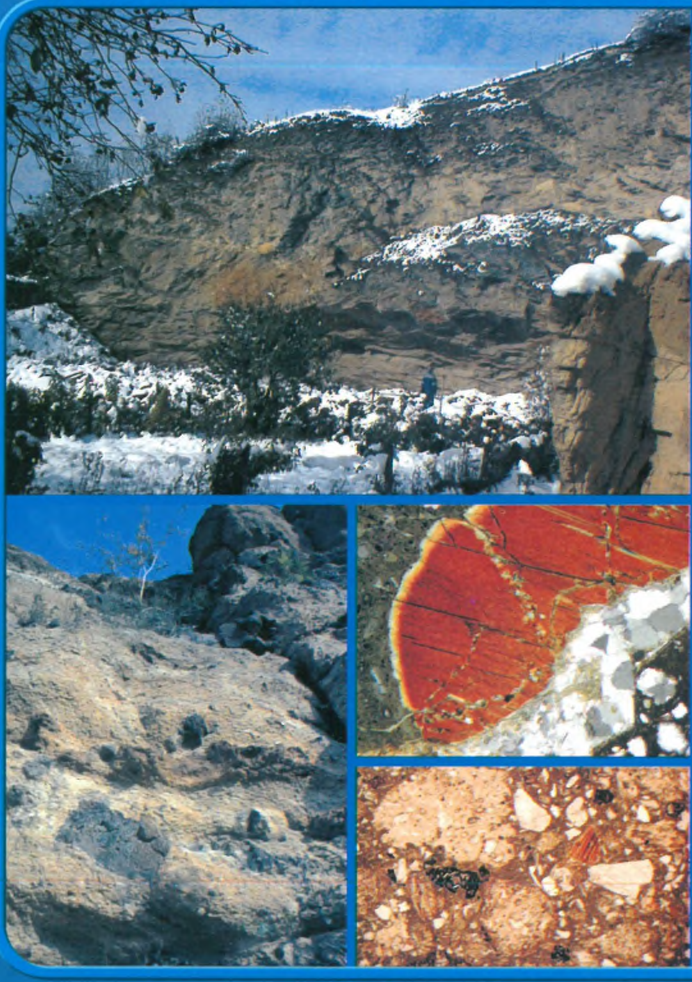
Occasional Papers of the Geological Institute of Hungary, volume 203

Abstract Volume

of the

Second International Maar Conference

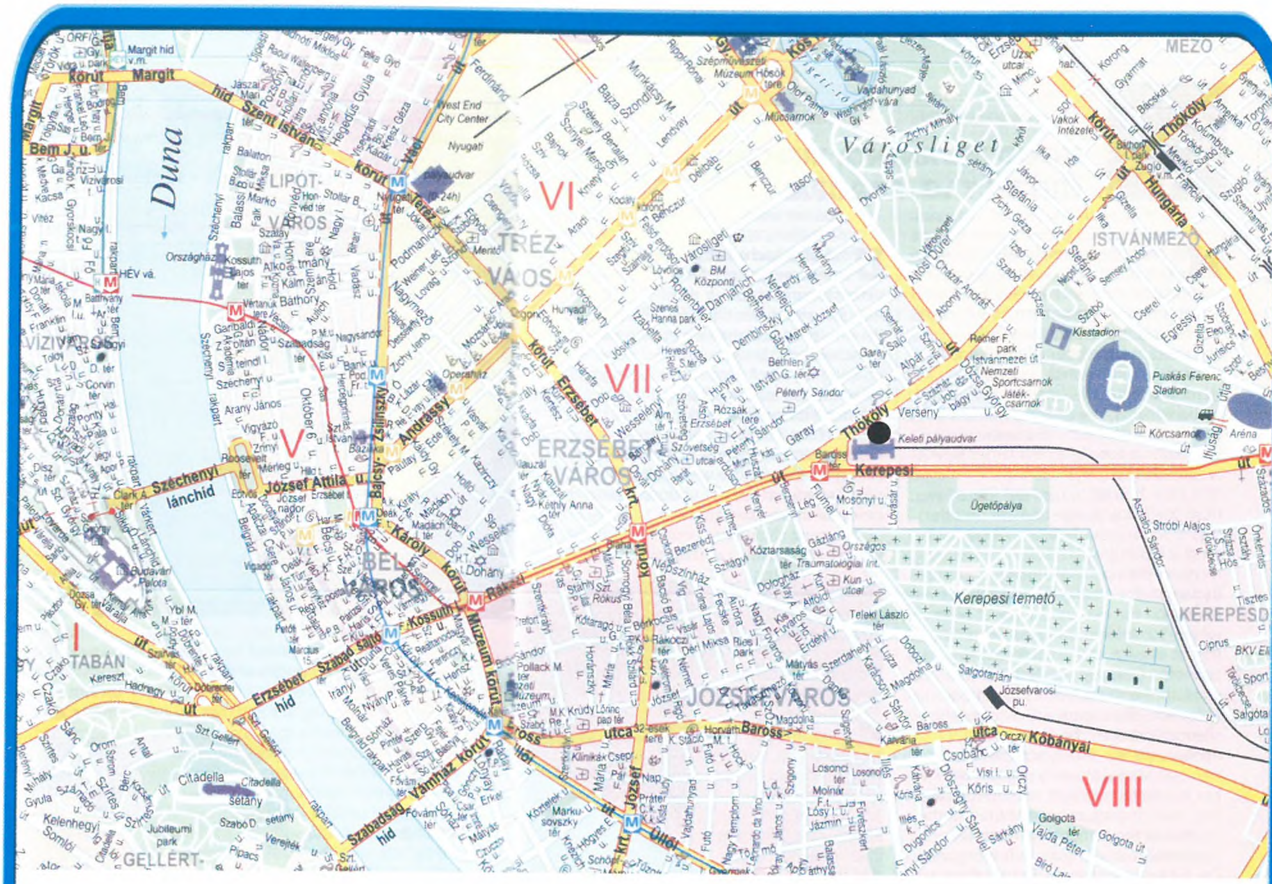
Hungary–Slovakia–Germany



Edited by

Károly Németh
Ulrike Martin,
Kurt Goth
and
Jaroslav Lexa

Budapest, 2004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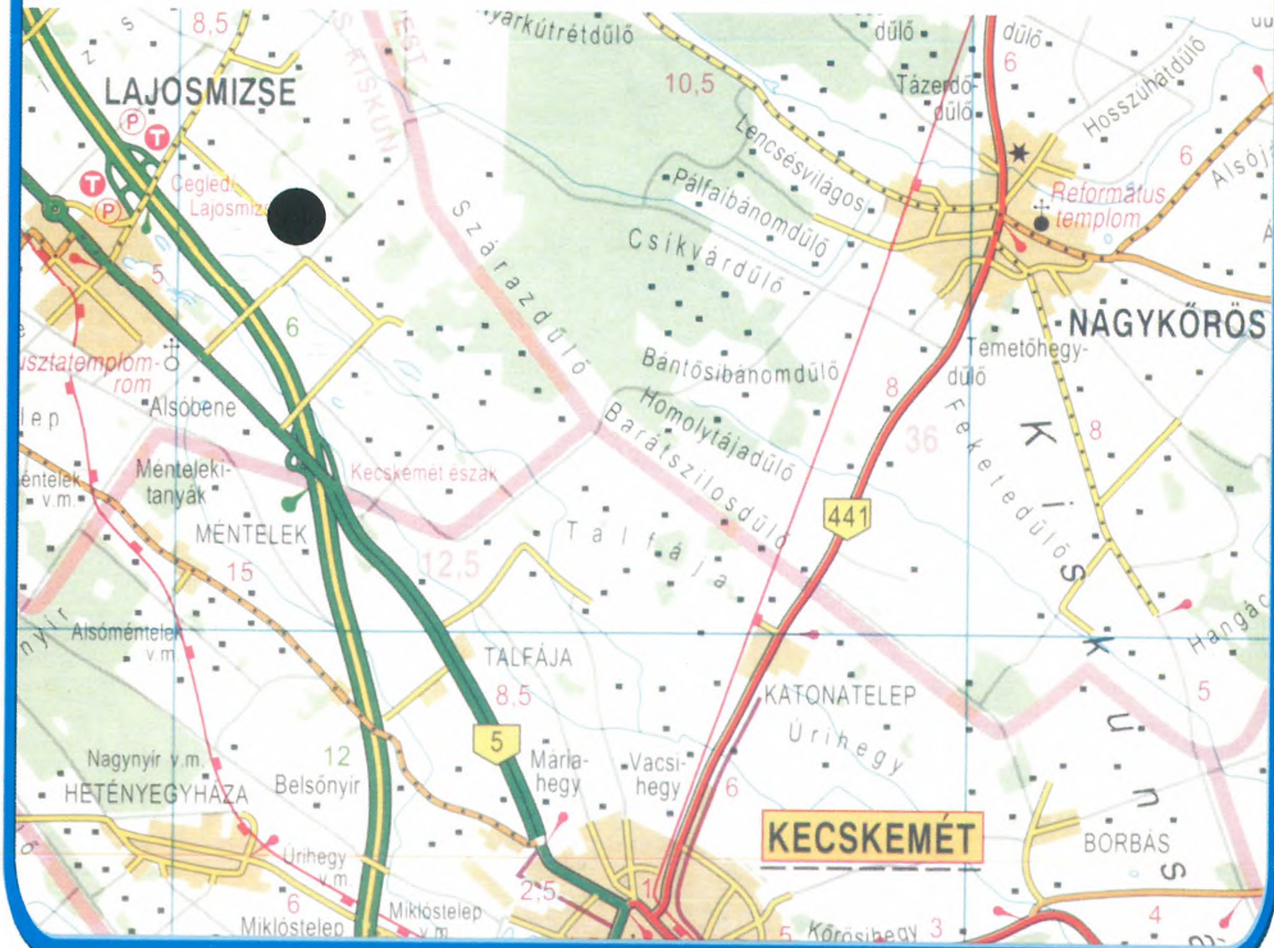
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Abstract Volume

of the Second International Maar Conference

21–26 September 2004

Lajosmizse/Kecskemét, Hungary

Editors:

KÁROLY NÉMETH, ULRIKE MARTIN, KURT GOTH and JAROSLAV LEXA

Budapest, 2004

A Magyar Állami Földtani Intézet 202. Alkalmi kiadványa
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A tribute to
Professor George P. L. Walker

Dear Professor,

We wholeheartedly dedicate the 2nd International IAVCEI/IAS Maar Workshop to Professor George Walker. George, who is now 78 years old, has made an immense contribution to our understanding of plate tectonics and Iceland geology between 1954 and 1964 and then to our beloved science of volcanology, more directly, starting in 1963.

Many of us regard George as the father of modern quantitative physical volcanology. At a time when there were few detailed and systematic studies of volcanic processes and products, and when pyroclastic deposits in particular had received little attention, around the mid-to-late 1960s, George pioneered such studies. George was in Iceland when Surtsey erupted between 1963 and 1965 and this exceptional phreatomagmatic eruption fascinated him and drew him into volcanology. He has worked non-stop on volcanic processes and products ever since. In the last 5 years alone, he has worked, on subjects as diverse as cone-forming eruptions, rift zones and dike complexes, dynamics of lava flow facies formation, new methods of studies of tephra fallout deposits, assessments of tephra fall dispersal data quality, a reassessment of phreatosubplinian eruptions, the origin of the diversity pyroclast shapes, and more.

George promoted quantitative field studies in volcanology and emphasized the need for modeling and laboratory analogue experiments. He would often carry out experiments in the field and in the classroom, making a mess hard to clean up but enlightening his audience about how volcanic processes worked. He helped all these areas of volcanology start in earnest and develop through celebrated collaborative studies with colleagues such as Peter Francis and Lionel Wilson and numerous students whom he inspired including Ian Carmichael, Steve Self, Steve Sparks, John Roobol, Colin Wilson, John Wright and many others. New fields of enquiry including quantitative and process-oriented field volcanology, physical volcanology and volcano sedimentology, planetary volcanology, volcano geomorphology and volcano remote sensing, emerged as a direct result of George's inspiring example.

At a time when quantitative studies of pyroclastic deposits were rare, George introduced rigorous methods to recognize them and study them in the field and in the laboratory. This included deposits associated with maar volcanoes such as base surges and ash falls. He also carried out the first detailed studies of littoral cones, documenting that the entrance of some lava flows into the sea can result in highly explosive and hazardous cone-forming eruptions. His studies of the Rabaul eruptions, and of the AD 180 Taupo eruption sequences with Colin Wilson, have become great classics and set new standards in volcanological field work and eruption reconstruction from deposits. This inverse modeling approach, fine-tuned with a few others like Steve Sparks and Lionel Wilson, was successfully applied to hazard assessment at hazardous volcanoes around the world and has enabled to save countless lives at volcanoes (e.g. at Mt Pinatubo). George was particularly interested in the phreatomagmatic phases of the Taupo or Rabaul eruptions and he was the first to point out that volcanological and meteorological processes can interact and to document how this affected the deposit features. Not surprisingly this is now starting to be recognized as one of the most exciting contemporary areas of volcanology.

Of course, George's interest in monogenetic volcanoes and basaltic volcanism generally is also well known. During his 15 years as Gordon Macdonald Professor of Volcanology at the University of Hawaii (1981–1996), George spent much of his time mapping the Hawaiian volcanic systems. He was able to do this thanks to the realization that the different Hawaiian Islands had formed in a similar way but were at different stages of erosion. He carried out systematic field work for many years on these volcanoes, integrated all the data, and was able to shed new light on the 3D structure and time-evolution of basaltic systems like those in Hawaii. His work on rift zones and dike complexes, notably in Iceland and Hawaii, remains the best to date.

Asked if he would write a few words to inspire this conference a few weeks ago, George told us that there were plenty of good reasons for studying monogenetic fields and especially maar volcanoes and their deposits. He noted that of course any work that would enable to avoid another Lake Nyos-like disaster would be most welcome, but he said that an overwhelming reason for studying maars and monogenetic fields is that "they are there". How could we not study them? One will recognize in this statement that scientists are often driven by a simple and powerful urge to describe the natural world and by an irresistible curiosity and need to understand how the Earth works.

George is delighted that the workshop is taking place and that once again it will be attended by such a diversity of scientists, covering all the aspects of volcanology that he promoted including several that he helped pioneer. George has always championed quantitative and process-oriented field and laboratory work and no doubt he would have taken special delight in attending those talks and posters presenting an abundance of new field *and laboratory data, and in those modeling presentations informed by such field and laboratory constraints.*

While George wishes us well for this exciting workshop, we want to give tribute to him for showing us the paths to follow, for serving as an example for so many years, for his generous and disinterested support to students, researchers and to our volcanological community as a whole. George, we thank you from the bottom of our hearts for having been and continuing to be a great pioneer of modern volcanology. We also want to wholeheartedly thank your family, who has always supported your efforts, through thick and thin, thereby enabling you to revolutionise our science.

In the words of Wes Hildreth and others who feel that you profoundly influenced their research, the importance of your contributions and the usefulness of the rigorous and systematic methods of analyses you introduced to volcanology, will continue to inspire us for another 100 years.

This workshop is dedicated to you. We wish you and your family well!

On Behalf of the Workshop Attendees and the 2IMC Organising Committee:

Gerald Ernst, Steve Sparks, Károly Németh, Ulrike Martin

Programmes and technical informations

Organizing Committe

Károly Németh, *Geological Institute of Hungary, Budapest*
Ulrike Martin, *Heidelberg, Germany*
Jaroslav Lexa, *Geological Institute of Slovakia, Bratislava*
Vlastimil Konečný, *Geological Institute of Slovakia, Bratislava*
Volker Lorenz, *University of Würzburg, Germany*
Kurt Goth, *Geological Survey of Saxony, Germany*
Peter Suhr, *Geological Survey of Saxony, Germany*

Chairpersons

Károly Németh, *Geological Institute of Hungary, Budapest*
Ulrike Martin, *Heidelberg, Germany*
Jaroslav Lexa, *Geological Institute of Slovakia, Bratislava*
Volker Lorenz, *University of Würzburg, Germany*

Conference office

Finance:
Petra Koerner *(Germany)*

Coordinator:
Katalin Gméling *(Hungary)*

Scientific Committee

Alexander Belousov *(Petropavlovsk-Kamchatsky, Russia)*
Georg Büchel *(Jena, Germany)*
Pierfrancesco Dellino *(Bari, Italy)*
Kurt Goth *(Freiberg, Germany)*
Grant Heiken *(Los Alamos, New Mexico, US)*
Michael Ort *(Flagstaff, Arizona, US)*
Bruce Kjarsgaard *(Ottawa, Canada)*
Vlastimil Konečný *(Bratislava, Slovakia)*
Stephan Kurszlaukis *(Toronto, Canada)*
Jaroslav Lexa *(Bratislava, Slovakia)*
Volker Lorenz *(Würzburg, Germany)*
Ulrike Martin *(Heidelberg, Germany)*
Károly Németh *(Budapest, Hungary)*
Ian Skilling *(Pittsburgh, Pennsylvania, US)*
Peter Suhr *(Freiberg, Germany)*
Greg Valentine *(Los Alamos, New Mexico, US)*
James D. L. White *(Dunedin, New Zealand)*
Kenneth Wohletz *(Los Alamos, New Mexico, US)*
Bernd Zimanowski *(Würzburg, Germany)*

Schedule and deadline

The scientific sessions will be held from morning of 22nd until afternoon 25th September 2004. Pre-meeting field trips will start 18th September and last until 21st afternoon, whereas post-conference field trips will start 26th and last until 29th September 2004. A workshop will be held prior to the first fieldtrip at Würzburg University in Germany from 15th to 17th September 2004.

