

Cities on **VOLCANOES**¹¹



Volcanoes and Society: environment, health and hazards

Main Conference

23-27 May 2020

Pre-Conference Workshops / Field Trips

17-22 May 2020

Post-Conference Workshops/ Field Trips

28-31 May 2020

Heraklion
Crete

Second Circular
call for abstracts



Cities on **VOLCANOES**

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INVITATION TO PARTICIPATE

Cities on
VOLCANOES



11

Letter(s) from the President(s)

Dear colleagues,

It is my pleasure to invite you to participate, as many as possible, to the COV11 Conference, headed by the Commission Cities On Volcanoes, that will be held in Heraklion, Crete (Greece), from May 23th to May 27th, 2019. IAVCEI greatly acknowledges the organizing efforts of the National and Kapodistrian University of Athens, in collaboration with the University of Crete and its Natural History Museum, to invite the international scientific community and decision makers dealing with volcanic risks to participate in this COV11 conference entitled "Volcanoes and Society: environment, health and hazards". After several different countries (Italy, New Zealand, USA, Ecuador, Japan, Spain, Mexico, Indonesia, Chile), Greece will host for the first time this important COV Conference.

Crete island is extremely famous in the Mediterranean for its beauty, its ancient history, and its archeological remnants of the Minoan civilization. For volcanologists it is also a special site that was dramatically impacted by the around 1627 BC cataclysm of Santorini (Thera) volcano (VEI 6-7, 60 km³ of DRE magma). In addition to visiting archeological treasures, the 2020 Heraklion Conference will allow worldwide volcanologists and decision makers to exchange about the up-to-date scientific advances in understanding how volcanoes work, how forecasting their eruptions and how mitigating their environmental and societal impacts. In addition to Santorini, a few other active volcanoes of the Hellenic arc (Milos, Nisyros, Methana) are interesting targets for field excursions related to the Conference.

Therefore, IAVCEI strongly encourages your participation to the COV11 Conference in Crete in May 2020 and acknowledges the organizing efforts undertaken by our Greek colleagues and local authorities. We look forward to seeing you numerous in Heraklion!

Patrick ALLARD
IAVCEI President

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INVITATION TO PARTICIPATE

Cities on
VOLCANOES



Letter(s) from the President(s)

Dear Colleagues,

I am honored to invite you to participate to the Cities on Volcanoes11 Conference, which will take place in Heraklion city, in the island of Crete (Greece), from 23rd of May to 27th of May, 2019.

The Greek Organizers, which are the Department of Geology and Geonvironment of the National and Kapodistrian University of Athens, in collaboration with the Post Graduate Programme of «Environmental, Disaster and Crisis Management Strategies» (EDCM) and the Natural History Museum (University of Crete), with a high sense of responsibility, organize the COV11 with the title «Volcanoes and Society: environment, health and hazards» and anticipate to bring together not only to scientists worldwide but also the Civil Protection authorities, concerning the volcanic risk. It will focus on multidisciplinary monitoring volcanic environments in the vicinity of cities and highly touristic areas, the ability to recognize the hazards and their impacts of people, community education, case studies and risk mitigation to reduce the impacts of volcanism and its effects on society.

We are happy that Greece, one of the most touristic places in the world, with the beautiful volcanoes of the Aegean Sea, will organize such an International Conference about volcanoes. Very interesting and exciting field trips will take place before, during and after the Conference in the islands of Santorini, Milos, Nisyros and Methana peninsula (Hellenic Volcanic Arc) as well as in Knossos Archaeological site and Priloritis UNESCO Global geopark.

Crete is a well-known island in the Mediterranean Sea, at the crossroads of three continents, due to its friendly and warm people, amazing landscapes, delicious food and famous archaeological site like Knossos. Heraklion city, the 4th biggest city in Greece and birth city of the famous artist Domenikos Theotokopoulos, known as El Greco, has various architectural styles, riche cultural life and magnificent weather.

Santorini volcano is a unique scientific natural laboratory with a spectacular caldera. The famous Minoan Plinian eruption, took place in the Late Bronze Age and its impact was the decline of the Minoan Civilization. The last eruption of the Kameni islands occurred in 1950, at the centre of caldera.

We will be delighted to host the participants from all over the world for a very fruitful Conference. The Greek scientific and local community, look forward to seeing you all in Heraklion.

Efthymios Lekkas
President of E.P.P.O

INVITATION TO PARTICIPATE

Letter(s) from the President(s)

Cities on
VOLCANOES



Dear Colleagues,

We, the National and Kapodistrian University of Athens (NKUA), in collaboration with post graduate programme of “Environmental, Disaster and Crisis Management Strategies” (EDCM) and the Natural History Museum of Crete (University of Crete), are honored to invite you to participate in the Cities on Volcanoes 11, in Heraklion, Crete, Greece.

It will be our pleasure to welcome you to Crete and give you the opportunity to visit Knossos (the largest Bronze Age archaeological site on Crete called the oldest city of Europe), and the Heraklion Archaeological Museum (one of Europe’s most important museums with archaeological finds from all over Crete, covering over 5500 years of the island’s history).

Additionally, we will organize several field trips to Methana, Milos, Santorini, Nisyros, Psiloritis UNESCO Global Geopark, etc. We strongly believe that Crete, considered as one of the top global tourist destinations, having easy access and the appropriate infrastructure, will fulfill all your expectations for a successful meeting. Sincerely,

Paraskevi Nomikou
Assistant Professor NKUA
President of COV11

ORGANIZERS

Cities on **VOLCANOES**



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The National and Kapodistrian University of Athens (NKUA), in collaboration with post graduate programme of “Environmental, Disaster and Crisis Management Strategies” (EDCM), the Natural History Museum of Crete (University of Crete), the Earthquake Planning & Protection Organization (EPPO) and the Hellenic Oceanographers’ Association (HOA) are honored to work with you in the Cities on Volcanoes 11



Cities and Volcanoes Commission



International Association Volcanology
and Chemistry of Earth Interior

In collaboration with



Earthquake
Planning &
Protection
Organization



Hellenic
Oceanographers'
Association

Under the Auspices



With the support of

- Region of Crete
- Municipality of Herakleio
- Archaeological Museum Herakleio

Cities on VOLCANOES



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STEERING COMMITTEE

Paraskevi Nomikou	National and Kapodistrian University of Athens, President of COV11
Efthimios Lekkas	National and Kapodistrian University of Athens
Dimitrios Papanikolaou	National and Kapodistrian University of Athens
Konstantinos Kyriakopoulos	National and Kapodistrian University of Athens
Gerassimos Papadopoulos	National Observatory of Athens (ret.)
Charalampos Fassoulas	Natural History Museum of Crete
Maria Manousaki	Earthquake Planning and Protection Organization, Athens

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Stavros Arnaoutakis	Regional Governor of Crete
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Nikos Koukouzas	CERTH, Athens
Spyridon Lalechos	Earthquake Planning and Protection Organization, Athens
Vasilis Lamprinos	Mayor of Heraklion
Stella Mandalaki	Archaeological Museum of Heraklion
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Spyros Staridas	Natural Museum of Crete, Geography S.A., Heraklion
Kostas Synolakis	Technical University of Crete, Chania
Vasiliki Sythiakaki	Ephorate of Antiquities of Heraklion
Odyseas Zoras	University of Crete, Heraklion
Nikos Zouros	University of Aegean, Lesvos

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Rebecca Carey	University of Tasmania, Australia
Tom Casadevall	U.S. Geological Survey, United States of America
Giovanni Chiodini	Istituto Nazionale di Geofisica e Vulcanologia, Pisa, Italy
Antonio Colombi	Civil Protection Agency of Regione Lazio, Italy
Angela Doherty	Auckland Council - Auckland Emergency Management, New Zealand
Timothy Druitt	University Clermont Auvergne, France
Ramón Espinasa Pereña	Centro Nacional de Prevención de Desastres, Mexico
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James White	University of Otago, New Zealand

IAVCEI EXECUTIVE COMMITTEE

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Prof. Fidel Costa (SINGAPORE)	Committee
Dr. Eisuke Fujita (JAPAN)	
Prof. Lizzette A. Rodriguez (PUERTO RICO)	
Prof. Jose Viramonte (ARGENTINA)	
Dr. Julia Eychenne Rowan (FRANCE)	Early Career Committee member



THE HOSTING CITY: HERAKLION





CAPITAL OF CRETE

With more than 170,000 inhabitants, Heraklion forms the largest urban area of Crete, as well as the island's administrative, economic, and commercial center. It is one of the five largest cities in Greece. Heraklion has many attributes, such as nice weather, various styles of architecture as well as a rich cultural life. Some of the main attractions of Heraklion are the Venetian fortress and loggia, the Archaeological Museum and the site of Knossos, considered as the oldest city in Europe. Many artists come from Heraklion, the most famous one being Domenicos Theotokopoulos, commonly known as El Greco.





Crete is the largest and most populous island in Greece, located on the southernmost part of the country. Its administrative capital and economic epicenter is Heraklion. The city proper has around 170.000 residents, whereas the metropolitan area includes more than 200.000 people. Over one third of the island's total population lives there.

Lying at the center of Crete's northern coastline, Heraklion is connected with all major cities on the island via its national road. The economy of Crete focuses on tourism, services and agriculture. All these sectors are influenced by the mild climate of the island. Crete is among the most popular tourist destinations in the Mediterranean and Heraklion is its international hub. The "Nikos Kazantzakis" Airport is the second busiest in Greece, whereas the port of the city welcomes daily numerous ferries along with cruise and cargo ships. Agricultural products, like fruits, legumes and olive oil, are the basis of the Cretan diet, famous for its benefits on health and span of life.



The history of Heraklion goes back into the Bronze Age. It was one of the ports of Knossos, the largest city of the Minoan civilization. Arguably the oldest sophisticated society in Europe, its name derives from Minos, a mythical figure thought to be the first king of Crete. According to Greek mythology, he was the son of Zeus and Europa, a Phoenician princess. She was abducted by the king of gods and was brought to Crete. The name of the mother of Minos is the source for the name of the European continent.

Like Crete itself, the Greeks, the Romans, and the Byzantine Empire successively ruled Heraklion. Then the Arabs conquered the island during the 9th century, thus forming the Emirate of Crete, which lasted for more than a century. The new state chose Heraklion as its capital. The origins of the second name of the city, Chandax or Candia, are to be found here. The Byzantines recaptured Crete, but the island eventually fell under the control of the Venetians. It was one of the most prosperous eras for Candia, as numerous vestiges spread around the city can attest. When the Ottomans subjugated the island after a 21-year siege of Candia, the city fell from grace. As a result, Chania, the second most important city on the island, took over. Crete became a part of Greece at the beginning of the 20th century, during which Heraklion reemerged progressively to its former status.



The city has been marked not only by its numerous conquerors, but also by physical phenomena that have literally changed the course of its history. Two of the most important ones are earthquakes and volcano eruptions.

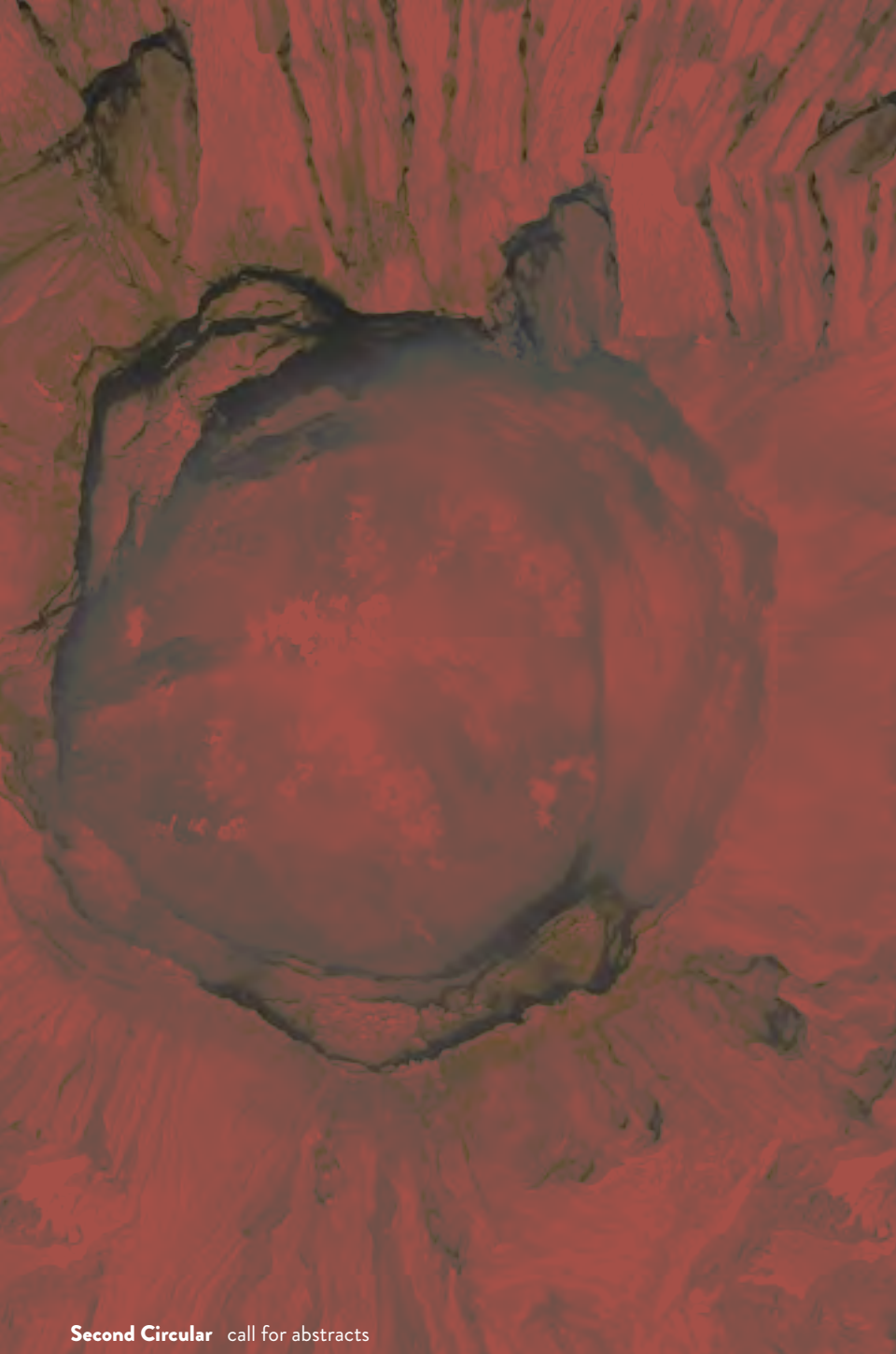
Earthquakes are very common in Crete as the island lies on the southern edge of the Aegean Sea Plate, under which the African Plate is submerging. The fault length created by this ongoing activity has subjected Heraklion, and Crete as a whole, to numerous earthquakes, sometimes with catastrophic results. In 1508 the earth trembled so strongly that most houses in Heraklion were left unsafe for occupancy. In 1856 it is estimated that one third of the buildings of the city had the same fate during an earthquake that was felt all the way to Cyprus and northern Africa. These examples are indicative of the consequences felt by the people of the island throughout history.

Even though Crete isn't known for its eruptions, Heraklion is only 110 km (around 68 miles) south of Santorini, an island in the Aegean Sea marked by volcanic action. This has been proven quite unfortunate in the past. For example, historians mention an eruption on September 1650 during the siege of Candia by the Ottomans. It is considered as one of the biggest on the Eastern Mediterranean. It took place at Kolumbo, a submarine volcano, around 8 km (almost 5 miles) northeast of Santorini. The phenomenon was visible from Heraklion, creating a tsunami that reached the shores of the city. It had such an impact on the defenders of Candia that it was thought as a bad omen.

Nevertheless, the most prominent eruption in the area had already happened more than 3000 years before. In the 16th century BCE, the volcano of Santorini produced one of the largest explosions in human history. The results were dire: a large part of the island plunged into the sea, earthquakes and tsunamis emerged and the coasts within reach were severely hit. Crete was no exception. As a result, the Minoan civilization was affected to such a degree that the phenomenon is mostly known today as the "Minoan eruption".

All the aforementioned wars and natural catastrophes have shaped the landscape of Crete and the character of its inhabitants. As a further attestation to the perseverance of the island, the Battle of Crete is regarded as the first time during the Second World War that the German army faced such a strong resistance from the local population. Perhaps Nikos Kazantzakis (1883-1957), one of the biggest Greek writers and a native of Heraklion, has summed up best this continuous battle for survival. Buried on the Venetian walls of the city, his epitaph reads: "I hope for nothing. I fear nothing. I am free".





MEETING VENUE



Aquila Atlantis Hotel

Main Congress Venue

Within 200 m from the Archaeological Museum of Heraklion, the 5-star Aquila Atlantis Hotel features an outdoor pool with unobstructed views over the harbor, a semi-covered pool and an elegantly decorated restaurant.

Fitted with parquet floors and earthy colours, all rooms and suites of Atlantis Hotel enjoy views over the city of Heraklion, the harbor or the hotel's atrium. Each unit includes a desk and comes equipped with air conditioning, flat-screen TV with satellite channels, coffee machine and minibar. The modern bathrooms are stocked with free toiletries, bathrobes and slippers. You have the chance to relax at the sun loungers by the pool and enjoy a refreshing drink from the on-site bar. Breakfast is served daily at the modern setting of the lounge bar, where drinks and cocktails can also be enjoyed. Mediterranean flavors accompanied by fine wine are available daily at the hotel's main restaurant.

Extra hotel services include a 24-hour front desk, luggage storage and free Wi-Fi access throughout. Laundry, dry cleaning and ironing can be provided on request and upon charge.

2, Ygias Street, Heraklion – Crete, GR – 71 202



Capsis Astoria Hotel

Parallel Sessions Venue

At the city's main square, in the historic center of Crete's capital city and right next to one of Europe's most important Museums, the renowned Heraklion Archaeological Museum, Capsis Astoria Hotel offers upgraded and sophisticated services to both corporate and leisure travelers.

Capsis Astoria Hotel

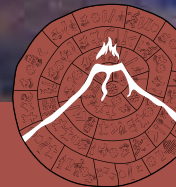
11 Eleftherias Sq., 712 01 Heraklion – Crete





IMPORTANT DATES

April 6, 2019	First Circular
April 30, 2019	Web-Site launch and opening of Call for Session/ Workshop
July 20, 2019	Deadline for submission of Session/Workshop proposals
September 1, 2019	II Circular (containing the scientific-technical program, with sessions, workshops and field trips)
November 1, 2019	Abstract submission and Registration opening
January 25, 2020	Deadline for abstract submission
February 28, 2020	Final conference program
March 9, 2020	Deadline for Early registration
April 30, 2020	Closing date for pre-registrations



According with the Cities and Volcanoes Commission (CaV) the COV conferences are intended to promote multi-disciplinary approaches to hazards. In submitting the abstracts and associated posters/presentations we invite you to address the relevance of their topic to some aspect of hazards mitigation, as stated by the mission of CaV *“The Cities and Volcanoes Commission aims to provide a linkage between the volcanology community and emergency managers, to serve as a conduit for exchange of ideas and experience between volcano cities, and promote multi-disciplinary applied research, involving the collaboration of physical and social scientists and city officials.”*

ABSTRACT SUBMISSION

Abstract submission starts on November 1st 2019 and ends on January 25th , 2020. It will be carried out online only via the conference website.

All abstracts must be written in English.

Abstract format includes: session number, title, author(s), affiliation(s) and email of corresponding author.

Text length is maximum 300 words.

Authors are invited to express their preference for oral or poster presentation; the final assignement will be made by the session convenors.

Abstract fee The payment of abstract fee (€ 35) can only be made online at CoV11 website.

PRESENTATION GUIDELINES

Oral presentations Duration of oral presentations is 15 minutes (12 minutes for presentation and 3 for questions).

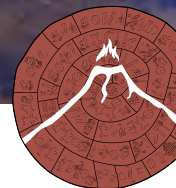
Presentations are requested in electronic format (.pptx).

Poster presentations Posters sessions are scheduled in dedicated rooms and time-slots.

Maximum poster size is A0 format (width 84.1 x height 118.9 cm).

LANGUAGE

The official language of the CoV11 Conference is English.



REGISTRATION FEES

Registration Type	Early Bird November 1 st , 2019 till March 9 th , 2020	Late Registration March 10 th till April 30 th & On Site
Life Member IAVCEI	€ 525	€ 575
Regular Member IAVCEI	€ 575	€ 625
Student Member IAVCEI	€ 250	€ 300
One day Registration	€ 120	€ 170
Local non scientific participants	€ 250	€ 300
Accompanying persons	€ 400	€ 450

The Registration fee includes: Conference center access | Oral and poster sessions | Plenary talks | Workshops | Bags and supplementary materials | Abstract collection | Working group rooms (depending on prior reservation) | Ice breaker cocktail | Coffee breaks | Buffet lunch | Intra conference field trip | Farewell party | Other benefits will be published on the CoV11 website

Registration to the Conference is mandatory for participating to Field Trips. Meeting registration can only be made online at the CoV11 website from 1st of November 2019.

Field trip registration can only be made online at the CoV11 website.

Registration cancellation

Registration cancellation can be requested by email only to Local Organizing Committee (info@citiesonvolcanoes11.com).

Before March 10th, 2020 the fee will be refunded except for € 80 as administrative charge. After this date no refund will be made.

Financial assistance

A limited number of grants are available.

Please address request to the Local Organizing Committee mailbox (info@citiesonvolcanoes11.com).

Requests should be accompanied by a reference letter. Grant Application will be open from 1st of February to 10th March.

ORGANIZING SECRETARIAT



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Congress Email: info@citiesonvolcanoes11.com

Congress Website: www.citiesonvolcaoes11.com

Corporate Website: www.convin.gr

CONFERENCE PROGRAM

Cities on
VOLCANOES



	May 22 nd	May 23 rd	May 24 th	May 25 th	May 26 th	May 27 th
8.30-9.30		Opening Ceremony	Oral Sessions		Oral Sessions	Oral Sessions
9.30-10.30		Plenary - Special Session		-09.00- Visit Archaeological Museum		
10.30-11.00	REGISTRATION	Coffee Break	Coffee Break		Coffee Break	Coffee Break
11.00-12.00		Oral Sessions	Plenary - Special Session	Oral Sessions	Plenary - Special Session	Oral Sessions
12.00-13.00			Poster Session		Poster Session	
13.00-14.30		Lunch	Lunch	Lunch	Lunch	Lunch
14.30-15.30		Oral Sessions	Oral Sessions	-14.30-1600- Poster Session	Oral Sessions	Poster Session
15.30-16.30						-16:00- Plenary - Special Session
16.30-17.00		Coffee Break	Coffee Break	-16.00-18.00- Knossos	Coffee Break	
17.00-18.00		Oral Sessions	Oral Sessions		Oral Sessions	Closing Ceremony
18.00-19.00		Poster Session				
19.00-20.00		Icebreaker Cocktail	Parallel Program	Parallel Program	Parallel Program	
20.00					Farewell Party	



Cities on
VOLCANOES



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SESSIONS

Image by Wikimedia from Pixabay



S1

© artemia argirou

SYMPOSIUM 1

Volcano Observatory work and monitoring

S1.1 > Volcano hazard modelling

CONVENERS:

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Gabor Kereszturi *Massey University, New Zealand* | G.Kereszturi@massey.ac.nz

Vito Zago *Northwestern University, United States of America* | vito.zago@northwestern.edu

Gaetana Ganci *Istituto Nazionale di Geofisica e Vulcanologia, Italy* | gaetana.ganci@ingv.it

Developing physical-mathematical models able to describe the evolution of eruptive phenomena is a key point in volcanology. In the case of high-risk phenomena, such as lava flows or ash dispersal, predicting their spatial and temporal evolution and determining the potentially affected areas is fundamental in supporting every action directed at mitigating the risk as well as effective land use planning. This session aims to address unresolved challenging questions related to complex geophysical flow modeling and simulation, gathering physical-

mathematical models, numerical methods and field and satellite data analysis in order to: (i) expand knowledge of complex volcanic processes and their space-time dynamics; (ii) monitor and model volcanic phenomena; (iii) quantify model robustness and simulation performances through validation against real case studies, analytical solutions and laboratory experiments; (iv) conduct sensitivity analysis and optimization/calibration of input parameters in all components of volcanic hazard modelling in response to eruptive crisis.



