

Analysis of Diffusive Fractionation During Chaotic Mixing of Magmas

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CHRONOS

A geochemical clock to measure timescales of volcanic eruptions

ERC Consolidator Grant. Principal Investigator: Dr. Diego Perugini

- Magma mixing structures as **geochemical clocks** to measure timescales of volcanic eruptions.
- **Multidisciplinary strategy:** Volcanology, Experimental Petrology, Geochemistry, Mathematics, Physics, Fluid-dynamics and Engineering



European Research Council



About me

From **Oviedo, Asturias - Spain**

B.Sc Geology, University of Oviedo (2009)

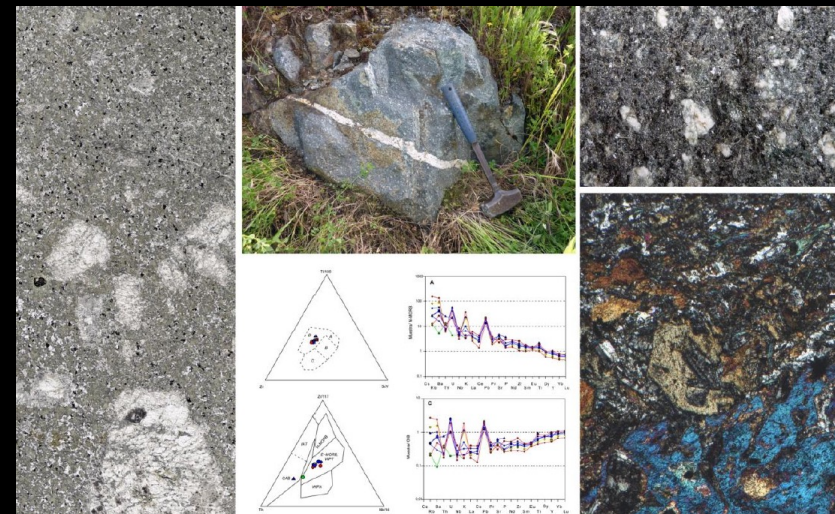
M.Sc. Geological Resources and Geotechnics, University of Oviedo (2011)

Master Thesis: *Petrology and Geochemistry of the Metabasic Rocks of Zarza la Mayor-Ceclavin (Cáceres, Spain)*

2012-2013: **R&D Technician**, Pasek Minerales, S.A.U., Spain

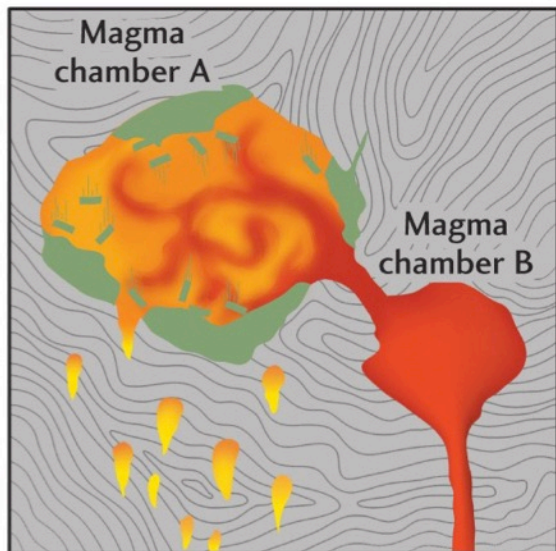
Ultramafic rocks as refractories in the steel industry

From November 2014: **PhD student**, Petro-Volcanology Research group, University of Perugia



