UNIVERSITÀ DEGLI STUDI
DI PERUGIA

DOTTORATO DI RICERCA

SCIENZA E TECNOLOGIA PER LA FISICA E LA GEOLOGIA

Short Course on Magmas, Eruptions and Hazard

(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.)
- 3 days of exercises in the afternoon (2:30- 5:00 p.m.)
- Beers and some snacks on Wednesday 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 two 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 requires the effort of the whole civil protection system and the scientific community. The part will provide a complete overview of Italian Civil Protection National Agency, whose core structure is the Department of Civil Protection (DPC), plays a guiding role in the emergency field, in agreement with regional and 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 intervention procedures that are common to the whole civil protection system. The phases of the "emergency cycle" (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 – Comparison with European rules 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

1. Monday morning from 9:00 to 13:00 lectures as described above;
Monday afternoon from 14:30 to 1700 exercises/simulations:
Viscosity of magma: modeling of viscosity experimental data with the aim to build up a viscosity model.
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 TVF parameters A, B and T0 using Microsoft xls. Then, the produced model will be used to provide an insight on the magma rise velocity at the Island of Vulcano (Aeolian Archipelago).

2. Tuesday morning from 9:00 to 13:00 lectures as described above;
Tuesday afternoon from 14:30 to 1700 exercises/simulations:

Multiparametric monitoring of a desktop eruption using high-speed cameras.
Visible and infrared high-speed videos will be acquired at tens to hundred frames per second, and high pixel resolution, respectively. Moreover, by using microphones acoustic signals will be recorded. By using this methodology, several volcanic processes can be thus simulated:1) Initial jet-plume dynamics; 2) Ballistic pyroclast trajectories 3) The generation and propagation of acoustic and shock waves 4) The settling velocity of ash- to lapilli-sized pyroclasts.

3: Wednesday morning from 9:00 to 13:00 lectures as described above;
Wednesday afternoon from 14:30 to 1700 exercises/simulations:
The emphasis is on problem identification, problem solving and critical decision-making, coordination, communication, and teamwork.
The exercise scenario deals with the simulation of the early warning phase up to the final evacuation of the people from the emergency zones. This exercise focuses on the preparatory phase to give the participants an opportunity to learn about how a volcano eruption emergency is handled in an Emergency Operation Centre (EOC) setting.
Students will be required to assume the duties of specific professionals involved in emergencies. This includes: scientists, emergency managers, elected officials (e.g., Mayor), Fire and Police Chief, etc.
Roles will be decided prior to the exercise based on individual expertise interests in a specific position. Each student will be provided a hand-out to guide him or her through several stages of managing a volcano emergency.

Breakout sessions between key officials will last for durations of 10 to 30 minutes, during which time group discussion and decision-making must occur.
Participants are forced to make decisions and take action based on information that is not ideal. Specific trainers who are there to serve as expert advisors will support students.
These include emergency management trainers and volcanologists. After the conclusion of the exercise, students and faculty will discuss successes of specific decisions and actions and alternatives.

Contacts

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