S1.2 > Cosmic-ray geotomography for volcanic hazard assessment

CONVENERS:

C.D. Athanassas *Department of Geological Sciences, NTUA, Athens, Greece* | athanassas@central.ntua.gr

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A. Tasianias *Geolympus* | tasianias@geolympus.com

Geophysical exploration of the Earth's interior involves the introduction of some type of energy (i.e. electric, seismic or electromagnetic) and the measurement of the Earth's response as to some physical property (i.e. electric resistivity, refraction or dielectric permittivity respectively). With the exemption of passive seismic tomography which utilizes the natural microseismicity and gravimetry, tomography of volcanoes by cosmic rays (*muography*) is an alternative and inexpensive way that exploits the energy attenuation of cosmic muons crossing the volcano along different paths to gather information about their internal structure.

Muography has mainly been used to explore the density variations of volcanoes and to monitor the magma kinetics therein by employing cutting-edge particle detector technologies. Muography is increasingly gaining ground in a greater number of geoscientific applications ranging from mining engineering to geotechnical engineering,

archaeology and more.

Muography has been a great success in imaging the internal structure volcanoes and monitoring eminent volcanic eruptions such as the 2009 Asama and 2013 Satsuma-Iwojima eruptions in Japan. The latter opens up the possibility of muographic imaging of active volcanoes worldwide, including the south Aegean active volcanic arc (SAAVA). Therefore, we here promote muography as an innovative, real-time monitoring method of active volcanoes for the purposes of civil protection. By this session, we want to attract the attention of both specialists and audiences to the essentials of muography, case studies and future directions. It is essential to inform the scientific community and civil protection authorities that muography is the cutting-edge method for detecting volcanic hazards in the making.

S1.3 > Unmanned robotic autonomous platforms on volcanoes for research, monitoring and rapid crisis response

CONVENERS:

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Angelos Mallios *Woods Hole Oceanographic Institution, United States of America* | aggelos.mallios@gmail.com

Angie Diefenbach *USGS Cascades Volcano Observatory & Volcano Disaster Assistance Program, Vancouver WA, United States of America* | adiefenbach@usgs.gov

Unmanned autonomous robotic platforms including UAS/UAVs and AUVs, are an emerging and rapidly evolving new technology used in volcano research, monitoring, and rapid crisis response. Unmanned platforms have been used in a variety of environments including aquatic (marine, lacustrine, geysers), subterranean (volcanic vents and caves), and subaerial domains. Payload sensor options, real-time data transmissions via mesh and ad-hoc networks, fleet/swarm options, constellation options with CubeSat Low Earth Orbit satellites, and

increasing use of autonomy and artificial intelligence (e.g., intelligent subaerial and subaqueous plume navigation and obstacle avoidance, terrain and canopy-following), and homing are frontiers experiencing rapid development to ready this new technology for event crisis tracking and response. We welcome any contribution including but not limited to case studies, citizen science, technology demonstrations and development related to unmanned autonomous or semi-autonomous sensor applications in volcanic environments.



S1.4 > Gaseous emissions from volcanic systems – science, monitoring, and impacts

CONVENERS:

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Gases (volatiles) in magmatic and hydrothermal systems play a pivotal role in magma transport and drive volcanic eruptions. Changing emissions herald eruptions and document otherwise hidden subsurface changes before, during, and after eruptions. Observatories increasingly monitor gas emissions to track and predict volcano behavior. Scientists research volatiles in magmas and their emissions into the hydro-, atmo-, pedo-, and biosphere, which affect and often dominate the hazard potential on active volcanoes (e.g., slope stability changes, toxic gas accumulations, crop damages). Emissions may be masked by lakes, soil, vegetation, geology, and groundwater, however affected in measurable and often quantifiable ways which offer new approaches to detect and observe current and past activity. Hydrothermal systems mitigate heat and volatile emissions from underlying magmas, potentially affected by changing hydrological conditions in a changing climate. Volcanic gas emission sites are increasingly used as natural analogues to study the effects of rising atmospheric CO₂ levels or leaking geologic CO₂ storage systems, on land and under water.

This session aims to mix technical presentations with a strategic discussion on innovation to bolster cross-disciplinary dialogue on monitoring capabilities,

and draft a strategic white paper / roadmap on integrating the competencies presented into a better framework for monitoring volcanic emissions.

We welcome contributions from a broad spectrum of expertise, including but not limited to regional and local case studies, mantle and magmatic petrology, hydrothermal geochemistry, volcanic gas investigations, observational and monitoring studies and instrumentation approaches, as well as impacts on aquatic and terrestrial ecosystems, infrastructure, and human health.

Core connection to societal risk mitigation: The emission of gaseous constituents provides for good science, monitoring, and directly impacts vulnerable populations. Emissions from volcanoes before, during, and after unrest periods can be a unique tool for monitoring and eruptive behavior tracking and prediction. The impacts of these emissions on the hydro-, atmo-, pedo-, and biosphere affect and often dominate the hazards potential on active volcanoes (e.g., landslide susceptibility and slope stability change via chemical alteration, dangerous gas accumulations, crop damages, etc.). Understanding and monitoring volatile emissions and the processes they reflect are an underutilized, though essential, part of risk mitigation decision-making strategies

S1.5 > Reconstructing the topography of active volcanic areas by using Geomatics techniques: volcanic phenomena investigation and hazard mapping

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The morphologies of volcanic active areas are the surface expression of several volcanic processes, and the accurate digital reconstruction of such morphologies has received great attention over the past years due to the importance of such data. A detailed digital elevation model is in fact fundamental for modelling several volcanic phenomena such as lava flows, pyroclastic flows, lahars, tephra fall-out deposition and ballistic impacts. In addition, in case of high magnitude eruptions affecting highly populated and urbanized areas, an accurate reconstruction of the

topography becomes an essential tool for volcanic hazard and risk assessment. This session welcomes contributions that use Geomatics disciplines such as Airborne and Terrestrial LIDAR, Aerial and Satellite Stereo Photogrammetry by using Multispectral Optical and IR data, Synthetic Aperture Radar and Photogrammetry by drones, to obtain volcanic topographies used as input data for modelling the investigated phenomena or mapping the volcanic hazard. New ideas, developments and applications are welcome.



S1.6 > The application of drones in volcano monitoring, volcanological research and volcanic emergency management

CONVENERS:

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Unmanned aerial vehicles (“UAVs” or “drones”) provide the opportunity to safely enter so-far inaccessible areas on active volcanoes. The last years have seen a rapid development of drone technology and they are now increasingly utilized as an essential tool for monitoring and scientific purposes. Initially mostly used for visual observation, applications now range from photogrammetric and thermal mapping, to sampling and gas measurements. These allow us to obtain unique and novel data sets that help to better understand volcanic systems and eruption processes and thereby support hazard assessments. Drones have proved especially advantageous during volcanic crises. They can be used to assess the state of volcanic activity and update the ever-changing topography of the volcano in a cheap, quick and safe way. This is crucial for hazard propagation models and decision-making in a volcanic crisis and thereby directly supports risk mitigation efforts.

This session is supposed to offer a forum for researchers, pilots, developers and those who manage volcanic crises to present and discuss recent advances, new approaches and best strategies in this young discipline. This exchange will be helpful to determine the optimal way to exploit drone technology for hazard assessment and management in volcanic areas. We invite all contributions presenting drone applications for scientific, monitoring and/or crisis management purposes, ranging from individual case studies to developments of systematic strategies.

Core connection between the proposed session and societal risk mitigation: The use of drones for volcano monitoring and especially during volcanic crises as a tool to easily assess the current state of volcanic activity is directly supporting decision-making and risk mitigation at active volcanoes.

S1.7 > Progression of unrest in volcanic systems: An evaluation and a multiparameter update of the Generic Volcanic Earthquake Swarm Model (GVESM)

CONVENERS:

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Link to volcano societal risk mitigation: The session seeks to develop volcano forecasting methods which may improve safety for human populations and property near volcanoes.

Session and workshop description: Volcanic systems are thought to evolve in a systematic manner with a range of observations that may be ascribed to unrest and eruption. Such a system is akin to the progression of illness in humans, where the evolution of symptoms may occur in a specific pattern which may be exploited to improve patient health outcomes. For volcanic systems, the pattern may relate genetically to the upward migration of magma through constricted pathways and into the overlying groundwater/hydrothermal system. This systematic progression was first described as the Generic Volcanic

Earthquake Swarm Model (GVESM) more than 2 decades ago and included the onset of volcano-tectonic activity > long-period earthquakes > shallow tremor and eruption. This session welcomes multidisciplinary contributions in geochemistry and geophysics (especially, but not limited to, ground deformation and seismo-acoustic monitoring) that can be used to critically assess the GVESM and other conceptual volcano forecast models. We are also interested in contributions utilizing sophisticated Machine Learning techniques which may enable identification and assessment for subtle evolutionary patterns in data. The session hopes to develop an improved multi-parameter “Generic Unrest Model” which may then be applied to hazards assessments of unrest globally.



S1.8 > The role of geosciences in monitoring and managing volcanic hazard

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Volcanoes are, understandably, considered one of the most important natural hazards. Recent volcanic eruptions have led to significant human loss and considerable economic damage. Accurate hazard estimation is fundamental in increasing preparedness and mitigating potential risks from volcanoes. Today, multiple disciplines of geosciences have been involved in this topic and interdisciplinary actions demonstrate significant promise.

Traditionally, volcanoes have been explored through seismic signals, by studying sequences of earthquakes related to volcanic activity. However, advanced seismology has developed more sophisticated approaches that offer greater potential, whether by analyzing ambient noise recordings or documenting stress changes through shear-wave splitting and classifying volcanic tremors. Temporal variations of surface deformation have been studied with the aid of

GNSS networks and data-analysis techniques, as well as gravity measurements. Moreover, gas emissions have been extensively used in investigating volcanic processes. Finally, the emerging field of geological disaster management can contribute significantly in improving the response of authorities and reduce potential secondary damages. The combination of monitoring and management plans is critical in successfully and efficiently reducing risk.

In this session, we invite contributors dedicated to monitoring volcanoes from fields of geosciences, including researchers involved in the analysis of seismic, GNSS, gravity and geochemical data, to submit their work on advanced, innovative approaches of applying current and past knowledge in estimating and modelling volcanic hazard, as well as experts on the risk management field to share their work on improving response for potential disasters

S1.9 > Management of the Volcanological Data: from the production to the curation

CONVENERS:

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Volcanological data are heterogeneous in nature. They come from field observations, ground based and remote sensing instruments, permanent stations or campaign deployments, and include geochemical analyses, geophysical time series, images, video, and other data types. These data are collected, processed, and stored in different formats, with varying levels of support and infrastructure, and are managed by diverse institutions worldwide (observatories, universities, and research institutions). Considering this framework, volcanologists have adopted different approaches and solutions to manage their data. The range of data management solutions reflects the goals with which the data are collected, e.g. scientific monitoring, hazard mitigation/civil protection, research projects.

Technological evolution has added additional complexity to data management. During recent decades, data acquisition has dramatically increased in both quantity

and quality, and previously analog data are now routinely acquired digitally.

The recent implementation of the “Open Science” framework poses both technical and policy challenges to increasing data access within the volcanological community. This session solicits contributions on strategies and best practices being used and adopted by the volcanological community in managing and distributing data. We will discuss broad topics related to the application of the FAIR (Findability, Accessibility, Interoperability, and Reusability) principle to volcanological data, such as standardization of data and interoperability, data archiving/repository infrastructures, data access policies, data licensing, citation and publications. We also aim to stimulate a debate about the capacity of the volcanological community to guarantee a long-term curation of data for science reproducibility.



S1.10 > Volcano monitoring and eruption forecasting in the presence of uncertainty

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Geological, geophysical and geochemical monitoring data provide the best insights we have into the status of a volcanic system. However, forecasts of the timing, location, size, and style of eruption based on these data are fundamentally uncertain. A statistical approach is required to work with them, and information useful to decision makers. Forecast uncertainty arises for a number of reasons. The physical and chemical processes controlling eruptive behaviour are inherently stochastic. Monitoring data is limited, ambiguous, and erroneous. Geological records are incomplete. And our models that relate changes in any of these to the likelihood, timing, and nature of future activity are wrong. Consequently, more reliable and useful quantitative forecasting will require developments in a range of statistical methods and understanding.

This session is looking for contributions that address statistical issues in volcano monitoring and eruption forecasting. Topics could include: optimization of monitoring networks (for single volcanoes or across volcanic regions) to provide

most useful forecasting information; approaches to deal with an absence of baseline monitoring data; forecasting changes in eruption style or the end of eruption; adjusting forecasts to account for missing data; the integration of 'physics-based' and empirical forecasting models; and tools to allow better decisions to be made on the basis of uncertain forecasts.

Core connection between the proposed session and societal risk mitigation: Eruption forecasting can be a key component of risk management strategies, allowing timely measures to reduce societal risk, such as evacuations or land use and infrastructure planning. However, forecasts are uncertain, and decision making under these conditions is challenging. As a community of scientists and risk managers, in order to make better decisions, we need improved understanding of the nature of eruption forecasting methods, the data on which they are based, and their uncertainties.

This session is sponsored by the IAVCEI Commission on Statistics In Volcanology.

S1.11 > Large- to small-scale instability-to-collapse processes and mass wasting: dynamics, models and hazard implications

CONVENERS:

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Mass-wasting in volcanic environment, both on-shore and subaqueous, comprises a wide spectrum of phenomena, from large lateral collapse to shallow debris remobilization that represent a major threat for societies. Slope stability ranges from slow and continuous to sudden and catastrophic and the interpretation of such events is challenged by the complex and evolving interactions between tectonic, magmatic, fluid, and gravitational processes. The moving masses can behave in different ways depending on water content and flow rheology and can demonstrate different modes from flank spreading or collapse to granular or viscous flow. Water plays an important role in the transport and emplacement mechanisms of the flows, enhancing their run-out and destructive power. Many volcanoes worldwide are located in tropical, high-precipitation environments or

are covered by snow or glaciers, which exacerbates the potential for landslides, lahars and debris avalanches. In most cases, volcano slopes continue below sea level and also subaqueous volcano flanks can be prone to mass wasting, often affected by terrestrial volcano built-up and activity. This session encourages multidisciplinary contributions from both earth and social scientists that critique, explain and discuss how high-resolution vulnerability and risk analysis and volcanic mass flow studies are necessary to reduce disaster risk within vulnerable populations. We expect contributions that integrate field-based geological and geochemical studies, geomorphological mapping, geophysical investigations, remote sensing and analytical, numerical and analogical modelling.



S1.12 > Pyroclastic density current transport and emplacement mechanisms: insights from field, experimental, and modelling studies

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Pyroclastic density currents (PDCs) are among the most hazardous of all volcanic processes. These currents can rapidly disperse volcanic material over large areas presenting substantial threats to life and property. PDCs can also generate buoyant plumes of ash (co-ignimbrite) that endanger aviation and result in downwind ashfall hazards. Despite our knowledge of the stratigraphic and sedimentological characteristics of PDC deposits, and the recent advances in laboratory experiments, our comprehension about the flow and emplacement dynamics of these gravity-driven flows is still incomplete. Ongoing studies focus on characterizing physical properties (such as velocity, particle concentration, temperature, and grain-size distribution), and how those properties evolve through time and space, and how they are affected by topography and other external parameters.

Consequently, detailed descriptions of physical and textural properties of volcanic deposits, and physics-based numerical and analogue experiments must be used together to improve the knowledge of the phenomenon and our conceptual models of PDCs transport and emplacement dynamics. Ultimately, such models aim to improve volcanic hazard assessment and forecasting.

This session aims to gather multidisciplinary contributions (such as field surveys,

rock magnetic analysis, numerical models, and laboratory experiments) to investigate internal (dynamic pressure, thermal state, fluid turbulence conditions, granulometry, depositional rate) and external (morphological characteristics, topography confinement, slope angle) conditions of PDCs that potentially affect their energy dissipation, transport mechanisms and depositional behaviour.

Core connection between the proposed session and societal risk mitigation: High-speed, gravity-driven flows of hot particles and gas represent a highly destructive product of explosive volcanism. Despite the numerous historical cases of fatalities provoked by hot gas and ash mixture flows (e.g. Mont Pelée 1902, El Chichón 1982, Soufrière Hills 1997, Mount Unzen 1991, Fuego 2018 eruptions), increasing numbers of people live in the pyroclastic flow paths of active volcanoes. Due to the elevated vulnerability of these populated areas, in terms of human losses and economic damages, we are proposing this session to highlight the importance of a better understanding of the physical processes involved during PDC transport and emplacement. The multidisciplinary approach will contribute to PDC risk mitigation with the development of advanced numerical and analogue models reproducing and simulating probable future events and, therefore, more detailed hazard maps as outputs.



S1.13 > Conciliating research, volcano monitoring and socio-economic issues: advances and prospects in low- to middle- income countries

CONVENERS:

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Allan Derrien *OVPF-IPGP, Bourg Murat, La Réunion, France*

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Volcanic provinces constitute a dilemma regarding our future on Earth. With more than 500 million of inhabitants living near a volcano, eruptions constitute one of the main sources of natural hazards for the humanity. On another hand, volcanic provinces tend to favor the settling of local populations due to the plethora of induced natural resources as geothermal energy, construction materials and fertile volcanic soils.

Considering the continuous growth of the global population, it becomes fundamental to understand today how human activities may develop in volcanic provinces where can exist imbalance between connected natural hazards and resources. It is even truer in low- to middle-income countries where agriculture and tourism represent often the main economic sources and are fundamental

for the survival of local populations. In these countries, it may be particularly difficult develop research programs as well as networks able to monitor active volcanoes, because of limited financial resources, environmental conditions and potential geopolitical troubles.

In this session, we focus on advances in research studies performed in low- to middle-income countries that are oriented towards volcano monitoring and risk assessment which can favour local socio-economic development. In particular, we solicit contributions concerning (i) monitoring prospects, specially if realized by low-cost and easy-deployable systems and, (ii) new protocols merging volcanic hazard assessment and human sustainability. We encourage a focus on volcanic provinces in Africa, Central and South America and Southeast Asia.

S1.14 > Volcano Seismology and Geodesy: Recent Advances in Understanding Volcanic Processes in Methana Volcano, Greece

CONVENERS:

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The build-up of the Methana stratovolcano at the NW corner of the Hellenic arc involved a variety of hazardous phenomena including explosions, pyroclastic flows, and lava flows. Since 230 BC (age of last eruption) the volcano entered a period of volcanic quiescence. We can gain insights into volcanic hazards in Methana by tracking subsurface processes such as magma and hydrothermal fluid migration using volcano seismology, geochemistry and GNSS studies. Moreover, recent advances in analysis and interpretation of seismic and GNSS data

from permanent and non-permanent networks on Methana may facilitate a precise characterization and quantification of the physical processes leading to and producing volcanic phenomena. We welcome submissions that explore new seismic, geodetic and geochemical observations, interpretations, models, instrumentation, or techniques that promote our understanding of volcanic processes and assist in future monitoring efforts at Methana.



S1.15 > Volcanic Degassing: Insights into Volcanic Processes, Impacts and Hazard

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Volcanoes release gas and aerosol particles into the atmosphere during eruptive episodes and by quiescent emissions. Volcanic degassing exerts a dominant role in forcing the timing and nature of unrests and volcanic eruptions. Understanding the behaviour/exsolution of gases dissolved in magma, and measuring their emissions is crucial to characterise eruptive mechanism and evaluate impacts on health, atmospheric composition and environment. Emissions range from silent exhalation through soils to astonishing eruptive clouds that release gases and particles into the atmosphere exerting a strong impact on the Earth's radiation budget and climate over a range of temporal and spatial scales. Volcanic sulphate aerosols may lead to decrease in Earth's surface temperatures for years, and emitted halogens can perturb atmospheric chemistry. Through direct exposure and indirect effects, volcanic emissions may influence local-regional air quality, seriously affect the biosphere and environment, and the

release of gas from soil may pose long-term health-hazards. Gases are measured and monitored via a range of in-situ and remote sensing techniques, to gain insights into both the subterranean-surface processes and quantify the extent of volcano's impacts. Modelling of the subsurface and atmospheric processes, as well as laboratory experiments, are fundamental to the interpretation of the field-based and satellite observations. This session focuses on the state of the art and multi-disciplinary science concerning all aspects of volcanic degassing and impacts of relevance to the volcanology, environment, atmospheric/climate science and hazard assessment. We invite contribution discussing how we go from observations to synoptic understanding of volcanic processes and their impacts.

Core connection between the proposed session and societal risk mitigation: health, atmospheric composition and environment.

S1.16 > Seismicity and ground deformation link in volcanic areas: multidisciplinary approaches and joint investigation over different timescales

CONVENERS:

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Multidisciplinary analysis of data coming from different fields, such as ground deformation and seismic observations, represents a successful strategy to investigate the dynamics of volcanoes. The deformation pattern related to fracture processes or induced by fluid mass movements are often associated with the occurrence of seismicity, and the two phenomena can be interpreted in a unified framework. The time scales involved in these processes span from seconds up to tidal periodicity (diurnal, fortnightly, monthly). This main topic of this session is to provide a contribution to the understanding of the link between ground deformation and seismicity. Indeed, joint analysis of

tilt and seismic data could evidence the relationships between tilt patterns and the rate and energy of seismicity (earthquakes) also on different time scales. The characterization of the kinematics and evolution of crustal deformation associated with volcano activity could allow a prompt identification of eruptive precursors.

In this context, studies concerning the analysis and interpretation of ground deformation are welcome, including tiltmeter, GPS, strainmeter data as well as seismic signals. Contributions adopting innovative techniques or multidisciplinary approaches are strongly encouraged.



S1.17 > Advances in understanding volcanic debris avalanche processes and hazards - from field studies to experimental and numerical modelling applications

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The formation of volcanic debris avalanches (VDA) resulting from the failure of an unstable edifice represents the largest-magnitude hazard from active, dormant and even extinct stratovolcanoes. While these events are much less frequent than other volcanic hazards, they represent by far the most destructive scenario, involving large volumes of debris and potential travel distances of more than 100 km. The 18 May 1980 Mount St. Helens eruption, 40 years ago this month, presented the first opportunity to observe and document the generation and emplacement of a large VDA. These observations integrated with studies of the produced deposits provided a ground-breaking model for the interpretation of similar deposits elsewhere. Consequently, VDA deposits have been recorded at many volcanoes worldwide and their generation through catastrophic edifice failure is now recognised as a common, often recurring phenomenon in the lifecycle of long-lived composite volcanoes. While research since the 1980 event has significantly improved our knowledge of the factors leading to volcano collapse as well as VDA transport and emplacement processes, their complex flow dynamics are still not fully understood. In particular the observed excess runout and transformation into cohesive debris flows pose challenges for accurate numerical modelling and similarly, more precise input parameters are

required for the development of realistic hazard models. We invite contributions from field, experimental and modelling approaches focused on advances in understanding volcanic instability, trigger mechanisms of catastrophic edifice failure, VDA transport and emplacement processes and sedimentary characteristics of the resulting deposits.

