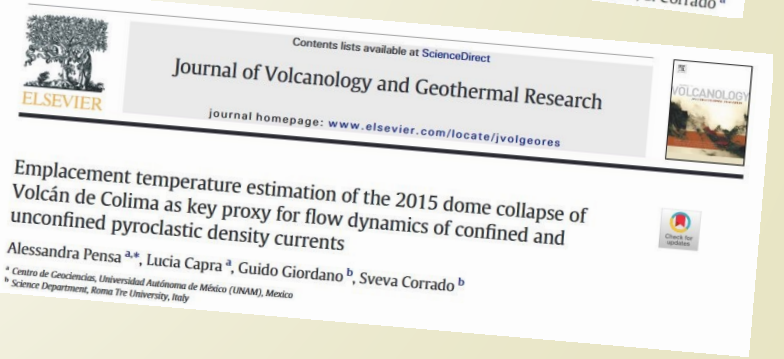
Very rapid cooling of the energetic pyroclastic density currents associated with the 5 November 2010 Merapi eruption (Indonesia)

M. Trolese [a,*], G. Giordano [a], J.-C. Komorowski [b], S.F. Jenkins [c], P.J. Baxter [d], N. Cholik [e], P. Raditya [e], S. Corrado [a]

SCIENTIFIC REPORTS

Ash clouds temperature estimation. Implication on dilute and concentrated PDCs coupling and topography confinement

A. Pensa[1,2], L. Capra[1] & G. Giordano[2]



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Journal of Volcanology and Geothermal Research

journal homepage: www.elsevier.com/locate/jvolgeores

Emplacement temperature estimation of the 2015 dome collapse of Volcán de Colima as key proxy for flow dynamics of confined and unconfined pyroclastic density currents

Alessandra Pensa [a,*], Lucia Capra [a], Guido Giordano [b], Sveva Corrado [b]

[a] Centro de Geociencias, Universidad Autónoma de México (UNAM), Mexico
[b] Science Department, Roma Tre University, Italy

The validity of Ro%, has been established in different case studies, **Fogo Volcano, Colima Volcano, Merapi Volcano, Vesuvius Volcano, Doña Juana Volcano, Laacher See Volcano,** resulting comparable with the paleomagnetic analysis (pTRM).

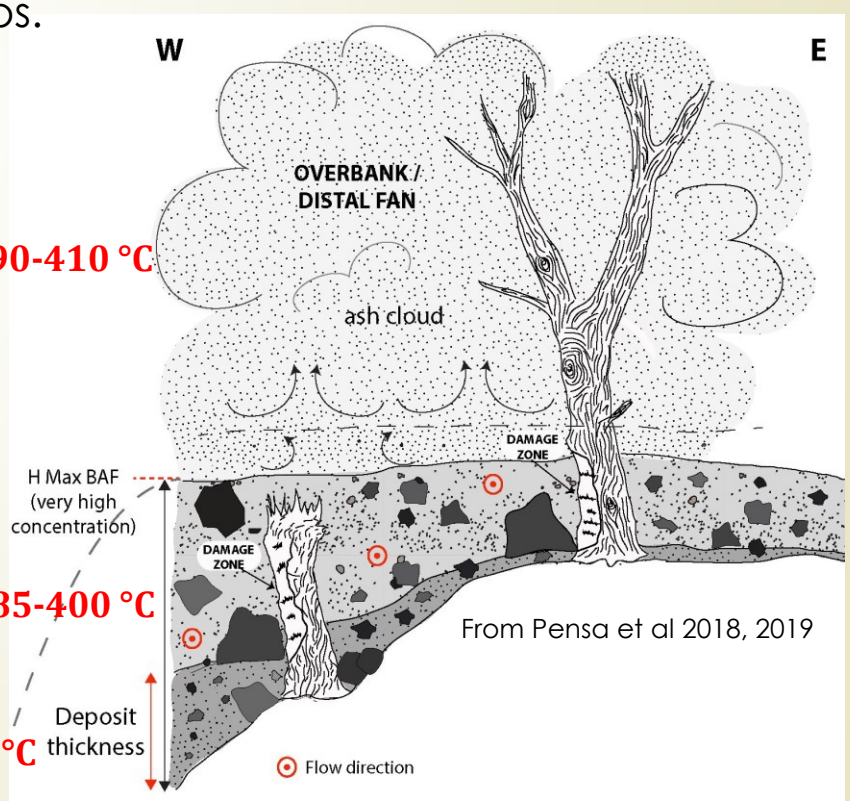
Key studies

Colima Volcano, Mexico
2015 eruption

Due to its not retrograde nature, the process of carbonification records over time the maximum temperatures experienced by the wood fragment/tree trunk/furniture.

This peculiarity has great importance in terms of timing of charring events, as the charred wood can record the possible temperature fluctuations in case of multiple pulses event.

This allows to reconstruct the thermal and dynamic of PDCs history at different steps.

