



International workshop on:
**Mechanics of magma emplacement
and volcanotectonics**

4-6 February 2013

Physics of Geological Processes, University of Oslo

Organisation committee

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Summary

On the 4-6 February 2013, at the Physics of Geological Processes research centre, University of Oslo, Norway, the volcanotectonics workshop, as approved in the framework of the European Science Foundation network MeMoVolc, took place. The workshop hosted 19 scientists, including geophysicists and geodesists, structural geologists, petrologists and geochemists, experimental and numerical modellers, and theoreticians from eight European countries.

The first two days of the workshop were dedicated to presentations, with ample time for discussions, and a visit of the experimental laboratories at PGP. The presenters were asked to (1) summarize their field of expertise and the methods they use, (2) highlight the main strengths and outcomes of their methods, and (3) overall identify the limitations of their methods. A third day was dedicated to group brainstorming activities, which were passionate yet constructive, and reflect the enthusiasm of the workshop participants.

The main outcomes of the workshop are:

(i) Formulation of a principle strategy for triggering multidisciplinary research on Volcanic and Igneous Plumbing Systems (VIPS). To achieve this goal, we listed the limitations of each traditional method presented during the first two days. We then set out to identify how other approaches would help overcome these limitations. Such a strategy is a crucial step to bridge complementary approaches that usually do not interact, such as petrology/geochemistry and structural geology or geophysics. The broad involvement of Earth scientists from all these disciplines made this strategy relevant for the entire community addressing sub-volcanic processes.

(ii) Formulation of a strategy for coordinating future research on VIPS. We are in the process to propose a new commission of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) that focuses on VIPS processes, aiming to fill a niche between existing topical commissions such as the Collapse Caldera, the Large Igneous Provinces, and the Remote Sensing commissions. We are actively involving the leaders of the LASI community (The Physical Geology of Subvolcanic Systems: Laccoliths, Sills and Dykes) in this commission, who have pioneered a scientific network on sub-volcanic plumbing systems. This new IAVCEI commission will be the formal seed for organizing prestigious meetings through the Gordon and Chapman Conferences funding schemes, in order to generate a long-lasting multi-disciplinary stream on VIPS, and considerably impact the community.

Scientific content and discussions

The dynamics of volcanic and igneous plumbing systems (VIPS) are governed by complex interacting chemical and mechanical processes, which control how magmas stall or propagate through the Earth's crust, the way they are emplaced and the dynamics of their eruption. In addition, these processes also control dramatic volcanotectonic phenomena such as caldera and sector collapse. Traditionally, the study of the dynamics of VIPS is method-based, and relatively limited bridges between the distinct methodological approaches exist. Consequently, independent studies that employ different methods often lead to contradicting conclusions, illustrating a need for integrated multi-disciplinary research approaches.

The workshop therefore aimed at better integration of results from distinct scientific approaches on VIPS, and to convert method-based approaches to question/problem-based approaches. In order to achieve this goal, we invited scientists with distinct backgrounds on a variety of methods. The workshop thus involved geophysicists and geodesists, structural geologists, petrologists and geochemists, experimental and numerical modellers, and theoreticians. On the basis of the participants' expertise, the workshop established (1) the need for a formal scientific network for studying VIPS, (2) a need for triggering multidisciplinary interactions for a quantitative understanding of the dynamics of Volcanic and Igneous Plumbing Systems, and (3) created the first steps to the establishment of a formal discussion group that can sustain multidisciplinary interactions after the workshop in the framework of a IAVCEI commission.

The first two days of the workshop were dedicated to scientific presentations of approximately 25 minutes each, followed by time for questions and discussions. The presenters were asked to (1) summarize their field of expertise and the methods they use, (2) highlight the main strengths and outcomes of their methods, and (3) overall identify the limitations of their methods. This strategy allowed the other participants to be aware of each other's methods, potential and limitations, which is a required step for multidisciplinary discussions and brainstorming.