Core connection between the proposed session and societal risk mitigation: While volcanic debris avalanches are typically of low frequency, they are a common process at active, dormant and even extinct composite volcanoes worldwide. Their extreme mobility and large volume make them a high-magnitude hazard with widespread, devastating impacts on communities and infrastructure in the surroundings of unstable volcanoes. Such events often occur with little warning, thus in order to mitigate future risk from debris-avalanche generating volcanic edifice failures, it is important to understand their probability and likely scale. Modelling approaches can help test various scenarios and identify areas most at risk of these catastrophic mass flows. As they rely on a range of input parameters such as the nature of past events, present-day geomorphology and up-to-date knowledge of flow dynamics, it is crucial to continue improving our multi-disciplinary understanding of debris avalanche processes



S1.18 > Integrating knowledge of tectonic and magmatic processes with monitoring during periods of volcanic unrest

CONVENERS:

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While volcanotectonic, geophysical and petrogenetic studies attempt to explain how and why volcanoes erupt, volcano monitoring (e.g. ground deformation, seismicity, gas analysis, and thermal imaging) evaluates the active and dynamic state of a volcano. Linking and testing models derived from the study of tectonic and magmatic processes with data from monitored volcanoes is essential on improving eruption forecasting. This remains challenging partly because there lacks a unified model for the dominant processes that drive the formation and arrangement of magmatic plumbing systems.

In this session, we seek contributions related to multidisciplinary approaches and

novel methodologies (volcanotectonics, petrography, experimental volcanology, monitoring, modelling) on linking the effects of active tectonics (regional tectonics, faulting) and magmatic activity (generation and movement of magma in the crust, magma chamber triggering processes, host rock-magma interaction and assimilation), with real-time monitoring (imaging, eruption precursors, data collection and interpretation) during volcanic unrest periods. Our hope is that this session will provide interesting discussions on volcano dynamics related to volcanic plumbing systems and aid in more effective identification and interpretation of volcanic unrest and ultimately develop eruption forecasting.

S1.19 > Volcano deformation: data integration, models, ambiguities and implications for eruption forecasting

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Ground deformation observations are critical components of volcano monitoring, they are able to reveal ongoing and long-term dynamics and, yet used in isolation, they can raise many unanswerable questions about, for example, the type and density of fluids causing deformation, or the total volume of eruptible magma. Like all disciplines, volcano geodesy alone can solve only a part of the problem, revealing some dynamics and hiding or being blind to others. For this session, we seek presentations focused on volcano deformation that integrate geological, geophysical or geochemical data, or conceptual, experimental, analytical or numerical modeling to reduce the ambiguities of interpreting deformation

alone. We also encourage contributions investigating time variable source processes and source evolution constrained by non-geodetic observations, or formally integrating data from multiple disciplines (joint inversions, physics-based modeling, machine learning). Of interest are also investigations into the performance and trade-offs between simple analytical and more realistic and complex source models in time-constrained monitoring or rapid-response settings that analyze impacts of model-biases on interpretations and eruption forecasts, and examples of these results being shared with the public or civil authorities



S1.20 > Submarine Volcanism: volcanic hazards, seafloor monitoring and public awareness

CONVENERS:

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Over 75% of the volcanic activity on Earth occurs under water. Recent increased unrest at many submarine volcanoes raises serious concerns regarding the level of risk posed to local communities. The overall goal of this session is to promote an integrated volcanological and socio-economic approach to underpin new concepts (e.g. for risk monitoring protocols or civil hazard planning), next-generation commercial products (e.g. for in-situ sensors or imaging instrumentation), and innovative services (e.g. for education/training or early-warning systems for society) for understanding the impact of disastrous submarine volcanic hazards on society.

The topics of session should cover, without being limited to, the following

areas: i) documentation and identification of submarine volcanic hazards such as: volcanic eruptions and related seismic activity, submarine landslides, hydrothermal emissions and volcanogenic tsunamis using classical field geology, numeric modeling, and analog experiments, ii) exploration of optimal monitoring technologies and state of the art methods, providing new insights for further exploration and potential exploitation of submarine volcanoes, which host significant hydrothermal deposits, minerals and fauna, iii) volcanic crisis management, general public awareness and preparedness, for a better understanding of the hazards and impacts of submarine volcanoes.

This session is under the aegis of the IAVCEI Commission on Submarine Volcanism.

S1.21 > Volcanogenic tsunamis

CONVENERS:

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The 2018 sector-collapse generated tsunami at Anak Krakatau highlighted the potentially devastating impacts of volcanogenic tsunamis, as well as the current challenges in forecasting the timing of such events. Volcanic tsunamis can be generated through a variety of processes, not all of which are directly associated with or driven by eruptive activity, and have been responsible for a substantial proportion of volcanic fatalities in the historical record. However, the relatively small number of well-observed events, as well as the diverse and complex tsunami sources, means that many aspects of this hazard remain poorly understood, limiting our ability to effectively mitigate this hazard. This session invites contributions researching all aspects of volcanic tsunamis, including volcanological interpretations of individual events and their precursors, investigations of

tsunami source processes, the use of tsunami modelling in developing mitigation strategies, and approaches to monitoring and communication.

In addition to talks and posters, we would like this session to include a discussion aimed at identifying the specific conditions that make volcanogenic tsunamis a challenging hazard to monitor and mitigate, and the approaches required to address this challenge.

The proposed session seeks to define current knowledge of volcanically-generated tsunamis, to identify priorities for improving the monitoring and forecasting of such events, and to explore the challenges and mechanisms of developing effective warning and communication strategies for volcanic tsunamis.



S1.22 > Session: Volcanic tsunamis: generation mechanisms and hazard assessment

CONVENERS:

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In active volcanic areas tsunamis are generated by a variety of mechanisms related to the type of the volcano and the mode of activity. Usually such tsunamis are local or regional but still quite powerful and destructive although the transoceanic ones are not missing, e.g. the 1888 Krakatau tsunami in the Indonesian arc. In this session we seek contributions regarding all aspects of

volcanic tsunamis ranging from the generation mechanisms to propagation modelling and potential impact. Contributions about the lethal volcanic tsunami in Anak Krakatau of 23 December 2018 are mostly welcomed. Of special interest is also the development of instrumental monitoring and warning of volcanic tsunamis particularly in the near-field domain.



S2

SYMPOSIUM 2 Physical Sciences

S2.1 > Volcanoes under pressure: monitoring and biotechnology

CONVENERS:

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Life can be found everywhere on Earth, evolving ways to survive even at the strangest and most inhospitable places such as the volcanic systems. Studying microbes and finding how they can live at volcanoes can help us set the boundaries of life on Earth and get more insights into microbial survival strategies. Microbial monitoring of volcanoes can provide significant genetic and genomic information with potential biotechnological applications. Despite the vast possibilities of environmental biotechnology in providing goods and services to society, only a small fraction of the enormous biodiversity at the extreme habitats of volcanic systems has been explored to date. The aim of this session is to bring together scientists who work on microbial genomic monitoring of volcanic sites in order

to understand the benefits of microbial volcanic exploration and exploitation to society. We particularly encourage submissions of presentations that are related to monitoring work of volcanic sites by using -omics technologies (e.g., genomics, metagenomics, metabolomics) and cultivation-based approaches.

Core connection between the proposed session and societal risk mitigation: The aim of this session is to bring together scientists who work on microbial genomic monitoring of volcanic sites in order to understand the benefits that can bring the microbial volcanic exploration and exploitation to society.



S2.2 > Towards innovative models describing the complex mechanics of debris flows and lahars

CONVENERS:

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Debris flows and lahars are multiphase mixtures made of variable amounts and types of sediment and water. They can be triggered by a variety of processes, like the interaction of explosive volcanic eruptions with a source of water (e.g. crater lake or a glacier), prolonged and intense rainfall remobilizing loose sediments among others. They flow downslope due to gravity and are characterized by a high bulk density and complex particle interactions which explain their capability of transporting large blocks and debris and exerting significant dynamic impact on building and infrastructures.

The intrinsic complexity of the physical processes taking place in these flows has been addressed through different approaches with little or no interaction between them. These include fieldwork, real-time measurements (monitoring), experiments (from laboratory to large scale) and numerical modelling. Bringing them together has the potential to lead to a better understanding of the fluid dynamics and eventually improving the constitutive equations and initial and

boundary conditions required for predictive simulations. Simulation tools, in turn, are fundamental for assessing the hazard related to these processes.

In this session we welcome contributions presenting results from applications of the different approaches described above. We particularly encourage multidisciplinary contributions, e.g. combination of experiments and modelling or exposure and vulnerability analyses for risk assessment. To integrate and discuss multiple sources of information will summarize the challenges still needed in improving our current knowledge of these phenomena and will extend networks focused on designing new and more accurate models for hazard assessment and mitigation strategies.

Core connection between the proposed session and societal risk mitigation: Understanding the physics of debris flows and lahars is of paramount importance for improving our capability to predict the impact of these flows on the environment and human society and then mitigate their hazard.

S2.3 > Looking at eruptive style transitions and patterns of cyclicity in volcanic activity

CONVENERS:

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Diego Coppola Dipartimento di Scienze della Terra, Università di Torino, Turin, Italy

Sylvain Charbonnier University of South Florida, School of Geosciences, Tampa, United States of America

Eruptive style transitions and pattern of cyclicity in eruptive activity have becoming among the main challenging topics in present-day volcanological research. This is because their understanding is relevant for both physical description of volcanic phenomena and hazard mitigation plans. Complex eruptive cycles and alternating eruptive styles have been frequently observed in most volcanoes worldwide, but they are far from being fully understood. In the last few years, new efforts have been devoted to better constrain some physical variables controlling changes in eruption dynamics (i.e. changes in local and far-field stress, geometrical evolution of the conduit feeding system).

In addition, many magmatic/volcanic processes can also be characterized by patterns of cyclicity during both effusive and explosive eruptions. These include

variations in lava effusion rates, gas flux, ground deformation, seismicity as well as any temporal change in the properties of the magma-chamber-conduit system. For this reason, analyzing and modeling these patterns during volcanic activity is fundamental to understand eruptive dynamics and to evaluate current hazards and future scenarios. In this session, we encourage contributions focused on evidence of both eruptive style transitions and increasing, decreasing, stationary, and cyclic eruptive activity, collected by using either single parameter or multi-parametric approaches. The combination of field data, ground- and satellite-based measurements, and numerical modeling are welcome, with special emphasis to the correlation between internal processes, occurring inside the volcano plumbing system, and external phenomena, observed at/above the vent.



S2.4 > Time-scales of magmatic and volcanic processes combining analytical, experimental and field observations

CONVENERS:

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A magma's journey is characterized by a variety of reactions and processes occurring at different timescales, which can be from seconds to hundreds of thousands of years depending on local conditions (e.g., X, T, P, fO₂). Different processes may happen concurrently in the magma chamber (e.g., magma mixing, mingling, crustal assimilation, crystal formation, bubble nucleation) and/or during the ascent of magma toward the Earth's surface (e.g., crystal growth/dissolution, volatile degassing and permeable outgassing, fragmentation), hence controlling the internal dynamics of a volcanic plumbing system, including mechanisms of magma genesis, storage and transfer conditions and eruption style. Furthermore, all of these processes influence the morphology of a deposit and the path of its emplacement depending on the time/temperature conditions.

We want to dissect glasses, minerals and melts, or their volatile emissions, in order to constrain the timescales and location of those magmatic processes and to define the driving parameters of any magmatic plumbing system as it evolves.

This session welcomes contributions that employ analytical, numerical, experimental, geophysical, and field-based methods by volcanologists, geochemists, geochronologists and petrologists addressing rates and timescales of volcanic and magmatic processes. Innovative and interdisciplinary studies are also encouraged in order to improve our knowledge of ever evolving volcanic environments, crucial for volcanic hazard assessment and social support.

Core connection between the proposed session and societal risk mitigation: The most critical parameter to determine when dealing with risk mitigation is time. Volcanic events can be measured in units of seconds up to hundreds of thousands of years depending on local conditions such that a knowledge of these timescales can be of tremendous benefit to both the issues of hazard assessment and response. This session aims at exploring timescales from pre-eruptive processes within a magma chamber to critical phenomena occurring at time of eruption and leading finally to its subsequent course of emplacement.

S2.5 > Rates and dates: magmatic and volcanic processes from source to surface

CONVENERS:

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Timescales of magmatic processes and eruptive histories are fundamental pieces of information required for understanding magmatic systems, and which can contribute to improve short- and long-term eruption forecasting. For example, timescales and rates of crystallisation, degassing and magma ascent are crucial for understanding magma residence, magmatic differentiation, and the driving forces leading to eruption. Knowledge about timing and frequency of past eruptions is essential for accurate hazard assessment, as well as for understanding long-term magmatic evolution at a volcano. Current development of novel

methods, and continued advances in existing analytical and imaging techniques mean that elements, isotopes and rock textures can be measured and analysed at ever improving precision and spatial resolution. We encourage contributions which investigate magmatic timescales and volcanic histories, using a range of techniques including but not limited to, geochronology and radioisotopic dating, uranium-series isotopic analysis, field studies, diffusion modelling and quantitative textural studies.



S2.6 > Uncertainty quantification in volcanic phenomena: an essential component for modeling physical processes and for hazard/risk assessment

CONVENERS:

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Pablo Tierz *British Geological Survey, The Lyell Centre, Edinburgh, United Kingdom*

Mary Grace Bato *NASA Jet Propulsion Laboratory, Pasadena, CA, United States of America*

Sebastien Biasse *Earth Observatory of Singapore, Nanyang Technological University, Singapore*

Gabrielle Tepp *U.S. Geological Survey, Alaska Volcano Observatory, Anchorage, AK, USA*

Samantha Engwell *British Geological Survey, The Lyell Centre, Edinburgh, United Kingdom*

Volcanic phenomena are affected by a high degree of uncertainty, both epistemic (i.e. related to incomplete knowledge of the phenomena themselves) and aleatoric (i.e. linked to the physical variability typical of complex natural systems). Uncertainty quantification (UQ) is a fundamental task in hazard and risk assessment (e.g. for emergency management and long-term planning) and is essential for making advances in modeling physical processes. UQ has a significant effect on the solution to many different problems in volcanology, both the inverse problems aimed at the reconstruction of past events and the forward problems aimed at the forecasts of future events. These problems include:

- The calculation of eruptive parameters, such as the mass of different volcanic phenomena (fallout, PDC, etc.), the mass flow rate at the eruptive vent/fissure, and the maximum or average plume height. The uncertainty in this case defines the probability density function of input parameters to the models of volcanic processes.
- The definition of the behavior of the volcano, including the spatial location of eruptive vents, the temporal estimates of eruption onset and duration, and the probability of different eruptive styles and/or hazardous phenomena.

- The modeling of volcanic phenomena, especially in those approaches where great simplifications have been introduced to allow the reduction of computational times (e.g. 1-D integral plume models; Gaussian Tephra transport and dispersal models; kinetic, integral, or depth-averaged mass flow models). UQ is in this case crucial to define the limits and the advantages of each model, through the comparison with past data.

UQ can be performed with different approaches, including the application of expert judgement techniques, the comparison of different sampling/integration techniques for measuring field data, the employment of different multi-model procedures and modeling benchmarks for numerical simulations, stochastic processes, event trees, and Bayesian networks.

In this session we welcome contributions that cover this wide spectrum of UQ of volcanic phenomena, with a specific focus on those studies focused on modeling of physical processes and/or those which provide a direct application of the results to hazard/risk assessments (e.g. hazard or risk maps obtained through approaches that consider all the above mentioned problems).



S2.7 > Multidisciplinary approaches to caldera deformation studies

CONVENERS:

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Calderas are very complex volcanotectonic systems with possible long dormant periods. Active and recent calderas can pose a very high threat to large populations and infrastructure. Caldera structures can span up to tens of kilometres and their origin can be linked to magma dynamics, gravity and regional tectonics. Frequently, their deformation history shows inversion of movements from subsidence to uplift and vice versa. The understanding of caldera evolution can benefit from research carried out at active systems as well

as at ancient eroded structures. Studies from different disciplines are welcome, in order to emphasize how different approaches, possibly in synergy, can improve knowledge. Among possible approaches, but not limited to, there are field and offshore geological-structural and morpho-stratigraphic studies, geophysical exploration methods, geodesy, interferometry, seismology, numerical modelling and analogue experiments that lead to an interdisciplinary approach to a better understanding of caldera dynamics.

S2.8 > Source to surface magma transport at small-volume intraplate basaltic volcanoes

CONVENERS:

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Understanding the sub-volcanic journey of magma from mantle source to surface in small-volume basaltic volcanic fields is critical for improved assessment of volcanic hazards. Magma transport pathways from the mantle may be direct and rapid, or more complex, involving storage and evolution and so provide greater warning time of an eruption. In this session we welcome contributions that unravel the pathways, dynamics and timescales of magma ascent at small-

volume continental basaltic 'monogenetic' and 'polygenetic' volcanoes. The session covers studies utilising but not limited to: field relations in exposed plumbing systems, geophysical imaging, paleomagnetism, the petrography and mineralogy of erupted rocks and associated xenoliths, whole-rock geochemistry and isotopes. We welcome contributions at the scale of single-volcanic centres to field-wide studies.



S2.9 > Magma fragmentation: primary volcanic deposits, their clasts, experiments and models, and an open discussion

CONVENERS:

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Tobias Dürig *Geology Department, University of Otago, Dunedin, New Zealand* | tobias.durig@otago.ac.nz

Bettina Scheu *Department für Geo- und Umweltwissenschaften, Ludwig-Maximilians-Universität München (LMU), München, Germany* | b.scheu@lmu.de

Magma fragmentation is a fundamental process of volcanism, and its mechanisms have important hazards implications for active volcanoes and monogenetic volcanic fields, since some eruptive styles are more dangerous than others to humans and infrastructure. Learning about magma fragmentation mechanisms for unwitnessed eruptions (and even witnessed ones) builds understanding of eruptive energy partitioning, and helps build a picture of “what this volcano (or volcanic field) can do”, supporting risk mitigation.

This special session aims to bring together scientists working on magma fragmentation processes – and the state of the magma before fragmentation in all environments and from all different perspectives. This includes the study

of primary volcanoclastic deposits on land or in water, with particular focus on juvenile clasts (particle density, shapes, surface features and internal textures), all relevant laboratory experiments, and physical models for fragmentation.

This is intended as a full-day event. The morning will consist of regular talks. In the spirit of moving “towards more interactive configurations”, the afternoon will be an open community discussion about methodological best practices and protocols for juvenile pyroclasts studies. The current lack of a standardized methodology makes comparisons between different studies and laboratories very difficult. The afternoon discussion will aim to take steps towards convergence.

S2.10 > Extant and extinct shallow submarine hydrothermal geobiology laboratories and ore-forming systems in volcanic-arcs

CONVENERS:

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Modern and fossil geothermal systems associated with shallow submarine and emergent arc-volcanoes constitute sources of seawater acidity, energy donors for marine microbial communities and, analogues for ore-forming systems that have produced minable metal deposits; these attributes result from a complex and dynamic interplay between geothermal, metallogenic, biological and volcanotectonic processes. The Aegean is a world renown type locality for interdisciplinary data derived from such systems associated with shallow submarine (<500m) (Kolumbo, Santorini) and submarine-to-subaerial (Milos) components of the Aegean Volcanic Arc (HVA), S. Aegean Sea, Greece. Actively forming polymetallic seafloor massive sulfide mineralization at Kolumbo, is enriched in critical metals/metalloids (Sb, Tl, Hg, As, Au, Ag, Zn) and exemplifies mineralization across the submarine-subaerial transition, whereas at Milos this style of mineralization has been uplifted and preserved intact providing

on-land analogue of hybrid epithermal-to-VMS mineralization. Milos hosts the first identified <1 Ma biogenic fossiliferous sedimentary iron formation comparable to Precambrian banded iron formations (BIFs); Santorini caldera, may constitute potential analogue for geobiological formation mechanisms of Fe-rich chemical sediments in the Precambrian rock record. Ore-grade Mn-Ba beds, associated with the Milos IF, typify Microbially Induced Sedimentary Structures formed due to interaction of littoral sedimentation, white smokers and active photosynthetic and/or chemotrophic microbial activity. We welcome contributions from the Aegean or elsewhere, related to the implications of such systems for understanding ocean acidification and CO₂ leakage and benthic accumulations from subsea carbon capture and storage sites, Fe-Mn biomineralization, submarine metallogenesis, volcanic hazard preparedness, and submerged metal and critical raw material resource potential.



S2.11 > Urban planning and Volcanic Derived Construction Materials

CONVENERS:

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To reduce the economic and environmental impacts of cement industry, supplementary cementitious materials, including Volcanic Derived Construction Materials, can be used as partial replacement of cement in concrete. The partial replacement of cement will cause the immediate reduction of the concrete manufacturing costs and will make it possible substantially to decrease the gas emissions for purpose of greenhouse, minimize thus the harmful environmental impacts. Additionally it will reduce the consumption of natural resources and energy. Nowadays, due to the rush towards sustainability, many countries have adopted a sustainable development program based on the use of the supplementary cementitious materials, namely natural pozzolanic materials.

The local availability (and better quality control of raw materials) of natural volcanic pozzolans in significant quantities is promoted as a cheap alternative for the adoption of activated cements and concretes on an industrial scale.

Additionally soils derived from volcanic ash are common in several countries including Greece, Turkey, Iran, Cameroon, Japan, China, Saudi Arabia, Jordan, Italy, USA, Mexico, Chile, Ecuador and Colombia. Natural volcanic pozzolan deposits, glassy or zeolitic, are usually concentrated in areas of high demographic and economic growth, while southern Europe is the original source of pozzolans. Besides natural pozzolanas, volcanic derived construction materials include glassy and Zeolitic tuffs used for the production of environmentally friendly building blocks, used in construction since the antiquity. Examples exist in South and Central Italy, Greece, Bulgaria, Romania and Hungary. Perlite is also a multifunctional raw material of volcanic origin, used with the form of grains, after expansion for the production of lightweight aggregates and concrete, but also used after cutting and finishing as building blocks. Examples exist from Greece, Bulgaria, Sardinia Italy and Turkey.

S.12 > Pre-eruptive magmatic processes and their timescales: how to utilize them for the mitigation of volcanic risk?

CONVENERS:

Eugenio Nicotra *Università della Calabria, Italy*

Teresa Ubide *University of Queensland, Australia*

Maren Kahl *Universität Heidelberg, Germany*

Patricia Larrea *Universidad de Chile, Chile*

Marisa Giuffrida *Università di Catania, Italy*

Volcanoes are among the most important natural hazards able to produce serious consequences to human habitats and large-scale economies. A global understanding of how magmatic processes work prior to eruption plays a fundamental role in the assessment of volcanic hazard and the mitigation of potential risk.

During the last two decades, the advancement in volcanic monitoring networks, together with the development of more precise and accessible analytical techniques, have led to better constraints on the physical and chemical processes affecting magmas *en route* to the surface (i.e., storage/crystallization conditions, contamination, mixing, degassing). Great advances in the calculation

of timescales of pre- and syn-eruptive processes have brought new insight into the mechanisms and durations of magma residence and ascent throughout the lithosphere. Nonetheless, a great point of discussion is still related to how this knowledge can contribute to the definition of plans of mitigation of volcanic risk, also in terms of highlighting of eruptive precursors.

We invite submissions related to field and experimental volcanology, petrology, and geochemistry, that contribute to improve our current knowledge on magma dynamics and pre-eruptive timescales, and explore how these results can be linked with other disciplines and/or technologies, in terms of mitigation of volcanic risk.