The registration will take place from 2 p.m. 21st, followed by an Ice-Breaker Party, including typical Hungarian goulash soup and drinks.

Venue

The Second International Maar Conference (2IMC) is held in Lajosmizse approximately 100 km southeast of Budapest, 20 km northwest from Kecskemét, Hungary. The conference site may be accessed by car on the Budapest –Szeged Motorway E75–M5 (toll road). It takes about 1 hour from the Budapest Ferihegy 2 Air-terminal to the conference site by car or bus.

The conference site is located in the middle of the so-called Puszta, a steppe, in the heart of Europe. This region is considered to be the largest flat area in Hungary, surrounded by the mountain ranges of the Carpathians in the north and east, the Alps in the west, and the Dinarides in the south. This low lying land is the collecting point of water courses descending from the mountain ranges, and especially the lands east of the Danube River, were extensive swamps occur, surrounded with small forests, and divided by a wide flood plain of the Tisza river in the east. Just after the regulation of the Danube and Tisza rivers after the middle of the 18th century, the flat lands of the Great Hungarian Plain, became a more suitable place for living. Vineyards and the scarred surface of saliferous fields, backwardness and great initiatives, international roads and footpaths strolling from one lonely farmhouse to another – this is Bács-Kiskun, the county of extremes, where the 2IMC conference will be held. National cold and hot records in temperature were measured here. Thousands of farmers struggle with drought, though the area is embraced by two rivers, which are among the largest in Europe. Although the families used to have a reputation for having many children, it is this region where the density of population is the lowest in Hungary.

The conference venue is an old traditional Hungarian farm complex including a main mansion, surrounding old buildings, horse stalls, winter houses for other animals, all surrounded by grass land with grazing animals. The Gerébi Kúria, is one of the renewed old traditional building complexes, which often host international conferences, having accommodation, relaxation and conference facilities. The conference room is an old traditional mansion.

Kecskemét, which is the capital of Bács-Kiskun County, is the nearest major town to the Conference Venue. A document from 1368 mentions Kecskemét as a market town. During the Turkish occupation the inhabitants dealt with animal keeping and there were several different craftsmen in the town, too. The villages of the surrounding area were destroyed during the fights with the Turks but due to the special rights, such as cattle trade, the town had a significant development. After the destruction of the villages the market towns obtained huge territories. In the second part of the 19th century as well as at the turn of the 20th century there was a great development in the process of urbanization in Kecskemét. The structure of the inner town was formed, roads and railways were built. In 1950 it became the capital of Bács-Kiskun County and developed into an important modern town of one hundred thousand inhabitants. The tolerance towards the people of different religions has always been a characteristic feature of Kecskemét. The followers of the “old” and the “new” belief made an agreement in 1564 on the use of the old brick church and following this event the believers of other religions found a home in the town. The churches of the main square and those of the neighbouring streets attest to this fact. The literary and cultural traditions of Kecskemét are strongly connected to the Hungarian culture as a whole. The 55th psalm was translated by Mihály Vég here and its music was written by Zoltán Kodály and his Psalmus Hungaricus is one of the most outstanding values of the Hungarian culture. The director of the first professional Hungarian theatre company was also born in Kecskemét. The author of the greatest Hungarian drama, Bánk bán, was born to one of the old families of Kecskemét in 1791. Mór Jókai, the writer, was the student of the Calvinist Academy of Law from 1842 to 1844. Sándor Petőfi, the great Hungarian poet, acted in Kecskemét as a strolling player for three months in 1843. He was a pupil of the Evangelist elementary school between 1828–1831. During his stay in Kecskemét as a strolling player he wrote nine poems. Zoltán Kodály, the famous composer and music-master, was born in Kecskemét in 1882. Today’s character of the inner town was formed at the turn of the last century. The Town Hall was built by the plans of Ödön Lechner and Gyula Pártos between 1893–1895. Even today the atmosphere of the town is determined by the secessionist style. The Town Hall of Kecskemét – where a reception will be given to honour the participants of the 2IMC – is the masterpiece of Ödön Lechner. It is a wonderful building. The many twisted old streets meet at the 45-meter-wide avenue in front of the Town Hall and make the town one of European beauty. The avenue is bordered by palaces built in Hungarian style in both directions: it has a particular character by all means.

The great Hungarian poet, Sándor Weöres when he looked around the surrounding quiet streets and the market and when he made excursions to the farms from the Hotel Aranyhomok (Golden Sand) of Kecskemét, described his impressions: `*you can find Europe and Asia here 'since' the tin-civilization has not swallowed everything up yet*' - and he meant it as a compliment.

Registration includes

Meeting Package Rate (white name tag)

1. five night accommodation
2. five breakfasts
3. three dinners (including gipsy music and unlimited wine consumption)
4. eight coffee breaks (including fresh fruits, sandwiches, coffee and soft drinks)
5. one ice-breaker party (with Hungarian Goulash, bread, spreads and drinks)
6. one Gala dinner (including horse show, gipsy music and unlimited wine consumption)
7. transport with buses from and to airport and train station in Budapest upon arrival and departure in a set time (on afternoon in 21st of September and morning in 26th September)
8. registration fees
9. congress bag and material

Accompanying Persons Fee (white name tag)

1. five night accommodation
2. five breakfasts
3. three dinners (including gipsy music and unlimited wine consumption)
4. one ice-breaker party (with Hungarian Goulash, bread, spreads and drinks)
5. one Gala dinner (including horse show, gipsy music and unlimited wine consumption)
6. transport with buses from and to airport and train station in Budapest upon arrival and departure in a set time (on afternoon in 21st of September and morning in 26th September)

Meeting Only Rate (green name tag)

1. eight coffee breaks (including fresh fruits, sandwiches, coffee and soft drinks)
2. one ice-breaker party (with Hungarian Goulash, bread, spreads and drinks)
3. one Gala dinner (including horse show, gipsy music and unlimited wine consumption)
4. registration fees
5. congress bag and material

Local Rate (yellow name tag)
(for presenting local students only in limited number in accordance of pre-arrangement)

1. eight coffee breaks (including fresh fruits, sandwiches, coffee and soft drinks)
2. registration fees
3. congress bag and material

Contact information

For any questions concerning scientific aspects of the meeting please contact: organiser-maar2004@web.de.

Insurance

Health care, dental and ambulance services are not free in Hungary, however, Hungary has bilateral agreement with most of the European and OECD countries to cover immediate emergency and treatment. EU citizens obtain the E171 form from their home country for free immediate emergency compensation plan in Hungary. The Organizing Committee kindly advises all the participants to have a comprehensive health and travel insurance and/or up-to-date information about the necessary administrative information may need in case to access the free of charge health and insurance facilities in case they are needed. The Organizing Committee will not accept any liability for personal injuries or loss or damage of property belonging to the Conference participants and accompanying persons.

Contributions Information

Oral presentations

Oral presentations will be 20 minutes long (15 minutes for presentation and 5 for questions). Data projector, slide and over head projectors will be available, so please inform your requirements together with your abstract submission (see instructions). There wont be parallel sessions allowing people to be able to attend in every oral presentation.

Posters

Posters will have a high profile and importance, daily poster sessions are devoted only to poster presentations (cca. 2 hours), with no simultaneous oral presentations. Posters are a particularly effective way of displaying data, including maps, tables and experimental results. Posters will be grouped by thematic sessions and clearly identified by a code both in the programme and the display area to facilitate easy location. A special area for posters will be arranged. Size of the panels will be large enough to fit an A0 size portrait style poster (approx. 900 mm width by 1600 mm in height).

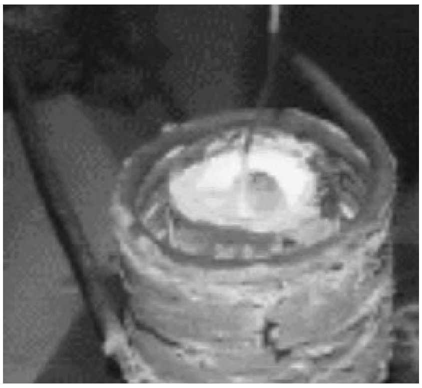
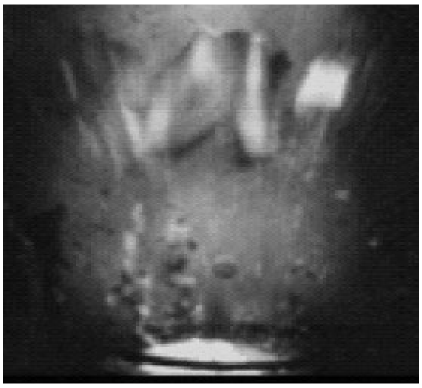
Other Scientific Activity

WORKSHOP
15–17 September 2004

Workshop leaders:

Bernd Zimanowski *(Würzburg),*
Ralf Büttner *(Würzburg),*
Volker Lorenz *(Würzburg),*
Kenneth Wohletz *(Los Alamos),* and
Pierfrancesco Dellino *(Bari)*

"***The maar engine: workshop on experimental volcanic MFCI***"
Physikalisch Vulkanologisches Labor, Würzburg, Germany


Bernd Zimanowski und **Ralf Büttner:** PVL Uni-Würzburg, **Volker Lorenz:** Institut für Geologie Uni-Würzburg **Kenneth Wohletz:** Los Alamos National Laboratory, Pierfrancesco Dellino: Instituto Geomineralogico Uni-Bari

During this workshop we aim to introduce into the physics of explosive water–magma interaction and the implications for the eruption dynamics during the formation of maar volcanoes. The workshop focuses on experimental research, however, the link of experimental data to field observations will also be a major subject.

Where?
Institut für Geologie, Universität Würzburg, Pleicherwall 1, D–97070 Würzburg
http://www.geologie.uni-wuerzburg.de/D_Studienberatung/Lageplaene.htm

Accommodation?
http://www.wuerzburg.de/hotels/

Time Table

Wednesday, September 15:	09:00	welcome and introduction
	10:00	coffee break
	10:30	magma and explosion physics
	12:00	lunch
	13:15	laboratory tour
	17:00	franconian-vulcanian evening event
Thursday, September 16:	09:00	eruption physics
	10:30	coffee break
	11:00	transport and sedimentation
	13:00	lunch
	14:15	transport and sedimentation (cont.)
	15:00	coffee break
	15:30	volcanology of maar-diatreme volcanoes
Friday, September 17	09:00	maar deposits: diagnostic tools
	10:30	coffee break
	11:00	phreatomagmatic risk and hazard assessment
	13:00	lunch
	14:15	phreatomagmatic risk and hazard assessment (cont.)
	15:00	coffee break
	15:30	open discussion…. à adjourn

Suggested references:

BÜTTNER, R., and Zimanowski, B. 1998: Physics of thermohydraulic explosions. – *Phys. Rev.* E, 57 (5), pp. 5726–5729.

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WOHLETZ, K. H. and MCQUEEN, R. G. 1984: Experimental studies of hydrovolcanic volcanism. – In *Studies in Geophysics*. Natl. Acad. Press., Washington, pp. 158–169.

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ZIMANOWSKI, B. 1998: Phreatomagmatic explosions. – In: Freundt, A. and Rosi, M. (ed.): *From magma to tephra, Developments in volcanology 4,* Elsevier, Amsterdam, pp. 25–54.

ZIMANOWSKI, B., WOHLETZ, K. H., DELLINO, P., and BÜTTNER, R. 2002: The volcanic ash problem. – *Journ Volcanol. Geotherm. Res.*, doi: 10.1016/S0377-0273(02)00471-7.

Scientific Programme

Plenary Talk

The scientific programme will be opened with a plenary talk by

Hans-Ulrich Schmincke.

EXTERNAL FORCING OF VOLCANIC ERUPTIONS

The Organizing and Scientific Committee selected 10 Scientific Symposiums to cover wide range of research fields dealing with monogenetic volcanic fields and maar/diatreme volcanism. The following Scientific Symposia will take place during the 2IMC:

Symposium 1

MAARS AND THEIR TEPHRA DEPOSITS

Symposium 2

DIATREMES AND THEIR ROOT ZONES

Symposium 3

STRUCTURAL CONTROL ON PIPE EMPLACEMENT AND ECONOMY GEOLOGY OF MAAR-DIATREME VOLCANOES AND THEIR ROOT ZONES

Symposium 4

DYKES, SILLS, PLUGS, DOMES, SCORIA CONES, LAVA LAKES AND ASSOCIATED PEPERITES IN MAAR-DIATREME VOLCANOES

Symposium 5

GEOPHYSICS OF MAARS AND DIATREMES

Symposium 6

PHYSICS OF MAAR-DIATREME VOLCANISM

Symposium 7

MAAR CRATER LAKE LIMNOLOGY AND MAAR CRATER SEDIMENTS

Symposium 8

SURTSEYAN VOLCANISM

Symposium 9

HAZARDS, ENVIRONMENTAL ISSUES, NATURE PROTECTION, AND GEOPARKS OF MAAR-DIATREME-VOLCANOES

Symposium 10

VOLCANIC FIELDS – POLYGENETIC VOLCANOES

Oral presentations are marked by the symposium number and a capital "O"
Poster presentations are marked by the symposium number and a capital "P"

Conference Programme

The scientific sessions will be held from morning of 22nd until afternoon 25th September 2004. Pre-meeting field trips will start 18th September and last until 21st afternoon, whereas post-conference field trips will start 26th and last until 29th September 2004. A workshop will be held prior to the first field trips at Würzburg University in Germany from 15th to 17th September 2004.

Note for the Lecturers

The Organising Committee of the 2IMC prefers PowerPoint Presentations. The Conference will provide laptop and suitable projectors. We do not accept presentations from own personal computers due to security reasons. Each talk must be uploaded a day before the lecture is in the programme on a PC provided by the Conference Center. We suggest to put the presentation file(s) on CD and/or PenDrive that are easy to connect to the Conference PCs. The presenters are responsible to try out their presentations upon upload their file. In case of any problem in this way, there still would be enough time to find a solution. The Conference uses PCs operated by MS XP operation systems. Macintosh users should prepare their presentation in a way that it should be compatible with the Conference PC system.

Student Awards

The Organising Committee of the Second International Maar Conference (2IMC) will evaluate oral and poster presentations of students. Each student presenter automatically enters to the evaluation process. The Organising Committee of the 2IMC will announce the results of the evaluation during the Closing Ceremony and will give awards to the presenters and send their name to the IAVCEI and IAS to print their name and title of their work in their Newsletters.

Prizes are offered by Prof. Jocelyn McPhie (CODES, Tasmania); Prof. Dr. Volker Lorenz (Würzburg University); SEMP, Oklahoma; Geological Institute of Hungary, Budapest; Geological Institute of Slovak Republic, Bratislava; Elsevier, Amsterdam; Springer Verlag, Heidelberg; Dr. James D. L. White (Otago University, Dunedin)

SECOND INTERNATIONAL MAAR CONFERENCE SCHEDULE

21 September	***22 September***	***23 September***	***24 September***	***25 September***	***26 September***
Registration	*8.30 – 9.40* ***Opening Ceremony*** *9.40 – 10.20* **Plenary talk**	*9.00 – 10.20* ***Oral Session (4)*** **Symposium 3**	*9.00 – 10.00* ***Oral Session (3)*** **Symposium 6**	*9.00 – 12.00* ***Oral Session (4)*** **Symposium 9**	*8.30* *Field Trips Start* *9.00* *Shuttle Drop off to Budapest*
	10.20 – 10.50 *Coffee*	*10.20 – 10.50* *Coffee*	*10.00 – 10.30* *Coffee*	*10.20 – 10.50* *Coffee*	
	10.50 – 12.10 ***Oral Session (4)*** **Symposium 1**	*10.50 – 12.10* ***Oral Session (4)*** **Symposium 4**	*10.30 – 12.30* ***Oral Session (6)*** **Symposium 7**	*10.50 – 12.10* ***Oral Session (4)*** **Symposium 10**	
	12.10 - 13.40 *Lunch* and Poster	*12.10 – 13.40* *Lunch*	*12.30 – 14.30* *Lunch*	*12.10 – 14.10* *Lunch*	
15.00 Shuttle Pick ups from Budapest	*13.40 – 15.00* ***Oral Session (4)*** **Symposium 2** *15.00 – 15.30* *Coffee*	*13.40 – 15.40* ***Oral Session (3 + 3)*** **Symposium 4** **Symposium 5** *15.40 – 16.00* *Coffee*	*14.30 – 15.30* ***Oral Session (3)*** **Symposium 8** *15.30 – 16.00* *Coffee*	*14.10 – 14.50* ***Oral Session (2)*** **Symposium 10** *15.00 – 15.30* **IAVCEI-CVS** *15.30 – 16.00* *Coffee*	
	15.30 – 16.50 ***Oral Session (4)*** **Symposium 2**	*16.00 – 17.00* ***Oral Session (3)*** **Symposium 5**	*16.00 – 17.00* ***Oral session (3)*** **Symposium 9**	*16.00 – 17.00* **Poster session** ***(Session 6-10)***	
17.00 Field Trips Arrivals	*17.00 – 18.00* **Poster session** ***(Session 1–5)***	*17.00 – 18.00* **Poster session** ***(Session 1–5)***	*17.00-18.00* **Poster session** ***(Session 6–10)***	*17.00 – 17.40* ***Closing ceromony***	
19.00 *Ice Breaker Party,*	*19.00* *Dinner*	*19.00* *Reception at Kecskemét*	*19.45* *Dinner*	*19.00* *Gala Dinner and Horse Show*	
			Soccer Game with participants Europe against the Rest of the World (RW)		

Numbers in bracket after the **Oral Sessions** represent the total number of talks.