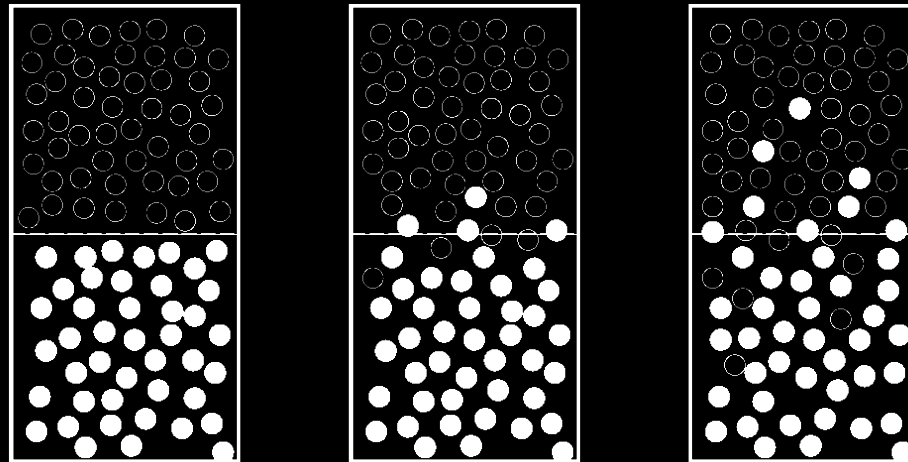
Background

- **Magma mixing:** refilling of a chemically evolved magma chamber with a new, more primitive magma coming from depth
- **Trigger process** for explosive volcanic eruptions (*e.g.* Askja 1876, Novarupta 1912, Eyjafjallajökull 2010)



Background

- When two magmas of different composition mix, a **chemical exchange process** by *diffusion* starts between them.
- Diffusion pattern is dependent of magma mixing time
- Studying diffusion can allow us to determine **how much time** magmas have been in contact before an eruption → Pre-eruptive behaviour of a volcano



Review of diffusion data

- Available data set is not systematic: disparity of P, T and melt composition
- Some elements have a high amount of data, while others have little to no data

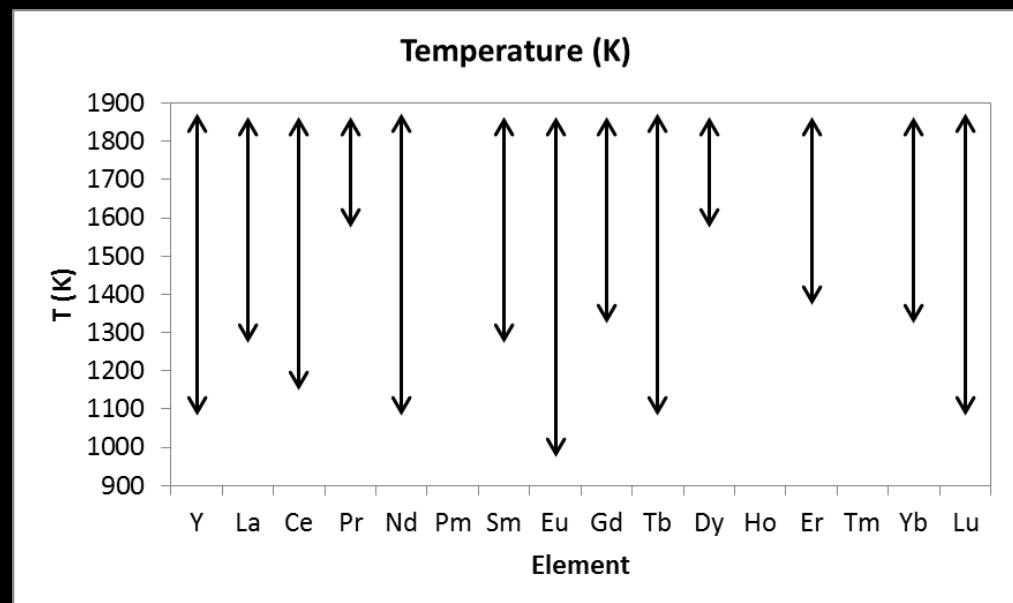
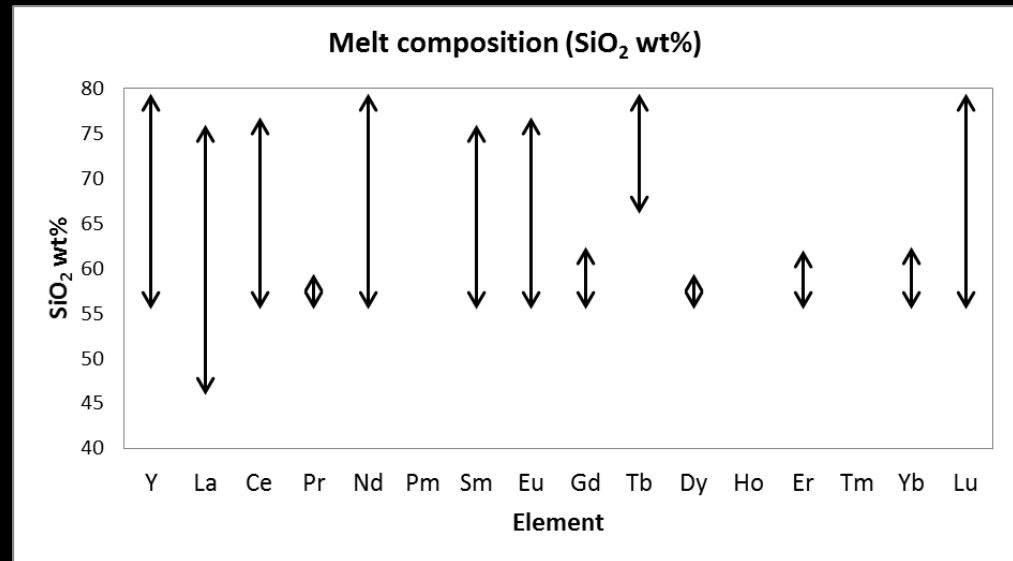
E.g. Y-REE (Zhang *et al.*, 2010, RiMG 72)

