



Science Meeting – Scientific Report

Proposal Title: MeMoVolc Summer School: ‘Magma: from crustal storage to eruption triggering’

Application Reference N°: 5896

1) Summary (up to one page)

This, the third summer school of the MeMoVolc RNP, took place as planned over 4 days (28 September to 1 October 2015) on Santorini Volcano, Greece. It was attended by 10 lecturers and 29 students of Masters, PhD and postdoctoral levels. Nine of the lectures addressed different concepts and techniques relevant to the theme of magma ascent through the crust, and one presented recent work carried out on this theme on Santorini Volcano. The lectures involved a mixture of presentations and student exercises. The third day was devoted to a field excursion including a visit to a quarry, a visit to the Kameni volcano, and a volcanological tour of the caldera. The lecturers came from 7 countries, and the students from 8 countries. All but 3 students derived from countries contributing to the MeMoVolc RNP. Overall the summer school was a great success and contributed significantly to the training of the next generation of European volcanologists.

2) Description of the scientific content of and discussions at the event (up to four pages)

Over the last decade it has become increasingly evident that the evolution of the magma crustal storage system can strongly influence the eruptive dynamics and hazards at volcanoes. For example,

- The upper crustal storage conditions determine the initial parameters of the erupting magma: driving pressure, temperature, volatile content and composition;
- Arrival of new batches into the upper crustal storage system can result in heating, mush remobilization, magma mixing and the rapid build-up to eruption on timescales of months to years;
- Sequential extraction of deep magma batches can strongly influence the eruptive style and eruptive transitions at the surface (e.g. Vesuvius 1944, [Eyjafjallajokull 2010](#));

- The separation of a discrete vapour phase, and its fluxing through the shallow plumbing system, can also influence eruptive behaviour;
- Magma ascent and pressurization generates seismic and geodetic signals that can be detected at the surface and used in eruption forecasting.

There now exist a plethora of petrological methods for investigating crustal magmatic processes. These allow us to reconstruct melt batches 'seen' by the crystals during growth, to calculate crystal growth rates, to estimate P, T, volatile contents, volatile compositions and species fugacities in the melts, and to calculate timescales of crystal residence, magma chamber assembly and eruption triggering through recharge. In addition, advances in geodesy allow us to measure tiny deformations of the earth's surface associated with magma intrusion, and to reconstruct the geometry, magnitude and time-evolution of the pressures source.

The school was co-organised by Drs. Druitt, Francalanci and Caricchi. It brought together ten lecturers in the fields of these different techniques. The lecturers were:

- Dr. Catherine Annen, University of Bristol, UK
- Dr. Luca Caricchi, University of Geneva, Switzerland
- Dr. Fidel Costa, EOS, Singapore
- Dr. Tim Druitt, Blaise Pascal University, Clermont-Ferrand, France
- Dr. Marie Edmonds, University of Cambridge, UK
- Dr. Lorella Francalanci, University of Florence, Italy
- Dr. Julia Hammer, University of Hawaii, USA
- Dr. Thierry Menand, Blaise Pascal University, Clermont-Ferrand, France
- Dr. Michelle Parks, University of Iceland, Iceland
- Dr. Olgeir Sigmarsson, University of Iceland, Iceland

The lectures and exercise sessions lasted 2 hours each, and were accompanied by questions from the students. All the lecturers had gone to remarkable lengths to generate courses that were up to date and of excellent quality.

The first day was devoted to a brief introduction to Santorini Volcano, followed by courses on 'Understanding magma dynamics and eruption triggers by macro- to micro-scale petrochemical and isotopic studies', 'Petrological controls on transport and storage of magma in the crust', and 'Surface deformation associated with magma storage and ascent'. These courses set the scene for the school by summarising recent concepts in crustal magma ascent. The second day included courses on the 'Use of melt inclusions in reconstructing magma deep ascent and storage histories', 'Reading the information recorded in crystals', 'Timescales of magmatic processes from diffusion modelling', and finally a summary of some recent studies on Santorini using the different techniques described : 'Magma deep ascent, storage and eruption triggering at Santorini caldera'. Following the field trip of the third day, the fourth and final day included courses entitled 'Timescales of magmatic processes from short-lived isotopes', 'Thermal modelling of magmatic systems', and 'Modelling magma ascent and storage in the crust'.

All students were required to bring a poster on their research related to the school theme. Ten posters were presented each day, the authors having five minutes to present

the essential features of their work orally, followed by 1.5 hours of poster-led discussions.

The school lectures were held in the Bellonia Cultural Centre in the centre of Fira town on Santorini. The centre was located in a beautiful traditional building, and was fully equipped with lecture, poster presentation and wifi facilities.

A field excursion on the third day of the school was organised. The day began by a visit to the Mavromatis pumice quarry, where the students examined and discussed the products of the Bronze-Age eruption. Particular attention was paid to the different types of juvenile component in the products, and their implications for the processes of magma ascent and eruption. The group then visited the spectacular and famous excavations of Bronze-Age Akrotiri, which were buried by the eruption. Finally, there was a boat tour to the Kameni volcano followed by a volcanological tour of the caldera. The day was led by Drs. Druitt and Francalanci. A guide summarizing the volcanic and magmatic development of the caldera, as well a geological map of the caldera, was provided.

All courses will be placed online at www.memovolc.fr in the coming weeks.