Italic text after the **Poster Sessions** indicates the time gap offered for poster presentaters to introduce their poster in 2 minutes.

IAVCEI–CVS – International Association of Volcanology and Chemistry of the Earth Interior, Commission on Volcanogenic Sediments meeting

OTHER ACTIVITIES

22nd September 2004 *All Day*

Open day for Expert Attachès of the Diplomatic Representations in Budapest

Presentation of the event and the poster section

24th September 2004 *18.15–19.15*

Soccer Game: Europe–RW.

Registration for the game at the Registration Desk on the given form. Game will be on small grass field and will consist of two times 25 minutes with 5 minutes break. Teams should be 5+1 people (women and men mixed teams are encouraged) with unlimited changing possibility (giving way to play as much people as possible).

25th September 2004 *Morning*

4th Regular Meeting of the Working group of Geology, Slovak–Hungarian (Intergovremental) Joint Committee of Natural Protection and Environment (co-chairmen: RNDr. Jozef Franzen, section chief, Ministry of Environment and Natural Resources, Bratislava, and Dr. Istvan G. Farkas, diretor general, Hungarian Geological Survey, Budapest)

25th September 2004 *15.00–15.30*

Commission Meeting of the IAVCEI Commission on Volcanogenic Sediments

lead by Ulrike Martin and Károly Németh commission leaders.

OPENING CEREMONY

22nd September 2004

8.30 – Welcome to the 2IMC by Károly Németh (Chair person of the 2IMC)
8.40 – Introduction to the Conference by Ulrike Martin (IAVCEI CVS)
8.50 – Memory for the First Maar Conference by Georg Büchel (University Jena)
9.00 – Welcome from the Mayor of Kecskemét City
9.10 – Welcome from the Mayor of Lajosmizse City
9.20 – Official opening by Károly Brezsnyánszky (Director, Geological Institute of Hungary)
9.30 – Introduction by Oded Navon (President of the IAVCEI)
9.40 – Plenary talk by Hans-Ulrich Schmincke (GEOMAR, Kiel)

SPECIAL VOLUMES WITH SELECTED CONTRIBUTIONS FROM THE MEETING

Special Volume of the Journal of Volcanology and Geothermal Research

U. Martin, K. Németh, J. D. L. White, V. Lorenz (Editors)

"Mongenetic volcanic fields including maar-diatreme volcanoes and their root zone, tuff rings, tuff cones and scoria cones"

Contributors to this Special Volume are expected to submit any manuscripts in the field of any process oriented studies, volcanological modelling, volcaniclastic facies analysis of pyroclastic deposits associated with maar-diatreme volcanoes, description of diatremes, relationship between Surtseyan and maar volcanism, intra-crater effusive and intrusive processes, lava surface morphological studies and dating methods based on new techniques, volcanic hazard studies relevant to maar-diatreme volcanism, new results of experimental volcanology to understand phreatomagmatism. Manuscripts should be submitted to any of the Editors not later than 10th November 2004. Manuscripts will go through standard review processes, and they should be submitted in the standard form the JVGR Instructions for Authors describes it. *However, final publishing agreement will be based on the JVGR Editor in Chief's approval!*

Special Volume of the Zeitschrift für Deutschen Geologischen Gesellschaft

K. Goth, V. Konečn , G. Büchel, P. Suhr, J. Lexa (Editors)

"Maar-diatreme volcanism: geophysical studies, economic geology, maar lakes as sedimentary traps"

Contributors to this Special Volume are expected to submit any manuscripts in the field of any new methods applied to discover buried maar-diatreme structures, to give estimates of the volume and geometrical parameters of the maars, applied for to identify the location of volcanic conduits. Contributors to this volume are expected to submit any manuscripts in the field of sedimentological, palaeontological or climatological results based on studies of lacustrine units accumulated in maar basins and pyroclastic successions associated with maar volcanoes. Especially welcomed manuscripts intend to present palaeoclimatological and complex palaeoenvironmental reconstructions on the basis of such deposits. Manuscripts should be submitted to any of the Editors not later than 10th November 2004. Manuscripts will go through standard review processes, and they should be submitted in the standard form as prescribed by the Zeitschrift für Deutschen Geologischen Gesellschaft Instructions for Authors.

OTHER IMPORTANT INFORMATION

Time table

Opening of registration	*21 September 2004, 14.00*
Würzburg workshop	*15–17 September 2004*
Pre-conference fieldtrips A1 and B1	*18–21 (afternoon) September 2004*
Registration office open	*21 September 2004, 14.00*
Icebreaker party	*21 September, 19.00*
2IMC	*22–25 September 2004*
Post-conference field trips A2 and B2	*26–29 September 2004*
Deadline for manuscripts in Special Volumes	*10 November 2004*

Social Events

Ice Breaker Party*: 21 September 2004, 7.00 PM*

This event will include a traditional Hungarian Goulash party, bread and spreads, unlimited wine and soft drinks. The event will take place at the Gerébi Kúria, in the garden and on the terraces.

Reception by the Mayor of Kecskemét in the Town Hall*: 22 September 2004, 7.00 PM*

The event will take place at the historic Town Hall of Kecskemét.

Gala Dinner and Hungarian Horse Show*: 23 September 2004 7.00 PM*

This event will include a complete traditional dinner with great selection of specialities. There will be vegetarian alternatives. Unlimited wine and soft drink consumption as well as coffee, and snacks. The event will take place at the historic Gerébi Kúria and Horse field.

Vegetarian and other medically food requirements may be arranged on request!

Tipping

Also normal tipping is not regulated in Hungary as it is in other countries where tips are included to the prices at restaurants or service stations. Tipping is your decision and usually is about 10% in restaurants, if you are satisfied with the service. Hotel porters are tipped normally. Tips do not exist in petrol stations, however, most of the service stations are self service.

Banking/Currency exchange

Banks in Hungary are open, Monday to Friday, from 8 am to 4 or 6 pm, closed on Saturday and Sunday, also exchange boots are available at airports, hotels, or in small official exchange offices. In Hungary, bank notes of Euro, US Dollar, Swiss Frank, British Pounds, Australian Dollars, Japanese Yen, Canadian Dollars, Swedish and Norway Kronen, are easy to change and widely accepted in exchange offices. However, New Zealand Dollar, Korean Won, Mexican Peso, South African Rand, most of the Latin American, African, and Asian currencies are hard to exchange. Bank notes from Slovakia, Poland, Romania, Croatia, Slovenia, and the Czech Republic are generally easy to exchange. Bank cards (cash point or debit cards) are accepted by most of the ATM-s. Most of the larger villages and small towns have ATM, and in Budapest, or Kecskemét, using cards to take cash is easy. To use credit cards in shops, however, is often a difficult and time consuming procedure. Hotels, bigger shopping centres, travel agencies and airlines can take any major credit cards.

The Hungarian Forint (HUF or Ft) is the national currency of Hungary, the current exchange rate (August 2004) is: 1 Euro is about 255 HUF, 1 US$ is about 210 HUF.

The Slovansky Korun is the national currency of Slovakia, the current exchange rate (August 2004) is: 1 Euro is about 40.25 SK.

Shopping hours

Most shops are open Monday to Saturday from 9 am to 7 pm. Larger shopping malls open 7 days a week and until 10 pm. Food stalls, small shops for food, basic consumables are common, and open 7 days a week, often 24 hours a day.

Road rules, toll road, petrol

In Hungary cars are driving on the right side of the road, similarly to other European Countries. Road signs are more less identical to other places in Europe. Road conditions are in generally good, however, the motorways are not free anymore. The road between the Austrian border to Budapest, from the Balaton and from Miskolc to Budapest, and Budapest to Kecskemét is state owned and a uniform 1 week unlimited travel pass is valid for all these roads, costs about 6 Euro. Petrol is not cheap in Hungary, it is about 1 Euro per litre, carrying more less the same names and grades as in other European countries. On open roads, head lights on the car must be switched on at all time.

Tourist Information

Further information about Hungary, travelling in Hungary, or having a holiday, please visit any of the following homepages:

http://www.fsz.bme.hu/hungary/homepage.html
http://www.fsz.bme.hu/hungary/intro.html
http://www.hungarytourism.hu/
http://www.hungaryemb.org/
http://www.lonelyplanet.com/destinations/europe/hungary/
http://www.gotohungary.com/
http://www.met.hu/
http://hungary.gtahotels.com/
http://www.access-hungary.hu/
http://www.posta.hu/
http://www.usembassy.hu/
http://www.matav.hu/tudakozo/index_e.html
http://www.mkogy.hu/
http://www.panaco.hu/angol.htm
http://www.mav.hu/
http://hungary.org/hungary/
http://www.elvira.hu

Symposium 1

MAARS AND THEIR TEPHRA DEPOSITS

Convenor: Michael Ort, (Flagstaff, Arizona, US) – michael.ort@NAU.EDU
Co-Convenor: Piero Dellino, (Bari, Italy) – dellino@lgxserve.ciseca.uniba.it

Maars produce complex deposits both inside and outside of their craters. The record of the eruption is complicated by complex interactions between magmatic and phreatomagmatic processes in the conduit, transport processes in the vertical and lateral currents, and depositional processes. Many new and old techniques are being applied to understanding these processes. This session invites papers presenting new information on maars and their deposits. What can techniques such as particle shape and size analysis, sedimentary analysis, geophysical measurements, etc. tell us about vent dynamics and flow and depositional processes? How do we quantitatively model phreatomagmatic processes accurately? Can we design scaled experiments that elucidate real processes? How can we see through the "chaos" of the eruption to determine what processes are active at different stages? What techniques can we use to understand maar processes, and what do they tell us?

Oral Presentations

22 September

10.50–11.10 **A. Belousov**; M. Belousova
MAARS OF KAMCHATKA (RUSSIAN FAR EAST): THE FIRST DATA. p. 42

11.10–11.30 **G. A. Valentine**
SHALLOW CRUSTAL XENOLITHS IN CONTINENTAL BASALTS AND IMPLICATIONS FOR MAGMA ASCENT DYNAMICS p. 98

11.30–11.50 **G. Gençalioglu-Kuşcu**; N. Şatvan; C. Atilla
AN EXAMPLE TO QUATERNARY MAAR VOLCANISM IN CAPPADOCIAN VOLCANIC PROVINCE: CORA MAAR, CENTRAL ANATOLIA, TURKEY p. 59

11.50–12.10 **G. Carrasco-Núñez;** M. Ort; P. Dávila; R. Puente; A. Ortega-Guerrero
EVOLUTION OF MAAR VOLCANOES IN CENTRAL MEXICO p. 48

Poster Presentations

22 September: *17.00–18.00* **and**
23 September: *17.00–18.00*

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QUATERNARY PHREATOMAGMATIC VOLCANOES OF SOUTHERN TENERIFE, SPAIN: MONTAÑA PELADA TUFF RING AND CALDERA DEL REY MAAR p. 74

W. H. Geissler, H. Kämpf; P. Bankwitz; E. Bankwitz
THE QUATERNARY TEPHRA-TUFF DEPOSIT OF MÝTINA (SOUTHERN RIM OF THE WESTERN EGER GRABEN/CZECH REPUBLIC): INDICATIONS FOR ERUPTION AND DEFORMATION PROCESSES p. 58

W. H. Geissler; H. Kämpf; R. Kind; W. Seifert
SEISMIC AND PETROLOGICAL STUDIES OF THE CRUST AND UPPERMOST MANTLE BENEATH THE EARTHQUAKE SWARM REGION VOGTLAND/NW BOHEMIA p. 58

U. Grunewald; G. Büchel
FORMATION OF COLLAPSE STRUCTURES DURING PHREATOMAGMATIC ERUPTIONS: A FIELD STUDY FROM A COMPLEX MAAR VOLCANO IN THE WEST EIFEL VOLCANIC FIELD, GERMANY p. 61

T. T. Newkirk; M. H. Ort
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ACCRETION TEMPERATURES OF THEPHRA DEPOSITS OF THE MESSEL STRUCTURE DERIVED FROM ROCKMAGNETIC INVESTIGATIONS p. 84

T. Scolamacchia; J. L. Macías
DILUTED PYROCLASTIC DENSITY CURRENTS PRODUCED DURING THE 1982 ERUPTION OF EL CHICHÓN VOLCANO, CHIAPAS, MEXICO: TRANSPORT AND DEPOSITIONAL PROCESSES p. 90

M. Sumita; H.-U.Schmincke; N. Miyaji; K. Endo
COCK'S TAIL JETS AND THEIR DEPOSITS p. 94

U. Martin; K. Németh
ERUPTIVE MECHANISM OF PHREATOMAGMATIC VOLCANOES FROM THE PINACATE VOLCANIC FIELD: COMPARISON BETWEEN CRATER ELEGANTE AND CERRO COLORADO, MEXICO p. 75

Y. Weinstein
THE PHREATIC DEPOSITS OF THE STROMBOLIAN-HYDROVOLCANIC STRUCTURE OF MT AVITAL, GOLAN HEIGHTS p. 101

A. Y. Rotman; J. Ganga; N. N. Zintchouk; S. F. Nosyko; S. V. Somov; S. D. Cherny; V. I. Vuiko; J. Shimupi; Y. B. Stegnitsky
HETEROGENEOUS COMPLEX OF ROCKS IN KIMBERLITE OCCURRENCES' CRATERS OF NORTH-EAST OF ANGOLA p. 85

A. Auer; U. Martin; K. Németh
THE FEKETE-HEGY VOLCANIC COMPLEX – NESTED MAARS IN THE CENTRE OF THE BAKONY - BALATON HIGHLAND VOLCANIC FIELD p. 41

Symposium 2

DIATREMES AND THEIR ROOT ZONES

Convenor: Volker Lorenz (Würzburg, Germany) – vlorenz@geologie.uni-wuerzburg.de
Co-Convenor: Vlastimil Konečn (Geological Insitute of Bratislava, Slovakia)

A diatreme is the substructure of a maar crater and its tephra ring. Diatremes themselves are cone-shaped volcanic structures cut into pre-eruptive rocks. They are up to 2.5 km deep and up to 1- 2 km in upper diameter. They are filled by clastic debris, subsided larger blocks and frequently intrusive rocks. The volume of the diatreme fill is about the same as that of the thinly bedded tephra ring and distal ash deposits. Thus, diatremes form an important part of the maar-diatreme volcano. The rather regular cone-shaped diatremes continue at depth into a root zone. This rootzone is irregular in shape and overlies the magmatic feeder dyke of the volcano. Maar-diatreme volcanoes are associated with any magma type involved in volcanism. Depending on magma type and other geological aspects diatremes may contain diamonds or other commodities, they may be quarried for road metal, and may represent aquifers.

There exist two models on the formation of maar-diatreme volcanoes: the magmatic model and the phreatomagmatic model. The magmatic model is especially concerned with ultrabasic, ultramafic and carbonatitic magmas. It invokes volatile rich fluid magmas which, close to the Earth´s surface, fragment the country rocks thus forming progressively from deeper levels to almost the surface the irregular shaped root zone. Explosive breakthrough to the surface is supposed to result in the formation of the maar crater and then via downward propagating fluidization of the root zone contents to shaping of the cone-shaped diatreme, and mixing of the diatreme clasts.

The phreatomagmatic model, in contrast, invokes explosive interaction of rising magma with groundwater, originally close to the surface and then downward penetration of the sites of explosion. The various individual explosion sites or chambers jointly form the root zone. Ejection of explosively fragmented country rocks leads to a mass deficiency and consequently to collapse of the overlying rocks. Via these processes the diatreme forms and, in principle, it represents a collapse feature like a sink hole. Downward explosive penetration of the root zone on its own feeder dyke and consequent collapse phases of the diatreme leads to a growing diatreme and a growing maar crater above.