S2.13 > Interdisciplinary reconstructions of the impact of past volcanic eruptions on climate and society

CONVENERS:

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Volcanic eruptions can affect climate and societies over a range of spatial and temporal scales. Understanding the impact of past eruptions is critical for the assessment and mitigation of future volcanic risk. Reconstructing past eruption impacts requires interdisciplinary approaches at the intersection of geology, history, archaeology, dendrochronology, ice-core and climate science. Combining methods from multiple disciplines provides a more detailed understanding of the number, timing, circumstances, and impact of eruptions. This multidisciplinary approach is critical in regions lacking eruption chronologies, but can also yield important insights even at volcanoes with highly constrained eruption histories. At any volcano, such information is fundamental to appropriately assess its hazards. Given the uncertainties in observations, paleoclimate estimates, and model simulations, this session aims to provide a multidisciplinary interface to discuss direct or indirect causal relationships between the timing and magnitude of volcanic eruptions and climate variability and societal events. Under the remit of the PAGES (Past Global Changes) Volcanic Impacts on Climate and Society (VICS) Working Group, we invite presentations of state-of-the-art results on volcanic

impacts on climate and society, combining methods using ice-core, tree-ring, geological, historical and/or archaeological records. We hope to discover and discuss new results on the history, archaeology and anthropology of direct or indirect climatically mediated consequences on past human societies.

This proposal is endorsed by the Volcanic Impact on Climate and Society (VICS) working group from PAGES.

Core connection between the proposed session and societal risk mitigation: This session focuses on the reconstruction of the impact of past volcanic eruptions on climate and society using multidisciplinary methods. Major explosive eruptions (>VEI 5) have occurred during the Quaternary on a frequency and magnitude (e.g., Toba super-eruption) far beyond the range of contemporary human experience. Studying the impacts of such eruptions in climate model simulations, as well as examining the fingerprints of such eruptions in geologic deposits (e.g., ice cores) and proxy records (e.g., tree-rings and others) provides valuable insight into the likelihood and consequences of this major geological and climatic hazard.

S2.14 > Sustainable use of geothermal activity and environment friendly power generation

CONVENERS:

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Geothermal energy is a renewable energy source (RES) with a low environmental impact, low greenhouse gas emissions and feasible technology providing power over time regardless the weather conditions. It is a RES that presents a rapid growth worldwide as recent technological advances expanded the range and size of viable resources making it exploitable for a variety of uses. Geothermal energy can be used over a range of temperature to supply electricity, heat and cool. Taking into consideration the expanded use of the geothermal energy, a plan for its sustainable use in addition to an estimation of the field's renewable power capacity, should be developed.

Geothermal power plants can provide clean and renewable energy and can be proposed as integrated units for simultaneous production of cooling and power. However, generating electrical power from geothermal activity is likely to have environmental impacts, which include gaseous emissions, water pollution, land usage, solids emissions to the surface and the atmosphere. In this session, we call for contributions from scientists who work on the sector of the geothermal activity to introduce exploitation updates, breakthroughs and innovation techniques under the perspective of the geothermal energy.



S2.15 > The Role of Tectonics on the Emergence and Evolution of Volcanic Features

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Volcanism is related to the plate tectonics geodynamic processes, usually occurring along divergent plate boundaries or within back-arc basins of converging boundaries above subduction zones. In most cases, the volcanic features appear within tectonic grabens, forming rift zones of the upper crust, both onshore and offshore. Thus, volcanoes may be aligned along tectonic trends, indicating the intermediate stress axis of the dominant extensional field along the rift zone. More rarely, strike-slip fault zones may also control volcanism, with more complex relationships between volcanic features and tectonic stress orientation. The evolution of the tectonic structures may control the evolution of the successive volcanic centres as well as their geometry. The opening and deepening of the rift zones in marine basins is accompanied by the appropriate

growth of the volcanism and its volcanic relief, driving to the emergence of volcanic islands. The migration of the volcanic activity to another rift zone may follow the overall migration of the convergent boundary within a geological time frame of several millions of years, depending on the rate of subduction and subsequent deformation in the back-arc area. The relation between tectonics and volcanism can be studied both in active volcanic areas as well as in older, eroded volcanic successions. The overall volcanic evolution can be studied against the tectono-sedimentary evolution of the hosting basin with comparison of slip rates of synsedimentary faulting and sedimentation rates throughout the basin's evolution. In this session, worldwide examples of the above relations in active or ancient volcanic areas may be presented and discussed.

S2.16 > What do volcano seismo-acoustic signals mean?

CONVENERS:

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Connecting seismic and acoustic signals recorded around volcanoes to subsurface and subaerial processes is crucial for improving monitoring, as well as for eruption forecasting and characterization. In particular, combining seismic and acoustic data with theoretical, numerical, conceptual, and probabilistic models has become essential to identify repetitive patterns, the opening of fractures and cracks beneath the surface, the transfer of magma through the crust and shallow subsurface, the accumulation of gases beneath volcanic craters, eruptive activity of varied styles, surficial mass movements, or the sensitivity of volcanoes

to external forces (e.g., far-field earthquakes, tidal stresses). In this session, we invite contributions focused on the study of seismic and/or acoustic signals around volcanoes and the robust interpretation of these signals. We encourage presentations that combine seismic and/or acoustic data with other observables, data science, and cutting-edge modeling techniques aiming to shed light on new monitoring strategies to better forecast the onset, duration, intensity, and end of volcanic events.



S2.17 > Time after Time

CONVENERS:

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Unraveling the timescales at which magmatic processes take place at depth prior to eruption is crucial to improve the interpretation of monitoring data. In particular, the combination of petrological and geochemical analyses with monitoring data has become an essential working strategy to understand the reactivation of magmatic plumbing systems, and therefore to improve the interpretation of the eruption precursors and potentially improve the

forecasting of volcanic activity. In this session, we invite contributions focused on the timescales of magmatic processes and the evolution of plumbing systems, especially proposing a timeline of the magmatic system evolution. We encourage presentations connecting processes at depth to ground-based and satellite-based monitoring data, including but not limited to seismicity, deformation, gas and heat emissions.

S2.18 > Linking remote and local monitoring data through physical volcano models to understand and forecast unrest

CONVENERS:

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Understanding volcanic systems and predicting their behavior through volcano physical models constrained by in-situ and remotely sensed data is an area of increasing importance as the amount of data available grows. Ground-based monitoring data form the backbone of volcano monitoring, yet many volcanoes are poorly instrumented and/or the instrumental network is too sparse. On the other hand, space-based instruments offer complementary information thanks to their spatial resolution, broad coverage, and global reach, yet remain discrete in time. As remotely sensed data grow, particularly satellite multispectral and interferometric synthetic aperture radar (InSAR), the potential to constrain active magma sources, identify physical processes, and forecast volcanic behavior increases. When possible, combining both local and remote monitoring observations greatly increase our ability to advance scientific understanding and improve volcano monitoring. In particular, combinations of time series from satellite remote sensing observations (e.g., thermal infrared, TIR; visible-short-wavelength infrared, VSWIR; ultraviolet, UV; InSAR) with *in-situ* observations (e.g., seis-

mic; gravity; Global Navigation Satellite System, GNSS; tilt meter) are proving increasingly relevant to test physical models of magmatic systems. When combined with model parameter estimation methods (e.g. Bayesian inference; Ensemble Kalman Filter), volcano system parameter forecasting on time-scales relevant to observatories become increasingly possible. In this session, we invite contributions focusing on the observations of unrest, eruptions, and longer-term volcanic processes, as well as contributions demonstrating the implementation of analytical, experimental, and numerical models to gain understanding of volcanic system physics towards improving hazard mitigation.

Core connection between session and societal risk mitigation: Remote sensing satellite data (multispectral, InSAR) are increasingly being combined with in-situ data (if they exist) to improve both tracking unrest and constraining physical volcano models which have the potential to inform decision makers regarding eruption forecasts.



S2.19 > Magma fragmentation: primary volcanic deposits, their clasts, experiments and models, and an open discussion

CONVENERS:

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Magma fragmentation is a fundamental process of volcanism, and its mechanisms have important hazards implications for active volcanoes and monogenetic volcanic fields, since some eruptive styles are more dangerous than others to humans and infrastructure. Learning about magma fragmentation mechanisms for unwitnessed eruptions (and even witnessed ones) builds understanding of eruptive energy partitioning, and helps build a picture of “what this volcano (or volcanic field) can do”, supporting risk mitigation.

This session aims to bring together scientists working on magma fragmentation processes – and the state of the magma before fragmentation – in all environments and from all different perspectives. This includes the study of primary volcanoclastic deposits on land or in water, with particular focus on juvenile clasts (particle density, shapes, surface features and internal textures), all relevant laboratory experiments, and physical models for fragmentation.



S3

SYMPOSIUM 3

Civil protection, education, community members, news media, citizen science, hazards and risk specialists

S3.1 > Health hazards and environmental impacts associated with volcanic eruptions: emissions, exposure and response

CONVENERS:

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Volcanic eruptions pose a considerable threat to the wellbeing and livelihoods of communities living near active volcanoes, where a range of potential human health and environmental impacts may arise following an eruption. In addition, exposure to volcanic pollution may adversely impact downwind environments and populations, notably in the event of active and passive degassing, ashfall, and resuspension of deposited material, since ash and gases can be transported over great distances. Human physical health can be affected in various ways, including fatalities and injuries from pyroclastic flows/surges, lava flows and ballistic projectiles, whereas exposure to fine-grained ash and gases can exacerbate or

induce respiratory diseases and symptoms, and eye and skin irritation. Other, more indirect, effects include contamination of water supplies and crops, and psychological distress related to the eruption crisis.

A recent period of unrest (2011-2012) at Santorini volcano (Nea Kameni), Greece, raises concerns about the possibility of a future gas and/or ash emission crisis. Consideration of such hazards, and those from existing passive degassing on other islands like Nisyros, are of importance because of their potential impact on population health and the overall economy of Greece. Co-ordinated, multi-disciplinary efforts are needed to assess and successfully prepare for health



hazards associated with volcanic phenomena, and to provide timely advice to anxious populations and emergency managers during volcanic crises.

In this session, we welcome submission of abstracts from a broad range of disciplines relating to human and environmental health in volcanic areas, including: i) community exposure and protection, ii) health hazard and impact assessment (mineralogical, toxicological, clinical and epidemiological studies), iii) air and water quality monitoring and forecasting, iv) risk assessment and hazard management, including modelling studies predicting impacts from future eruptions, v) community preparedness and response to volcanic eruptions.

This session is sponsored by the International Volcanic Health Hazard Network (IVHHN).

Core connection with societal risk mitigation: Volcanic eruptions pose a considerable threat to the wellbeing and livelihoods of communities living near active volcanoes. Co-ordinated, multi-disciplinary efforts are needed to assess and successfully prepare for health hazards associated with volcanic phenomena, and to provide timely advice to anxious populations and emergency managers during volcanic crises.

S3.2 > Outreach Exchange

CONVENERS:

The Cities and Volcanoes Commission Executive Board

Carolyn Driedger Cascades Volcano Observatory, Vancouver, WA, United States of America | driedger@usgs.gov

Natalia Deligne GNS Science, New Zealand

Gustavo Villarosa National Scientific and Technical Research Council, Buenos Aires, Argentina

Tom Wilson Department of Geological Sciences, University of Canterbury, New Zealand

Graham Leonard GNS Science, New Zealand

The COV Outreach Exchange is an informal 90-minute session for the sharing of volcano-related educational projects and products. Participants are asked to prepare a thirty second to four-minute presentation about the project or product's purpose, scope, and broader availability. Convenors encourage

participants to bring product descriptions, samples, copies for distribution, materials for demonstration, and files for viewing on a computer. Observers are warmly welcomed. A presenter sign-up list will be available at the start of COV11.



S3.3 > Communicating across the science, policy, and user domains: considering relevance, legitimacy, and credibility of communication tools

CONVENERS:

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Sarah Beaven University of Canterbury, New Zealand

Amy Donovan University of Cambridge, United Kingdom

Carolyn Driedger USGS, United States of America

Micol Todesco INGV, Italy

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Volcano observatories have adapted to provide numerous communication strategies and policies to disseminate information about volcanic behaviour and potential hazards to stakeholders. These tools differ between countries but typically include: call-down lists, warning systems, bulletins, social media, stakeholder meetings and plans, and personal communication between the decision-makers. These can be described as either information provision or knowledge sharing, depending on whether they allow for one-way (uni-valent) or two-way (multi-valent) communication. These tools can be general, event, or time driven and are usually implemented under policies devised at either national or local levels.

It is widely accepted that the effective use, value, and deployment of information across science-policy interfaces of this kind depend on three criteria: i) the scientific credibility of the information or knowledge, ii) its relevance to the needs of stakeholders, and iii) the legitimacy of the information or knowledge, the processes that produced it, and the outcomes of decisions based upon it.

In this interactive participatory session, we invite contributions to explore the capacity of communication tools to enhance the relevance, legitimacy, and

credibility of knowledge sharing and decision-making across the science, policy, and user domains using translation and two-way communication. The conveners will host a 'campfire' discussion that enables participants to create content themselves through discussions and mini presentations (of varying formats), and a Q&A. This provides the opportunity for participants to learn from their peers, share experiences, and build new connections that may result in guidance on the varying tools available to assist stakeholders and policy globally.

Core connection with societal risk mitigation: This session explores the interaction of volcanic science and societal risk mitigation by focusing on how different stakeholders communicate across different policies and user groups. This session focuses not just on 'multi-valent' two-way session communication in terms of volcanic practices, but also by the nature of the session set up. Using a 'Campfire' style, this session will be facilitated by the conveners to enable the participants to create content themselves through discussions and mini presentations (using PowerPoint, or posters, or other tools), and a Q&A. It is hoped this session will attract a wide diversity of stakeholder attendees to really focus on multiple perspectives of risk mitigation.



S3.4 > State of the Volcanic Hazard Map: Crisis and scenario mapping

CONVENERS:

On behalf of the Hazard Mapping Working Group part of the IAVCEI Commission on Hazard and Risk

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Volcanic hazard maps are visual, spatial depictions of the areas that could be potentially impacted by volcanic phenomena. They can represent a common reference point for discussion and mitigation of volcanic risk when developed, communicated, and used appropriately, as they put all parties quite literally “on the same page” of hazard information. Although most volcanic hazard maps show similar types of content, such as hazard footprints, they vary greatly in input data, communication style, appearance, visual design and their purpose.

Hazard maps used to communicate during volcanic activity sometimes vary from those used to produce during quiescence. These maps, known as crisis or short-term maps, are crucial visual communication tools used within a wide variety of hazards (e.g. wildfires, earthquakes, flooding) and have been developed for recent

volcanic events (e.g. Kilauea, Fuego). The hazard areas used on these maps have been informed by real time field data or based on historical scenarios. They need to be compiled, designed and updated rapidly in order to meet the demands and expectations of many different users. Additional information, such as evacuation centres, are also often used alongside hazard data, meaning there are unique design challenges.

This session welcomes discussion around the development, use and effectiveness of all volcanic hazard maps. However, we encourage submissions that address techniques and frameworks used to develop rapid maps during a volcanic crisis and those willing to share their experiences regarding how hazard maps are interpreted and used by diverse audiences during volcanic activity.



S3.5 > Evaluation and quantification of errors and uncertainty in models and data to support volcanic hazard and risk assessment

CONVENERS:

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Errors and uncertainties are inherent components in any attempt to observe, measure and predict ('model') our volcanic environments and their impacts on society. Epistemic uncertainty arises from a lack of perfect knowledge of the physical system, the possibility of alternative models, and limitations in our ability to pragmatically describe the system. Aleatoric uncertainty is associated with the difficulty of measurements of the natural phenomenon, the scarcity of data, the limited repeatability of observations, and irreducible randomness of volcano behavior. While we can work to reduce both epistemic and aleatoric uncertainty, they can never be eliminated; thus, it is important to quantify them when conducting any volcanic hazard assessment. The presence of errors or uncertainties do not necessarily make any model or data invalid; rather, effective assessments of accuracy and uncertainty can (1) identify limitations, (2) support model calibration, validation and benchmarking, and (3) give confidence in measurements and predictions. Furthermore, well constrained measurements of differences between reality and modelled/measured systems can improve our understanding of volcanic processes, support critical assessment of risk and ensure decisions are made using the best available data and models.

This session aims to bring together scientists and practitioners to improve our understanding of volcanoes, their hazards and risk through the measurement, analysis and quantification of errors or uncertainty in both models and data. We

welcome submissions from all aspects of volcanic environments, hazards and risk that quantify, use, and account for uncertainty in numerical, statistical and experimental models, as well as field, laboratory and remote sensing data. This session is supported by the IAVCEI Commissions on Statistics in Volcanology and Volcanic Hazards and Risks.

Core connection between the proposed session and societal risk mitigation: Errors and uncertainties are present in all models and data of volcanic processes as well as in assessments of hazards, risks and benefits to society. Despite their pervasiveness, their evaluation and quantification is sometimes limited in volcanic hazard and risk assessment. This session seeks to open discussions on error and uncertainty, highlighting the benefits that quantification of data/model errors and uncertainties can bring and demonstrate ways it can enhance decision making for risk mitigation. Examples of submissions we expect to this session include model validation and benchmarking studies, model averaging approaches to improve hazard estimates and techniques to measure error/uncertainty in field and laboratory data. This session will be most relevant to decision makers such as volcano observatories, government officials and civil protection authorities who need to make effective decisions despite the presence of errors and uncertainty.



S3.6 > Culture, Ethics and Religion in Disaster Mitigation and Recovery

CONVENERS:

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Roger Abbott *Faraday Institute for Science and Religion, Cambridge, United Kingdom*

Amy Donovan *University of Cambridge, Cambridge, United Kingdom*

There is an increasing recognition that it is important to take account of the cultural and religious practices and beliefs of populations at risk from volcanic disasters when planning for mitigation, and emergency response to crises. Whilst we recognise that there have been encouraging signs of advancement in this recognition recently, we believe there is still room for improvement, so that a far more efficient delivery of aid results and mitigation strategies are owned by the local population. Local communities should be more involved in consultations concerning what aid is required and also in forming mitigation strategies that these communities can legitimately claim ownership of, so that they feel empowered by them.

This session will explore how scientific knowledge can be combined with an

understanding of the local cultural and religious practices in disaster mitigation, preparation, emergency response and recovery. We welcome contributions from physical and social scientists, ethicists, and aid workers with case studies and examples from a wide range of religious and cultural settings. Multidisciplinary collaboration between science, culture and religion will benefit emergency response and the affected communities. We welcome talks on how local religious and cultural beliefs affect the way that volcanoes are perceived by the public community, and on religious and cultural influences on hazard perception and disaster mitigation. We also welcome examples of the role of religion and faith communities in developing local emergency response protocols and practices.

S3.7 > How the arts and humanities can improve warnings of eruptions: innovation in engaging communities at risk

CONVENERS:

Karen Holmberg *New York University, United States of America* | karenholmberg@nyu.edu

Christopher Kilburn *University College London, United Kingdom*

Anna Hicks *British Geological Survey, United Kingdom*

Kate Walker *University College London, United Kingdom / Royal Academy of Dramatic Art, United Kingdom*

Maria Laura Longo *University of Naples, Italy*

How communities see their local volcano is often conditioned by a complex mixture of culture and natural heritage. Scientific ideas can become altered by selective filtering and can hinder confident responses to warnings of eruptions, especially at volcanoes reawakening after several generations in repose. Faded memories of eruptions can engender uncertainty in warnings and mistrust of official advice. Trust is improved by community engagement, which is enhanced by building on a community's cultural and artistic frames of reference rather than relying on the science-based instructions conventionally issued by civil protection agencies. Instead of presuming that communities understand the science behind warnings, official advice may be received more readily when expressed as part of a community's existing narrative of volcanic behaviour.

This session invites anyone with relevant practical and research experience, including earth scientists, social scientists, science communicators, art-science

collaborators, and civil protection officials to discuss how trust in warnings can be improved by engaging communities through artistic expression, education, celebration and conservation. Early-career researchers are especially welcome. Essential questions include: How can we make memories relevant to understanding the future? What new roles can museums, oral histories, and dramatic presentations play in raising understanding of warnings - and reducing risk - in local communities? Can volcanological understanding be improved by reinterpreting volcanic behaviour in terms of cultural history? Addressing these questions will provide an exceptional opportunity to share local experiences, establish a network of institutions and activities, and encourage a new generation of 'inspirational ideas' to design best practices for application in wider volcanic contexts.



S3.8 > Mt. Baekdu volcano: Risk Perception and Preparedness (Volcanic risk: evaluation and mitigation)

CONVENERS:

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Mt. Baekdu (or Baekdu Mountain), also known as Paektu Mountain (in North Korea), and as Changbai Mountain (in China), is a potentially active volcano on the Chinese-North Korean border. With the summit at the altitude of 2,750 m, it is the highest mountain of the Changbai and Baekdudaegan ranges. Koreans hold a mythical quality for the volcano and its caldera lake, considering it to be their country's spiritual home. A large crater lake, called Heaven Lake (Cheonji; 天池), is in the midst of caldera atop the mountain, formed by the VEI 7 "Millennium" eruption of AD 946, which erupted about 100-150 km³ of tephra. This was one of the largest and the most violent eruptions in the last 5,000 years. Between 2002 and 2005, that tranquility came to a rumbling halt as a swarm of earthquakes shook the mountain's slopes. Like a restless giant, though, whatever rumbled beneath the volcano rolled over and went back to sleep afterwards. It's way too soon to judge whether future eruptions are possible, but the partially melted magma suggests that whatever is fu-

eling Mount Baekdu's outbursts is not quite yet done. And many scientists agree on that an explosion on the scale of the volcano's AD 946 outburst could be catastrophic. Preparedness is the key to mitigation of the disastrous effects of a super-eruption. We will discuss the geology, magma genesis, historic eruption records, monitoring the unrest and precursor of recent activities, preparedness and mitigation of the potential disasters in the near future.

Core connection between the proposed session and societal risk mitigation:

- *Magma plumbing system, evolution and historic explosive eruption (VEI 7) of the Mt. Baekdu*
- *And monitoring the unrest and precursors of recent activities*
- *Potential impact from eruption including lahars, PDC and ash dispersion*
- *Preparedness and mitigation of the potential disasters in the near future.*

S3.9 > Probabilistic volcanic hazard assessment: from numerical modeling to benefits for society

CONVENERS:

Silvia Massaro *Istituto Nazionale di Geofisica e Vulcanologia, Bologna, Italy*

Pablo Tierz *British Geological Survey, The Lyell Centre, Edinburgh, United Kingdom*

Mattia de' Michieli Vitturi *Istituto Nazionale di Geofisica e Vulcanologia, Pisa, Italy*

Sarah Ogburn *USGS/USAID, Volcano Disaster Assistance Program, United States of America*

Karen Strehlow *GEOMAR Helmholtz Centre for Ocean Research Kiel, Kiel, Germany*

In the last decades, the study of volcanic hazard in a probabilistic framework has become one of the most rapidly developing topics in volcanology, but also in decision making and education, in particular for risk mitigation issues. A number of tools (either methodological or numerical) have been developed to help scientists apply quantitative methods in different volcanic settings. Of paramount importance is then quantifying uncertainties (both aleatory, which reflects the intrinsic natural variability of eruptive processes, and epistemic uncertainty, due to our limited knowledge on such processes).