At the end of the second day, a visit through the experimental facilities of PGP was organized. The laboratory being always an inspiring environment to "feel" the processes, such a visit was important. Several presentations during the workshop were dealing with laboratory studies, and this visit was a perfect occasion to exchange information about laboratory techniques and approaches. In addition, many participants did not have a laboratory background, making it often hard to get a proper feeling of laboratory capabilities and technical constraints. The visit was hence useful for educational purpose and for establishing a link between those participants who are familiar with laboratory approaches and laboratory experts with those participants that are not.

The third day of the workshop built up on the presentations and the discussions initiated during days 1 and 2. This day was thus dedicated to group brainstorming activities, which were passionate yet constructive and reflect the enthusiasm of the workshop participants. Several themes were chosen.

The first theme was technical, and dealt with a definition of scaling. Interestingly, the workshop participants had different definitions of scaling. This spread of definitions highlights that the concept of scaling is relatively vague, yet crucial in Earth sciences. This shows that the community needs to work out a relevant definition of the concept of scaling, and overall to establish a clear procedure of how to use the concept of scaling in Earth sciences.

The second theme was related to the future strategy of the community involved in the workshop. Indeed, there was a need of creating an interactive yet multidisciplinary environment, in which discussions and interactions would be promoted and triggered. We thus agreed on a short- and long-term strategy, which is outlined in the next section.

The third theme of the brainstorming activity was dedicated to establish a strategy for launching future multidisciplinary research on Volcanic and Igneous Plumbing Systems (VIPS). The concept of multidisciplinary research is to combine two complementary approaches, which fills each other's limitations. The brainstorming activity consisted of (i) identifying the limitations of each approach presented during days 1 and 2, and (ii) identifying how the other approaches can overcome these limitations. Combining all scales and approaches to study VIPS is a key for a global strategy in furthering our research on VIPS.



Fig. 1 – Group photograph of the workshop participants.



Fig. 2 – Brainstorming activities during day 3 (Wednesday 6th February).

Results and impact of the event on the future directions of the field

The main outcomes of the workshop are the establishment of:

(i) a strategy for triggering multidisciplinary research on VIPS. To achieve this, we listed the limitations of each traditional method presented during the first two days. We then set out to identify how other approaches would help overcome these limitations. Such a strategy is a crucial step to bridge complementary approaches that usually do not interact, such as petrology/geochemistry and structural geology/mechanics. This strategy aims at establishing a robust procedure to integrate distinct approaches in multidisciplinary research programmes on Volcanic and Igneous Plumbing Systems. In particular, we aim to have an impact on the community by modifying the classical “method-based” scientific culture, which is too restrictive and is not adequate for conducting multidisciplinary work, to “problem- or question-based”. Such philosophy is drastically different: instead of focusing on a method and interpreting the results from this single approach, we aim to establish a philosophy based on a scientific question/problem, to subsequently figure out which methods can be useful to address the questions and how they can be associated.

(ii) a strategy for coordinating future research on VIPSs. Such strategy will be implemented in successive steps.

- First, we aim to propose a new commission of the International Association of Volcanology and Chemistry of the Earth’s Interior (IAVCEI) on VIPS processes, aiming to bridge existing topical commissions such as the Collapse Caldera, the Large Igneous Provinces, and the Remote Sensing commissions. We propose to actively involve the leaders of the LASI community (The Physical Geology of Subvolcanic Systems: Laccoliths, Sills and Dykes) in this commission, who have pioneered scientific network on sub-volcanic systems. Such a new IAVCEI commission will be essential for the scientific community dealing with VIPS to formally organize regular specialized meetings and so to promote multi-disciplinary interactions on VIPSs after this workshop.
- Second, we aim to apply for prestigious funding to organize topical scientific meetings on Volcanic and Igneous Plumbing Systems. The potential funding schemes are Gordon Conferences or Chapman Conferences. In contrast to large meetings such as EGU and AGU, these conferences are designed to promote exchange between the attendees, as they dedicate lots of time for discussions. All the oral presenters are invited, and the presentations last 45 minutes each, leaving enough time for in-depth development of key topics. Applying for such funding requires an official visibility, and the proposed new IAVCEI commission will be essential for this purpose.