Contributions are invited on all aspects of the complex physical processes resulting in the formation and evolution of diatremes and their root zones. Contributions are also invited dealing with the magmatic model and the phreatomagmatic model.

Oral Presentations of Symposium 2

22 September

13.40–14.00 **B. Zimanowski**
THE MAAR ENGINE – A REVIEW p. 106

14.00–14.20 **B. A. Kjarsgaard**
MAGMATIC VERSUS PHREATOMAGMATIC ERUPTION OF KIMBERLITE MAGMA IN THE UPPER CRUST AND AT SURFACE p. 65

14.20–14.40 **S. Planke;** H. Svensen; A. Malthe-Sørenssen; S. S. Rey; B. Jamtveit
RELEASE OF GREENHOUSE GASES IN HYDROTHERMAL VENT COMPLEXES CAUSING GLOBAL WARMING p. 83

14.40–15.00 **S. Kurszlaukis;** V. Lorenz
ROOT ZONE PROCESSES IN MAAR-DIATREME VOLCANOES p. 69

15.30–15.50 **H. Svensen;** B. Jamtveit; S. Planke
FORMATION AND EVOLUTION OF HYDROTHERMAL PIERCEMENT STRUCTURES IN VOLCANIC BASINS: CONSTRAINTS FROM THE KAROO BASIN IN SOUTH AFRICA p. 95

15.50 -16.10 **C. M. Hetman;** B. H. Scott Smith; J. P. Paul
GEOLOGY OF THE HEARNE KIMBERLITE PIPE, NORTHWEST TERRITORIES, CANADA: MAGMATIC KIMBERLITE EMPLACEMENT p. 63

16.10–16.30 V. Konečn ; J. Lexa
MAARS AND DIATREMES OF THE SOUTHERN SLOVAKIA ALKALI BASALT VOLCANIC FIELD p. 66

16.30–16.50 **M. H. Ort;** G. Carrasco-Nuńez
VENT ALIGNMENTS AT MAAR VOLCANOES p. 82

16.50–17.10 J. D. L. White; P-S. Ross; **M. McClintock;** O. Reubi; S. Hood Hills; G. Lockett
PYROCLASTIC PRECURSORS TO FLOOD-BASALT ERUPTIONS, COOMBS AND ALLAN HILLS, TRANSANTARCTIC MOUNTAINS, ANTARCTICA p. 102

Poster Presentations of Symposium 2

22 September: *17.00–18.00* **and**
23 September: *17.00–18.00*

I. Suiting; H.-U. Schmincke
THE SUBMARINE "COSTA GIARDINI" DIATREME (MONTI IBLEI, SICILY) p. 93

Symposium 3

STRUCTURAL CONTROL ON PIPE EMPLACEMENT AND ECONOMY GEOLOGY OF MAAR-DIATREME VOLCANOES AND THEIR ROOT ZONES

Convenor: Stephan Kurszlaukis (Toronto, Canada) – Stephan.Kurszlaukis@ca.debeersgroup.com
Co-Convenor: Bruce Kjarsgaard (Ottawa, Canada) – BKjarsga@NRCan.gc.ca

The control on pipe emplacement is integrally linked with the understanding of the physical structure of the lower and upper lithosphere. It is generally accepted that prominent crustal discontinuities act as favourable ascent paths for the magma towards the surface.

The West Eifel Volcanic Field, Germany, represents a classic example of how pre-existing country rock structures influenced and controlled the position and emplacement behaviour of rising magma in the uppermost crust. The West Eifel maar-diatreme volcanoes were formed by phreatomagmatic activity on the intersections of mostly basaltic dykes with local water bearing faults or joints especially, but not exclusively, underneath fault-controlled valley floors. If meteoric water was not available, scoria cones were formed on dykes by magmatic activity, without the formation of diatremes. The internal and external geology of a maar-diatreme volcano must be carefully mapped and evaluated to understand its emplacement.

Kimberlites and carbonatites also seem to follow an emplacement pattern that appears to be controlled by country rock structures. While their final emplacement mechanism is still under discussion (the major diatreme-forming process is thought to be related either to the expansion of a juvenile gas phase or to the interaction of the rising magma with groundwater), work published mainly over the last two decades has shown that the position of many of these economically important pipes is to at least some extent controlled by crustal discontinuities. Deep-seated shear zones, faults, mobile belts, transform faults, arch-style uplifts of pre-existing basement structures and the general stress field at the time of emplacement of these magma types have been quoted as being responsible, or at least as having influenced, the emplacement of pipes and dykes.

Of interest, particularly for exploration purposes, is the extent to which the position and emplacement of a kimberlite pipe is controlled by country rock structures. In addition, it is important for mining purposes to define the interaction of the pipe shapes with inhomogeneities in the country rock. The morphology of root zones of maar-diatreme volcanoes seems to be particularly susceptible to country rock faults and joint patterns.

Thus, we call for papers which explore whether and to what extent the position of a pipe, a pipe cluster or even a volcanic field is controlled by pre-existing country rock structures. Emphasis should also be placed on the interaction of pipe shapes with country rock discontinuities and a possible control on the style of eruptions.

Depending on magma-type involved, locality and state of erosion, maar-diatreme volcanoes may be of economic relevance. The economically most relevant maar-diatreme volcanoes are diamondiferous kimberlite and lamproite pipes which occur on all major cratons. The diamonds annually retrieved rank fourth in the list of mined commodities (excluding coal and oil) when assessed for value of production. Diatremes may be hosting other commodities as e.g. Au, Hg, etc., with the respective diatreme having channelled and thus having hosted fluids concentrating such commodities. Because of their Hg content, several diatremes in Palatinate, Germany, were mined for centuries. In the West Eifel, Germany, some diatremes underlying maar craters channel CO_2 towards the surface which may be used in fizzy water or soft drinks, or for purely industrial purposes. The pyroclastic rocks of diatremes and maar tephra rings may represent material suitable for use as road metal and similar purposes.

In the Sydney Basin, eastern Australia, pyroclastic diatreme rocks have been mined for road metal. And the basaltic lava lake rocks emplaced in many maar craters in a second non-phreatomagmatic phase are quarried for road metal, and for material used in concrete procuction. Columnar-jointed basalts from such lava lakes were used in building dykes in the Netherlands and along the North Sea. Scoria deposited in maar craters from a second non-phreatomagmatic phase serves similar purposes (road metal, production of light concrete, filter material, abrasives).

Posteruptive crater lakes can accumulate sediments which may be quarried for their diatomite beds respectively their "oilshale" (i.e. bituminous shales/alginite beds) for diverse uses in industry or in agriculture.

When more permeable than the surrounding country rocks, diatreme rocks and the coarse marginal facies of their clastic crater lake deposits may serve as important local groundwater producers. In the West Eifel the fractured country rocks immediately surrounding two maars also produce groundwater.

Young maars with their beautiful crater lakes, deep open pits (with or without a lake) left from former mining or quarrying, and pipes standing high above general ground because of greater resistance to erosion than the surrounding country rocks (e.g. Agathlan Peak, Ship Rock in the SW USA) are all attractive tourist sites and relevant in teaching the general public. Locally, in some countries, crater lakes may be relevant in respect to their fish. And last not least research on maar-diatremes with its many spin-off effects is economically relevant.

Oral Presentations of Symposium 3

23 September

9.00–9.20	**O. Navon;** N. G. Lensky; V. Lyakhovsky VOLATILE DEGASSING, DIKE INITIATION AND PROPAGATION AND XENOLITH ENTRAPMENT BY ALKALINE MAGMAS	p. 79
9.20–9.40	**W. P. Barnett;** L. Lorig; M. Watkeys A MODEL FOR STRESS CONTROLLED PIPE GROWTH	p. 42

9.40–10.00 **C. Szentesy;** A. Minut; L. Nadasan; S. Leary
EPITHERMAL GOLD MINERALISATION HOSTED IN MAAR-DIATREME COMPEXES, APUSENI MOUNTAINS, ROMANIA p. 96

10.00–10.20 **T. T. Newkirk;** M. H. Ort
PRELIMINARY FACIES STUDIES AT THE MERALE URANIUM PROSPECT, MIO-PLIOCENE HOPI BUTTES VOLCANIC FIELD, NAVAJO NATION NE ARIZONA: IMPLICATIONS FOR VOLCANIC PROCESSES, VOLCANIC PALAEOENVIRONMENTS, AND MINERAL EXPLORATION p. 81

Poster Presentations of Symposium 3

22 September:** 17.00–18.00* ***and
***23 September:** 17.00–18.00*

V. Cajz; J. Adamovic
TECTONIC CONTROLS ON LOCATION OF PHREATOMAGMATIC PHENOMENA, EASTERN EGER RIFT, NORTH BOHEMIA p. 47

C. Szentesy; G. V. O'Connor; A. Minut; C. R. Nash
THE STRUCTURAL SETTING OF THE ROSIA MONTANA MAAR-DIATREME COMPEX, ALBA, ROMANIA p. 96

W. J. W. Williams; M. G. Abdel-Salam; C. L. V. Aiken; X. Xu; S. F. Meigs, Jr.
PLEISTOCENE POTRILLO VOLCANIC FIELD, SOUTHERN RIO GRANDE RIFT, U.S.A. AND MÉXICO: REMOTE SENSING, CYBERMAP VISUALIZATIONS AND MORPHOMETRIC EVALUATION p. 104

H. Corbella
STRUCTURAL CONTROL OF THE PALI-AIKE LAVAS AND MAARS – PATAGONIA p. 49

A. Y. Rotman; J. Ganga; N. N. Zintchouk; S. F. Nosyko; S. V. Somov; S. D. Cherny; V. I. Vuiko; J. Shimupi
DIAMOND PLACERS IN DIATREME CRATERS OF NEAR-EQUATORIAL AFRICA (ANGOLA) p. 86

L. P. Boyer; T. E. McCandless; R. M. Tosdal
INTRA AND EXTRA-CRATER KIMBERLITE TEPHRA DEPOSITS OF BUFFALO HEAD HILLS, ALBERTA CANADA p. 44

D. Vass
ECONOMIC MINERALS OF MAAR LAKES SEDIMENTARY FILL, SOUTHERN SLOVAKIA p. 99

Symposium 4

DYKES, SILLS, PLUGS, DOMES, SCORIA CONES, LAVA LAKES AND ASSOCIATED PEPERITES IN MAAR-DIATREME VOLCANOES

Convenor: Ian Skilling (Pittsburgh, Pennsylvania, USA) – skilling@pitt.edu
Co-Convenor: Jaroslav Lexa (Bratislava, Slovak Republic) – lexa@gssr.sk

Maar-diatreme volcanoes are created by phreatomagmatic eruptions arising from a contact of ascending magma with groundwater in available aquifers. If this contact is eliminated magma continues its ascent towards the surface giving rise to a wide range of volcanic forms and products associated closely with maar-diatreme volcanoes. Usually this happens in the advanced or closing stage in evolution of the volcano. However, in arid regions the maar-forming eruptions were often preceded by effusive and/or Strombolian activity. Various scenarios are possible and factors controlling changes in the eruption style are understood poorly. Phreatomagmatism might be inhibited unless the magma flux is low relative to the rate of water supply and unless the top of the magma column has subsided, probably below the water table.

Magma, that has not reached the surface, appears as dykes, sills and/or plugs in diatreme/maar filling. Some of them may represent feeders to surficial activity. Features relating dykes to the eruption types are open to discussion. Hawaiian to Strombolian type eruptions build up spatter, scoria and/or cinder cones. Eruption rate, volatile content, magma composition and temperature are the most obvious controlling factors. 95% of observed cinder-cone eruptions lasted less than a year in contrast to composite volcanoes formed from multiple eruptions over thousands of years – an important notion in view of the hazard assessment. Comparative morphology of scoria cones is a useful dating tool, however, new researches suggest that their erosion could be more complex. Rare basaltic Plinian eruptions are poorly known but dangerous volcanic phenomena. Outpourings of lava feed up lava flows and/or lava lakes in maar depressions, often in fully subaqueous environment. In such a case pillow lavas, hyaloclastite breccias and/or peperite breccias are present. Phreatomagmatic eruptions of the Surtseyan type due to interaction of ascending magma with water in the maar lake give rise to palagonite tuff cones. Eruption rate and water depth are factors controlling Surtseyan-type eruptions and transition towards Strombolian-type eruptions. Lava flows and lava lakes provide an excellent opportunity to study evolution of jointing and its relationship to the form of the lava body. They are also good objects to calibrate and compare Quaternary dating methods, remote sensing methods, and rates of geomorphic processes.

Peperite results from the interaction and mingling of magma and wet sediment and commonly exhibits a range of complex textures. The occurrence of peperite demonstrates contemporaneous volcanism and sedimentation and provides important insights into subsurface magma transport, magma fragmentation, host-sediment properties and the "pre-mixing" mechanisms of FCI explosions. Recent studies demonstrate that peperite commonly occurs at the contact of lava lakes with the thephra ring of maar and tuff ring/cone volcanoes, and within the subsurface surrounding these edifices.

We welcome submission of presentations that discuss peperite generation in this or other phreatomagmatic environments, and are particularly interested in any studies that address the following: links between peperite formation and eruptions, morphology of peperite domains, mingling mechanisms, influence of host sediment on peperite textures, duration of mingling and duration between host sediment deposition and magma intrusion.

Contributions to this session are expected on any subject related to understanding of fundamental processes involved in eruption styles and relationship to maars and diatremes. Presentations of new methods of dating lava flow surfaces as well as studies on radiometric age determination of magmatic systems associated with maar volcanoes are also welcomed in this session.

Oral Presentations of Symposium 4

23 September

10.50–11.10 **C. M. White;** B. D. Brand
MAGMATIC AND PHREATOMAGMATIC DEPOSITS AT SINKER BUTTE,
A LARGE PLEISTOCENE VOLCANO IN THE WESTERN SNAKE RIVER PLAIN,
IDAHO, USA p. 101

11.10–11.30 U. Martin; **K. Németh**
SHALLOW SUBSURFACE SILL AND DYKE SYSTEMS ASSOCIATED WITH
AN ALKALINE BASALTIC INTRACONTINENTAL VOLCANIC FIELD,
WESTERN PANNONIAN BASIN p. 74

11.30–11.50 **N. A. Van Wagoner;** R. W. D. Lodge; K. A. Dadd
CONTROLS ON MAAR VOLCANISM: EVIDENCE FROM SILLS AND DYKES
OF THE SILURIAN EASTPORT FORMATION, MAINE, USA p. 99

11.50–12.10 **K. Balogh**; V. Konečn ; D. Vass; J. Lexa; K. NØmeth
METHODICAL RESULTS OF K/Ar DATING OF POST-SARMATIAN ALKALI BASALTS
IN THE CARPATHIAN BASIN p. 41

13.40–14.00 **U. Martin;** K. Németh
MAGMA/WET SEDIMENT INTERACTION IN CRATER LAKES AND VENT ZONES
OF MONOGENETIC VOLCANOES IN MIO/PLIOCENE VOLCANIC FIELDS
OF WESTERN HUNGARY p. 73

14.00–14.20 **I. P. Skilling**
MECHANISMS OF FORMATION OF CORED ASH-LAPILLI AND ELONGATE FLUIDAL
ASH-LAPILLI DURING HYDRODYNAMIC MINGLING WITH SEDIMENT p. 91

14.20–14.40 V. Konečn; **J. Lexa**
A COMPLEX EVOLUTION OF THE BULHARY MAAR, SOUTHERN SLOVAKIA p. 67

22 September:** 17.00–18.00 **and
***23 September:** 17.00–18.00*

J. Wijbrans; K. Németh; U. Martin; K. Balogh
^{40}AR/^{39}AR GEOCHRONOLOGY OF A MIO/PLIOCENE PHREATOMAGMATIC VOLCANIC FIELD IN THE WESTERN PANNONIAN BASIN, HUNGARY p. 103

K. Birkenmajer; **Z. Pécskay;** M. W. Lorenc; P. P. Zagozdzon
RECENT GEOCHRONOLOGICAL AND GEOCHEMICAL STUDY OF ALKALI BASALTIC ROCKS IN LOWER SILESIA, POLAND p. 43

K. Birkenmajer; **M. W. Lorenc;** Z. Pécskay; P. P. Zagożdżon
SPATIAL DISTRIBUTION AND PETROGRAPHIC DIFFERENTIATION OF BASALTIC ROCKS IN LOWER SILESIA, POLAND p. 43

K. Gméling; K. Németh; U. Martin; N. Eby
BORON CONCENTRATION IN DIFFERENT MAAR-DIATREME VOLCANIC ENVIRONMENTS p. 59

I. Seghedi; A. Szakács; A. H. Pacheco; J-L. B. Matesanz
MIOCENE ULTRAPOTASSIC VOLCANOES IN SOUTH-EASTERN SPAIN – AN ASSOCIATION OF PHREATOMAGMATIC AND MAGMATIC PRODUCTS p. 90

U. Martin; K. Németh
GROWTH OF SCORIA CONES FROM THE WESTERN TRANSMEXICAN VOLCANIC BELT, NEAR VOLCÁN CEBORUCO, MEXICO p. 75

A. Y. Rotman
PHANEROZOIC VOLCANIC ASSOCIATIONS OF THE SIBERIAN PLATFORM'S EAST p. 86

W. J. W. Williams; E. Y. Anthony; J. Poths; W. C. McIntosh; T. B. Housh
PLEISTOCENE POTRILLO VOLCANIC FIELD, SOUTHERN RIO GRANDE RIFT, U.S.A. AND MÉXICO: SPATIAL AND GEOCHEMICAL DISTRIBUTIONS THROUGH TIME p. 104

Symposium 5

GEOPHYSICS OF MAARS AND DIATREMES

Convenor: Georg Büchel (Jena, Germany) – buechel@geo.uni-jena.de
Co-Convenor: Peter Suhr (Freiberg, Germany) – Peter.Suhr@lfug.smul.sachsen.de

Geopysical anomalies over maars and diatremes vary in their character and do not provide definitive evidence for a phreatomagmatic origin. Many known maars and diatremes are buried by post-genetic sediments. Geophysical methods resulted in their initial discovery and subsequent drilling provided geologic samples, which confirmed their phreatomagmatic origin. Interpretation of a single geophysical data set over a suspected maar or diatreme structure can be ambiguous. When combined, however, with complementary geophysical methods and the existing database over other known maar or diatreme structures, a more definite assessment can be made.

