

International Conference on Evolution, Transfer and Release of Magmas and Volcanic Gases (MAG2007) – An Overview

Introduction

MAG2007 was the first international workshop devoted to bringing together igneous and gas geochemists working on volcanology-related topics. It was held at the Institute of Earth Sciences, Academia Sinica, and at Taiwan's East Coast, from 22 to 27 April 2007, and hosted an international group of some 45 leading experts and students of volcanology and igneous and gas geochemistry. The meeting was intended to provide a learning experience for all participants. The goal of this report is to summarize the proceedings and to convey the spirit and accomplishments of the meeting.

Structure

The conference was organized around a thematic set of keynote presentations by leading researchers. On the first day, the focus was on volcanic gases, with presentations on [1] sources of volcanic gas emissions, [2] degassing fluxes from subduction zones, [3] satellite based monitoring of volcanic emissions, and [4] continuous degassing from open conduits; on the second day, the focus shifted to igneous processes, with presentations on [5] rates of magma generation, evolution and degassing, [6] insights on magma dynamics from Mount St. Helens, [7] processes of incremental growth of magma reservoirs, and [8] the mechanisms and timescales of crustal assimilation. Much of the meeting was devoted to moderated in-depth discussions of these topics, with scheduled three-minute presentations of the participants following each keynote talk. Poster sessions provided opportunities for participants to display current research and to interact further with interested colleagues. Lunchtime laboratory visits provided a detailed overview of the state of the art facilities available at the Institute of Earth Sciences for collaborative research. Finally, a three-day conference field trip to visit active fumaroles of the Tatun Volcanic Group and exposures of deposits from the accreted Neogene Luzon Arc in East Taiwan provided a forum for informal interaction, and enhanced the attraction of this meeting to a broad and international group. The format of the conference proved highly productive and stimulated many discussions, which will without doubt result in future collaboration between the participants.

Formal presentations and discussion topics

After a brief introduction by Georg Zellmer to the Institute of Earth Sciences and its facilities, the scientific part of the conference was opened with Tobias Fischer's talk on sources, variations and implications of volcanic gas emissions. Gas monitoring and sampling methods were introduced, and it was shown that systematic variations in gas species and isotopic compositions with tectonic setting provide insights into the relative contributions of volatiles from the crust, the mantle and the subducting slab. The importance of time-series data for the monitoring of changes in volcanic activity was stressed, and the advantages of integration of gas analyses with petrological studies, particularly melt inclusion and ash leachate geochemical work, was discussed.

The next keynote presentation by David Pyle was elucidating the degassing fluxes from subduction zones. The talk focused on the inferences that can be made from local studies of volcanic fluxes on global-scale volcanic emissions. It became clear that

although in principle, the budget of gas exsolution from cooling and decompressing magmas and of interactions with the crust can be resolved, sparse sampling density makes it difficult to infer global-scale emissions, particularly when attempting to constrain trace gas emissions. However, recent developments of portable ground-based and remote sensing instruments for the measurements of reactive volcanogenic trace gases is currently improving our knowledge of their budgets.

Simon Carn presented the latest advances in satellite based monitoring of volcanic emissions. A variety of space-based instrumentation in principle allows the detection of SO₂, BrO, HCl and aerosols, although in practice SO₂ release is the only species which - to date - can be well quantified. Recent improvements in the resolution of space-based monitoring enables the tracking of evolving volcanic gas plumes in the atmosphere during passive degassing. Detection of passive, i.e. non-eruptive degassing from space is a significant step forward towards continuous monitoring of volcanoes. Satellite based monitoring also allows quantification of degassing fluxes of remote volcanoes, and helps to constrain the global volcanogenic SO₂ flux into the atmosphere.

Concluding the first day of the conference, Hiroshi Shinohara elucidated the mechanisms of non-eruptive continuous degassing, as for example observed in Etna, Stromboli, Masaya, Sakurajima and Miyakajima, amounting to more than half of the global degassing budget from subaerial volcanoes. As the gas composition indicates low pressure degassing, and as the volume of magma to supply this gas flux is significantly larger than the erupted volume, magmatic convection in the conduit is required, with volatile rich magma rising and degassed magma sinking due to its higher density. The discussion focused on problems regarding conduit geometry and changes in magma viscosity due to degassing-induced crystallization, indicating that further work is needed to improve our understanding of this process.

The second day began with Ken Sims' tour-de-force of uranium series isotope systematics and its applications in igneous and gas geochemistry, providing insights into the processes and timescales of magma generation, evolution and degassing. After a thorough introduction to the principles of the uranium series decay chain, the introduction of disequilibria through geological processes such as melting, differentiation and degassing, and how the decay of such disequilibria may be used to date these processes, results from a number of case studies were discussed. These included the timescales of melt generation and migration at ocean ridges, the rates of differentiation and magma recharge in shallow reservoirs, and magma degassing rates. New (²²²Rn/²¹⁰Pb) data from volcanic aerosols of Masaya were also presented.