In this scenario, numerical models can reproduce volcanic processes under different conditions and their impacts over a wide range of spatial and temporal

scales, hence assisting a more focused use of sound statistical methods to assess volcanic hazards (e.g. sector collapses, lahars, pyroclastic flows, debris flows, lava flows, ballistic dispersal, gas dispersal). This session aims to collect contributions from numerical modeling to the evaluation of volcanic hazards through probabilistic techniques in order to highlight their applications in long- and short-term PVHA.

Since civil protection and researches have been focused on the public's understanding of volcanic hazards, particular attention should be paid to education programs. Therefore, we also encourage contributions that discuss about applications of PVHA for education and civil protection purposes.



S3.10 > Volcanic risk analysis as a tool for crisis management

CONVENERS:

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History has shown that successful volcanic risk and crisis management strongly correlates with proactive risk reduction policies and practice being in place before a volcanic crisis begins. Such policies and practice should ideally be co-developed by scientists and stakeholders based on comprehensive understanding and analysis of the volcanic risk that encompass the characterization of elements at risk and the full spectrum of vulnerability types associated with volcanic hazards. Volcanic risk assessments and related products and services are useful for decision makers such as national and local civil protection organization authorities before the event (long term), during the event (short term) and after the event (long-term). The UN Sendai Framework for Disaster Risk Reduction (SFDRR) recognizes that national and federal authorities have the primary role to reduce disaster risk; however

local governments, communities, the private sector and other stakeholders need to be involved in the process. Hence, comprehensive and effective risk assessments and related products and services should be co-designed and co-produced by scientists and stakeholders to answer specific needs and to enhance preparedness for effective response (e.g. SFDRR Priority 4).

We welcome contributions presenting innovative strategies and good practice on how volcanic risk assessments and related products and services facilitate real-time decision-making processes, improve emergency planning for future events, development of early warning systems and resilience action planning. Contributions describing the main challenges communicating risk to the public and local authorities are also invited.

S3.11 > The path from volcanic hazard to risk analysis

CONVENERS:

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Volcanic risk analysis is very complex given the interaction of multiple hazards, vulnerability dimensions and exposure acting dynamically over space and time with the potential of high impact on society. Additionally, the uncertainties associated both with the hazards and the effects of cascading hazards and impacts require accurate description.

This theory is fine, but the reality at many active volcanoes is very different. The data needed to fully analyse risk (or even exposed elements) can be insufficiently or inaccurately catalogued or even totally lacking, and risk is dynamic, constantly shifting during the course of unrest, eruption and post-eruption time period. In addition, no comprehensive methods for vulnerability and risk assessment are widely accepted and, while some models identify individual interactions between volcanic hazard and physical vulnerability, the limited analyses on multiple

dimensions of vulnerability obscures our understanding of the real volcanic risk. The UN Sendai Framework for Disaster Risk Reduction 2015-2030 recognizes that a better understanding of risk in all its dimensions is needed for effective risk reduction (e.g. SFDRR Priority 1). The need for a new generation of approaches to volcanic risk analysis is clear.

We welcome contributions presenting strategies for the assessment of exposure, vulnerability and risk; discussing ways of identifying and characterizing elements at risk; combining hazard, exposure and vulnerability; presenting vulnerability and risk assessment in a multi-hazard setting; describing how to benefit from local knowledge through participatory risk assessment; and showing how dynamic vulnerability and risk assessments should be carried out to implement useful mitigation measures.



S3.12 > International Risk Communication to mitigate Transboundary effect caused by Volcanic Eruption

CONVENERS:

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This session focuses on international risk communication to mitigate direct/indirect effects caused by massive volcanic eruption. The 2010 Icelandic volcano Eyjafjallajökull eruption caused huge international air traffic disturbances, and left large economic and social impact to international community. Disaster management system or volcano monitoring systems are generally established and developed based on each country's own regulation and purposes, however, the experience demonstrated necessity to develop international risk communication to mitigate transboundary effect caused by eruption. After 2010 eruption several new efforts were started. In Iceland, Catalogue of Icelandic Volcano was

newly developed as an open-access web resource in English to share on-time eruption information with international community.

In order to improve disaster response for volcanic eruption, International Civil Aviation Organization (ICAO) revised International Volcanic Ash Contingency Plan for North Atlantic (NAT) and European (EUR) Region, and annual Volcanic Ash Exercises (VOLCEX) are conducted.

This session discusses how to improve international risk communication system to share information of volcanic eruption from different research disciplines such as disaster management, volcanology, environmental politics.

S3.13 > Volcanic ashfall, gas and acid rain impacts: current and future research and resources in support of preparedness, assessment and mitigation

CONVENERS:

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Special accommodations: This session has been developed in collaboration with and is intended to pair with the Ashfall/Gas/Acid Rain Workshop proposed by Carol Stewart et al.

Understanding volcanic impacts and how to reduce or manage their effects forms a cornerstone of volcanic disaster risk reduction. Multi-volcanic hazards occurring simultaneously and/or sequentially can be challenging to assess and manage the likely impacts. Volcanic ash, gas and acid rain are hazards which often occur together and collectively have the largest footprint of all volcanic phenomena: they are most likely to affect the greatest number of people. It may be difficult to attribute specific impacts to just one of these three phenomena; recent experience highlights the need to consider these collectively.

This session aims to explore how science can improve management of volcanic impacts through field and laboratory-based assessment of impacts and mitigation measures, and the translation and application of this knowledge into volcanic risk management approaches. This includes exploring how to assess impacts from long-duration, multiple and cascading hazards across complex systems

as well as the longer term effects of disruption. We invite volcano scientists, city and emergency managers, environmental monitoring agencies and health professionals to work together to:

- Share current knowledge and new research concerning impacts and mitigation resources for ash, gas and acid rain
- Share case studies of recent eruptions where civil authorities grappled with the combined impact of ash, gas, and acid rain, exploring key lessons and implications for best practice

This session is sponsored by the IAVCEI Cities and Volcanoes Commission, International Volcanic Health Hazard Network, and the Volcanic Ashfall Impacts Working Group, and will pair with the post-conference Ash/Gas/Acid Rain workshop.

Core connection with societal risk mitigation: Volcanic ash, gas and acid rain often occur together and collectively have the largest footprint of all volcanic phenomena: they are the most likely to affect the greatest number of people. Effective mitigation of ash, gas and acid rain impacts is a cornerstone of volcanic disaster risk reduction.



S3.14 > Emergency planning tools in inhabited volcanic risk areas

CONVENERS:

Antonio Colombi *Civil Protection Regional Agency of Latium Region, Italy* | acolombi@regione.lazio.it

The Civil Protection Emergency Plans are a valid tool to allow the community living in volcanic risk areas to know better their territory, to understand the behavioral methods for self-protection systems, to increase the culture of civil protection among the population to get to a resilient community.

Scientific research is the first important step for the creation of risk scenarios at the base of emergency planning and the Civil Protection Emergency Plans can be the valid instrument for transferring scientific data into an application in the territory with administrative-operational language.

The relationship of trust between the scientific world and administration, on the

one hand, and population, on the other, must be the element to be safeguarded in order to be able to manage a possible emergency. The synergic active participation of citizens, scientific world and Administration to create a shared Civil Protection Plan must be the modern goal of a Civil Protection System.

Core connection between the proposed session and societal risk mitigation: The session aims to highlight the close relationship between emergency planning, scientific research and the management of the community living within the volcanic area.

S3.15 > Creating “volcano-ready” communities: communicating for resilience and response

CONVENERS:

Angela Doherty *Auckland Emergency Management, New Zealand* | angela.doherty@aucklandcouncil.govt.nz

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Mylene Villegas *Philippine Institute of Volcanology and Seismology, the Philippines* | mlmvillegas.phivolcs@gmail.com

Wendy K. Stovall *USGS, United States of America* | wstovall@usgs.gov

When it comes to volcanoes, Readiness is as important as Response. Our greatest tool in both is communication--whether online or in person. There is important work to do during both quiescence and crisis to promote awareness; provide timely and accurate information; and build trust and relationships with at-risk communities, decision makers, and emergency responders.

In this session, we aim to share communication knowledge, experience, and, where possible, research results within the international volcanological community. Half of the session will be dedicated to oral presentations from practiced communicators. The second half will be an open forum discussion led by invited guests. Attendees should feel free to bring examples of effective ways to help create “volcano-ready” communities!

Submissions may explore, but are not limited to, the following topics:

- Raising awareness and building resilience in our communities, while avoiding sensationalism or warning fatigue during quiescence.
- Effective communication during a crisis, with limited resources.
- Using social media as a tool to engage during quiescence and alert during crisis.
- Understanding our diverse communities and their different communication preferences and needs.

- Conveying complex topics in simple terms.
- Addressing misinformation without feeding the frenzy.
- Helping mainstream media to report on volcanic hazards more responsibly.
- Building partnerships for stronger communication.
- Evaluating effectiveness of communications efforts.

With a better understanding of our international community’s successes and challenges, we can both learn from and better support each other in a global media landscape. Perspectives from all sectors of volcano communication, including emergency response, academia, scientific agencies, and media, are welcome.

Core connection between the proposed session and societal risk mitigation: Communication is our greatest tool in building resilient, “volcano-ready” communities, and helping inform and protect them during times of volcanic crisis. But communication needs vary between countries and communities. Coming together to learn from each other and better support each other in a global media landscape, can help build our global capacity and develop networks of effective communicators to support our communities living with volcanic risk.



S3.16 > Evacuations in volcanic environments; practice, realities and advances

CONVENERS:

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Estu Wulang Mei *University Gadjah Mada, Indonesia* | estu.mei@ugm.ac.id

Conducting timely and complete evacuations in volcanic environments, coupled with maintaining them over time, is a complex issue. It is crucial to optimize the factors that lead to efficient evacuations to be able to save lives during a volcanic crisis, as shown for example during the 2010 Merapi eruption during which gradual evacuations saved 10,000 to 20,000 lives.

However, an efficient evacuation in the eyes of the authorities (with as few fatalities as possible) might not necessarily be considered as effective by the evacuees themselves. Inconveniences and disruptions in their daily life (e.g. access to livelihoods), create incentives to return to exclusion zones, against advice.

This session invites submissions that evaluate the drivers for a successful evacuation from the point of view of scientists, decision-makers, any other stakeholders, and the population at risk. Contributions that explore the incentives, limitations, strategies, and root causes that inform decisions to evacuate in the

face of a volcanic threat are particularly welcome. Any type of evacuation will be considered: either short or long-term, emergency, compulsory, spontaneous, marked by refusals, real or exercise-based, passed or expected.

We welcome case studies, as well as propositions of approaches, methods, and tools to study and improve the efficiency of evacuation procedures and their acceptability for evacuees in volcanic environments.

We invite contributions from physical and social sciences researchers as well as from practitioners from the communities, NGO's, and authorities who have experienced and/or potentially will experience evacuations.

Connection to societal risk mitigation: We believe that the session we propose is well connected to the societal risk mitigation, engaging in deep thinking on how to lead successful evacuations and safe lives and livelihoods.

S3.17 > Strategies and tools for communicating geohazards and georisks, raising public awareness and enhancing preparedness to natural disasters

CONVENERS:

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Dimitrios Papanikolaou *University of Athens, Greece* | dpapan@geol.uoa.gr

The communication of geohazards and georisks is very complicated, due to the inherent complexity of Earth Sciences, and the psychological and social perception of natural hazards, towards which most local communities tend to have a fatalistic approach. However, the effective communication and popularization of geoscience are paramount to make citizens aware of geohazards and related risks. Strategies aimed at bridging the gap between scientists, decision-makers and civil protection institutions need to be implemented, so as to address the task of improving resilience to geological-related threats. The urgency of coming up with effective strategies and tools to reduce vulnerability towards geohazards is becoming imperative, as attested by a recent, life-threatening, paroxysmal

event at Stromboli volcano in Italy: On July 3rd, 2019, hundreds of tourists rushed into the sea after a major summit explosion, instead of trying to reach safe points. If a tsunami had hit the island's shores, as was the case here in 2002, very few would have escaped alive. This session is intended to foster discussion on these key topics, and is aimed at proposing innovative solutions not only for enhancing geohazard and georisk communication, but also for improving early warning systems; a further goal of the session is to identify new approaches and techniques to provide citizens with life-saving instructions during volcanic crises.



S3.18 > Application of geological mapping in volcanic areas for hazard assessment, geothermal potential evaluation and ore geology

CONVENERS:

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Although the current trend in volcanology is the increasing use of physical and mathematical models in order to understand volcanic processes, geology and field observations remain the basis for volcano studies. Mapping in volcanic areas are the basis for detailed volcanological, magmatic studies, computational modeling and for understanding the behavior of volcanoes and their future activity in terms of volcanic hazards for active volcanoes.

Accurate forecasting of future volcanic event requires detailed understanding of its past eruptive activity for extrapolating a possible behavior into the future, but is also critical for establishing guidelines for exploring economic and energy

resources associated with volcanic systems or for reconstructing the evolution of sedimentary basins in which volcanism has played a significant role.

The aim of this session is to present studies in which geological mapping in volcanic areas, stratigraphy and tephrostratigraphy in volcanic successions and volcano geology are essential in the hazard assessment, environmental management and mitigation of the volcanic risk and allow evaluating and exploring geothermal fields and ore geology. This session is under the aegis of the IAVCEI Volcano Geology Commission.

S3.19 > Innovative and cutting-edge techniques for geological exploration, data collection and teaching in onshore and offshore volcanic areas

CONVENERS:

Fabio L. Bonali Department of Earth and Environmental Sciences, University of Milan-Bicocca, Italy

Varvara Antoniou Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece

Nomikou Paraskevi Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece

Malcolm Whitworth School of Environment, Geography and Geosciences, University of Portsmouth, United Kingdom

Benjamin van Wyk de Vries University of Auvergne, Clermont Ferrand, France

Alessandro Tibaldi Department of Earth and Environmental Sciences, University of Milan-Bicocca, Italy / CRUST- Interuniversity Center for 3D Seismotectonics with Territorial Applications, Italy

Direct outcrop observation and data collection are key techniques in research, teaching and outreach activity in the Earth and Marine Sciences, especially in areas potentially affected by volcanic-related activity such as eruptions, caldera or flank collapse, geothermal and degassing, shallow intrusions, fracturing and faulting. The need to work, teach and communicate in a safe manner and to overcome problems with accessing dangerous and/or inaccessible areas, has prompted several new direct and indirect methods to develop in the last decade. The session will focus on new approaches and technologies for research,

teaching and communication purposes in volcanic areas for onshore and offshore environments, including 3D reconstruction and visualisation, as well as Virtual Reality. The session covers, without being limited to, the following areas: i) the use of unmanned aerial vehicles (UAV or Drone); ii) the use of remotely operated underwater vehicles (ROV); iii) Structure from Motion (SfM) techniques for field or underwater activity; iv) 3D reconstruction and dense cloud analysis and v) Immersive virtual reality and other innovative methods vi) examples of the practical use of methods in communication.



S4

SYMPOSIUM 4

Geoheritage and parks, archaeology, social and applied science, Law, economics, planning, governance

S4.1 > Legal and ethical issues surrounding the provision of knowledge and advice during periods of volcanic unrest by scientists and agencies

CONVENERS:

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Richard Bretton *Cabot Institute for the Environment, University of Bristol, United Kingdom* | Richard.Bretton@bristol.ac.uk

During periods of volcanic unrest, scientists and agencies (governmental and other) are expected to provide timely, trusted services that are risk-relevant, and comprehensible. These include scientific agencies, but also others e.g. health, civil protection or environment. These services are critical to the risk governance decisions required to promote the safety and wellbeing of vulnerable communities. Recently, these services have broadened from the provision of timely science-based knowledge (facts and data) to include advice about hazard/risk mitigation.

Risk governance measures are heavily scrutinised. Recent court cases have shown that service providers will be held accountable if it is thought that they have been negligent (e.g. providing advice that is inaccurate, incomplete or unsupported by objective evidence). Service providers are likely to face detailed public scrutiny on the ethics of their decision making and legal and other consequences.

A blurred boundary exists between the scientific characterisation of natural

hazards and the political exercise of managing their societal risks. There are complex legal and ethical issues arising from the formulation and use of authoritative quality assurance standards for the processes and outputs of all stages of the risk-governance cycle.

This session invites papers that:

- examine legal/ethical issues or case studies for periods of volcanic unrest or equivalent natural hazards that provide lessons for the volcanic context;
- present examples of the practical challenges of producing and communicating contextualised science-based knowledge;
- evaluate the scrutiny risks (including legal liability) faced by service providers and how they can be mitigated; and
- analysis of existing governance frameworks/methodologies/quality assurance standards and recommendations for reform.



S4.2 > Building resilience to volcanic eruptions by providing timely financial resources for observatories and government agencies during periods of heightened unrest.

CONVENERS:

Samantha Cook Senior Financial Sector Specialist, Crisis and Disaster Risk Finance, World Bank, United States of America | scook@worldbank.org

Alanna Simpson Senior Disaster Risk Management Specialist, Global Program for Urban, Resilience and Land, World Bank, United States of America | asimpson@worldbank.org

Gari Mayberry Lead Geoscience Advisor, USGS-US Agency for International Development/Office of U.S. Foreign Disaster Assistance, United States of America | gmayberry@usaid.gov

The World Bank, USAID/OFDA and partners are exploring the possibility of developing financial products that provide predictable financing for authorities during periods of volcanic unrest and eruption. This session focuses on methods to develop forecast-based financing to enable enhanced volcano monitoring to facilitate efficient evacuations and save lives. Similar products exist for flood, earthquakes, etc. with limited progress made to date for volcanic unrest and eruption due to the inherent complexity of volcanic activity. Many volcano observatories do not have the resources to monitor all potentially active volcanoes at the level required to provide baseline data for the development of financial products. With innovations in remote sensing and volcano monitoring, there is potential for a new global approach to monitor the 'health' of volcanoes (no change, unrest, eruption, etc.) and to link this research to the development of financial products that could trigger disbursement of resources during unrest and for recovery/reconstruction after eruptions.

Building the capacity of observatories is tantamount to a successful program and in this session we will consider resilience from all angles, from innovative techniques to improve monitoring and forecasting capabilities at observatories, to

the development of financial products that provide rapid and predictable finance when countries need it most. At this session we welcome input, discussion and ideas on how to move forward to provide authorities with resources to manage the financial burden associated with volcanic activity.

Core connection between the proposed session and societal risk mitigation: The session would add to the discussion within symposium 4 by considering options to build the resilience of authorities and citizens to volcanic eruptions. There is a need to ensure that there are adequate and timely resources for additional monitoring and operational funds for observatories and sufficient funds for evacuation, public awareness and planning in times of heightened volcanic unrest. The World Bank Group and partners are investigating options for robust measurements of volcanic unrest that could be linked to financial products to provide a rapid and predictable injection of funds to authorities who have a responsibility to monitor volcanoes. In addition, this program aims to better understand data limitations at the observatory level and in global remote sensing which currently preclude systematic, rapid, and robust assessments of volcanic unrest. The overarching aim is that that observatories can be adequately and sustainably funded to undertake volcanic monitoring.



S4.3 > Where history, archaeology, and geology intercept: multidisciplinary approaches to document the chronology, impacts, and legacy of volcanic events

CONVENERS:

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Florian Schwandner Jet Propulsion Laboratory, California Institute of Technology, United States of America | fschwand@jpl.nasa.gov

Geoscientists, historians, anthropologists, and archaeologists all recognize the impact of volcanic activity on human populations, yet often work in isolation from one another. Volcanic events intersect all these disciplines and are often recorded in more than one medium. An event may be recorded in a culture's oral history or in written records pre-dating European contact that exist in some non-European cultures. Such documents, however, can be physically fragile, not compiled into centralized archives, difficult to access, and in languages that require specialized knowledge to read and interpret. The advanced trade networks and complex colonial histories in many locations further resulted in documents recording such events but many such documents are dispersed, sequestered, and forgotten in regional or European archives. Volcanic events emplace characteristic deposits or leave other traces that are evident in archaeological and geological studies. Each data source, whether it be an archival document, story from an oral history, or deposit, records unique aspects and details of an event. At many volcanoes, detailed chronologies of activity and eruptions do not exist. Yet, the hazards and

impacts presented by such volcanoes require that we better understand their history. Research applying multidisciplinary methods provides a much richer and more detailed understanding of the number, timing, circumstances, and societal impact of such eruptions. We invite presentations discussing research combining geological, historical, anthropological, archaeological, or other methods to better understand volcanic eruptions and their related phenomena; to develop chronologies of such events; or to understand the societal impact of such past events.

Core connection to societal risk mitigation: The preserved geological, archaeological, and historical records of volcanic events combined provide a more complete understanding of how volcanic events unfold before, during, and after eruptions – of central relevance to adequate risk mitigation and planning in daily practice at observatories and crisis response.

S4.4 > Volcano Geoheritage

CONVENERS:

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Geoheritage is the description, valuing and protection of geological objects in a scientific, societal and cultural context. Geoheritage permits people to know and appreciate their natural environment, including the benefits and risks of nature weighed up within the imperatives of their normal lives. This is especially true for volcano geoheritage. Geoheritage methods include the description and inventorying of geosites, an approach that is very close to risk mapping arrived at from hazard assessment. In this session we propose to discuss all aspects of volcano geoheritage, including basic methods and their relation to hazard/risk

assessment, examples of volcano geoheritage and volcanic protected areas and their management, conceptual approaches to volcanic geoheritage, geotourism and the role of geoheritage in society's resilience to natural geohazards and sustainable development implications.

The session is sponsored by the IAVCEI Commission on Volcanic Geoheritage and Protected Volcanic Landscapes, and the UNESCO Geoscience Programme Project #692 "Geoheritage for Geohazard Resilience", and IUGS Geoheritage Commission.



S4.5 > Geoscience education and place-based learning for youth: informing and inspiring the next generation

CONVENER:

Elizabeth Westby *U.S. Geological Survey, Cascades Volcano Observatory, United States of America* | lwestby@usgs.gov

When volcano observatories develop hazard communication plans and strategies, the targeted audience is typically adults in at-risk communities. The adults are viewed as holding positions of responsibility within their families and communities, and the ones capable of taking appropriate actions to mitigate the risks associated with volcano hazards.

Youth, on the other hand, are assumed to be educated about hazards in school or in the home, but more likely, develop ideas and opinions influenced by media outlets and the entertainment industry. Without challenges from the scientific community, these “beliefs” or misperceptions become ingrained and will be carried well into adulthood.

To develop a knowledgeable and resilient future community, scientists need to devote time and resources to engage in youth-based programs. Hands on,

place-based learning, for example, is an impactful way to share information about volcanoes, volcano hazards, monitoring technologies, science careers and hazard education. Programs that emulate field experiences and explain the “what” and “why” through memorable hands-on learning opportunities help students understand hazards, normalize mitigation measures and develop the critical thinking skills desired in at-risk communities. Moreover, this knowledge will be shared with friends and family members.

This session will explore formal and informal youth-based geoscience education—with an emphasis on placed-based learning, youth-appropriate hazard and risk messaging, and ways in which scientists can build programs that increase interactions with youth in at-risk communities, with the desired outcome to both inform and inspire the next generation and their families.