The most notable geophysical signature associated with maars or diatremes is a negative gravity anomaly. These gravity lows are generally circular and cover the whole structures. They are due to lithological and physical changes associated with the preatomagmatic explosion. In well-preserved maar structures, low-density sedimentary infill of the topographic depression of the crater contributes to the gravity low.

In general, magnetic anomalies associated with maar or diatreme structures are more complex than gravity anomalies. Their reasons are very complex intrusion processes in the diatreme or in the sedimentary infilling of the maars. Also the development of spatter cones into the maar crater can cause a magnetic anomaly.

The presence of fluids in explosion-induced fractures and pore spaces of the maar and diatreme rocks leads to decreased resistivity levels that can be mapped effectively by various electrical methods.

Reflection seismic surveys allow for detailed imaging of maar structure morphology.

Well logging methods are very useful for the detailed investigation of drill holes in maar and diatreme structures. Contributors have been encouraged to consider these key topics.

Oral Presentations of Symposium 5

23 September

14.40–15.00 **H. Buness;** H. Wiederhold
DETAILED IMAGING OF MAAR-DIATREME STRUCTURES BY REFLECTION SEISMIC SURVEYS p. 46

15.00–15.20 **H. de Wall;** T. Nitzsche; C. Rolf ; T. Wonik
MAGNETIC SUSCEPTIBILITY LOGGING IN MAAR-DIATREM VOLCANOES– WHAT IS IT GOOD FOR? p. 50

15.20–15.40 **G. Gabriel;** R. Pucher; W. Jacoby; H. Wallner
INTERPRETATION OF THE POTENTIAL FIELD ANOMALIES ABOVE THE MAARS OF BARUTH (SAXONY/GERMANY) AND MESSEL PIT (HESSE/GERMANY) p. 57

16.00–16.20 **C. A. Locke;** S. J. France; J. Cassidy
CONTRASTING GEOPHYSICAL CHARACTERISTICS OF MAAR VOLCANOES IN THE AUCKLAND VOLCANIC FIELD, NEW ZEALAND p. 71

16.20–16.40 **T. Nitzsche;** C. Rolf; H. de Wall
ORIGIN OF MAGNETIC ANOMALIES IN VOLCANICLASTIC UNITS OF THE MESSEL MAAR-DIATREME (GERMANY) p. 81

16.40–17.00 **R. Schulz;** H. Buness; G. Gabriel; R. Pucher; C. Rolf; H. Wiederhold; T. Wonik
DETAILED INVESTIGATION OF PRESERVED MAAR STRUCTURES BY COMBINED GEOPHYSICAL SURVEYS p. 89

Poster Presentations of Symposium 5

22 September: 17.00–18.00 **and**
23 September: 17.00–18.00

J. Cassidy; C. A. Locke, S. J. France
THE AUCKLAND VOLCANIC FIELD, NEW ZEALAND: INSIGHTS FROM AEROMAGNETIC DATA p. 48

G. Gabriel; H. Wiederhold; T. Wonik; J. Rohrmüller; E. Geiss
GEOPHYSICAL INVESTIGATIONS OF A TERTIARY MAAR NEAR BAYERHOF (BAVARIA/GERMANY) p. 57

G. Büchel; G. Hesse
HYDROGEOLOGICAL POTENTIAL OF MAAR VOLCANOES DERIVED FROM THE GEES MAAR, WEST EIFEL VOLCANIC FIELD, GERMANY p. 45

S. Senitz; G. Hesse; M. Pirrung; G. Büchel
PROSPECTION OF THE PRODUCTIVE GROUNDWATER POTENTIAL OF MAAR VOLCONOES AND SCORIA CONES IN THE WESTEIFEL VOLCANIC FIELD (GERMANY) WITH GRAVITY AND GEOMAGNETIC SURVEY p. 91

A. Goepel; S. Senitz M. Pirrung; G. Büchel
GEOPHYSICAL, GEOMORPHOLOGICAL, AND LITHOLOGICAL IMPLICATIONS FOR A SPECIAL TYPE OF PHREATOMAGMATIC VOLCANOES p. 60

P. Kubeš; V. Konečn ; V. Syčev; J. Zuberec
GEOLOGICAL-GEOPHYSICAL EXPLORATION OF MAAR STRUCTURES IN SLOVAKIA p. 68

H. Lindner; R. Käppler; C. Pretzschner; P. Suhr
GEOPHYSICAL EXPLORATION OF MAAR LOCALITIES IN UPPER LUSATIA, GERMANY p. 70

T. Lipovics; A. Csontos; L. Lenkey
PRELIMINARY RESULTS OF GEOPHYSICAL STUDIES OVER THE TIHANY VOLCANO
AT THE TIHANY PENINSULA, HUNGARY p. 70

B. Zec; V. Sycev
GEOLOGICAL AND GEOPHYSICAL EVIDENCES OF VOLCANIC PRODUCTS
OF THE KOSICKÝ KLECENOV TUFF CONE, SLANSKE VRCHY MTS, SLOVAKIA p. 105

P. Schulze; **P. Suhr**
DISCUSSION OF THE DIATREM UNDER THE MAAR OF KLEINSAUBERNITZ IN EAST-SAXONY
BY GRAVIMETRICAL CALCULATIONS p. 89

Symposium 6

PHYSICS OF MAAR-DIATREME VOLCANISM

Convenor: Bernd Zimanowski, (Würzburg, Germany) – zimano@geologie.uni-wuerzburg.de

Phreatomagmatic explosions and eruptions represent the key mechanism for the formation of maar-diatreme volcanoes, irrespective of magma composition or host rock type. However, it is environmental conditions (including magma and host-rock characteristics) that apparently cause quite a variability in size and shape of maars and the characteristics of their deposits. Furthermore, phreatomagmatism in maar volcanoes can occur with eruptive stages of purely magmatic explosivity, mixed magmatic/phreatomagmatic eruptions, or even final stages of lava lake effusion. The aim of this session is the discussion of physical processes of phreatomagmatism, how such processes lead to eruption variability, and the environmental factors that influence them.

We invite experimental and theoretical contributions as well as field studies that provide insight into the physics of phreatomagmatism. From the generalized controlling parameters and processes that are common to many maar volcanoes to specific phenomena that demonstrate the range of variability in phreatomagmatism, contributed presentations will further the ability to predict the physical processes and interpret their manifestations in maar volcano structures and deposits.

Contributors are encouraged to consider several key topics:

1. Environmental conditions that constrain how much water and magma interact
2. Influence of magma composition, crystal fraction, bubble fraction, and crystal-melt-bubble interfacial interaction
3. Interaction between magma and hydrothermal liquids
4. Magma-water interaction in subaqueous volcanism: the role of hydrostatic pressure
5. The potential contributing role of magmatic fragmentation in phreatomagmatic fragmentation (e.g., carbon dioxide degassing in alkaline diatremes)
6. Tephra deposit characteristics that lend quantitative interpretation to the energetics and processes of phreatomagmatism
7. Experiments: potential analogues, designs, and dimensional requirements, including industrial experience of vapour explosion
8. Computational physics: can this complex scale-dependent phenomenon be realistically simulated by numerical techniques?
9. The role of shock waves in multiphase flow and analogies to detonation
10. Field, laboratory, or theoretical analyses of phreatomagmatic fragmentation and tephra formation.

Oral Presentations of Symposium 6

24 September

9.00–9.20 **L. G. Mastin**
THE HYDRODYNAMICS OF MAGMA-WATER MIXING AND ITS EFFECT
ON FRAGMENTATION AND ERUPTIVE VIOLENCE p. 76

9.20–9.40 **G. G. J. Ernst;** A. J. Durant; W. I. Rose; S. Self
ACCRETIONARY LAPILLI AND WATER -RICH ERUPTION COLUMNS: NEW DATA
AND INSIGHTS p. 51

9.40–10.00 J. Adamovič; K. Malý; J. Zachariáš
SECONDARY QUARTZ CEMENTATION AROUND PHREATOMAGMATIC STRUCTURES, BOHEMIAN CRETACEOUS BASIN, CZECH REPUBLIC p. 40

Poster Presentations of Symposium 6

24 September: *17.00–18.00 and*
25 September: *16.00–17.00*

G. G. J. Ernst; L. Sanz; G. P. L. Walker
DISPERSAL DYNAMICS FROM PHREATO-SUBPLINIAN ERUPTIONS: THE 1937 VULCAN ERUPTION, RABAUL CALDERA, PAPUA NEW GUINEA p. 51

J. Lexa
BASALT/SEDIMENT MINGLING IN THE ROOT ZONE OF THE SHIPROCK DIATREME, ARIZONA. p. 69

Symposium 7

MAAR CRATER LAKE LIMNOLOGY AND MAAR CRATER SEDIMENTS

Convenor: Kurt Goth (Freiberg, Germany) – Kurt.Goth@lfug.smul.sachsen.de

When the phreatomagmatic explosions of a maar-diatreme volcano finally come to an end, the crater fills up with water. The resulting maar lakes are deep in relation to their diameter and damned from the surroundings by the ejected material (crater wall). This special architecture effects the lake and its sediments. These lakes trap the material of an extreme small catchment area. Allochthonous clastic material reaches the crater mainly as turbitity currents originating from the crater rim (ejected material). The autochthonous sediment in maar lakes is often dominated by algal material. Algal bloom layers alternate with the background sediment layers creating laminated deposits. And maar lakes often develop a meromiktic division of their water column providing in this, way exceptional conditions for the preservation of sedimentary structures as well as fossils.

Papers are included that are dealing with the history of maars lakes from different periods in earth history. Reconstruction of the ecology in maar lakes, comparison of the sedimentary processes and description of maar lake chemistry and other parameters should contribute to an improved understanding of these remarkable structures.

We encourage speakers to consider the following key topics:

1. Post-eruptive history of maar lakes.
2. Composition of maar lake sediments and their diagenesis.
3. Laminated maar lake sediments with palaeoclimatic evidence (proxy-data, cyclic stratigraphy, time series).
4. Ecology of algae, reasons for algal blooms, decomposition of algae, settlement of algal remains.
5. Preservation of fossils in maar lake sediments.
6. Palaegeographic reconstructions of maar-diatreme volcanoes.
7. Field and laboratory analyses of sedimentological events in maar lakes (e.g. turbidites).
8. Chemistry of lakes: experiments and field observations.
9. Meromiktic lakes: parameters, chemistry, typical sediments.
10. Formation and diagenesis of siderite in maar lakes.

Oral Presentations of Symposium 7

24 September

10.30–10.50 **S. O. Franz;** J. Thein; T. Bottin; D. Hrissanthou; J.-F. Wagner
ENVIRONMENTAL AND DEPOSITIONAL HISTORY OF LATE OLIGOCENE MAAR LAKE ENSPEL (WESTERWALD, GERMANY) VIA GEOCHEMICAL AND MINERALOGICAL SEDIMENT ANALYSIS p. 56

10.50–11.10 **K. Goth;** U. Martin; P. Suhr; K. Németh; G. Csillag
CRATER LAKE SEDIMENTS IN THE PLIOCENE PULA MAAR (WESTERN HUNGARY) p. 60

11.10–11.30 **P. Suhr;** V. Lorenz; K. Goth
SUBSIDENCE WITHIN AND ABOVE MAAR-DIATREME VOLCANOES p. 94

11.30–11.50 **H. Lutz**
A DYNAMIC MODEL FOR THE MEROMICTIC ECKFELD MAAR LAKE (MIDDLE EOCENE, GERMANY) BASED ON BIOSTRATINOMICAL AND SEDIMENTOLOGICAL DATA p. 72

11.50–12.10 **I. Rupf,** K. Goth; H. Schaeben; G. Radons
TIME-SERIES ANALYSIS OF THE OLIGOCENE BARUTH MAAR LAMINITES (EASTERN GERMANY) – FIRST RESULTS p. 87

12.10–12.30 **D. Vass;** N. Ogujanova-Rumenova, V. Konečn
SEDIMENTOLOGY AND PALAEOECOLOGY OF SOUTHERN SLOVAKIAN BASALT MAAR LAKES p. 100

Poster Presentations of Symposium 7

24 September:** 17.00–18.00* ***and
***25 September:** 16.00–17.00*

G. Gruber; P. Schäfer
OSTRACODS OF THE EOCENE MAAR LAKES ECKFELD AND GRUBE MESSEL – PALAEONTOLOGICAL IMPLICATIONS p. 61

G, Csillag; K. Németh; U. Martin; K. Goth; P. Suhr
3D ARCHITECTURE OF A PLIOCENE MAAR VOLCANO ON THE BASIS OF DRILL CORE DATA AND ITS IMPLICATION FOR THE SYN-VOLCANIC GEOMORPHOLOGY, PULA MAAR, WESTERN PANNONIAN BASIN p. 50

M. Felder; R. Gaupp
δ^{13}C- AND δ^{18}O-VALUES OF SIDERITE – A TOOL FOR THE RECONSTRUCTION OF MIXIS IN ANCIENT LAKES p. 52

M. Felder; F.-J. Harms
LAKE MESSEL: THE IMPRINT OF THE BASIN ORIGIN ON THE SEDIMENTARY AND FOSSIL RECORD p. 54

M. Felder; R. Gaupp; M. Wuttke
SIDERITIC BIOLAMINATES IN THE OIL SHALE OF PALAEOGENE MAAR LAKES p. 53

P. Suhr; K. Goth
EVENT SEDIMENTATION IN THE BARUTH MAAR LAKE p. 93

M. Fey; H. Corbella; T. Haberzettl; S. Janssen; A. Lücke; N.I. Maidana; C. Mayr; C. Ohlendorf; F. Schäbitz; G.-H. Schleser; M. Wille; B. Zolitschka
EXTRA-ANDEAN CRATER LAKES FROM SOUTHERN PATAGONIA, ARGENTINA – ACTUO-LIMNOLOGY AND PALAEOCLIMATE RECONSTRUCTION p. 54

A. Pászti; Z. **Szűcs**
FISH REMAINS FROM A PLIOCENE MAAR LAKE (PULA, HUNGARY); AND THEIR CONSERVATION METHODS p. 82

M. Pirrung; **G. Büchel;** D. Merten
MAAR LAKE SEDIMENTS IN JAVA – A TROPICAL CLIMATE ARCHIVE? p. 83

I. Rupf; K. Goth; H. Schaeben; G. Radons
TIME-FREQUENCY PATTERNS OF THE OLIGOCENE BARUTH MAAR LAMINITES (EASTERN GERMANY) p. 88

M. Sabol; **D. Vass;** V. Konečn ; N. HudÆčkovÆ-HlavatÆ; M. Slamková; I. Túnyi; K. Balogh
RECONSTRUCTION OF THE PALAEOENVIRONMENTAL EVOLUTION OF THE BONE GORGE MAAR NEAR HAJNÁČKA (SOUTHERN SLOVAKIA) p. 88

J. Vegas; A. Pérez-González; A. García-Cortés; L. Galán de Frutos; J.L. Gallardo-Millán
THE FUENTILLEJO MAAR LACUSTRINE RECORD (CAMPO DE CALATRAVA VOLCANIC FIELD). PRELIMINARY SCIENTIFIC ACTIVITIES FOR THE PALAEOCLIMATIC RECONSTRUCTION OF THE QUATERNARY IN CENTRAL SPAIN p. 100

T. M. Kaiser; G. Arratia; V. Bullwinkel; G. F. Gunnel; B. F. Jacobs; J. Mingram; C. Msuya; **E. Schulz;** V. Wilde
THE MAAR LAKE OF MAHENGE (TANZANIA) – SINGLE EVIDENCE OF EOCENE TERRESTRIAL ENVIRONMENTS IN SUB-SAHARAN AFRICA p. 64

Symposium 8

SURTSEYAN VOLCANISM

Convenor: James D.L. White (Otago, New Zealand) – james.white@stonebow.otago.ac.nz
Co-Convenor: Alexander Belousov (Petropavlovsk – Kamchatsky, Russia) belousovsasha@yahoo.com

Surtseyan eruptions are characterized by interaction of a fluid erupting magma with abundant external water. Commonly they start in shallow subaqueous environments where accumulating tephra forms a mound-shaped volcano prior to emergence. During this subaqueous stage density currents play a significant role in shaping the edifice and imparting characteristic bedding features. Emergent to subaerial Surtseyan eruptions generally produce cone-shaped edifices by accumulation of wet fall deposits with subordinate density currents. Surtseyan deposits typically consist almost entirely of glassy fragments formed by fragmentation of the erupting magma, and lack a significant country-rock component. This an important difference from deposits of maar-forming eruptions, and it indicates that in Surtseyan eruptions fragmentation occurs at very shallow levels in the edifice or/and as the magma emerges from it. If or when the erupting magma no longer encounters water (e.g. by enclosure of an emergent vent, or isolation from/depletion of groundwater), both Surtseyan and maar-forming eruptions may transform to Strombolian or Hawaiian ones.