In order to ensure a good communication of the results of the workshop to the relevant scientific community, a publication plan has been established. First, we have already submitted a short Meeting report manuscript to EOS – AGU Transactions; the manuscript is accepted for publication. Second, we plan to write a longer and more detailed manuscript for Geology Today. This communication strategy will ensure that the scientific community working on VIPS will be informed of the on-going strategic plan, and so will ensure a proficient coordination of multidisciplinary research on VIPS.

Annexes

List of Speakers

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Workshop schedule
Magma emplacement and volcanotectonics
4-6 February 2013

Monday 4th February: Volcanotectonics

1030-1045 *Olivier Galland (PGP, University of Oslo)*

Welcome

1045-1100 *Bjørn Jamtveit (PGP, University of Oslo)*

PGP: the host institution

Chair: Olivier Galland

1100-1300 *Benedikt G. Ófeigsson (Icelandic Meteorological Office, Reykjavik)*

Volcanic activity in Iceland: Divergent plate boundary influenced by a hot spot

1130-1200 *Jun Okada (University of Azores)*

Unveiling the mechanisms of regional tectonics and volcanic deformations by GPS data

1200-1300 Lunch

Chair: Olivier Galland

1300-1330 *Valerio Acocella (University Roma Tre)*

15 years of analogue volcanoes at Roma Tre. What have we done, where are we now, where do we go?

1330-1400 *Matthieu Kervyn (Vrije Universiteit Brussel)*

Advanced techniques to image the dynamics of 3D structures of gravity-driven volcano deformation in analogue models

1400-1430 Coffee break

Chair: Steffi Burchardt

1430-1500 *Valentin Troll (University of Uppsala)*

Unravelling the deep plumbing system of caldera volcanoes using petrology

1500-1530 *Eoghan Holohan (University College Dublin-GFZ Potsdam)*

Advances in volcano-tectonic modeling from the Distinct Element Method

1530-1600 Coffee break

Chair: Steffi Burchardt

1600-1630 *Olivier Galland (PGP, University of Oslo)*

Ground deformation associated with shallow magma intrusions

1630-1700 *Benjamin van Wyk de Vries (University of Clermont-Ferrand)*

The Macro-Micro problem and the use of scaling with the real life analogues

1700-1730 Concluding remarks and discussions

1800- Workshop dinner downtown Oslo

Tuesday 5th February: Magma emplacement processes

Chair: Valentin Troll

- 0930-1000 *Lukas Baumgartner (University of Lausanne)*
Intrusion mechanism and life time of the Torres del Paine igneous system
- 1000-1030 *Sverre Planke (Volcanic Basin Petroleum Research)*
Paleogene igneous deposits and processes on the conjugate Mid-Norway –
Northeast Greenland margins
- 1030-1100 Coffee break

Chair: Valentin Troll

- 1100-1130 *Steffi Burchardt (University of Uppsala)*
Modelling the emplacement of cone sheets and dykes in volcanic systems
- 1130-1200 *Mansour Abdelmalak (University of Oslo)*
2D experiments of shallow intrusion propagation in brittle materials
- 1200-1300 Lunch

Chair: Valerio Acocella

- 1300-1330 *Thierry Menand (University of Clermont-Ferrand)*
Plutons versus magma chambers
- 1330-1400 *Eleonora Rivalta (GFZ Potsdam)*
Laboratory and theoretical modeling of dyke emplacement in layered media
- 1400-1430 Coffee break
- 1430-1600 *Olivier Galland, Karen Mair, Håvard Bertelsen (PGP, UiO)*
Lab. visits
- 1600-1730 Concluding remarks and discussions. Discussions about the future evolutions
of the group (LASI, IAVCEI, EPOS).
- 1800- Dinner downtown Oslo