Next, Jon Blundy's presentation on magma storage and volatile fluxes beneath Mount St. Helens provided many new insights into the petrogenetic processes operating at intermediate arc volcanoes. Plagioclase hosted melt inclusions provide direct evidence for degassing-induced crystallization during decompression in a rising magma column. The latent heat of crystallization may increase magma temperatures by up to 100°C, providing an alternative explanation for many disequilibrium textures observed in intermediate arc volcanic products that are frequently attributed to heating by influx of hotter, more mafic lavas. A broad correlation of the depth of the deepest earthquakes with geobarometric constraints on magma extraction depth neatly relates petrological and geophysical observations. Finally, data on variations in the Li content of melt inclusions were discussed, indicating the condensation of a Li-rich brine at depth.

Catherine Annen drew our attention to recent advances in the understanding of magma differentiation and shallow magma storage by presenting models of incremental growth of magma reservoirs. The controlling parameters are the geothermal gradient, depth of intrusion, intruded magma volume, fertility of the magma, and the emplacement geometry and rate. It was shown that models of over-accretion, under-accretion and random accretion result in different degrees and timescales of crustal melting, and that the partial/residual melt ratio is dependent on emplacement rate. These principles can be applied to melt generation and evolution in deep crustal hot zones, as well as shallow magma chambers of different sizes, where accretion rates can be inferred by combining thermal models with a variety of external constraints. Examples were given from the Mount Pelee magma chamber, where an accretion rate of 3 cm yr^{-1} is inferred, and the Manaslu leucogranite, where the model predicts an accretion rate of a few mm per year.

David Peate concluded the day with a review of the mechanisms and timescales of crustal assimilation. Recent advances in the development of realistic quantitative compositional models, and the advantages in using high-precision Pb isotope data to track assimilation, were discussed. Using the East Greenland flood basalts as a case study, crustal contamination appears to increase with decreasing magma supply rate. The focus then shifted to simple and young magmatic systems (suitable for uranium series dating) and constraints on the rates of assimilation. Examples from the Paricutin monogenetic cone, Mexico, and the Ice Springs flow of SW Utah were given. In the latter, dissolution of crustal xenoliths appears to take months to years and may be responsible for the entire observed geochemical variation within the flow. The potential in using olivine hosted melt inclusions to track assimilation during early stages of crystallization was also discussed.

Finally, it is noted that a number of significant contributions were made through the many short presentations of the other participants. These contributions were thematically scheduled after each keynote talk, giving every participant the opportunity to provide insights from their current research, thereby enhancing our common learning experience.

Laboratory visits

To give an overview of the state-of-the-art facilities available for collaborative research at the Institute of Earth Sciences, Academia Sinica, lunch-time laboratory visits were organized. Participants had the opportunity to view the Electron Probe Microanalysis Lab, the Laser Ablation ICP-MS Lab, the Silicate Oxygen Isotope Lab, the Gamma Spectrometry Lab, the Isotope Hydrology Lab, the Thermal Ionization Mass Spectrometry Lab, and the Atmospheric Chemistry Labs. For a description of these laboratories, the available instruments, and the contact personnel, please refer to the MAG2007 program and abstract volume available from the conference website (www.earth.sinica.edu.tw/~mag2007). Other instruments available are described on the institute website (www.earth.sinica.edu.tw/index_e.html).

Conference field trip

The conference field trip began with an introduction to Yangmingshan National Park, and included a viewpoint of the Taipei basin and a tour of some of the fumarolic activity of the Tatun Volcanic Group. The second day was devoted to the complex geology of Eastern Taiwan's coastal range, and had participants discuss the significance of many of

the outcrops in the area, with some good examples of distal and proximal volcanic and sedimentary facies, and opportunities to investigate dolerite dikes, volcanic bombs, remainders of a fringing reef, and the Chimei fault zone. The last day included visits to the famous Taroko gorge and some of the geologically most interesting examples of Northern Taiwan's hot springs, which were thoroughly enjoyed.

A few days after the conference fieldtrip, a number of participants conducted gas monitoring and sampling fieldwork in the Tatun Volcanic Group, providing the best possible hands-on example of the collaborative spirit that characterized this meeting.

Conclusion

The success of MAG2007 can be attributed to the presence of a diverse group of active researchers, including a number of young scientists who brought with them novel ideas and expertise with new approaches and technologies. The relatively small size of the group promoted active discussion and interchange. Through conferences like MAG2007, the communication and integration of expertise among disparate specialists is promoted, which is usually not possible in larger international meetings. Finally, all participants appreciated the conference setting in East Asia, which for many was an exotic location giving ample opportunities to discover a very different lifestyle.

In the end, the success of MAG2007 will be measured at least partly by the number of new collaborations formed and new ideas developed. From that perspective, it is great news that despite the relatively small number of participants, a JVGR special issue on "Evolution, Transfer and Release of Magmas and Volcanic Gases" is planned, which summarizes some of the most recent work in the field, with studies of Taiwanese and international topics. Also, many opportunities exist for conducting collaborative research with researchers from the Institute of Earth Sciences, which offers the use of its state-of-the-art analytical facilities for promising research projects.

Further information

Details of the conference, including a program with submitted abstracts and a list of participants, are available on the MAG2007 webpage (www.earth.sinica.edu.tw/mag2007). In 2008, a compilation of thematic papers submitted by conference participants will be published as a special volume of the Journal of Volcanology and Geothermal Research.

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