This session has invited contributions on all aspects of Surtseyan eruptions and their products, and particularly solicits those that address the relationship between Surtseyan and maar-forming eruptions and underlying causes for the distinct eruption styles.

Oral Presentations of Symposium 8

24 September

14.30–14.50 **A. Fulop;** M. Kovacs
SUBMARINE VOLCANISM IN OAS-GUTAI MTS., EASTERN CARPATHIANS, ROMANIA p. 55

14.50–15.10 **H. B. Mattsson;** Á. Höskuldsson; S. Hand
CRUSTAL XENOLITHS IN THE 6220 BP SØFELL TUFF-CONE, SOUTH ICELAND: EVIDENCE FOR AN UNUSUALLY DEEP, DIATREME-FORMING, SURTSEYAN ERUPTION p. 77

15.10–15.30 **M. McClintock**
EVOLUTION OF THE STERKSPRUIT COMPLEX, SOUTH AFRICA: A COMPOSITE MAAR CRATER-COMPLEX DEVELOPED DURING LIP VOLCANISM p. 78

Poster Presentations of Symposium 8

24 September:** 17.00–18.00 **and
***25 September:** 16.00–17.00*

T. Budai; **K. Németh;** U. Martin; O. Piros
SUBAQUEOUS VOLCANICLASTIC SUCCESSIONS IN THE MIDDLE TRIASSIC OF WESTERN HUNGARY p. 46

H. Solgevik; **H. B. Mattsson;** O. Hermelin
EVOLUTION OF AN EMERGENT TUFF-CONE: A DEPOSITIONAL STUDY OF THE CAPELAS TUFF-CONE, SÃO MIGUEL, AZORES. p. 92

S. Bretschneider; **C. Breitkreuz;** K. Németh; H.-G. Wilke
VOLCANO-SEDIMENTARY SUCCESSION ASSOCIATED WITH A LOW-LYING INTRA ARC VOLCANIC SYSTEM IN THE NORTH CHILEAN JURASSIC LARGE IGNEOUS PROVINCE: THE CERRO BLANCO COMPLEX , TALTAL p. 45

M. Karthe
TRANSITION FROM PHREATOMAGMATIC TO HAWAIIAN ERUPTIONS WITH EVIDENCE FOR WATER LEVEL – A CASE STUDY ON THE SÁG HILL, HUNGARY p. 65

Symposium 9

HAZARDS, ENVIRONMENTAL ISSUES, NATURE PROTECTION, AND GEOPARKS OF MAAR-DIATREME-VOLCANOES

Convenor: Ulrike Martin (Heidelberg, Germany) – Ceboruco@web.de
Co-Convenor: Barnabás Korbély (Budapest, Hungary) – korbely@ludens.elte.hu

Maar-diatreme volcanoes are the phreatomagmatic equivalent of scoria cones. Whereas tuff-rings and tuff-cones form in shallow water bodies and in groundwater-rich environments maars form in rather "normal" groundwater environments. Maars occur in volcanic fields and on foot plains and inside calderas of polygenetic volcanoes. Only a few maars erupted in historic times. Maars usually form when magma rises within a fissure and interacts with groundwater.

Hazards associated with maar eruptions are: volcanic earthquakes (up to cca. M: 4-5), possibly several 1000 individual eruptions, eruption clouds rising to maximum heights of economic air travel, ejection velocities of tephra clasts of up to 400 m/s, ejection distances of ballistic clasts up to 4 km; size of ejected clasts up to 8 m, base surges travelling up to several km and with time building a tephra ring of a height up to 100 m and of a radius of up to 4 km (measured from centre of crater), thin distal tephra falls extending to more than 100 km, syn- and post-eruptive slumps and lahars inside and in part also outside the crater, destruction of buildings and transport lines within a radius of up to 5-6 km. Associated formation of the maar crater floor and underlying diatreme results in subsidence of country rocks, tephra, and buildings to depths of possibly 1000-2000 m.

In addition, recent studies have shown that there are hazards associated to recurrence of activity within volcanic fields but also in single maars.

Oral Presentations of Symposium 9

24 September

16.00–16.20 **V. Lorenz**
SYNERUPTIVE AND POSTERUPTIVE HAZARDS OF MAAR-DIATREME VOLCANOES p. 71

16.20–16.40 **L. S. Teng**
POTENTIAL THREAT OF LAHAR-INDUCED CATASTROPHIC FLOODING TO THE TAIPEI METRPOLIS, NORTHERN TAIWAN p. 98

16.40–17.00 **K. Moreaux K;** J-P. Henriet; G. G. J. Ernst; W. Versteeg; P. Staelens; T. Missiaen; R.Swennen; P. Lavina
LANDSLIDE HAZARD IN MAAR AND CALDERA LAKES p. 78

25 September

9.00–9.20 **B. Korbély;** G. Csillag
PROPOSED PROTECTION AND CONSERVATION STRATEGIES OF VOLCANOLOGICAL FEATURES IN A MONOGENETIC VOLCANIC FIELD IN THE WESTERN PANNONIAN BASIN: A PERSPECTIVE OF BALATON UPLANDS NATIONAL PARK, HUNGARY p. 68

9.20–9.40 **M. Felder**
THE ONTOGENY OF THE MESSEL MAAR–A TOPIC OF INTEREST FOR GEOTOURISM AND RECENT RESEARCH p. 52

9.40–10.00 **W. J. W. Williams;** R. I. Brame; C. S. Jacobs
MEETING THE LEARNING NEEDS OF A MORE DIVERSE POPULATION: APPLYING UNIVERSAL DESIGN TO VOLCANOLOGY, PETROLOGY AND HAZARDS EDUCATION p. 103

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Symposium 10

VOLCANIC FIELDS — POLYGENETIC VOLCANOES

Convenor: Greg Valentine (Los Alamos, New Mexico, US) — gav@lanl.gov
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Volcanic activity in terrestrial settings often results in the formation of volcanic fields rather than single volcanic edifices. Volcanic fields, especially basaltic ones, are common volcanic systems on Earth. Monogenetic volcanic fields are those in which individual volcanoes (mainly basaltic) commonly form during single episodes of volcanic activity, without subsequent eruptions, while the volcanic field as a whole may be active for millions of years. Fundamental physical characteristics of volcanic fields that are the focus of current research include 1) the number, type and eruption history of individual vents; 2) the timing and recurrence rates of the volcanic eruptions in a given volcanic field, 3) the distribution of vents and volcanic complexes, and 4) the relationship of volcanic fields and the volcanoes within them to tectonic features such as basins, faults and rift zones. In general there are three major elements to be considered in the ascent and emplacement of magma either on Earth or other planets, and each strongly depends on the physical properties and structure of the lithosphere encountered by the magma. The three factors are: 1) magma generation and buoyancy, 2) rheological boundaries in the lithosphere and 3) density boundaries in the lithosphere. In addition to these factors, the stress field (local and regional) plays an important role in controlling magma ascent which is generally related to the structural features of the lithosphere encountered by the magma. In this session we are calling for contributions that address the following questions: What determines whether a volcanic field will consist only of scattered monogenetic volcanoes, versus development of one or a few central, polygenetic volcanoes? What are the controlling factors, how these processes can be modelled? How large can a monogenetic volcano be, and what are the criteria that distinguish, or mark the transition between, monogenetic and polygenetic volcanoes? Are all small basaltic centres monogenetic?

We welcome presentations on any approach to addressing these questions, including geochemistry, high-precision geochronology, petrology, geophysics, geomorphology, and spatial analysis. A special topic for this session includes studies on the distribution characteristics of maars versus scoria cones versus polygenetic volcanoes in a volcanic field.

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Plenary talk

22/9.40–10.20

External forcing of volcanic eruptions

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Magma–water interaction is the main of several external forcing mechanisms of volcanic eruptions now accepted by the scientific community. It all began with the milestone analysis of the structural features of the deposits of the observed eruption of Taal Volcano in Lake Taal (Moore et al. 1966). Many different environments are now recognized where magma–water encounter triggers and/or influences the style and energy of volcanic eruptions. Following a discussion of a proposed systematic overview of different environments (Schmincke 2004) I will stress the prevalence of complex combined external and internal forcing mechanisms. The review will conclude with a comment on the recent revival of the CO_2-explosion model ("Verneshot", Morgan et al. 2004) proposed as a possible mechanism to explain global mass extinctions. Veterans in the magma–water debate will recall the early years (1970ies) when a lot of energy was needed to convince the community that maars are not the result of CO_2-explosions.

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Abstracts in Alphabetical Order

***6 O** – 24/9.40–10.00*

Secondary quartz cementation around phreatomagmatic structures, Bohemian Cretaceous Basin, Czech Republic

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Phreatomagmatic structures related with the Tertiary volcanic activity of the Ohre Rift concentrate along the southeastern fault limitation of the rift graben, being hosted by the sedimentary fill of the Bohemian Cretaceous Basin. Quartz cementation around these structures occurred at three different settings: (1) cementation of sandstone xenoliths enclosed in volcanic breccia, (2) cementation of sandstones hosting volcanic breccia bodies, and (3) cementation of sands in maar fills. The best examples of sandstone silicification from the area come from subsided, within-graben blocks with a relatively low degree of post-emplacement erosion (Pisecny vrch and Verpanek near Becov, Strazny vrch and Wiesners Busch near Mimon).

Silicified sandstones from Pisecny vrch Hill were studied by means of optical microscopy, cathodoluminescence and X-ray diffraction. They form irregular enclaves up to tens of cubic metres in size in a bed of white, fine-grained kaolinic sands cca. 8 m thick in the maar fill. This bed overlies, and is disturbed by, a body of chaotic, xenolith-rich basaltic breccia. Samples of three different intensities of silicification were observed. Type I is a sandstone with pressure solution (cocavo-convex grain contacts) and overgrowths of colourless quartz. Type II is a sandstone with syntaxial quartz overgrowths, prism faces are covered by younger microquartz. Voids are filled with fibrous to radiating chalcedony. Type III is a lighter/darker-zoned quartzite with conchoidal fracture and partly corroded angular quartz grains covered by radiating chalcedony showing spherulitic growth structure. Voids are filled with fibrous chalcedony. No unambiguous two-phase liquid-rich inclusions were found in the samples. Instead, the samples contain numerous tiny phases (<5 μm, solid? fluid?).

The types of silica cement suggest hydrothermal fluid-related alkaline dissolution of detrital quartz (corrosion, pressure solution) and silica reprecipitation at the level of mixing with cold meteoric waters higher up in the maar fill.

1 P — 22/17.00–18.00, 23/17.00–18.00

The Fekete-hegy volcanic complex — nested maars in the centre of the Bakony – Balaton Highland Volcanic Field

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Small alkaline volcanic fields developed in the Pannonian Basin from the late Miocene to Pliocene time. They are related to a relict subduction signature in the upper mantle, caused by subduction processes during the Carpathian evolution. One of these fields is the Bakony – Balaton Highland Volcanic Field (BBHVF), which is characterized by intense phreatomagmatism, due to its location in a fluvio-lacustrine basin. The research area itself is a large NE–SW striking hill, located in the centre of the BBHVF, were the vent density of the whole field is highest. Individual closely nested vents, formed during periods of activity, are recently exposed in different erosional levels. Marls and partly unconsolidated sandstones of Cainozoic age as well as Mesozoic limestones and dolomites with large karst water bearing aquifers are forming two types of clearly distinct basement rocks beneath the volcanic complex. Thus, nearly all major characteristics of a maar volcano are exposed in one small area. For example, rags of unconsolidated sandstones, showing soft sediment deformation, up to one metre in size, as well as blocks of Mesozoic carbonate, up to 30 cm in diameter, are exposed in the pyroclastic series at different locations. This shows that individual eruptions occurred in a soft sediment environment as well as a hard rock environment. Thinly cross and dune bedded deposits from the maar related tuff ring and an insight in the upper diatreme zone, with large tilted blocks and a chaotic bedding situation is given in the same volcanic complex. In addition the emplacement of late scoria cones and effusive series, forming a lava lake, controlled by the tuff ring geometry is well known from other maar volcanoes, covering the pyroclastic series after water supply was used up.

4 O — 23/11.50–12.10

Methodical results of K/Ar dating of post-Sarmatian alkali basalts in the Carpathian Basin

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In the early 80's the first K/Ar studies of alkali basalts revealed that K/Ar data either agree with the foreseeable geological age or they are older: old ages were explained by the presence of excess Ar. In order to account for the excess Ar the isochron method has been applied, but its success was limited. Namely, the K content in a basalt body is more or less uniform, this makes the recognition of "mixing lines" difficult. Application of the isochron methods became more promising when fractions from a single piece of rock, produced by magnetic and heavy liquid separation, were used for defining the isochrons. After the elaboration of a sophisticated method for producing rock fractions it has been experienced that for a part of the rocks the conditions for applying the isochron methods are not fulfilled: clearly, the Ar isotope composition and/or the Ar(rad) concentration was not uniform in the rock samples. Dating of fractions has been very useful even in this case, since it helped to recognize unreliable K/Ar ages and avoid erroneous chronological conclusions. Unfortunately, this help was still insufficient to avoid all pitfalls of interpretation of K/Ar ages. It has been demonstrated that "good" isochrons may give erroneous ages if there is a linear relation between the K and excess Ar concentrations of the used rock fractions. This is a realistic possibility, since both K and Ar are concentrated in the glass phase. Information on the excess Ar concentration has been obtained from the Ar(atm) concentration. It has been concluded that most reliable ages can be obtained when fractions with similar and low Ar(atm) concentrations are used. This method has been applied successfully in Slovakia and Hungary. It is believed that great deviation of palaeomagnetic time-scales is caused by the insuffcent control of the K/Ar ages and the method presented here could help to solve this serious problem.

3 O — 23/9.20–9.40

A model for stress controlled pipe growth

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The rock mechanics theory for deformation of underground mining excavations under high stress conditions can be used to explain the growth and geometry of volcanic kimberlite pipes. In an underground excavation the stress concentrates greatest on the sides of an excavation perpendicular to the principal vector of compression. If the stress is high enough fractures will develop causing scaling of the tunnel sidewalls and tunnel growth perpendicular to the principal vector of compression. Pre-existing structures aid the physical mechanisms of pipe growth such as gravity, explosions and turbulent erosion; and should also aid stress-induced scaling. Numerical modelling in this study reproduces the stress conditions around a circular pipe under uniaxial compression and simulates pipe growth as wedges bounded by failed pre-existing joints form around the pipe and are "assimilated" into the pipe. The results show how a volcanic pipe will tend to grow perpendicular to the principal vector of compression if the internal magma pressure is low or absent. The orientations of the pre-existing joints affect the exact direction of pipe growth in a predictable manner. Examples considered from other studies demonstrate that the model is consistent even in extensional tectonic environments. Case studies from kimberlite occurrences such as Venetia, River Ranch and the Oaks in the Limpopo Belt, as well as Finsch Mine demonstrate how dykes and magmatic bodies of kimberlite have geometries trending near parallel to the principal vector of compression, and yet parts of the pipes comprising fragmental volcaniclastics have elongation near perpendicular to the same vector. Thus the stress-induced pipe growth model is demonstrated to be relevant for kimberlites. The study of kimberlite pipe and dyke shapes can therefore be used to determine the stress regime at the time of emplacement, and to distinguish between different kimberlite occurrences formed at different times with different stress vectors.

1 O — 22/10.50–11.10

Maars of Kamchatka (Russian far east): the first data

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Volcanism in Kamchatka Peninsula is concentrated in two regions: in the Eastern Volcanic Belt (where most of the active volcanoes are situated) and in the Sredinny Ridge (where last eruptions ceased several thousand years ago). Together with many polygenetic volcanoes (stratovolcanoes, dome complexes, calderas), both regions have numerous monogenetic volcanoes, represented mostly by cinder cones. The monogenetic volcanoes are either associated with polygenetic volcanoes (vents of flank eruptions), or form extensive independent fields.