S4.6 > Pyroclastic Density Currents and the Destruction of Cities - the Archaeological Evidence

CONVENERS:

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Timothy Druitt *Clermont Auvergne University, Clermont-Ferrand, France* | tim.druitt@uca.fr

Pyroclastic density currents (PDC's) can be mechanisms for both preservation and destruction of anthropogenic structures. Certainly, these form suitable sites for understanding the dynamics of PDC's and their interaction with buildings and walls. As barriers to PDC flow such structures form obstacles of variable shape, size, design, and gross density, all a function of construction materials, mortars and cements, open spaces, and placement within landscape and urban areas, etc. The combination creates variable flow barriers, aerodynamic roughness factors, friction coefficients, and more to PDC flow. An additional complication comes from the highly variable landscape conditions, flow characteristics, and components of PDC's. Archaeological sites provide excellent locations to observe these factors and their interaction with PDC's. An example comes from the Late Bronze Age (LBA) eruption of Santorini (Thera, Cyclades, Greece) and the interaction of PDC's at the prehistoric city of Akrotiri where

PDC flows both preserved and destroyed ancient structures – here the contact between preserved and broken structures marks a significant transition in PDC dynamics. This session discusses the eruptive and flow dynamics of PDC's with anthropogenic structures as indicated by preservation/destruction patterns at archaeological sites to estimate flow dynamics and characteristics – critical criteria for designing modern structures threatened by such flows as well as for understanding destruction of ancient structures.

Core connection to societal risk mitigation: Pyroclastic density currents (PDC's) are one of many potential hazards during explosive volcanic eruptions. This session will focus on PDCs that have preserved and destroyed anthropogenic structures during historical eruptions as shown by the archaeological record.



S4.7 > Geoparks in and near volcanic areas, geotouristic activities and raising awareness on geophysical hazards

CONVENERS:

Nickolas Zouros *Department of Geography, University of the Aegean, Greece | nzour@aegean.gr*

Charalampos Fassoulas *University of Crete, Natural History Museum of Crete, Greece | fassoulas@nhmc.uoc.gr*

Ilias Valiakos *Department of Geography, University of the Aegean, Greece | ivaliakos@yahoo.gr*

Geoparks are areas with geodiversity of international value and wealthy natural and human environment that aim to protect and conserve their heritage through education and geotourism development. Many geoparks worldwide exist in volcanic areas or are strongly affected by active volcanism at their vicinity, being thus prone to various geophysical induced disasters. The geoparks develop

various educational, training and raising awareness activities for their inhabitants and visitors, as well as geotouristic actions focused on volcanoes. This session welcomes contributions in all previous topics as well as innovative approaches and best practices.

S4.8 > Volcanic tourism

CONVENERS:

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Volcano tourism becomes more and more popular the last years as people are getting more excited and more interested in nature, geodiversity, geological heritage, geoparks, national parks. Millions of visitors are enjoying the beauty of volcanic landscapes and that also gives an economic boost in many regions in the world. People nowadays are being attracted in geotourism and ecotourism, which play a vital role in a country's tourism and economic status.

The view of an erupted volcano might be a lifetime experience, but the excitement of the moment might turn to a dramatic scenery. The closer they get, the more

excitement they get. There have been recorded several victims, by molten lava, sulfurous gases, ejected products, trying to capture the unique moments. But this also poses a threat to the emergency services and put them in risk, in case of rescue. The local authorities need to take under serious consideration the possibility of the geotourists, who do not obey to their instructions and don't pay attention to the announcements of the scientists.

A dark tourism is also a fact nowadays, like visiting Pompeii which is a pole of attraction because of the total, deadly devastation.



S4.9 > Volcanoes in the museums

CONVENERS:

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Earth is a dynamic planet which never stops moving and sometimes it can be a violent planet. All Museums of Natural History, includes the category of volcanoes so as visitors to have a closer view on the creation of volcanoes, the distribution of volcanoes and why they are formed in that specific zones, the products of volcanoes, the beauty and the threat of volcanoes, the hazards, the side effects, their history and how they are connected with earthquakes.

Looking at the movements of our planet's plates in the past and referring to the previous eruptions, visitors can understanding the development of the volcanic areas and the earthquakes of the future. Photos, paintings, rock exhibitions,

objects such as fossilized trees, maps, films, videos, works of art, volcanic literature, computer models based on educational demands are some of what a visitor can see in a Natural History Museum.

However, it is important to have a more exciting and interactive experience on volcanic activity. But how we can attract more students and specially kids? It is so interesting to have landscape miniatures, simulators, to push a button or watch a film and see an eruption with light effects, hear the explosion and feel the earthquake. Virtual reality is also a teaching tool on volcanic fields in a museum.

S4.10 > Earthquakes, Crisis management and Public health in Crete during the 19th century

CONVENER:

Kostis Kanakis *Department of History and Archaeology, University of Crete / Hellenic Foundation for Research and Innovation, Greece, Museum of Medicine of Crete, University of Crete, Greece* | kanakis_kostis@yahoo.com

The island of Crete, located on the edge of the Aegean Sea Plate and the African Plate and in close proximity to the South Aegean Volcanic Arc, through the ages experienced heavy earthquake activity. We can even argue that earthquakes and volcanic eruptions determined Crete's history. The 19th century is not an exception. According to historical sources, during the 19th century Crete was struck hard by earthquakes. Historical sources bring to light that earthquakes hit the island on thirty-six (36) different years of the century. Indeed, the earthquakes of six (6) years (1805, 1810, 1815, 1846, 1856, and 1887) caused serious damages and for example, 1856's earthquake was responsible for the almost total raze of the city of Heraklion.

This session will focus on Crete's major earthquakes of the century using a variety

of published and unpublished historical documents, like Ottoman and Greek archives, European travelogues, newspapers, telegrams, mail correspondence and photographs. The aim of the session is to present these earthquakes, the locations that were mostly afflicted by them and the damages they caused. Also, the session will present the different earthquakes' disaster management strategies that the different administrations (Egyptian, Ottoman, and Semi-autonomous Cretan) of the island followed and the various responses of the Cretan society to these disasters. Finally, the session will attempt to highlight the consequences that these earthquakes, and the aftermath crises they caused, had to the public health of the island.

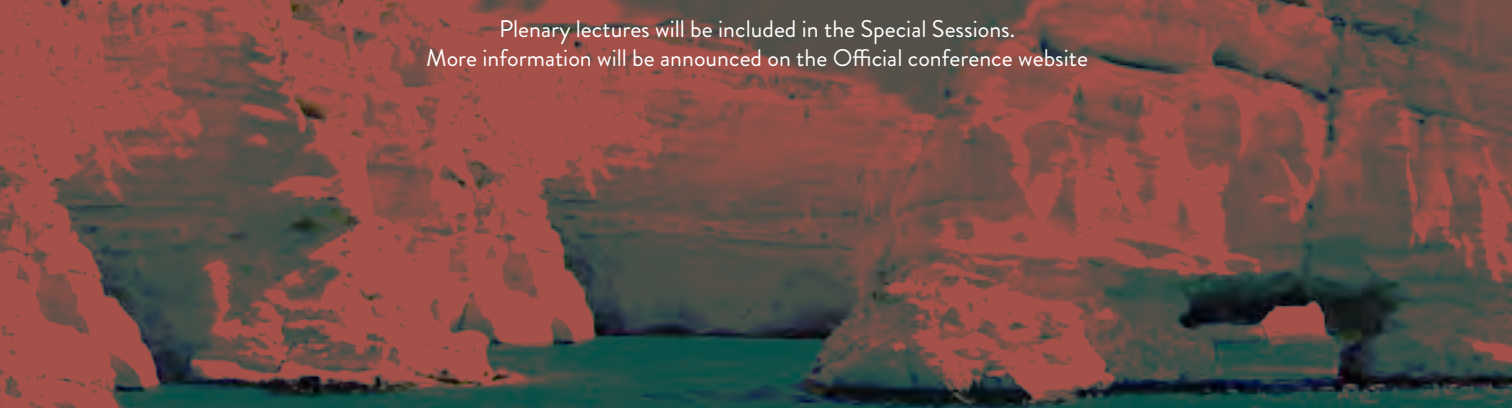


Image by David Mark, from Pixabay



PLENARY AND SPECIAL SESSIONS

Plenary lectures will be included in the Special Sessions.
More information will be announced on the Official conference website





SS1 > Bronze Age Cities and the Volcano of Thera

CONVENERS:

Professor Jan Driessen *Université Catholique de Louvain* | jan.driessen@uclouvain.be

Dr Irene Nikolakopoulou *Hellenic Ministry of Culture and Sports, Archaeological Museum of Heraklion* | irene_nikolak@yahoo.com

The cataclysmic eruption of the Thera volcano in the mid-second millennium BC had a tremendous effect on Bronze Age communities of the prehistoric Aegean. The evidence for widespread dispersal of volcanic material, destructions inflicted by earthquakes and/or tsunamis, combined with the elimination of the settlement at Akrotiri, a key harbour in maritime trade networks, suggests that the impact on the lives of people in Crete and the islands was significant in many aspects. Although the theory for the demise of Minoan civilization as a direct outcome of the eruption is now considered unlikely, data from environmental, geophysical and archaeological research paint a picture of severe turmoil at the time following the eruption. Experts from the abovementioned fields are invited to the workshop to present new evidence and synthetic approaches to the

following topics of interest:

- Physical evidence for the impact of the eruption (dispersal of volcanic material, destructions linked to seismic events and tsunamis, contamination of natural resources)
- Patterns of environmental and societal crisis management strategies (cleaning/rebuilding/rehabilitating activities, alternative strategies to ensure viability of the Cretan Bronze Age palatial system, e.g. storage and agricultural practices)
- Indicators for social, psychological and ideological uncertainty and instability in the aftermath of the eruption
- The nature of the Late Bronze IA to Late Bronze IB transition in Aegean Bronze Age communities

SS2 > Impact of volcanic activity in places of tourist interest: the 2019 paroxysmal eruption of Stromboli Volcano (Italy) and other case studies

CONVENERS:

Del Bello E. *Istituto Nazionale di Geofisica e Vulcanologia* | elisabetta.delbello@ingv.it

Di Traglia F. *Università degli studi di Firenze* | ditragliafederico@gmail.com

Andronico D. *Istituto Nazionale di Geofisica e Vulcanologia* | daniele.andronico@ingv.it

Scarlato P. *Istituto Nazionale di Geofisica e Vulcanologia* | piergiorgio.scarlato@ingv.it

Stromboli Island, a persistently active volcano in the Aeolian Islands, attracts thousands of tourists every year, who climb to the top to admire its spectacular explosive eruptions. Normally this volcanic activity is characterised by recurring explosive events (1-20 per hour) ejecting gas and disrupted magma fragments, which last tens of seconds and can continue uninterrupted for long periods without significant breaks. Sometimes however, this usually mildly-explosive style can shift into a more violent one, leading to a dramatic increase in hazard. On July 3rd 2019, a destructive, powerful paroxysmal explosion occurred, producing tephra and ballistic fallouts, pyroclastic flows, lava flows, tsunami and fires, causing one fatality, and damaging the lower slopes of the island and the village of Ginostra. Following the paroxysm, an increased level of activity was observed, with more intense and frequent explosions occurring at different vents and effusive activity still ongoing at the time of writing of this document.

This wide range of phenomena is largely affecting the economy of the whole archipelago because it coincides with the high season, when the number of residents is expected to be about 10 times higher than normal.

In this session, we welcome a wide range of contributions focusing on the eruptive crisis itself (like, e.g., eruptive dynamics, volcano modelling, and volcanic hazard) using a variety of direct and remote sensing tools, also including the use of social media as a source of scientific data. In addition, we strongly encourage submissions on the management of impact and risk mitigation of this and other recent eruptive crisis in highly touristic volcanoes (like, e.g., Ontake, Agung, Kilauea, Fuego, and Krakatoa).

This session has the sponsorship and support of the IAVCEI Commission on Explosive Volcanism.



SS3 > First steps in planning for the health response in a future eruption or period of volcanic unrest in Greece

CONVENERS:

Emmanouil Pikoulis *Department of Medicine, National and Kapodistrian University of Athens, Greece* | mpikoul@med.uoa.gr

Claire J. Horwell *Department of Earth Sciences, Durham University, Durham, UK* | claire.horwell@durham.ac.uk

Paraskevi Nomikou *Department of Geology and Geoenvironment, National and Kapodistrian University of Athens* | evinom@geol.uoa.gr

Peter J. Baxter *Institute of Public Health, University of Cambridge, UK* | pjb21@medschl.cam.ac.uk

William Mueller *Institute of Occupational Medicine, Edinburgh, UK* | Will.Mueller@iom-world.org

Greece has a number of volcanoes which are displaying signs of unrest. The substantial degassing following the Nisyros seismic crisis of 1997 and the Santorini volcanic unrest of 2011-12 alerted Greece to the possibility of a major eruption within our lifetimes. Volcanic emissions, either passive or during an eruption, may cause distress and potential harm to exposed communities. This workshop proposal invites Greek governmental and non-governmental health agencies, civil protection and related practitioners such as those responsible for environmental monitoring (e.g., air and water quality) to come together with international experts to discuss the potential health impacts, how the health of exposed communities would be monitored and to discuss potential actions to protect communities that could be taken in the event of negative health

consequences being measured or suspected.

The workshop is sponsored by the International Volcanic Health Hazard Network which works with governments to prepare for eruptions and provides public information for use during the responses. IVHHN has recently produced two standardized epidemiological protocols (<http://www.ivhnn.org/guidelines#epidemiological>), the first being for rapid deployment at eruption onset and the second being for follow up if health impacts are measured. These protocols will be presented and their potential for implementation discussed, along with other emergency management and civil/public health protection practices.

SS4 Tools in volcanology: A lightning demonstration session

CONVENERS:

Sebastien Baisse *Earth Observatory of Singapore* | sbaisse@ntu.edu.sg

Stuart Mead *Massey University, New Zealand* | s.mead@massey.ac.nz

Sarah Ogburn *Volcano Disaster Assistance Program, United States Geological Survey* | sogburn@usgs.gov

The benefits of scientific advances in volcanology, hazard and risk science have often been under-utilised by the community, observatories and decision makers. Technological developments such as the establishment of VHub, cloud-based geospatial platforms (e.g. Google Earth Engine) and web-based interactive computing (e.g. Jupyter and R Shiny) have gone some way to bridging the gap between scientific research and practice. IAVCEI commissions have also made considerable progress in increasing connections between scientists and end-users. However, the uptake of products and tools from scientific research and observatories by end-users and other observatories can be improved through simple, effective demonstrations of use.

To facilitate the uptake of such tools within the wider community, we seek contributions for a practical demonstration session. Presenters will have the

opportunity to demonstrate, within a strict time limit (5-10 minutes), the practical application of a tool (e.g. software, instruments, interactive applets etc.) they use or created to improve the day-to-day activities of volcanologists, observatories and decision makers; saving time, increasing resilience and improving outcomes for society. This session is supported by the IAVCEI Commission on Statistics in Volcanology with the aim of increasing the usage of quantitative tools for analysis of all kinds of volcanological data. We particularly encourage demonstrations of applications that simplify quantitative techniques into easy to use and freely available tools and/or are made by volcano observatories to support their operations. When submitting to this session, please indicate and special requirements needed for your demonstration.



SS5 > Blueprints for Effective Partnerships” and “Meet the Practitioners!

CONVENERS:

(Coordinator) **Brian Terbush** *Washington Emergency Management Division* | brian.terbush@mil.wa.gov

(Coordinator) **Angela Doherty** *Auckland Emergency Management* | angela.doherty@aucklandcouncil.govt.nz

Maria Manousaki *Earthquake Planning and Protection Organisation* | mmanousaki@oasp.gr

Stefano Ciolli *Dipartimento della Protezione Civile, Italia* | stefano.ciolli@protezionecivile.it

Paraskevi Nomikou *National and Kapodistrian University of Athens* | evinom@geol.uoa.gr

Carolyn Driedger *United States Geological Survey, Cascades Volcano Observatory* | driedger@usgs.gov

Volcano crises rarely occur within singular governmental jurisdictions. They almost always cross jurisdictional lines, both geographically and vertically across levels of government. Governmental agencies may not be accustomed to addressing hazards on the necessary broad scale. Effective volcanic eruption response requires partnering of multiple governmental entities and scientific institutions to address science, safety, recovery, and information management needs, for both the people impacted and for responders. This extended session explores the essentials of collaborations between scientists and public officials to define the building blocks of success in addressing volcanic threats.

The first part of the session will be an interactive workshop, where registered attendees will hear presentations and take part in facilitated break-out sessions on the philosophy, strategy, and mechanics of building and maintaining mutually-beneficial collaborations. Highlights will include case studies from the 2011/12 unrest in Santorini and other examples of effective collaborations before and during eruptions/crises around the world. Attendees will then break into smaller groups to discuss their own partnerships, returning to the larger group to collaboratively create a blueprint of the best practices for partnerships. This blueprint is intended to be a set of tools which will benefit practitioners and scientists upon returning to their home organizations. Additionally, we will use

the opportunity to discuss how we as a community can create a global network of emergency management practitioners to share information, resources, and techniques to deliver emergency management outcomes for our communities.

The second part of the session will be open to the wider conference attendees and be a series of two panels where 4-5 practitioners present lightning talks (5-7 minute presentations one after the other) based around the themes of governance, policy, and planning during quiescence, and information sharing and cooperation during unrest. The lightning talks may highlight an issue on which they would like to request advice, or showcase a project or topic from their organization. Panels will be followed by a moderated open-floor discussion between the panel and the audience on the topics of the lightning talks. This will be an opportunity for practitioners to highlight the work of their organizations and/or solicit targeted advice from the wider Cities on Volcanoes Community in a light, inclusive, but practitioner-focused session.

The whole event will be wrapped up with a mix-and-mingle session, where practitioners and their scientific colleagues can continue to discuss areas of shared interest, and potentially to improve old, or build new partnerships using the principles and foundations presented in both sessions.

SS6 > Open Source Software for Modeling Volcanic Processes

CONVENERS:

Maurizio Battaglia *Volcano Disaster Assistance Program, US Geological Survey* | mbattaglia@usgs.gov

Flavio Cannavò *Istituto Nazionale di Geofisica e Vulcanologia, Catania, Italy* | flavio.cannavo@ingv.it

Kyle Anderson *California Volcano Observatory, US Geological Survey* | kranderson@usgs.gov

Open source software implementing quantitative models of volcanic processes is an essential tool to investigate the physics of volcanoes and monitor volcanic unrest. This session will allow people that have written open source software to showcase their packages and learn about other available tools. The session will be divided in two parts: (a) short presentations (5 to 10 minutes) of open source

software freely available to the geoscience community; (b) people attending the presentation and authors will be invited to divide in small groups for a hands-on experience in the use of a particular software. It will be an opportunity to connect with others working on related problems and form new collaborations.



Cities on
VOLCANOES



11

WORKSHOPS





Pre-Conference Workshop in Santorini

Explosive processes and products on Santorini

Pre-conference workshop sponsored jointly by the IAVCEI Commissions on Explosive Volcanism and Tephra Hazard Modeling

Duration: 17-21 May 2020

Field organisers:

Tim Druitt University Clermont Auvergne | tim.druitt@uca.fr

Madison Myers Montana State University | madison.myers@montana.edu

Jack Simmons Monash University | jack.simmons@monash.edu

Paraskevi Nomikou University of Athens | evinom@geol.uoa.gr

Principal commission organisers:

Mattia De' Michieli Vitturi INGV Pisa | mattia.demichielivitturi@ingv.it

Alexa Van Eaton U.S. Geological Survey | avaneaton@usgs.gov

Workshop Description:

Santorini is a well-established natural laboratory for studying explosive volcanism, caldera collapse and their associated hazards. The Late Bronze Age eruption of Santorini volcano was one of the largest volcanic events of the last 10,000 years, with possible impacts on early European civilization. Mitigating societal risk at volcanoes depends critically on our ability to quantify volcanic hazards in the geologic record. This workshop, for a maximum of 30 participants, will focus on the quantification of hazardous volcanic phenomena based on measurements and modelling of pyroclastic processes and products, building on extensive new work carried out on the volcano.

Three days of field excursions will examine a wide range of pyroclastic deposits, including welded Plinian fall and pyroclastic current deposits and diverse facies of non-welded ignimbrite and lag deposits. The trip will explore field relations that can be used to constrain eruptive processes and their hazards to society, including infrastructure and human health. A boat trip of the caldera will be included. During one day focused around theory, lectures will review some state of the art techniques of eruption parameter estimation in the field and laboratory, as well as some numerical modeling tools available in physical volcanology.

Participants are expected to make their own way to Santorini by 17 May, then return to Heraklion on 22 May in time for the start of CoV 11 the following day. On Santorini, one day of lectures (18 May) will be followed by three days of field excursions (19, 20, 21 May).





Pre-Conference Workshop #1

Duration: 22 May 2020

State of the Hazard Map 4: Five Year Review

CONVENERS:

Danielle Charlton *University of Auckland, New Zealand* | danielle.charlton@auckland.ac.nz

Jan Lindsay *University of Auckland, New Zealand* | j.lindsay@auckland.ac.nz

Graham Leonard *GNS Science, New Zealand* | g.leonard@gns.cri.nz

Mary Anne Thompson *University of Auckland, New Zealand* | m.thompson@auckland.ac.nz

Eliza Calder *University of Edinburgh, UK* | eliza.calder@ed.ac.uk

Sarah Ogburn *USGS* | sogburn@usgs.gov

On behalf of the Hazard Mapping Working Group part of the IAVCEI Commission on Hazard and Risk

Workshop Description:

The IAVCEI Commission of Volcanic Hazard and Risk has a working group dedicated to hazard mapping. The hazard mapping working group held its first workshop at COV8 (State of the Hazard Map 1), second at COV9 (State of the Hazard Map 2), and third at the IAVCEI meeting in 2017. We propose to host a fourth meeting at COV11. The workshop will continue the broad aims of the earlier meetings, namely to work towards reviewing IAVCEI-endorsed considerations document for volcanic hazard map generation which will be in its final draft stages. The workshop will bring together people from around the world working on volcanic hazard maps, and will have three primary aims: 1) to discuss and modify the draft *Considerations* document; 2) discuss options for finalizing, and disseminating the *Considerations* document; and 3) to discuss new approaches and experiences regarding how hazard maps are created, interpreted and used by different groups. In line with previous working group events, a key philosophy of this workshop is that participants will be encouraged to bring their experience to the table for discussion, so that the workshop format will be more about exchange of knowledge rather than instruction about particular techniques.

Pre-Conference Workshop #2 Communicating During Crisis in a New Media Landscape.

An IAVCEI training based on newly developed professional considerations for the volcanology community

This workshop has the full endorsement of the IAVCEI Hazards and Risk Commission.

Duration: 22 May 2020

CONVENERS:

Wendy K. Stovall *USGS Volcano Hazards Program* | wstovall@usgs.gov

Beth Bartel *UNAVCO* | bartel@unavco.org

Micol Todesco *INGV, Lead for the IAVCEI Hazards and Risk Commission Communications Working Group* | micol.todesco@ingv.it

Workshop Description:

The media landscape for communicating volcano hazards has changed rapidly in the past decade. Social and other digital media can quickly provide information to communities at risk so they are able to make appropriate decisions to reduce their exposure to volcanic hazards and alleviate psychological distress. Digital

media also has global reach, informing those who may be concerned about at-risk family or helping others determine whether to travel to potentially at-risk regions. However, these new media forms also provide an unrestricted platform, where misinformation can go viral.

The aim of this workshop is to enable social media practitioners from all sectors to communicate effectively and responsibly about volcanic hazards on social media, and subsequently with the media, particularly during crises. Participants will have the opportunity to practice skills, as well as discuss methods for developing and strengthening partnerships between multiple sectors prior to the onset of a crisis.

The workshop builds on efforts by the IAVCEI Hazards and Risk Commission Communication Working Group to develop IAVCEI-wide professional considerations around social and mass media communication of volcanic hazards. The effort began with a workshop at CoV10; input continued in April 2019 with a related survey sent to the broad volcanology community. The resulting consensus of considerations have been summarized in a document that represents our best understanding of community needs at this time, and has been adapted into a community workshop. The supporting document is expected to evolve with further first-hand experience and as the media landscape changes.