- Dy, Er, Gd, La, Nd-144, Pr, Sm, Yb: **No data at atmospheric pressure**
- Pm, Ho, Tm: **NO DATA**
- **Disparity of melts:** only La has data on basaltic compositions)



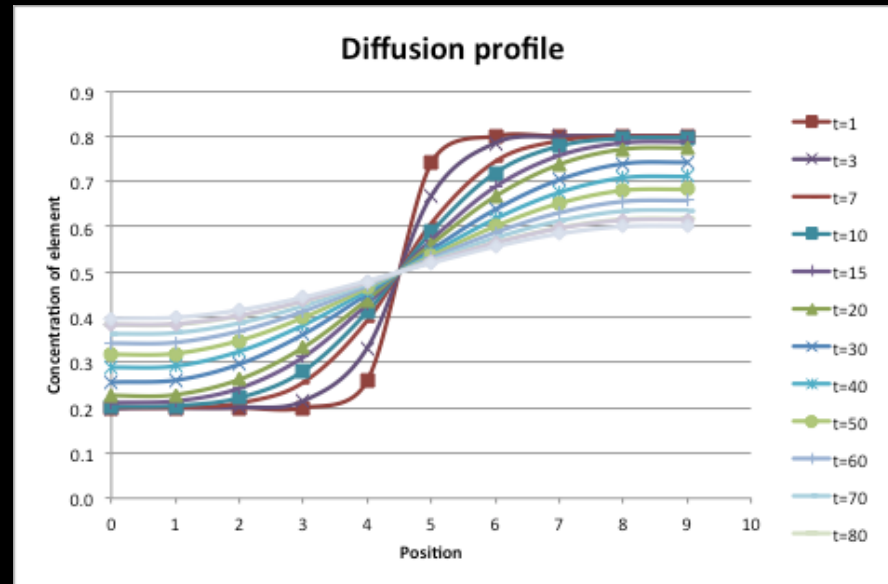
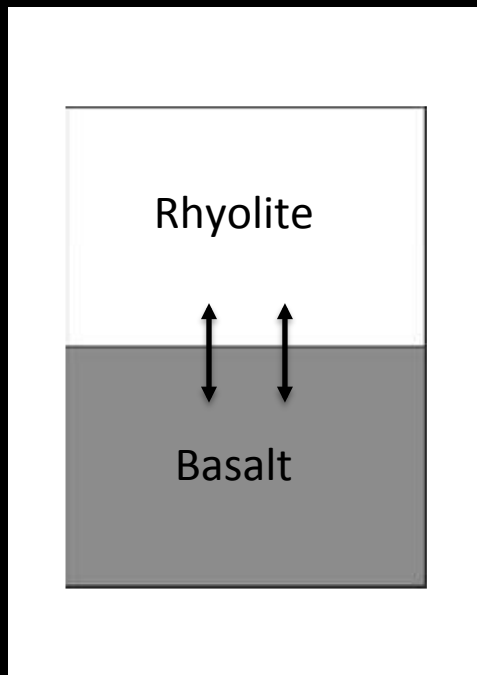
OBJECTIVE