Here we represent the first results of our study aimed on investigation of the role of magma–water interaction during formation of monogenetic volcanoes in Kamchatka. As a preliminary step we have studied maps and aerial images of Kamchatka and found totally 18 maars, most of which have never been studied. Available data show that most of the maars were formed in Holocene, and several maars were formed in the end of Late Pleistocene. Most of the maars contain lakes, sediments of which should contain a record of climate changes in NW Pacific in Holocene. Most of the maars are located in the lowermost locations of the areas commonly adjacent to rivers, lakes, and marshes. In several cases maars were formed on the lowermost parts of the eruptive fissures, while on higher elevations along the fissures the cinder cones were formed.

Kamchatkan maars erupted mostly basalts – basaltic andesites, and several maars erupted more silicic products (up to rhyoliths). We have examined deposits of four maars: Nachikinsky Maar (Late Pleistocene – Early Holocene), Krokur (4900 BP), Dal'neye Lake (3200 BP), Chasha Lake (4600 BP). Each of these maars was formed by a single eruption consisting of multiple explosions following one after another (pulsatory eruption style). The eruptions left typical maar deposits represented by layered sequences of ash fall and base surge deposits. Erupted material is represented by rather dense juvenile clasts with wide range of vesicularity, mixed with abundant fragments of country rocks. In the case of Dal'neye Lake the access of water to the magma conduit was blocked at the end of eruption, and the eruption became purely magmatic forming small cinder cone inside the maar.

Despite Kamchatka is rather wet area (annual precipitation exceeds 1 m), maars comprise less than 1% of the total amount of monogenetic volcanoes (99% are cinder cones). Tuff rings and tuff cones are also very rare. Several historical eruptions of cinder cones in Kamchatka did not demonstrate clear phreatomagmatic episodes of explosive activity in their courses as common in other regions of the world. Thus, our general conclusion is that the role of water–magma interaction is rather small during formation of monogenetic volcanoes in Kamchatka. Possible explanation is that very intensive explosive volcanism in the area has formed thick pile of very permeable volcaniclasts, and aquifers in most locations are situated at deep levels. In this situation explosive interaction of rising magma with water is impossible, being suppressed by high lithostatic pressure. Additional reason could be permafrost, existing in many areas, especially in highlands. Permafrost blocks the access of groundwater to magma conduit.

4 P — 22/17.00–18.00; 23/17.00–18.00

Spatial distribution and petrographic differentiation of basaltic rocks in Lower Silesia, Poland

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The main tectonic lines in the studied area are Marginal Sudetic Fault which divides Sudetes from the Fore-Sudetic Block and almost parallel zone of the Odra Faults between Fore-Sudetic Block and the Fore-Sudetic Monocline. Clusters of Tertiary basaltic rocks occur along or close to these tectonic lines in different geological units of different lithology, different tectonic evolution, and different age. In the Opole area the effusives occur within Miocene sediments while in the Niemcza-Strzelin area basaltic vents cut metamorphic rocks. Basaltoids from the vicinities of Jawor occur within granitoids of the Strzegom–Sobótka Massif and its metamorphic cover. Volcanics from the Złotoryja area cut epimetamorphic schists or Permian–Mesozoic deposits. In the vicinities of Lądek Zdrój volcanics exist in metamorphic rocks. Rocks from the Karkonosze–Izera and Lubań–Bogatynia areas are just being studied. Individual areas were selected supposing possibility of different magmatic evolution in different tectonic blocks. In such a case the neighbouring volcanics of Jawor and Złotoryja, divided by Marginal Sudetic Fault on two, were studied separately. On the base of recent petrographic and radiometric studies, five centres of Tertiary volcanic activity are distinguished in the Lower Silesia. 1. Melabasanites and melanephelinites (30.5±1.3 My to 25.5±1.2 My, until 21.2±1.1 My) of the Opole area; 2. Ankaratrites (28.72±1.13 to 25.32±1.06 My) and mainly basanites (20.91±0.84 to 18.54±0.96 My) of the Niemcza–Strzelin area; 3. Basanites, ankaratrites and alkaline-basalts of the Jawor–Złotoryja–Strzegom cluster (maximum activity: 21.96±1.36 to 18.72±0.81 My). 4. Karkonosze–Izera Block (27.75±1,16 to 25.34±1.03 My with the final stage 23.39±1.07 My). 5. Basanites of the vicinities of Lądek Zdrój (5.46±0.23 My to 3.83±0.17 My) seems to be an unique occurrence.

4 P — 22/17.10–18.00; 23/17.00–18.00

Recent geochronological and geochemical study of alkali basaltic rocks in Lower Silesia, Poland

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Detailed study was carried out on the Tertiary alkali basaltic rocks that occur in Lower Silesia, from its eastern part in the Opole Region to western part located close to the state boundary with Czech Republic and Germany. These rocks occur in the Fore-Sudetic Block and in the Sudetes. K-Ar dating has shown that in the Fore-Sudetic Block two phases of volcanic activity took place. The first phase was mainly Late Oligocene and it lasted from Late Rupelian (30.85 My) to Chattian (26.67 My). After a gap in vulcanicity about 3 My long at the Oligocene/Miocene boundary, the second phase started in Early Miocene and it lasted from Aquitanian (23.56 My) to Burdigalian (18.66 My). In Sudetes another two phases are marked in volcanic activity. The first phase overlap exactly with a gap in the fore-Sudetic Block and it lasted from Early Miocene (Aquitanian 23.39 My to Late Oligocene (Chattian 27.75 My). Rocks of such age occur in the North Sudetic Depression and in the Karkonosze Mts. A group of rocks from southwestern part of the Lower Silesia area are still in study but those form the Sudetes near Lądek Zdrój seems to be the youngest ones and they represent Neogene volcanic activity lasting from Messinian (5.46 My) to Zanclean (3.83 My). New petrologic and geochemical investigations show that Tertiary basaltic rocks from the Lower Silesia typically represent within-plate basalts. This concerns all studied rocks from both Fore-Sudetic Block and Sudetes. They vary, however, petrologically. Mineral and chemical composition of these rock interpreted according to the IUGS standards of igneous systematic permit to classify them mostly as basanites, anakaratrites and alkali basalts with some tephrites in minority. It seems that chemistry and mineral composition of basaltic magma changed in time and in space. Rocks of the first, Oligocene phase are mainly ankaratrites while those from the second phase are mainly basanites. Sudetic rocks repeat the same sequence: the oldest are ankaratrites while Neogene samples from vicinities of Lądek Zdrój are basanites.

10 P *— 24/17.00–18.00; 25/16.00–17.00*

Nature and causes of compositional variations within individual monogenetic volcanoes: insights from the coffeepot crater, Jordan Valley Volcanic Field, Oregon

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The presumed geochemical homogeneity of products of individual monogenetic volcanoes has been recently challenged and some studies demonstrate that compositional heterogeneity may be the rule, rather than the exception. Numerous models have been proposed to explain compositional variations within individual volcanoes. Coffeepot Crater, a monogenetic volcano in the Jordan Valley Volcanic Field provides an excellent opportunity to further evaluate the cause of such variations. Coffeepot Crater is the youngest (2–5 ky?) among a NNE–SSW trending alignment of four vents of varying ages. It consists of one principal scoria cone and several small spatter cones, along with an associated lava flow field. Based on a detailed study of field relations and the stratigraphy exposed within the crater of the scoria cone, two phases of eruptive activity are identified. Tephra and lava belonging to each of the two phases were sampled in detail and subjected to geochemical analyses. The analyses reveal subtle to distinct variations in the chemical and Sr isotopic composition of each phase. For example, two groups are clearly differentiated based on plots of Sr, Cr, K_2O/TiO_2, and $^{87}Sr/^{86}Sr$ versus MgO, and these correspond to the eruptive phases identified in the field. Geochemical modelling suggests that two principal models can explain the observed compositional variations. The first involves a complex assimilation-fractional crystallization process, along with magma mixing. The second model invokes small-scale heterogeneity in the mantle source of this volcano as being primarily responsible for the variations, with a secondary contribution from fractional crystallization. We attempt to evaluate these two models in the context of a realistic physical framework, suitable to the evolution of monogenetic volcanoes. We conclude, in agreement with other recent studies that the sources and plumbing systems for such volcanoes may be more complex than hitherto recognised.

3 P *— 22/17.00–18.00; 23/17.00–18.00*

Intra and extra-crater kimberlite tephra deposits of Buffalo Head Hills, Alberta Canada

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Late Cretaceous pyroclastic and epiclastic kimberlitic deposits are encountered in outcrop and drill core in the Buffalo Head Hills of Alberta, Canada. Four lithofacies are identified: 1. Massive crystal-rich deposits occurring in an intra-crater setting; 2. Accretionary, and juvenile pyroclast-rich units deposited intra-crater; 3. Well-sorted, finely-interbedded olivine crystal-rich ash and juvenile pyroclast-rich lapilli units occuring in both intra and extra crater settings; and, 4. Very well sorted crystal-rich deposits showing evidence of crystal abrasion that occur both intra and extra-crater. These deposits represent varying degrees of fragmentation, transportation and alteration, as well as subsequent sedimentary reworking and diagenesis. Post-depositional processes can mask the volcanic textures, however careful examination of clast populations, depositional structures and contact relationships reveals features of the eruptive style and transport dynamics.

Lithofacies 1, 2 and 3 have features indicating transport and deposition from a dilute mixture of ash, gases and fluids such as would be expected in a volcanic column or pyroclastic surge. Elutriation of fines and density sorting could account for the concentration of crystals in lithofacies 1. Circulation of material in an ash/fluid/gas mixture would result in the accretionary rims observed in lithofacies 2 where accretionary pyroclasts occur greater than 3 cm in size. In lithofacies 3, the presence of fine beds (<1 cm) for vertical intervals (depths) of more than 100 m, the preservation of delicate fragments such as juvenile pyroclasts and euhedral olivine crystals, and the presence of structures such as cross-bedding, shallow to steep bedding and normal grading, are consistent with deposition from pyroclastic surges. Lithofacies 4 contains features characteristic of reworked pyroclastic material such as abraded clasts, excellent sorting, and crystal concentration up to 100%.

The lithofacies identified in these kimberlites are texturally similar to volcanic facies recognized in maars thus indicating similarities between eruptive processes in kimberlites and those in maars.

8 P — 24/17.00–18.00; 25/16.00–17.00

Volcano-sedimentary succession associated with a low-lying intra arc volcanic system in the north Chilean Jurassic large igneous province: The Cerro Blanco Complex, Taltal

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Detailed sectioning and mapping in the Cerro Blanco area (3×7 km) southwest of Taltal in north Chile indicates a complex interplay of volcanic, pyroclastic and sedimentary processes. The rock complex forms part of the La Negra Formation, a Jurassic large igneous province dominated by thick piles of coherent andesitic lava flows cropping out extensively in the north Chilean Coastal Cordillera.

We distinguish three volcanosedimentary units from base to top: (i) Tegualda Beds: a 400 m thick reddish succession comprising a volcaniclastic alternation of mud flow deposits (individual bed thickness between 20 and 200 cm) with well-sorted, parallel to wavy bedded sandtones and conglomerate. Soft sediment deformation and faulting indicate syn-depositional movements likely to be regional tectonic ones. (ii) Cerro Blanco Beds: 220 m of grey to yellowish fossiliferous marls, sandstones and carbonates. Towards the top, a layer (<1 m thick) rich in angular dacitic lapilli occurs. At the top, the Cerro Blanco Beds interfinger with a 300 m thick pile of andesitic lavas which laterally grade into pillow lavas and -breccias. (iii) Puntilla Beds: >520 m thick sequence of sandy to gravelly volcaniclastic sediments intercalated with metre to tens of metre thick matrix-supported lava breccias, and a variety of graded lapilli-to-ash layers resembling waterlain fall deposits. Subordinate well-rounded boulders in a bedded sandy matrix with belemnites point to marine reworking near a rocky beach.

Intercalations of andesitic lava are abundant in the Tegualda and Puntilla Beds, and all units are intensively crosscut by andesitic dykes and sills, with soft-sediment deformation and peperites at their margins. These effusive and intrusive units, and the fall-deposited layers, indicate active volcanism in the Cerro Blanco area. The monotonous volcaniclastic Tegualda and Puntilla Beds most likely comprise syn- to intereruptive shallow-marine apron deposits formed near intermediate explosive volcanic centres.

5 P — 22/17.00–18.00, 23/17.00–18.00

Hydrogeological potential of maar volcanoes derived from the Gees maar, Westeifel Volcanic Field, Germany

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In the international literature there is only a very small amount of publications about the production of groundwater from maar volcanoes and neither a conceptional model nor a numeric groundwater flow model exist to explain the mechanism of groundwater movement in a sediment filled maar crater and its underlying diatreme.

In the Quaternary Westeifel Volcanic Field approximately 65 maars exist. Most of these maar craters are dry maars filled with sediments due to the strong erosion of the sourrounding tuff wall and the wall rocks of the inner crater slopes. In several dry maars productive water wells were established: Morswiesen-Hausten maar (East Eifel), Boos maars, Döttingen maar and Laach maar (West Eifel).

For a better understanding of groundwater movements in maar volcanoes we studied the Gees maar in detail. The Gees maar is located near Gerolstein in the central part of the Westeifel. It is a dry maar erupted several 100 000 years ago, with a maximum diameter of cca. 1000 m and a depth of the crater of about 100 m. The maar is void of a tuff wall due to the strong erosion. Steeply incised valleys originating from backstepping erosion start at a distance of up to one km away from the crater rim. Therefore the extent of the cachtment area is much larger than the original crater.

Gravity survey and geomagnetic measurements indicate a scoria layer under a sedimentary cover. The scoriaceous material represents an effective aquifer which is able to drain the whole crater. Hydrogeological and hydrochemical analysis performed during a two year period give us an idea about groundwater balance and hydrochemical composition of groundwater. On the base of these data we outline a conceptional model of groundwater balance which we will present.

8 P *— 24/17.00–18.00; 25/16.00–17.00*

Subaqueous volcaniclastic successions in the Middle Triassic of western Hungary

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In western Hungary Middle Triassic sedimentation was steady from the Permian/Triassic till the end of the Early Anisian that was followed by carbonate platform disruption. Alkaline acidic volcanism started due to Late Anisian tectonism. The Middle Anisian Lofer cyclic platform carbonates are sharply overlain by reddish, grey or greenish crinoidal volcaniclastic limestone with ammonites. This sequence is overlain by a few m thick altered calcareous tuff (*"pietra verde"*). These beds are montmorillonitised, bentonitic, with green, yellowish, red matrix hosting vitro-, litoclasts, and micro-holocrystalline crystals. The K-rich trachyte became rhyolitic upwards with increasing calc-alkalinity. These beds are thicker in the Anisian basins (18 m) than above the platforms (5–8 m).

The Upper Ladinian sequence consists of silicified thickly bedded, red, grey, limestone with tuff layers, and with alternations of tuff, marl and thinly bedded limestone (*"posidonia beds"*). This sequence (as *Buchenstein Formation*) deposited in a pelagic basin, where carbonate deposition was ended by volcanism. The deposition of this sequence (30 m) occurred during the Longobardian substage in condensed sedimentation. In contrast in the Southern Alps the much thicker Upper Ladinian is represented by a volcaniclastic sandstone-silty-marl.

In western Hungary the Upper Anisian to Lower Ladinian volcanics are thick while they are of subordinate in the Upper Ladinian. Similarity does not exist in the thickness of the sequences between volcaniclastic rocks of the Lower Ladinian of western Hungary (tens of m) and the Livinallongo Formation (Dolomites, Italy) (180–200 m). The wide distribution of Lower Ladinian pyroclastics related to the higher explosivity of the magma and/or subaqueous reworking/redeposition.

The volcanism became basic and effusive during the Late Ladinian in the Southern Alps. In Hungary this sequence consists of volcaniclastic sandstones (*„wengen group"*, Southern Alps). With decrease of silica content of the magma, its viscosity and explosivity decreased resulting limited dispersal of the deposits.

5 O *— 23/14.40–15.00*

Detailed imaging of maar-diatreme structures by reflection seismic surveys

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The Leibniz Institute for Applied Geosciences has performed geophysical surveys at two maar-diatreme structures in Germany: the concealed maar of Baruth and the Messel Pit. The surveys comprised potential field methods, geoelectrical measurements, reflection seismic surveys and downhole logging. Whereas potential field methods applied to maar research are quite established, the seismic reflection method is not. It enables a detailed image of the internal structures down to a depth of several 100 m. At the Baruth site, the former maar could be entirely imaged, at the Messel site, the strong relief of the opencast mining allowed only to reveal a part of the whole structure. The lake sedimentation at both sites can seismically be divided into two parts: (1) the early lake period, dominated by the deposition of breccias, debris flows and turbidity currents, is characterized by strong reflections; (2) the late lake period, dominated by undisturbed sedimentation of fine clastic and organic components, appears seismically nearly transparent. Reflectors are often continuously traceable for several 100 m. The thick lapilli tuff sequence underlying the lake deposits at the Messel site does not show strong reflectivity, but within the deeper collapse breccia horizontal as well as dipping reflectors hint to a deep extending layering of the collapse breccia. A multiple-offset VSP confirms the results of the surface reflection survey. The shape of the diatreme cannot be seen due to geometrical reasons. Borehole geophysics allows an exact assignment of lithological and/or physical in-situ parameters to seismic reflectors.