Core connection to societal risk mitigation:

Social and other digital media can quickly provide information to communities at risk so they are able to make appropriate decisions to reduce their exposure to volcanic hazards and alleviate psychological distress. Digital media also has global reach, informing those who may be concerned about at-risk family or helping others determine whether to travel to potentially at-risk regions.



Pre-Conference Workshop #3 Modeling Volcanic Deformation

Duration: 20-21 May 2020

CONVENERS:

Maurizio Battaglia *Volcano Disaster Assistance Program - US Geological Survey* | mbattaglia@usgs.gov

Flavio Cannavò *Istituto Nazionale di Geofisica e Vulcanologia, Catania, Italy* | flavio.cannavo@ingv.it

Kyle Anderson *California Volcano Observatory - US Geological Survey* | kranderson@usgs.gov

Workshop Description:

The precise measurement of ground deformation using satellite geodesy GPS and InSAR or classic geodesy e.g., tilt, gravimetry is an essential tool to monitor volcanic unrest, since geodetic observations can reveal important aspects of crustal magma chambers. Volcano deformation can be successfully interpreted in terms of simplified chamber geometries, such as spheres, ellipsoids or penny-shaped cracks embedded in elastic half-spaces to estimate the magma chamber geometry, location, depth and volume change. Of course, these model geometries are highly idealized relative to what one observes in eroded magma reservoirs. Traditional modeling approaches cannot resolve the total magma chamber volume, pressure acting on the chamber, or much about the properties of the fluid within the chamber. Simultaneous measurements of deformation and microgravity change have the potential to place constraints on the density of the fluid phase. Magma physics-based models of volcanic eruptions can directly link magmatic processes with diverse, time-varying geophysical observations, and when used in an inverse procedure make it possible to bring all available information to bear on estimating properties of the volcanic system like pressure, depth, and volatile content of a magma chamber, and properties of the conduit linking the chamber to the surface.





Pre-Conference Workshop #4

Workshop on volcano monitoring infrastructure on the ground and in space

Duration: 21-22 May 2020

LEAD CONVENERS:

Juliet Biggs *University of Bristol, UK* | Juliet.Biggs@bristol.ac.uk,

Fidel Costa *WOVOdat, Earth Observatory of Singapore* | fcosta@ntu.edu.sg

Susana Ebmeier *University of Leeds, UK* | S.K.Ebmeier@leeds.ac.uk,

Matt Pritchard *Cornell University, USA* | pritchard@cornell.edu

CO-CONVENERS:

Mariano Agosto *ALVO and Universidad de Buenos Aires, Argentina,*

Ben Andrews *Global Volcanism Program, Smithsonian Institution, USA,*

Sarah Brown *University of Bristol, UK*

Simon Carn *Michigan Technological University, USA*

Hugo Delgado *UNAM, Mexico,*

Nico Fournier *WOVO and GNS, New Zealand,*

Eisuke Fujita *National Research Institute for Earth Science & Disaster Prevention, Japan,*

Julie Griswold *Cascades Volcano Observatory, US Geological Survey, USA,*

Gill Jolly *WOVO and GNS, New Zealand,*

Sue Loughlin *British Geological Survey, UK,*

Paul Lundgren *Jet Propulsion Laboratory, California Institute of Technology, USA,*

Chris Newhall *Mirisbiris Garden and Nature Center, Philippines,*

Natalie Ortiz *UNAM, Mexico,*

Giuseppe Puglisi *Istituto Nazionale di Geofisica e Vulcanologia, Italy*

Elise Rumpf *Astrogeology Science Center, US Geological Survey, USA*

Christina Widwijayanti *WOVOdat, Earth Observatory of Singapore*

Workshop Description:

The goal of this 2-day workshop is to improve the understanding of the current capabilities and limits of volcano monitoring from the ground and space. By the end of the workshop, participants will contribute to the development of a Global Volcano Monitoring Infrastructure Database (GVMID) to be hosted at WOVOdat, and develop a roadmap to improve the utility of satellite data. We also hope to open more channels of communication among volcano observatories, space agencies, and the remote sensing/database community. We anticipate future workshops will be needed to further advance these goals.

On one day, we will discuss the motivations for the GVMID and the potential benefits of an infrastructure database for volcano observatories. A database of current infrastructure will provide a snapshot/baseline view of what techniques/instrumentation are in place at other similar/analogous volcanoes, which can help justify expanded networks by volcano observatories. These data will allow identification of what gaps exist that can be targeted by remote sensing and/or targeted deployments. In addition, we will discuss existing volcano-monitoring databases (e.g. GLOVOREMID, EPOS, VMID, INeVRH, and WOVOdat) and how we can improve or build upon those efforts.

On the other day, we will discuss the roles played by satellite systems in augmenting ground-based networks. Through presentations by participants, demonstrations of open-source resources, and case-studies of recent crises, we will address the following questions: 1) What satellite data are currently available? 2) What is the value of satellite data for volcano observatories and how are the data currently being used? 3) What is required to improve data use? One goal is to develop a global remote sensing observation strategy to ensure that the right satellites are collecting the right data at the right volcanoes. The recommendations will be communicated to the space agencies through the Committee on Earth Observing Satellites.

Core connection between the proposed session and societal risk mitigation:

The workshop is focused on improved monitoring of volcanoes from the ground and space. Increased monitoring has been shown to improve hazard forecasts for society (e.g., Winson et al., 2014).



Pre-Conference Workshop #5 (to be confirmed) Early Career - BV - Springer workshop: Getting published

Duration: 22 May 2020

CONVENERS:

Andrew Harris *Bulletin of Volcanology Editor in chief, Laboratoire Magmas et Volcans, Clermont-Ferrand* | andrew.harris@uca.fr

Jacopo Taddeucci *Bulletin of Volcanology Deputy Editor, INGV Roma* | jacopo.taddeucci@ingv.it

Johanna Schwarz *Springer Journal Manager* | Johanna.Schwarz@springer.com

Julia Eychenne *Early Career Researcher Network, Laboratoire Magmas et Volcans, Clermont-Ferrand* | julia.eychenne@uca.fr

Kyriaki (Sandy) Drymoni *Early Career Researcher Network, Royal Holloway University of London* | Kyriaki.Drymoni.2015@live.rhul.ac.uk

Workshop Description:

This one day workshop is aimed at Early Career Researchers who wish to improve their chances of getting published.

The grouping will gather editors from Bulletin of Volcanology, journal managers from Springer, as well as senior academic researchers with expertise in writing scientific publications and peer-reviewing them.

The workshop will provide information on the publishing system and how it works; scientific journals (their operation and expectations) and the publication process; the roles and expectations of journal editors; and scientific writing (including manuscript formatting, organization and content).

Through case studies and exercises we will explore writing strategies, including effective abstracts, titles, key words, introductions, data presentation, plus formulating convincing discussions, arguments and conclusions. The workshop will include full interaction between the participants and the leaders, providing an invaluable opportunity for Early Career Researchers to improve their ability to publish their research.

Pre-Conference Workshop #6 (to be confirmed) Volcano Alert Level Systems: Exploring Standardisation, Networks, and Resources

Duration: 22 May 2020

CONVENERS:

Carina Fearnley *University College London, UK* | c.fearnley@ucl.ac.uk

Amy Donovan *Cambridge University, UK*

Annie Winson *British Geological Survey, UK*

Sally Potter *GNS Science, New Zealand*

Workshop Description:

This workshop is run by the WOVO Volcano Alert Level Systems (VALS) Working Group that aims to support volcanologists and key user groups (e.g. civil protection) in their implementation and use of VALS and communication products and protocols used at volcano observatories around the world (including the Aviation Colour Code). We build on prior workshops to review recent publications on VALS, and share knowledge, experience, and best practices so that all practitioners can benefit, particularly those who are devising new or alternative systems, or managing the standardisation of systems.

We aim to explore specific issues of concern raised during our CoV10 discussions:

- i. The challenges of standardisation on VALS effectiveness: managing UN and other regional / global policies with local needs.
- ii. Developing a checklist for VALS usage: managing problems and issues to consider.
- iii. Creating networks for VALS information and support: learning from the past, present, and future in virtual and real worlds.

In addition we will also provide feedback on a global survey the VALS working group are conducting to review VALS used globally, providing some preliminary analysis.

Representatives from observatories and key user groups are invited to attend to present their existing VALS and communication procedures, and/or discuss any challenges and opportunities in the design and operation of VALS.

A proposed output is a series of handbooks and guidance for volcano observatories and users during late 2020 by the working group based on our survey, research, and workshop findings. The session will be interactive and interdisciplinary.

Core connection:

This workshop aims to explore the links between volcano observatory scientists, key stakeholders (government and others), and the public via volcano alert level systems (VALS). VALS sit at the interface between the practice, policies, and communication of all stakeholders and therefore it is imperative that in order to gain effective risk mitigation practices are shared and discussed between the different stakeholders to make sure these systems are effective. These workshops always aim (and achieve) a wide diversity of stakeholder attendees, and consequently focus on the connections between science and society.



Intra Conference Workshop #1 Towards a Uniform Approach for Risk Assessment due to Volcanoes and Earthquakes

Duration: 24 May 2020

CONVENERS:

Catalina YepesE | catalina.yepes@globalquakemodel.org

Anirudh Rao | anirudh.rao@globalquakemodel.org

Workshop Description:

The risk assessment due to any natural hazard typically requires a hazard model capable of defining the intensity and frequency of the hazard, an exposure model characterizing the built environment, and a vulnerability model defining the likelihood that each exposed element will suffer damage or loss. While the hazard component is highly dependent on the type of phenomena (e.g. volcanoes, earthquakes, floods,

storms), there are similarities in the exposure and vulnerability components across the majority of the natural hazards, as well as in the procedure for the estimation of the potential losses and damages. It is thus important to explore overlapping areas in order to maximize the available resources, and avoid duplication of efforts.

In this context, the CRAVE project (Collaborative Risk Assessment for Volcanoes and Earthquakes) supported by the United States Agency for International Development (USAID) and with participants from GEM, BGS, SGC, CVGHHM, IT Bandung, PHIVOLCS and EOS, is exploring common tools and datasets for the assessment of the impact from volcanoes and earthquakes. These resources allow the employment of the same exposure dataset and risk framework for the estimation of the expected losses and affected population, while maintaining a link with well-established tools for the assessment of the volcano and earthquake hazard. In this workshop participants will be invited to explore these datasets and tools using hazard and risk data for a realistic scenario, and all of the resources will be made publicly available to the scientific community.

Connection to societal risk mitigation:

Hands-on training with tools and datasets that allows estimating the impact due to volcanic and earthquake hazards

Intra Conference Workshop #2 International communication strategies for volcanic crises

Duration: 24 May 2020

CONVENERS:

Janine Krippner *Smithsonian Global Volcanism Program* | krippnerj@si.edu

Micol Todesco *INGV* | micol.todesco@ingv.it

Brian Terbush *Washington State Emergency Management Division* |

Brian.Terbush@mil.wa.gov

Boris Behncke | *INGV* boris.behncke@ingv.it

Sally Sennert | *USGS/Smithsonian KUHNS* | si.edu

Robin Andrews *freelance science journalist* | robingeorgeandrews.uk@gmail.com

Workshop Description:

Disseminating accurate and consistent messaging that is widely understood during a volcanic crisis requires a global, interdisciplinary, interagency effort in the digital age. This workshop examines global communication efforts by observatories, emergency management, social sciences, government, non-observatory geoscientists, and media. When a crisis strikes, official and non-official information mix and spread through a variety of communication channels, reaching different audiences and evolving through time. As a result, official messaging may be amplified to help local efforts, or the public may receive fragmented inconsistent messaging, which may

lead to injury and economic impacts on the area. Further complications may arise when volcanic crises affect multiple countries, and local communication strategies may not be consistent or sufficient.

To examine these issues, morning presentations will feature selected case studies that highlight common communication challenges. Case studies will include Agung, Campi Flegrei, Etna, Stromboli, and examples from participants. In the afternoon participants will divide into groups to address eruption scenarios, playing different roles in the communication chain and evaluating adequate public responses. The workshop will introduce the International Network for Volcano Communication and discuss preliminary ground rules for its operation. We encourage attendees to share communication plans and case studies, including what did and did not work, and surprises. A short report will be produced reviewing the different aspects of crisis communication, challenges, and tools and resources available (e.g. VolFilms, USGS, GVP, and IVHHN products). The report will serve as a resource to guide communications partners with best practices for future volcanic crises.

Core connection between the proposed session and societal risk mitigation:

To mitigate societal risk during a volcanic crisis, volcano observatories, emergency management, communicators, social sciences, and media have to work together to ensure that accurate and consistent messaging is disseminated and well understood. Communication efforts by scientists, agencies, and media around the world are now instantly available online for local communities to access. This workshop will examine the varied needs of different partners and communities, and the volcanic alerts, hazards, safety, and educational products that are disseminated during crisis communication from all parts of the global communication chain. This workshop will assist all partners in understanding the varied needs and limitations, and evaluate how we can best serve our global communities through science-to-society partnerships. Results will be compiled and shared in report format after COV11.



Post-Conference Workshop #1

Coping with volcanic ash, gas, and acid rain: new knowledge and key resources, information needs, and future research priorities

Duration: 28 May 2020

This workshop is sponsored by the IAVCEI Cities and Volcanoes Commission, the International Volcanic Health Hazards Network and the Volcanic Ashfall Impacts Working Group.

CONVENERS:

Natalia Deligne GNS Science | n.deligne@gns.cri.nz

Graham Leonard GNS Science | g.leonard@gns.cri.nz

Carol Stewart Massey University | c.stewart1@massey.ac.nz

David Damby USGS | ddamby@usgs.gov

Claire Horwell Durham University | claire.horwell@durham.ac.uk

Kristi Wallace US Geological Survey | kwallace@usgs.gov

Workshop description:

Volcanic ash, gas and acid rain often occur together and collectively have the largest footprint of all volcanic phenomena: they are most likely to affect the greatest number of people. It may be difficult to attribute specific impacts to just one of these three phenomena; recent experience highlights the need to consider these collectively.

This workshop, this workshop is sponsored by the IAVCEI Cities and Volcanoes Commission, the International Volcanic Health Hazards Network and the Volcanic Ashfall Impacts Working Group, invites volcano scientists, city and emergency managers, environmental monitoring agencies and health professionals to work together to:

- Share current knowledge and new research concerning impacts and mitigation resources for ash, gas and acid rain
- Work through case studies of recent eruptions where civil authorities grappled with the combined impact of ash, gas, and acid rain, exploring key lessons and implications for best practice
- Identify information needs of civil agencies to determine research priorities, emphasising research co-production with volcano scientists and civil agencies and linkages to global programs.

Core connection with societal risk mitigation:

Volcanic ash, gas and acid rain often occur together and collectively have the largest footprint of all volcanic phenomena: they are the most likely to affect the greatest number of people. Effective mitigation of ash, gas and acid rain impacts is a cornerstone of volcanic disaster risk reduction.



Image by Jesse Adams from Freerimages



Post-Conference Workshop #2

Possibilities and limitations of geothermal energy use for heating and production of electricity at volcanic islands

Duration: May 28, 2020

CONVENERS:

Vasiliki Gemeni *Centre for Research & Technology Hellas (CERTH)* | gemeni@certh.gr

Gregor Goetzl *Geological Survey of Austria (GBA)* | gregor.goetzl@geologie.ac.at

Emilio L. Pueyo Morer (tbc) *Instituto Geológico y Minero de España (IGME)* | unaim@igme.es

Monica Sousa (tbc) *Portuguese Association of Geologists (APG)* | msousa@apgeologos.pt

Workshop description:

The proposed event focuses on options and limitations of geothermal energy use in volcanic islands for base load heat and electricity supply by CHP facilities. The workshop aims at exchanging experiences linked to the application of geothermal energy in volcanic environments. The interactive part of the workshop focuses on future options and limitations of applying geothermal energy on islands. Attention is paid to the following main questions:

- What are the main techno-economical barriers for the development of geothermal energy in volcanic islands e.g. lack of groundwater, mismatches in energy demand and production profiles or high production costs)?
- Are there non techno-economical barriers like social acceptance and risks, which need to be considered for applying geothermal energy on volcanic islands?
- How can these barriers be removed and which technological concepts may allow to include geothermal energy in energy supply?

The first part of the workshop comprises short presentations of existing case studies based on submitted abstracts. The second part of the workshop includes group work activities and a final discussion round. The outcomes of the workshop will be summarized in a joint article.

Core connection with societal risk mitigation:

Due to unique landscapes, volcanic islands like the Canary or Aeolian are very attractive for tourists, which in turn puts stress on the energy supply of such islands. On-site resources for producing electricity and heat (e.g. for hot water) are limited and fluctuating, when they are represented by solar or wind energy. In many cases, these islands are still supplied by imported fossil fuels to fill base load gaps. In the context of climate change mitigation and nature preservation as well as for economical reasons, measures need to be undertaken to substitute the import of fossil fuels for energy production by on-site resources, which are able to provide base load supply.

Active or post-active volcanic islands offer elevated geothermal heat flux, which could be used for combined heat and power production at base load level. However, especially in arid or semi-arid volcanic islands, major constraints for using geothermal energy are given by lack of groundwater, which acts as a heat carrier fluid.





Post-Conference Workshop #3

2nd IAVCEI/GVM workshop on volcanic hazard to risk assessment: Contributions for the 2021 UN Global Assessment Report

Duration: 28 May 2020

CONVENERS:

Sue Loughlin *British Geological Survey, UK* | sclou@bgs.ac.uk

Costanza Bonadonna *University of Geneva, Switzerland* | Costanza.Bonadonna@unige.ch

Domenico Mangione *Dipartimento della Protezione Civile, Italy* | Domenico.Mangione@protezionecivile.it

Tom Wilson *University of Canterbury, New Zealand* | Thomas.wilson@canterbury.ac.nz

Chris Gregg *East Tennessee State University, USA* | GREGG@mail.etsu.edu

Mel Duncan *British Geological Survey, UK* | md@bgs.ac.uk

Workshop description:

In 2015, the Global Volcano Model network, in partnership with IAVCEI coordinated over 130 volcano scientists representing 86 institutions to document progress in disaster risk reduction for the UN Global Assessment Report (GAR15).

The GAR reports, and their associated background reports and resources, provide regular evidence on progress in disaster risk reduction in the form of both qualitative case studies and narratives and a quantitative multiple hazard global risk model. ‘The process contributes directly to greater access to risk information for decision-making, and identifies feasible practices that can be employed at the local, national, regional and international levels.’ (UNDRR).

The next full UN Global Assessment Report on progress in disaster risk reduction is due to be released in 2021, so our community has an opportunity to work with partners to document progress towards reducing volcanic risk worldwide and also to identify barriers and challenges that may be hindering progress.

This 2nd IAVCEI-GVM workshop builds on the outcomes of the 1st workshop and aims to:

- Reflect on current progress in volcanic risk reduction worldwide
- Identify progress/revision of existing materials (e.g. country profiles)
- Discuss ideas and contributions for GAR21
- Discuss key tasks and milestones and key indicators for success
- Discuss ways in which the CoV community can contribute to SFDRR progress worldwide



Image by iStock from Pixabay

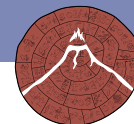


Cities on
VOLCANOES



11

**PRE-CONFERENCE
FIELD TRIPS**



Methana Volcanic Peninsula

FIELD LEADERS

Konstantinos Kyriakopoulos NKUA, Athens, Greece | ckiriako@geol.uoa.gr
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Christos Evangelidis NOA, Athens, Greece | cevan@gein.noa.gr

Date: 21-22 May 2020

Duration: 2 days

Number of participants: from 25 to 40

Cost: 100-150 euros

Methana is a volcanic peninsula of ~42km² located in the Saronic Gulf, 40 km SW of Athens, near three other volcanoes: an underwater volcanic field (Pausanias volcano), and the older Aegina and Poros. It is a composite andesite-dacite volcano that has developed numerous monogenetic vents.

The peninsula is located in the area of the Saronic Gulf, which is characterized by E-W normal faults and by NE-SW strike-slip faults and cross-cut by a myriad of smaller faults. The vents have usually developed along these tectonic lines.

According to scientists, at least 14 distinct eruptions can be identified, mostly effusive. Explosive activity is rare and emplaced at least 3 distinct pumice deposits. The erupted volumes are moderate, generally <0.9 km³.

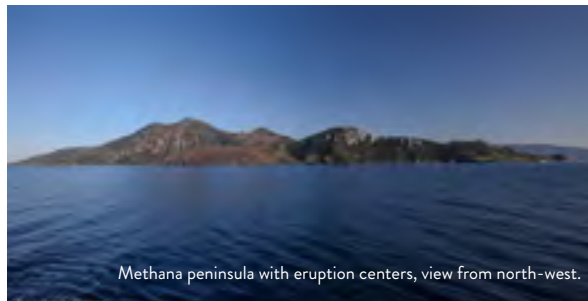
The volcanic stratigraphy of Methana has been documented on the “Geological Map 1:25000 of Methana” (Dietrich et al. 1996) and revised by Pe-Piper and Piper (2013).

The ages of the volcanic activity are poorly constrained. For simplicity, the eruptions can be separated in 4 phases and numbered from I to XIV, after the model of Popa et al. (in press):

Events I and II: the so-called “volcanic socle”, dated at 3.5 ± 0.9 Ma, covers the Mesozoic basement and Lower Pliocene marine marls (nannoplankton NN15 ~ 4.2 Ma). It is marked by an explosive eruption and by a series of domes and lava flows extruded all over the peninsula. Events III – XI (with random dates between 1.4 ± 0.3 and 0.6 ± 0.2 Ma): marked by two explosive eruptions (VI and VIII) and by a series of lava flows and domes. Limited hydrothermal activity is associated with this stage of volcanic activity. Events XII–XIII with ages of 0.34 and 0.29 Ma: lava flows and domes extruded from vents developed on N-S (XII) and E-W (XIII) directions. The eruptions are probably closely related to tectonic activity and the development of faults/fractures. Event XIV: the youngest eruption, the Mavri Petra lava flow complex, which has erupted in historical times ~ 250 BP in the NW corner of the peninsula.

An extensive geochemical survey on the fluids released by the volcanic/geothermal system of Methana was undertaken. Characterization of the gases was made on the basis of the chemical and isotopic (He and C) analysis. CO₂ soil gas concentration and fluxes were measured on the whole peninsula at more than 100 sampling sites.

Today, Methana is well situated for family, religious and health tourism. It is ideal for hiking trips in beautiful paths between the hills, interesting for the unique flora and fauna and offers plenty of Byzantine churches and small chapels. It is a traditional site for hot baths and health spas.



Methana peninsula with eruption centers, view from north-west.