Wednesday 6th February: Brainstorming activities

- 0900-1000 **Theme 1**
Field observations provide constraints on structures and/or geochemical patterns. How can we simulate such structures/patterns in experimental and numerical models? Which geophysical signals do such structures/patterns correspond to?
- 1000-1030 Coffee break
- 1030-1130 **Theme 2**
Petrology and thermo-barometry provide quantitative information on the dynamics and thermodynamics of magmas. How can such information be sensibly combined with structural field and geophysical observations? How can it be used for constraining initial and boundary conditions of laboratory and numerical models?
- 1130-1230 Lunch
- 1230-1330 **Theme 3**
Geophysical monitoring produces quantitative data of geophysical signals (seismological; ground deformation), but the processes generating these signals are poorly constrained. How could we reproduce these signals in experimental and numerical models to understand their origin? What type of field data is required to fully understand these geophysical signals?
- 1330-1400 Coffee break
- 1400-1500 **Theme 4**
Experiments and numerical models provide quantitative understanding by defining empirical laws based on dimensionless parameters and/or quantitative morphological patterns that have often not been addressed through fieldwork or geophysical monitoring. What is the best way to systematically constrain these parameters and study such morphological patterns in the field and through geophysical monitoring?
- 1500-1530 Concluding remarks

MEETING

Volcanic and Igneous Plumbing Systems: State-of-the-Art and Future Developments

***International MeMoVolc Networking Programme Workshop
on Magma Emplacement and Volcanotectonics;
Oslo, Norway, 4–6 February 2013***

The dynamics of volcanic and igneous plumbing systems (VIPS) are governed by complex interacting chemical and mechanical processes, which control how magmas stall or propagate through the Earth's crust, the way they are emplaced, and the dynamics of their eruption. In addition, these processes control dramatic volcanotectonic phenomena such as caldera and sector collapse. Traditionally, the study of the dynamics of VIPS is method based, and relatively limited bridges between the distinct methodological approaches exist. Consequently, studies that employ different methods often lead to contradictory conclusions, illustrating a need for integrated multidisciplinary research approaches.

To better integrate results from distinct scientific approaches in the field of VIPS, a workshop was held at the Physics of Geological Processes (PGP) Centre at the University of Oslo, Norway, in the framework of the European Science Foundation network MeMoVolc Networking Programme (<http://www.memovolc.fr/>). The workshop involved 19 scientists, including geophysicists and geodesists, structural geologists, petrologists and geochemists, experimental and numerical modelers, and theoreticians from eight European countries. The workshop aimed to establish a scientific network for studying VIPS, trigger multidisciplinary interactions for a quantitative understanding of the dynamics of volcanic and igneous plumbing systems, and establish a formal discussion group to sustain multidisciplinary interactions after the workshop.

The first 2 days of the workshop were dedicated to presentations, with time for discussions, and a visit to the experimental laboratories at PGP. The presenters were asked to summarize their field of expertise and the methods they use, highlight the main strengths and outcomes of their methods, and identify the limitations of their methods. A third day was dedicated to group

brainstorming discussions, which were passionate yet constructive and reflected the enthusiasm of the workshop participants.

There were two main outcomes of the workshop. First, the group established a strategy for triggering multidisciplinary research on VIPS. To achieve this, participants listed the limitations of each traditional method presented during the first 2 days. They then set out to identify how other approaches would help overcome these limitations. Such a strategy is a crucial step in bridging complementary approaches that usually do not interact, such as petrology/geochemistry and structural geology/mechanics.

Second, the workshop group established a strategy for coordinating future research on VIPS. The group aims to propose a new commission of the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) that focuses on VIPS processes, aiming to link existing topical commissions such as the Collapse Caldera, the Large Igneous Provinces, and the Remote Sensing commissions. The workshop group proposes to actively involve the leaders of the Physical Geology of Subvolcanic Systems: Laccoliths, Sills and Dykes (LASI) conferences, who have pioneered a scientific network on subvolcanic systems. The formation of such an IAVCEI commission will be essential for the scientific community dealing with VIPS, enabling them to formally organize regular specialized meetings and thus promote multidisciplinary interactions on VIPS after this workshop.

The workshop was sponsored by the MeMoVolc Networking Programme (Science Meeting grant 4739) and PGP.

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