



UNIVERSITÀ DEGLI STUDI  
DI PERUGIA

**DOTTORATO DI RICERCA**  
SCIENZA E TECNOLOGIA PER LA FISICA E LA GEOLOGIA

# **Short Course on Magmas, Eruptions and Risks**

(given by Chiara Cardaci, Jacopo Taddeucci  
and Francesco Vetere)

**23-25 March 2015**

## **Program**

- 3 days of lectures in the morning (9-13 a.m.) and exercises in the afternoon (2:30- 5:00 p.m.)
- Beers and some snacks on Thursday afternoon after 5 p.m.

## **Qualifications**

A certificate of “successful participation in the short course on Magmas, Eruption and Hazard” can be obtained. This certificate is equivalent to 3 credit points in the graduate program at the University of Perugia. To get the certificate you need to submit a short report, max five pages (and the report has to be accepted).

## **Introduction**

This course is aimed to provide an up to date and modern knowledge about magmatic-volcanic processes on Earth interior and their eruption on the surface.

The first part will deal on magma physical and physico-chemical properties. This aspect is of particular importance especially for volcanic hazard assessment. Experimental studies allow simulating processes that are responsible for both effusive and explosive eruptions. High-temperature and high-pressure facilities give the advantage to deal with data representing the magma in the Earth interior and possibly to elucidate and assess future volcanic scenarios. Only studying physical (i.e. density, viscosity), chemical (i.e. chemical elements distributions, volatile solubility) and structural properties (i.e. bond distance, oxidation state) we can build up general models to predict magma behaviour in dependence of intensive parameters such as composition, temperature, and pressure.

The second part will focus on the dynamics of volcanic eruptions, from vent dynamics to emplacement as pyroclastic deposits. State of the art eruption classifications will be covered together with the quantification of eruption magnitude and intensity and their associated limits. A twofold approach will be used to delve into the physical processes controlling volcanic eruptions. First, examples will be provided of multiparametric studies of well-documented eruptions. Such studies, integrating eruption signals routinely monitored at active volcanoes - from optical and thermal imaging to seismic and acoustic recordings - provide real 'broadband' coverage of the eruption dynamics outside of the volcanic vent. Second, selected study cases will illustrate how eruption parameters can be derived from laboratory simulations of otherwise inaccessible processes, such as magma fragmentation into the volcanic conduit and ash particles aggregation in volcanic clouds. All examples, natural and experimental, will be framed in a hazard mitigation perspective.

Finally, the third and last part will cover aspects related to volcanic hazard and the effective risk-reduction strategies, which requires a multidisciplinary knowledge and an effort of the whole civil protection system and the scientific community. The part will provide a complete overview of Italian Civil Protection, whose core structure is the Department of Civil Protection (DPC), plays a guiding role in the emergency field, in agreement with local authorities. DPC is also the focal point for

projects and activities devoted to the prevention, the forecasting and the monitoring of risks as well as the supervisor of all the whole civil protection system procedures. The “emergency cycle” phases (forecasting, preparedness, emergency management and emergency overcoming) will be illustrated. We will get into focus of the volcanic risk management in Italy, analysing the best practices for the prevention and the mitigation, the volcano monitoring systems and the prevention and preparedness actions. Experiences related to the basic level management of the volcanic hazard and of the volcano crisis occurred at Etna and Stromboli will be shown. Furthermore examples of scenario definition and planning emergency activities developed for Vesuvius and Campi Flegrei areas will be illustrated in detail.

## Topics

0. Introduction 1. Glass-forming systems and Glass Forming Ability (GFA) 2. Structure of silicate melts 3. Glass transition 4. Viscosity and melt relaxation 5. Volatiles in melts and magma	F. Vetere
6. Volcanic eruption styles: lights and shadows. 7. Eruption forces and dynamics 8. Integrated approaches to an eruption. 9. Eruption experiments.	J. Taddeucci
10. Overview of the Italian Service of Civil Protection 11. Stakeholders identification and roles 12. Volcanic risk management 13. Hazard and risk assessment and mapping 14. Prevention, preparedness and mitigation measures	C. Cardaci

# Detailed Program

23-25 March 2015

**1. Monday morning from 9:00 to 13:00 lectures as described above.**

**Tuesday afternoon from 14:30 to 17:00 - Density and Viscosity of magma: modeling experimental data.**

Density of magmas will be calculated using available models starting from laboratory measurements. Moreover, after a series of viscosity measurements, a dataset is produced at different temperatures. Students will deal with “Non-linear Curve fitting” using Microsoft Excel Solver. The aim is to calculate the Vogel-Tamman-Fulcher parameters A, B and  $T_0$  using Microsoft xls. Then, the produced model will be used to provide an insight on the magma rise velocity in a volcanic conduit. This exercise will be useful to depict the link between magma properties and eruption style.

**2. Tuesday morning from 9:00 to 13:00 lectures as described above.**

**Wednesday afternoon from 14:30 to 1700 - Multiparametric monitoring of a desktop eruption.**

Synchronized visible and infrared high-speed cameras and acoustic-infrasonic microphones will be used to monitor a scale volcano before and during an eruption. By using these methodologies, several eruption ‘precursors’ and processes will be simulated, including volcano deformation, jet-plume dynamics, and tephra sedimentation. Students will experience hands-on training on the use of actual volcano monitoring equipment and processing of the resulting data, thus acquiring knowledge to be used in the final crisis simulation of the course.

**3: Wednesday morning from 9:00 to 13:00 lectures as described above.**

**Thursday afternoon from 14:30 to 17:00 - Final volcano crisis simulation.**

This exercise will provide the participants with the unique opportunity to be part of an Emergency Operation Centre (EOC) during the management of a volcano crisis simulating the unrest of a volcano. Students will be required to assume the duties of specific professionals involved in emergencies, including scientists, emergency managers, public officials, press, and more. Roles will be assigned based on student expertise, and actual scientists and decision-makers will provide guidance through the

managing of the crisis. The simulation will end with a short debriefing to review critically actions and decisions carried out.

Participants will be forced to make decisions and take action based on limited information, with emphasis on problem identification and solving, critical decision-making, coordination, communication, and teamwork. Inter-relations between scientific community and decision makers will also be highlighted.

### Contacts

name	e-mail
Chiara Cardaci	Chiara.Cardaci@protezionecivile.it
Jacopo Taddeucci	jacopo.taddeucci@ingv.it
Francesco Vetere	francesco.vetere@unipg.it