3) Assessment of the results and impact of the event on the future directions of the field (up to two pages)

Like the previous two MeMoVolc summer schools, the present one will have a significant impact on the field by bringing together students of a range of levels (Masters, PhD, postdoctoral) from different scientific backgrounds (petrology, geochemistry, geophysics) and exposing them to cutting-edge concepts and techniques related to crustal magma ascent. The school served to expose the students to a team of international specialists, and to immerse them in an international community of young dynamic researchers working on similar topics using different techniques. By providing courses on widely different techniques, the students learnt to operate within different scientific cultures and to communicate with scientists using different approaches and terminologies. Furthermore, by forging friendships, the students were exposed to potential scientific collaborations, which our past experience proves commonly bear fruit. Being the last summer school organised by MeMoVolc, there were discussions at the end of the meeting as to how to maintain the inertia created by the RNP, and it was decided to investigate the possibility of a proposal to the European COST programme.

Breakdown of finances

Hotel accommodation, lunches, field trip organisation and airport travel were arranged through a local tourist company called *Heliotopos*. Hire of a conference room was done through the *Bellonio Cultural Centre*. When the application was made to the ESF, our university paid no added tax on these items. However added tax has since been introduced. We were therefore obliged to accommodate added tax into our budget.

Travel

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|---|---------|
| Reimbursement of participants (air, train, taxi) | 18664.0 |
| Transport from airport to hotel (paid through <i>Heliotopos</i>) | 200.0 |

Meals

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|--|--------|
| Evening meals (8 euros per participant limit; 30 euros per lecturer limit) | 1127.9 |
| Lunches (paid through <i>Heliotopos</i>) | 3555.0 |

Accommodation

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|---|---------|
| Hotel (paid through <i>Heliotopos</i>) | 11378.4 |
| Additional reimbursements (people who paid personally; extra night for organisers) | 615.0 |

Other costs

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|---|--------|
| Room rental (<i>Bellonio cultural centre</i>) | 1512.5 |
| Field trip costs (boat hire, bus hire) | 1537.0 |
| Purchase of geological maps for participants | 411.2 |

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|--------------|----------------|
| Total | 39001.0 |
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4) Annexes 4a) and 4b): Programme of the meeting and full list of speakers and participants

Annex 4a: Programme of the meeting

School programme

Monday 28 September

| | |
|-------------|---|
| 08.00-08.30 | Registration |
| 08.30-08.45 | Introduction to the summer school. T. Druitt, L. Francalanci and L. Caricchi |
| 08.45-09.30 | Introduction to Santorini Volcano. T. Druitt |
| 09.30-10.30 | Understanding magma dynamics and eruption triggers by macro- to micro-scale petrochemical and isotopic studies. L. Francalanci (part 1) |
| 10.30-11.00 | <i>Coffee and posters</i> |
| 11.00-12.00 | Understanding magma dynamics and eruption triggers by macro- to micro-scale petrochemical and isotopic studies. L. Francalanci (part 2) |
| 12.00-13.00 | Petrological controls on transport and storage of magma in the crust. L. Caricchi (part 1) |
| 13.00-14.00 | <i>Lunch</i> |
| 14.00-15.00 | Petrological controls on transport and storage of magma in the crust. L. Caricchi (part 2) |
| 15.00-16.00 | Student poster presentations (5 min each) |
| 16.00-16.30 | <i>Tea and posters</i> |
| 16.30-18.30 | Surface deformation associated with magma storage and ascent. M. Parks |

Tuesday 29 September

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|-------------|--|
| 08.30-10.30 | Use of melt inclusions in reconstructing magma deep ascent and storage histories. M. Edmonds |
| 10.30-11.00 | <i>Coffee and posters</i> |
| 11.00-13.00 | Reading the information recorded in crystals. J. Hammer |
| 13.00-14.00 | <i>Lunch</i> |
| 14.00-15.00 | Student poster presentations (5 min each) |
| 15.00-15.30 | <i>Tea and posters</i> |
| 15.30-17.30 | Timescales of magmatic processes from diffusion modelling. F. Costa |
| 17.30-18.30 | Magma deep ascent, storage and eruption triggering at Santorini caldera. T. Druitt |

Wednesday 30 September

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|-------------|---|
| 08.00-21.00 | The Minoan products in Mavromatis pumice quarry. Tour of Bronze-Age Akrotiri. Visit to Nea Kameni. Boat tour of the caldera cliffs. Dinner at Ammoudhi Bay. Return to Fira. |
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Thursday 1 October

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|-------------|---|
| 08.30-10.30 | Timescales of magmatic processes from short-lived isotopes. O. Sigmarsson |
| 10.30-11.00 | <i>Coffee and posters</i> |
| 11.00-13.00 | Thermal modelling of magmatic systems. C. Annen |
| 13.00-14.00 | <i>Lunch</i> |
| 14.00-15.00 | Student poster presentations (5 min each) |
| 15.00-15.30 | <i>Tea and posters</i> |
| 15.30-17.30 | Modelling magma ascent and storage in the crust. T. Menand |

Annex 4b: Full list of speakers and participants

School participant list (lecturers in bold)

| | | | |
|--------------------|------------------|---|---|
| Annen | Catherine | University of Bristol, UK | Catherine.Annen@bristol.ac.uk |
| Bonali | Fabio Luca | University of Milan-Bococca, Italy | fabioluca.bonali@gmail.com |
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| DiSalvo | Sara | University of Florence, Italy | sara.disalvo@stud.unifi.it |
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