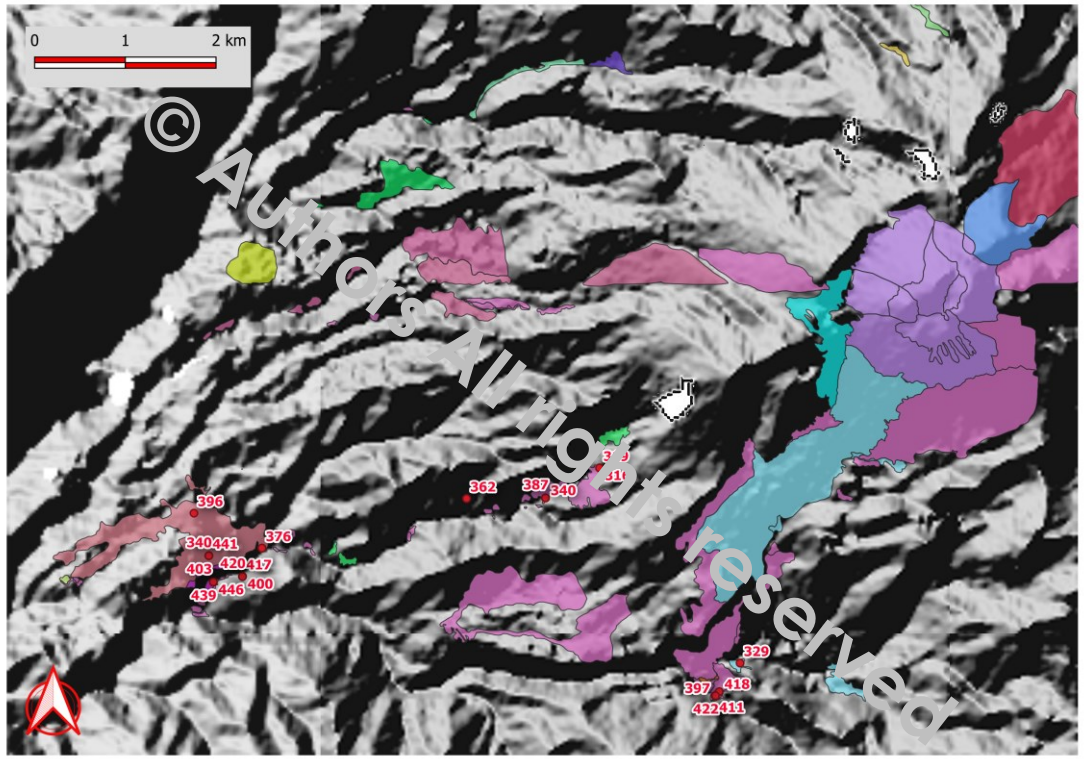


Doña Juana Volcano, Colombia

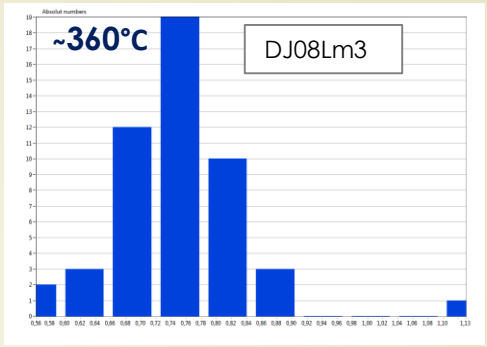
Key studies

- Reflectance data generally display unimodal trends, indicating a complete charring at same temperature
- The presence of Polymodal trends, previously discarded, are instead very important as they highlight variations in the charring temperature during the PDC flow

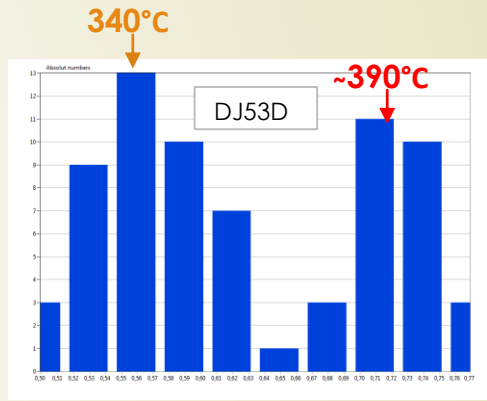
Image from web



- High T recorded during flow events,
- Low T recorded during emplacement
- Using only Mean value we lose info about different thermal eventsv