Mavri Petra flows (~ 250 BP) in the NW corner of the peninsula

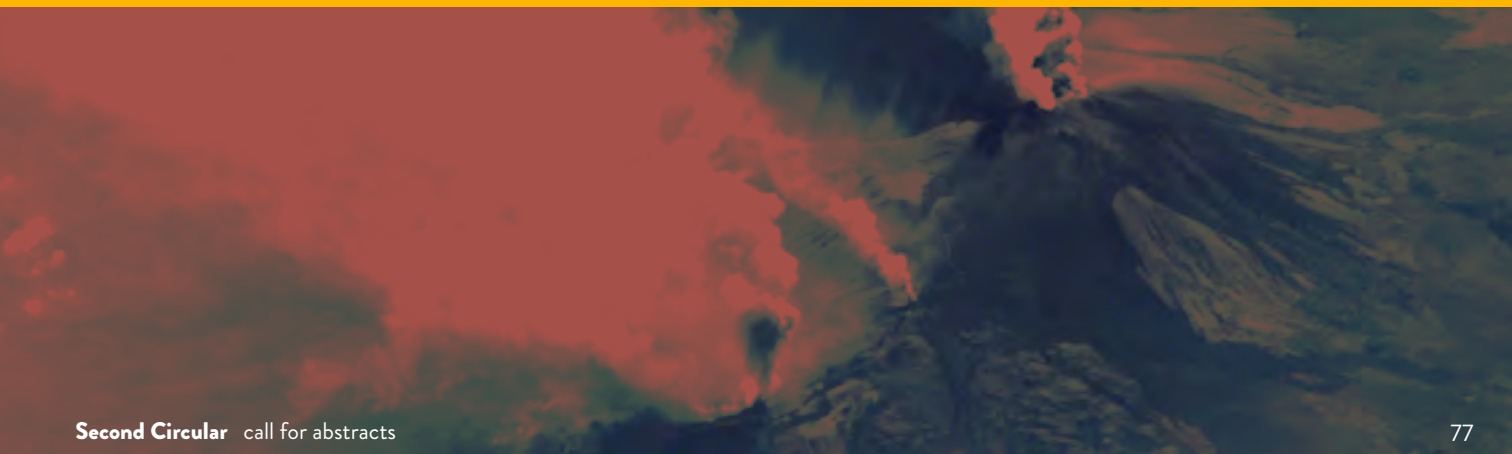


Thermal baths and yacht harbor Methana



Image by Shutterstock from Pixabay

INTRA-MEETING FIELD TRIPS





Field Trip. Archaeological Museum of Heraklion and Knossos

LEADERS:

Stella Mandalaki *Archaeological Museum of Heraklion* | smandalaki@culture.gr
Charalampos Fassoulas *Natural History Museum, University of Crete* | fassoulas@nhmc.uoc.gr

Date: 25 May 2020

Duration: 1/2 day

Number of participants: from 50 to 100

Cost per person (for a group of 50, including entrance fee at 2 places of 16 E):
 24 euros

The Heraklion Archaeological Museum is regarded as one of Europe's most important museums hosting unique samples of Cretan archaeology. The museum brings together archaeological finds from all over Crete, covering over 5500 years of the island's history. Pride of place is given to the treasures of Minoan civilization, the entire historical course of which can thus be appreciated. Justly regarded as the home of Minoan civilization par excellence, the museum houses the most important collection of Minoan antiquities the world over. The Museum is located at the center of the town and was recently renovated. A temporary exhibition on Daedalus is also hosted at present.

Knossos is the largest Bronze Age archaeological site on Crete and has been called Europe's oldest city. Settled as early as the Neolithic period, the name Knossos survives from ancient Greek references to the major city of Crete. The palace of Knossos eventually became the ceremonial and political centre of the Minoan civilization and culture. The palace was abandoned at some unknown time at the end of the Late Bronze Age, c.1380-1300 BC.

In the morning a visit will be made at the Archaeological museum where the archaeologists of the Museum will present and interpret the value of the various exhibits. In the afternoon, busses will travel participants at the site of Knossos, where special guiding will be offered by official tour guides.

Proposed Itinerary.

09:00-11:00 Visit at Archaeological Museum

16:00-18:00 Visit at Knossos Archaeological site.



Archaeological Museum



Archaeological Museum



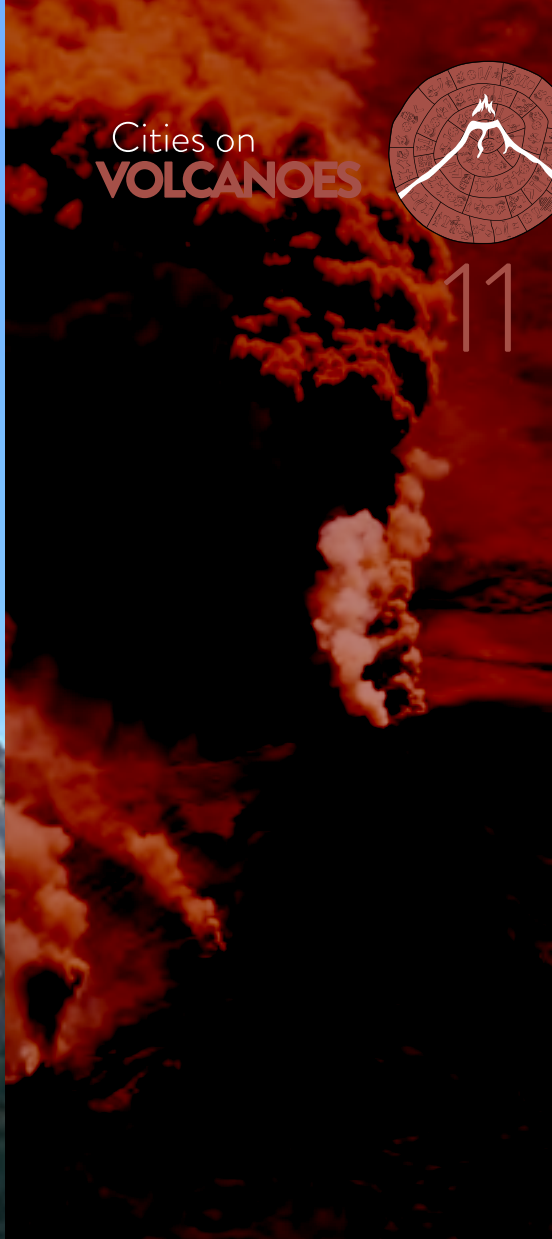
Knossos



Cities on
VOLCANOES



11



**POST-CONFERENCE
FIELD TRIPS**



Field Trip 1. Santorini - The naked child

FIELD LEADERS

Tim Druitt Clermont Auvergne University, CNRS | tim.druitt@uca.fr

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Tamsin Mather Department of Earth Sciences, University of Oxford | tamsin.mather@earth.ox.ac.uk

Dávid Karátson Institute of Geography and Earth Sciences, Eötvös University | dkarat@ludens.elte.hu

Date: 28-31 May 2020

Duration: 4 days

Number of participants: from 25 to 40

Cost: 650-750 euros

Santorini Volcano lies 110 km north of Crete. It consists of five islands in a small, circular archipelago around a caldera measuring 12 by 7 km, with 200-300 m high, steep cliffs on three sides. It is one of the largest volcanic centres of the 500 km long South Aegean Volcanic Arc, which is due to subduction of the eastern Mediterranean crust beneath the Aegean region.

Santorini lies on a submarine rift zone extending from the extinct Christiana Volcano in the SW to the submarine Kolumbo chain of volcanoes in the NE, and is the largest centre of the group. The earliest recorded volcanism on Santorini took place about 700,000 years ago, and since 350,000 years ago the activity has been highly explosive, with over a hundred explosive eruptions of which a dozen or more were of plinian intensity and shed pyroclastic flows into the sea. Repeat times for major explosive eruptions on the islands are on the order of about 20,000 years, although this has been very variable.

The last large explosive eruption occurred in the late Bronze Age, probably around 1620 BCE, and laid down deposits of pumice and ash up to 50 m thick all over the islands. The eruption products buried an affluent contemporary town at the ancient site of Akrotiri, and may have impacted the Minoan civilization on Crete through a combination of tsunamis, ash fallout, acid rain and atmospheric ozone depletion. The eruption is considered to have been one of the largest in the past 10,000 years worldwide, and is an iconic event in both volcanology and archaeology. It impacted both local and regional cultures, and may have fueled the Atlantis legend.

The eruption formed the present-day caldera, which consists of three flat-floored basins: a large northern basin 390 m deep, and two smaller ones (western, 320 m and southern, 270m deep). In recent years the caldera has been the subject of state of the art marine research, including high-resolution bathymetric mapping and seismic studies of the caldera volcano-sedimentary fill. The Christiana-Santorini-Kolumbo volcanic line was also the subject of a major seismic tomography experiment in 2017.

Following the eruption in the late Bronze Age, a new caldera cycle has formed the islands of Nea and Palea Kameni in the centre of the caldera. These islands are in fact the summits of a single, mostly submarine edifice 400 m high that has produced over nine eruptions of lava in historical times. The earliest recorded eruption of Kameni Volcano was 197 BCE, and the last took place in 1950. Over 15 months in 2011-2012 the Kameni



View of Santorini caldera



View of Fira (capital of Santorini)



Akrotiri excavations



Islands were uplifted by several centimetres, and the level of microseismicity greatly increased, probably due to intrusion of new magma at a depth of about 4 km beneath the northern caldera basin.

Santorini had a 2011 census population of 15,550, but it attracts over 2 million tourists a year from all over the globe. The municipality includes the inhabited islands of Santorini and Therasia and the uninhabited islands of Nea Kameni, Palea Kameni, Aspronisi, and Christiana. All urban settlements are considered as Historical and Cultural Heritage sites, and their development is protected and regulated by specific laws in terms of building materials and architecture. The traditional architecture of Santorini is similar to that of the other Cyclades islands, with low-lying cubical houses made of local stone and white-washed or limewashed with various volcanic ashes used as colours. The two main sources of wealth on Santorini are agriculture and tourism, but it remains the home to a small, but flourishing wine industry.

The field trip will visit many key outcrops of volcanic products from the Bronze-Age and earlier eruptions. A boat tour of the caldera will enable us to climb Nea Kameni Island and examine the products of the many historical eruptions. A guided visit of the archaeological site of ancient Akrotiri will also be included.



Palea Kameni



View of the northern part of Santorini Caldera



Nea Kameni



Field Trip 2. The Volcanic Landscapes of Milos

FIELD LEADERS

Dimitris Papanikolaou NKUA, Athens, Greece | dpapan@geol.uoa.gr

Stephanos Kiliias NKUA, Athens, Greece | kiliias@geol.uoa.gr

Johnathan Naden British Geological Survey, UK | jna@bgs.ac.uk

Date: 28-31 May 2020

Duration: 4 days

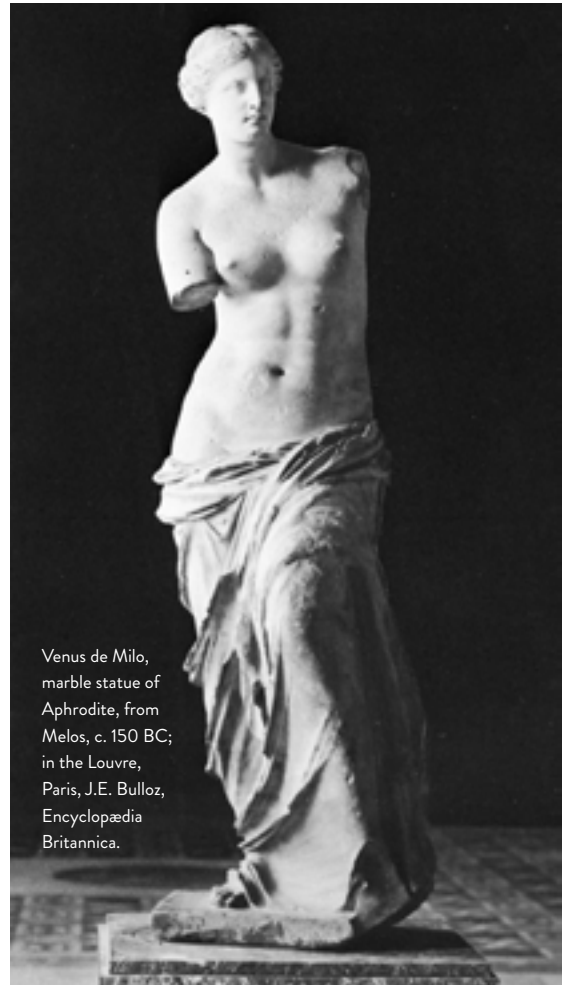
Number of participants: from 25 to 40

Cost: 600-700 euros

Milos Island is an active emergent volcano on the Aegean Volcanic Arc in the Southern Cyclades, which is the result of the subduction of the African plate beneath the Aegean plate. The volcanic activity of Milos, which started in the Pliocene (~4 Ma), records a transition from a relatively shallow but dominantly below wave-base submarine setting to a subaerial one. Milos has a tectonically controlled high enthalpy geothermal system, which has been active for around 1.5 Ma, and covers at least 35 km² of seafloor making this one of the largest shallow-sea hydrothermal systems described to date; it vents in the shallow (<100 m) marine (Palaeohori) environments, and can be found up to (at least) 300 m water depth, with maximum temperatures reaching 150 °C. Milos geography comprises two distinct parts, eastern and western, connected through a narrow E-W zone in the south, where the latest volcanic eruptions have occurred during Late Pleistocene forming the subaerial Phryriplaka volcano. The previous volcanic activity during Middle Pleistocene was located at the northern cape of Trachilas, where the subaerial volcanic crater is nicely preserved. The broad Milos Gulf is dividing the two parts of Milos, forming a neotectonic NW-SE graben structure. The volcanic history of the island is highly differentiated with the earlier volcanic products located at the western part during Pliocene – Early Pleistocene, followed by the younger volcanics during Early – Middle Pleistocene at the eastern part. The localisation of the successive volcanic centres is related to the tectonic activity with the distinction of several neotectonic blocks, which show vertical and/or tilting movements. This geodynamic process is related to the morphotectonic evolution of the island with characteristic planation surfaces formed either by the uplift of planar marine sedimentary formations or by weathering of previous landforms. The volcanic domes form a distinct morphological feature whereas the planar forms show the extent of former marine sedimentation areas, now being subjected to linear incision, forming small gorges and ravines. Each of the neotectonic blocks is characterised by a special tectono-stratigraphy and morphology related to the dominating volcanic forms (domes, craters, planar tuffs, lahars etc). Old catastrophic events can be observed as widespread lahar formations, volcanic debris avalanches, volcanic slope instabilities with submarine slides in the surrounding marine environments etc. In Milos, mineralized submarine hydrothermal system (ca. 200 m water depth) has been uplifted and preserved intact, containing Pb-Zn-Ag (Triades), Mn-Ba and Fe(BIF) mineralization (Cape Vani) and epithermal Au-Ag veins±critical metals Sb and Te (Profitis Ilias), as well as industrial mineral deposits (bentonite); this provides a rare on-land analogue of the relationship between submarine volcanic landforms, tectonic activity and the location of mineralisation. The island has a



Panoramic view of the Milos - Fyriplaka tectonic graben within the two horsts of Eastern and Western Milos.



Venus de Milo, marble statue of Aphrodite, from Melos, c. 150 BC; in the Louvre, Paris, J.E. Bulloz, Encyclopædia Britannica.



long history, starting from the neolithic period, when the obsidian deposits have been used for tools with remnants of the early industrial activity (Phylakopi). The Milos tools have been spread out all over the Mediterranean basin during the end of the neolithic period. Later, during the classical period the island was prosperous with exceptional culture, designated by the discovery of the «Milos Aphrodite» statue, actually demonstrated at the Louvre Museum in Paris. The Milos catacombs and the special constructions of small caves (sirmata) along the coast to protect the boats during winter (Klima) are characteristic of the special volcanic environment, which inspired special architecture forms and facilities for the exploitation and transportation of the mineral deposits of the island. It is very common to observe former constructions along the Milos coasts of small harbors/points of loading the minerals, which were transported from the surrounding open quarries until last century by animals. Fabulous coasts (e.g. Kleftiko) and extraordinary submarine thermal springs (Paleochori) along the coastlines are special points of geotourism. The Milos geothermal field is extended but not exploited. The last volcanotectonic event of 1992 produced characteristic damages and several surficial expressions of the active deformation.





Field Trip 3. Psiloritis UNESCO Global Geopark

LEADERS:

Charalampos Fassoulas *Natural History Museum, University of Crete* | fassoulas@nhmc.uoc.gr

Spiros Staridas *Staridas Geography* | staridasgeography@gmail.com

Kaloust Paragamian *HISR* | k.paragamian@gmail.com

Papadopoulos Gerasimos *NOA (ret.)* | papadop@noa.gr

Date: 28 May 2020

Duration: 1 day

Number of participants: from 50 to 100

Cost per person (for a group of 50) : 30 euros

Within the island of Crete, renowned for its culture and history, stands Psiloritis UNESCO Global Geopark, a place where the secrets of life and nature have been preserved for hundreds of centuries. The highest mountain of the Island, “Psiloritis”, rose up through the sea few millions of years ago when tremendous forces within the Earth were unleashed as the African continent encroached on Europe. Different types of Mediterranean rocks mixed together to create a unique environment within which life adapted and evolved. The combination of hundreds of plants and animals, which live exclusively in these mountains, has produced a region characterized by its great biodiversity.

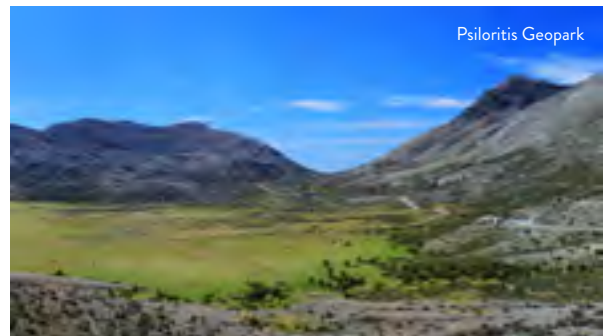
Field trip will focus on the various nappes constituting the Hellenic Arc, the tectonic processes that built the Psiloritis mt and exhumed the deep buried rocks, the active tectonism expressed as normal faults and finally the shaping of island’s landscape as a result of tectonism and karstic erosion. Important geosites of geopark, like the Talaia Ori section, the Vossakos fold Museum, the Sfentoni Cave, the Cretan detachment fault and Idaion Andron cave will be visited. Participants will also enjoy the typical Cretan cuisine and goods.

Proposed stops

08:30	Depart
09:00 – 09:30	Gonies gorge, Heraklion Neotectonic Basin, Giouchtas horst (panoramic view)
10:00 – 10:30	Gonies Ophiolites
11:30 -13:00	Nida plateau, Idaian fault, Idaion Andro (who wish will walk up to cave ; about 1 hour visit)
13:30 – 15:00	Lunch at Anogia
15:30 -16:30	Visit Sfentoni cave
17:30 – 18:00	Vossakos fold museum
19:00	Return Heraklion



Psiloritis Geopark



Psiloritis Geopark



Field Trip 4. Nisyros Volcano (to be confirmed)

Date: 28-31 May 2020

Duration: 4 days

Number of participants: from 25 to 40

Cost: 600-700 euros

The island of Nisyros is located at the easternmost end of the Quaternary South Aegean Volcanic Arc as part of the Kos-Nisyros-Yali Volcanic Field, from where 160,000 years ago the largest eruption in the eastern Mediterranean (the silicic Kos Plateau Tuff) devastated the entire Dodecanese islands. Nisyros volcano is almost circular, with an average diameter of 8 km, and covers an area of ~ 42 km². It lies above a basement of Mesozoic limestone and a thinned crust of the Alpine orogen, with a mantle-crust transition at ~ 27 km depth. The volcanic edifice of Nisyros comprises a succession of calc-alkaline lavas and pyroclastic rocks, with a summit caldera of an average diameter of 4 km. Although the last magmatic volcanic activity on Nisyros dates back at least 25,000 years, the present geodynamic activity encompasses high seismic unrest and widespread fumarolic activity with surface temperatures of $\sim 100^\circ\text{C}$ and 350°C at a depth of 1'500m. Violent earthquakes and steam blasts accompanied the most recent hydrothermal eruptions in 1871-1873 and 1887 and left large hydrothermal explosion craters behind. Mud and hydrothermal vapor rich in CO₂ and H₂S were emitted from fracture zones which cut the caldera and extend towards the NNW through the vicinity of the village of Mandraki, into the island of Yali, and even towards Kos. In 1996 and 1997 seismic activity started with earthquakes of magnitudes up to 5.5 and with hypocenters down to 10 km depth around inferred magna reservoirs between 5 -12 km.



Stephanos crater within Nisyros caldera



Paloi village



Nisyros caldera with the phreatic craters, view from the north



PARALLEL SCIENTIFIC PROGRAMME

VolcanOscars

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Jenni Barclay University of East Anglia | j.barclay@uea.ac.uk

Nomikou Paraskevi National and Kapodistrian University of Athens | evinom@geol.uoa.gr

Charalampos Fassoulas Natural History Museum of Crete | fassoulas@nhmc.uoc.gr

Films can be a memorable way of raising awareness, educating or simply sharing the joys of volcanoes and volcanology. As technology advances volcanologists are finding increasingly creative ways to produce and share these films, abetted by the proliferation of distribution platforms. This session aims to celebrate that creativity and share ideas as well as our love and fascination for volcanoes and volcanic phenomena.

Submissions will be invited in the run up to CoV in one of three categories:

- (a) films created or edited in collaboration with professional film-makers
- (b) films created or edited by volcanologists
- (c) films created and edited by early-career volcanologists.



Submitted films will have to be short videos, films or clips of < 10 minute duration. We request a 2-3 hour evening session and will use this to show the most engaging 20 or so films, while also choosing to reflecting ranges in topic, geographic distribution and category entries. Contributors will be asked to submit a short abstract to create a 'film booklet' and the organisers will create a playlist as a permanent record of the films, including those not shown should submissions exceed time available. Attendees will be able to vote for the winner in each category: The VolcanOscars!

Immersive Virtual Reality to study inaccessible and dangerous sites in onshore and offshore volcanic terrains

Fabio L. Bonali, Alessandro Tibaldi*, Elena Russo Department of Earth and Environmental Sciences, University of Milan-Bicocca, Italy

*CRUST- Interuniversity Center for 3D Seismotectonics with Territorial Applications, Italy

Varvara Antoniou, Nomikou Paraskevi Department of Geology and Geoenvironment, National and Kapodistrian University of Athens, Greece

Malcolm Whitworth School of Environment, Geography and Geosciences, University of Portsmouth, UK

Benjamin van Wyk de Vries University of Auvergne, Clermont Ferrand, France

Kyriaki Drymoni Department of Earth Sciences, Royal Holloway University of London, UK

The aim of this daily live demo is to involve the participants in surveying text-book outcrops for volcanic hazard assessment by utilizing the innovative Immersive Virtual Reality (VR), sites are both in onshore and offshore environment. Participants will explore and study in 3D key sites from Santorini and the Northern volcanic zone of Iceland by collecting field data in dangerous or inaccessible areas, where volcanic, volcanotectonic and tectonic processes produced outstanding and textbook-like geological outcrops. Such 3D real-world outcrops have been reconstructed using the Areal Structure from Motion technique, obtaining 3D models with cm to mm sharp resolution, and are focused on: i) magmatic dykes; ii) 1 to 30-m high normal faults; iii) active craters; iv) Holocene and historical volcanic edifices; v) tectonic-induced extension fractures; vi) transform fault zone; vii) volcanic deposits. This outreach activity is both supported by the Erasmus+ 3DTeLC Project (<http://3dtelec.lmv.uca.fr/>) and the Argo3D (<http://www.argo3d.unimib.it/>).

Open Meeting: How to contribute to the Journal of Applied Volcanology

Jan Margulies School of Environment, The University of Auckland, New Zealand



PARALLEL PROGRAM FOR STUDENTS AND CHILDREN

- 1. Treasure Hunts** in the city center, having as stations the largest/most important volcanoes in the world.
- 2. Informative Event** at the Museum's exhibition area, in the afternoon, with a lecture, a presentation on prevention, activities from the volcano museum, constructions, etc.
- 3. Archaeological Tour** of the Heraklion Archaeological Museum to adults on the volcano of Santorini, along with activities for children.

Organized by the Natural History Museum in collaboration with the Heraklion Archaeological Museum.

Details and updating of this programme will be published on the COV11 website



Cities on **11**
VOLCANOES