Obtaining a consistent dataset of **diffusion coefficients (D)** in natural melts



Diffusion couple experiments

Two glass cylinders with different composition joined together: changing diffusion profiles with time

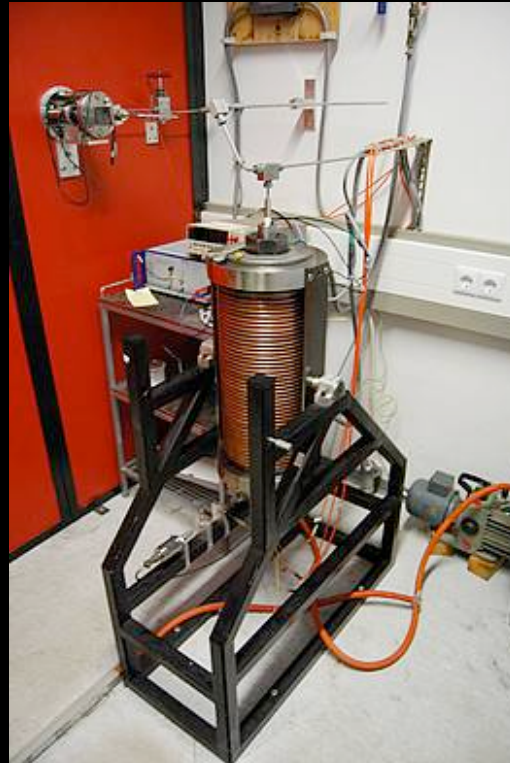


$$J = -D \frac{\partial C}{\partial x}$$

- Calculation of diffusion coefficient **D**
- Varying experiment conditions: Low P/High P and H₂O content

Diffusion couple experiments

- Internally heated pressure vessel (IHPV) at Institut für Mineralogie, Universität Hannover (Dr. Harald Behrens)



T: 850 - 1250°C

P: up to 500 MPa

Diffusion couple experiments: procedure



- Cleaning, crushing and milling of sample → powder
- Melting of powder to obtain a glass
- Geochemistry of glass (EPMA)
- Glass cylinders → Diffusion couple experiments
- Analysis of experiments: **EPMA, LA-ICP-MS**

Natural samples for experiments:

- Vulcano (Basalt/rhyolite)
- Campi Flegrei (Field campaign, TBD)



Future plans

First year: Data gathering. mainly devoted to experiments and their analysis.

15-22 February: Sampling at Campi Flegrei

February-March: sample and experiment preparation

Spring-summer 2015: Diffusion couple experiments, Hannover

Attending courses and conferences:

- 24-28 August: Short Course “*Application of diffusion studies to the determination of timescales in geochemistry and petrology*” Ruhr Universität Bochum



Thanks for your attention