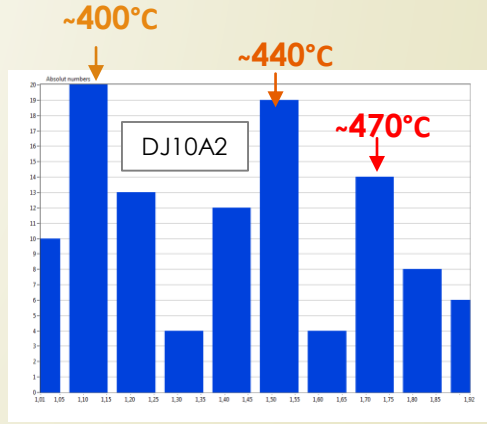


Group A



Group B

Mean=350°C



Group C

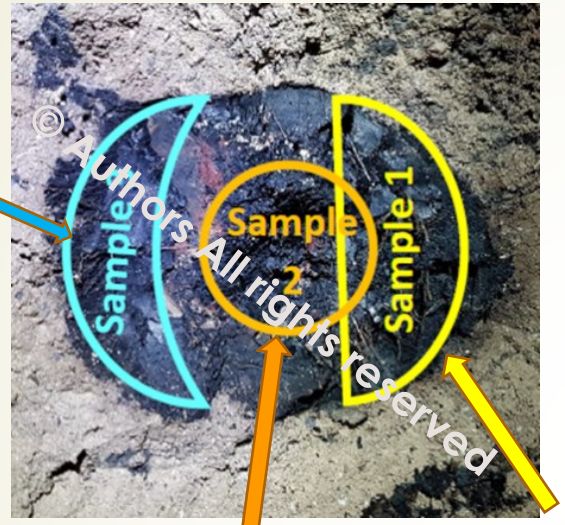
Mean=430°C

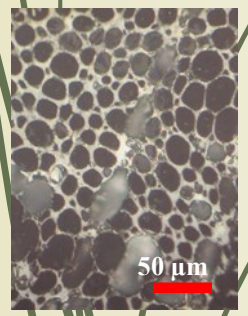
Laacher See Volcano, Germany

12.9 ka eruption

Key studies

From Riede & Zernack 2018

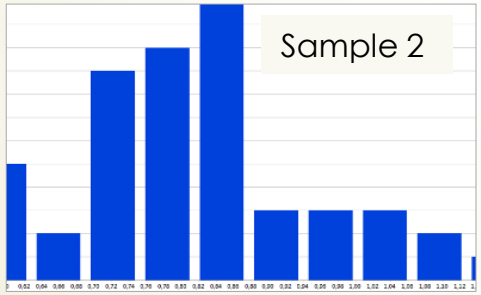


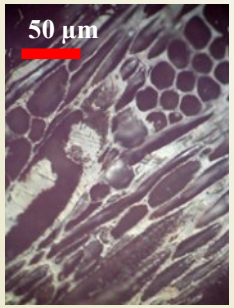


N°: 40

Ro% = **0,84±0,08**

T = **372±8 °C**





N° : 50

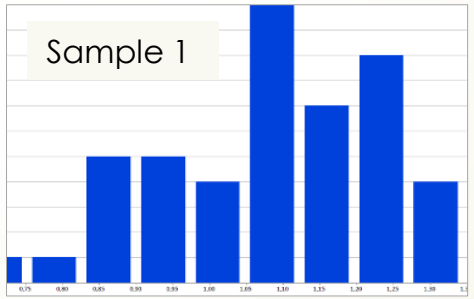
Ro% = **0,81±0,11**

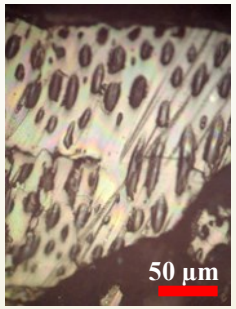
T = **370±11 °C**

N°: 50

Ro% = **1,11±0,13**

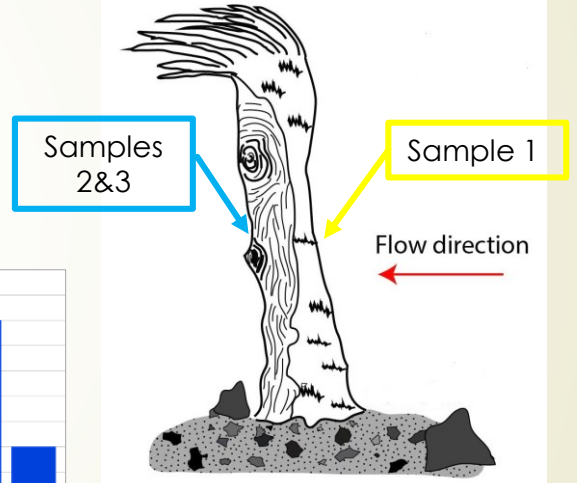
T = **400±13 °C**





Laacher See Maar

Images from web



Temperature exposition time:

- High Temperature recorded during flow events,
- Low Temperature recorded once emplaced

MEURIN CAVE

From Riede & Zernack 2018

Take home message!

- Charcoal Reflectance is a **valuable proxy** for PDCs emplacement temperature estimation
- The **polymodality** of the Reflectance data histograms is important in volcanic environment for the identification of multiple thermal events
- The **NOT RETROGRADE** nature of the charcoal and the rapid acquisition allow us to have a timeframe of the multiple thermal pulses occurred.
- The identification of temperature variation allows a better comprehension of the thermal energy transport within the flow.

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