3 P *— 22/17.00–18.00; 23/17.00–18.00*

Tectonic controls on location of phreatomagmatic phenomena, eastern Eger Rift, North Bohemia

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In the eastern part of the Eger Rift, superficial maar tuff ring deposits are not preserved due to the high rate of erosion. The diatremes preserved in this region, however, may represent the subsurface parts of maar-diatreme systems. The extent of phreatomagmatic phenomena may also be very difficult to identify because the diatremes can be covered by deposits of effusive volcanism (basanitic mostly), and by products of mostly explosive volcanism of a composite volcano (tephritic to trachybasaltic) in the rift graben axis. Nevertheless, their existence is highly probable as the lavas show signs of water-saturated environment and the country rock is represented by high-porosity Cretaceous sediments. In marginal parts of the Eger Rift graben, phreatomagmatic activity is asymmetrically concentrated along the SE margin. The SE limit of the eastern Eger Rift graben, the Ceske Stredohori Fault Zone, consists of several segments (fault fields) showing different tectonic patterns. The segmented generally known as the Straz Fault in the NE strikes NE–SW and is displaced by E–W-striking dextral strike-slip faults. The segment farther SW, the Ustek Fault s.l., consist of E–W-striking faults, left-laterally displaced by faults NNE–SSW and right-laterally displaced by faults NNW–SSE. These two segments of the SE graben margin are accompanied by phreatomagmatic volcanism, with the largest diatremes located at the intersections of the longitudinal faults with transverse faults (Srni, Brenna, Noviny, Straz). In the further SW course of the Ceske Stredohori Fault Zone (i.e. the Litochovice Fault and the Ohre Fault Field), diatremes are rare but probably follow hidden faults running oblique to the graben limits (Most-Bilina area). For instance, phreatomagmatic structures in the central Eger Rift, hidden beneath the sedimentary fill of the Tertiary Most Basin, have been well documented from several sites by coal-exploration drilling. Phonolitic breccias are much rarer than basaltic ones.

10 O *— 25/11.10–11.30*

Monogenetic and polygenetic activity as two end members of one general model: Towards a quantitative formulation of a volcanic system

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Although the lack of detailed information of individual volcanoes around the world prevents us from establishing a more quantitative model at present, when the available evidence is examined within the general framework of a volcanic system it is possible to identify the conditions upon which volcanic activity is either polygenetic or monogenetic. Based on this integral view of volcanism, it becomes apparent that the two main factors controlling the style of activity are (1) the characteristics of the zone of magma generation (in particular the interconnectivity of magma), and (2) the state of stress of the overlying rock (in particular its tensile strength). Based in specific combinations of these two factors, the end-member scenarios of a volcanic system can be envisaged. One of these scenarios typifies deep-rooted monogenetic volcanism whereas a second scenario typifies a polygenetic volcano in which monogenetic, parasitic volcanism may occur. Based in this model it is a simple task to explain the wide range of volumes that can be erupted by monogenetic vents, and the apparent similarity observed when comparing the characteristic periods of activity of polygenetic volcanoes and monogenetic fields. Consequently, our general model of volcanism not only provides a simpler qualitative explanation than previous models for these two contrasting styles of activity, but also provides explanations for other features of volcanism that were disregarded in many cases. Due to its predictive power, we therefore consider that a more quantitative model of volcanism will be easier to reach if future efforts aiming to gather detailed geochemical, chronological and structural information of individual volcanoes are guided by the blueprint provided by the model of volcanic systems.

1 O — 22/11.50–12.10

Evolution of maar volcanoes in Central Mexico

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Maar volcanoes in Central Mexico are concentrated in three main volcanic fields: San Luis Potosí, Valle de Santiago, and Serdán–Oriental. Each shows differences in their principal characteristics such as: tectonic environment, basement rocks, aquifer conditions, compositional diversity, abundance of xenoliths, magmatic chemical affinity, etc., which are somehow reflected in the nature of their respective deposits, their eruptive style and type of maar volcano. A comparison of these volcanic fields based on detailed stratigraphic investigations in the most representative maar craters indicate some similarities and differences regardless their geographic location. The San Luis Potosí field consists of isolated maar craters, which were built on highly deformed limestone rocks, and typically contain abundant xenoliths from the upper mantle. The Valle de Santiago field is part of the Michoacán–Guanajuato monogenetic field, whereas the Serdán-Oriental field formed on a lacustrine closed basin. Although the phreatomagmatic maar-forming activity occurred sometimes without any precursory activity, it is common to observe Hawaiian to Strombolian activity prior to the maar-forming explosions, but in an apparent transitional way, from dominantly effusive activity to dry and relatively weak explosive eruptions that finally varies to highly explosive and wetter eruptions. This was found in both fractured and granular aquifers, showing not relevant influence of the basement conditions. In contrast, some eruptive sequences indicate increasing dryer conditions ending with Strombolian activity, sometimes forming cinder cones inside the explosion craters. Most maars are basaltic and excavated a deep crater, in contrast with some rhyolitic maars that are shallower. In some cases, lateral depositional variations and distribution of internal vents indicate a relative migration of the eruptive focus along preferential orientations, which apparently follow the regional stress regime (NNW — SLP and Valle de Santiago; E–W — Serdán-Oriental). Different models of evolution are proposed due to the diversity of features exhibited by the maar volcanoes.

5 P — 22/17.00–18.00; 23/17.00–18.00

The Auckland Volcanic Field, New Zealand: insights from aeromagnetic data

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The Late Quaternary monogenetic Auckland Volcanic Field (AVF) consists of at least 49 distinct basaltic eruption centres, approximately one-third of which are maars. A wide variety of eruption styles is exhibited, with early tuff ring deposits associated with at least half of the volcanoes. Although ages are poorly known (ranging from 250 ky to recent), volcanic events appear to have become more frequent and larger with time. The volcanic centres are well exposed and hosted in sedimentary rocks, making geophysical methods ideal for investigating the subsurface structure of both individual volcanoes and any broader-scale subsurface features related to volcanic activity. High-resolution aeromagnetic data collected at 400 m elevation provide new insights into the eruption history of the AVF. These data reveal many volcanic features that are not evident from surface mapping, especially at maars where only tuff ring deposits are exposed. Some maars that appear similar at the surface have contrasting magnetic signatures which must reflect differences in the occurrence of sub-surface volcanic rocks. Significant subsurface basaltic bodies below such maars are interpreted either as ponding of lavas in early-formed explosion craters or as well-developed feeder systems. An unusual feature of the aeromagnetic data is the occurrence of anomalous negative anomalies at a number of geographically distinct volcanic centres which have recorded a geomagnetic excursion, and which give constraints on the relative timing of eruptions. There is no clear correlation between the occurrence of volcanic centres and the regional NW–SE and NE–SW trending basement structure defined by regional aeromagnetic data and geological mapping. The aeromagnetic data provide no evidence for subsurface dykes or other intrusive bodies either between or linking adjacent volcanoes.

3 P — 22/17.00–18.00; 23/17.00–18.00

Structural control of the Pali-Aike lavas and maars — Patagonia

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In southernmost South America, from 52°S to 50°S outcrops the Pali-Aike tectono-volcanic field, located in the Magellan Basin area, 300 kilometres east of the Andean volcanic front. These volcanics are part of a Pliocene– Holocene (3.8 to .01 My) back-arc volcanic field in a low convergence rate subduction zone. The volcanic outcrops, mostly basaltic and basanitic lava flows, scoria and ash cones and maars are oriented in a NW direction over an area of 50 by 150 km. An abundance of maars (~100) and their hyaloclastic tuff rings is observed in the area. The Pali-Aike volcanics lie on the Magellan Basin sedimentary sequence (~1500–8000 m thick) composed of Jurassic volcaniclastics, and Cretaceous and Palaeo-Oligocene marine sandstones and shales. After the Lower Miocene tectonic movements that uplifted the area, continental sandstones and tuffs of the Santa-Cruz Formation were unconformably deposited. Most of the volcanics lie on the Santa-Cruz Formation or on glaciofluvial gravels and conglomerates. West, east and south, the volcanics are flanked by till and glaciofluvial deposits and large moraine arches of different age (1.15–016 My). In Pali-Aike, two principal fracture systems of parallel or sub-parallel faults controlled the outpouring of the lavas and the close alignment of the scoria and ash cones and maars. Occasionally, some fractures are underlined by long linear depressions (15 km) due to the coalescence of several maars. The predominant fault system has a NW direction, followed by less frequent faults of E and ENE strike. The NW system coincides with an alignment of geothermal anomalies (<6 °C/100 m) and has developed approximately above an underlying Jurassic palaeo-rift zone. By reinterpretation of available seismic information, a close correspondence was established between the surficial tectonic structures, the hypabyssal bodies and the Jurassic basement (Bahia-Laura Group). The vertical development of these NW gravitational faults show that they were active during the Permo-Jurassic and remained active throughout the Cretaceous and Lower Tertiary, although with declining throws. Fault movement seem to stopped during the Tertiary. In the tectonic framework of Pali-Aike, given the absence of modern vertical throws detected in surface and underground, we suggest that the old NW fractures of the Jurassic rift were rejuvenated by strike-slip movements. The E and ENE structures are parallel or sub-parallel to the faults that channeled the large glacial valleys (e.g. Magellan Strait and the Skyring, Otway, Inutil and St. Sebastian Bays). During the Upper Tertiary, some authors consider that these structures were caused by a NW stretching, due to a new stress field in the southern flank of the Magellan Basin. The same origin can be invoked for the gravitational fractures of E and ENE direction in Pali-Aike. The geometric distribution of these two normal fracture systems, deployed at an horizontal angle of 60°, permits us to consider the existence of a conjugate fault system able to allow strike-slip, opening and closure movements depending on the applied stress field. This mechanism could account for the eruption of most of the magmatic gases and liquids and for its setting as aligned lava fields, scoria and ash cones and maars.

9 P — 24/17.00–18.00; 25/16.00–17.00

Volcanological sites of Balaton Uplands National Park as key points for a proposed geopark in Western Hungary

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Pyroclastic and effusive rocks, as well as a variety of geomorphic phenomena formed by the Late Miocene – Pliocene intracontinental alkaline basaltic volcanism rank among the most important natural and geomorphic values of Balaton Uplands National Park, founded in 1997. These volcanic rocks overlay the Permian–Triassic siliciclastic-carbonate units and they are commonly developed over Late Miocene siliciclastic successions with an erosional contact. During the volcanism maars, tuff rings, scoria cones and lava flows were formed. These volcanic landforms have been eroded in various degrees leaving behind a landscape where different volcanic facies of small-volume intracontinental volcanoes are exposed from deep diatreme root zones to gently modified lava flows.

Near-original landforms of lava (Fekete-hegy) and pyroclastic flows (Szentbékkálla), scoria cones (Bondoró) and maars (Tihany) can be recognized in the less eroded areas, while some diatreme remnants rise from the strongly eroded terrains (Kereki-domb). The well-known mesas of Balaton Uplands (Badacsony, Szent György-hegy, Csobánc etc.) belong to the latter landforms.

The volcanic rocks and landforms of basaltic volcanism, as well as their geological-geomorphic setting play an important role in formation of habitats, too. The abrupt difference between volcanic and non-volcanic rock units (siliciclastic and carbonate) such as steep slopes, rock cliffs, soil cover, water-saturation and wheatering lead to a development of characteristic changes in habitats commonly enhanced by microclimatic effects. These effects as well as the unique geological features must be considered as key point for future recultivation strategies implaced in land use management of abandoned quarries in the territory of the National Park. These features are presented in different ways. The geological demonstration site at Hegyestű was designed for the general public. There are some study trails with information boards for visitors. For those who have more profound knowledge, some geological excursion guides (in Hungarian and German) are available. For the professionals a geological map of Balaton Uplands (1:50 000) and its explanation booklet (in Hungarian and English) was published. Similar sites to Hegyestű are on the list to develop in strong cooperation between the National Park and the Geological Institute with support from local authorities.

7 P — 24/17.00–18.00; 25/16.00–17.00

3D architecture of a Pliocene maar volcano on the basis of drill core data and its implication for the syn-volcanic geomorphology, Pula Maar, western Pannonian Basin

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Pula is a Pliocene maar in the eastern part of the Bakony — Balaton Highland Volcanic Field. Upper Triassic carbonate succession (>1000 m thick) forms the basement of Pula. This unit is topped by a shallow marine to lacustrine siliciclastic succession (~300 m thick). Pula is sandwiched between two strike slip faults that were active during the syn-rift phase of the Pannonian Basin (18–11 My). A given reconstruction of the maar is based on the (1) reinterpretation of 40+ drills in the maar, (2) the GIS-assisted modeling of the maar and (3) the sedimentological study of the exposed sections. In the western Pannonian region, the Neogene shallow marine to lacustrine sedimentation ceased ~8 My and volcanism has started shortly after. The Neogene sediments have been preserved under basanitic lava near Pula (5.1 My). The Pula maar erupted through this landscape (~4.2 My). The twin-crater of Pula is elongated NE–SW. The larger crater is ~1000 m long and 600 m wide. This depression is filled with finely bedded (laminated) siliciclastic units. Along the proposed maar margin, tilted blocks of pyroclastic rocks have been identified and interpreted to be collapsed parts of the former tuff ring. The currently 260–270 m level is inferred to represent the palaeosurface on that the maar erupted. The thickness of maar crater deposits is about 130 m. Pyroclastic successions are preserved around the maar, and form the former tuff ring, that partly subsided to the maar. An eroded scoria cone is inferred in the maar, that is likely to be the source of lava sheet that is underlying the maar filling lacustrine units. The maar floor correlates well with the position of the Triassic succession suggesting that the magma–water interaction was fuelled by water from the contact of Neogene and Triassic units.

5 O — 23/15.00–15.20

Magnetic susceptibility logging in maar-diatrem volcanoes — what is it good for?

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The measurement of low-field magnetic susceptibility is a rapid, non-destructive method to quantify the contents of iron-bearing minerals. Therefore, magnetic susceptibility logging on drillcores or in boreholes is frequently applied as a routine method for getting continuous information on lithological variations. Especially for volcanic rock sequences with minor mineralogical or geochemical variations the determination of this rockphysical property has become a helpful tool for subdivision of larger rock units. This will be demonstrated for examples from several drilling projects in various volcanic settings, including the Messel maar-diatreme (Germany). The benefit of measurements on the temperature- , field- and frequency-dependence as well as of the anisotropy of magnetic susceptibility for lithological and structural characterisation and subdivision of volcanic units is also highlighted.

6 P — 24/17.00–18.00; 25/16.00–17.00

Dispersal dynamics from phreato-subplinian eruptions: The 1937 vulcan eruption, Rabaul caldera, Papua New Guinea

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The 1937 phreato-subplinian Rabaul eruption, which built a tuff cone, is one of the 10 worst volcanic disasters since Krakatau. It had not been studied in detail. 40 outcrops were visited in 1985 (GPLW). Thickness was measured, samples gransize-analysed. Observations from 1937 have been reanalysed. Water–magma interactions produced mainly fine ash at the vulcan vent, windblown to W/WNW The dispersal pattern is near-identical to that of the 1994 vulcan eruption during which an 16–20km high, ice-rich, bent-over eruption column depositing abundant mud-rain was observed from space. 1937 and 1994 eruptions have highly similar thickness decay rates (among steepest on record). Ice-coated ash particles/aggregates are much larger; premature fallout explains the steep decay rate. The 1937 trend displays a break-in-slope confirming Ht ~15–20km. Both eruptions produced damaging mud flows and deep gullies from wholesale column collapse at eruption switchoff. Some 1937 accounts contain evidence for hazardous volcanogenic tornadoes generated by a bifurcating, bent-over eruption column. Grainsize analyses are very similar in the fine grainsizes indicating an ashcloud flushing process dominated dispersal. The eruption was also accompanied by the fiercest electrical storm ever reported in the area. Only the coarse-tail grainsizes are locally variable. This indicates alternance between wet subplinian and dry strombolian fragmentation, from rapidly alternating ingression and outflux of external water into the vent. Generally, it emerges that phreato-subplinian eruptions have much more in common with severe thunderstorms than previously recognised: they generate water and ice-rich updrafts (leading to premature fallout), form (ash-filled) hailstones and (mud)rain, produce brief intense flashfloods (at switchoff) and deep gullying, are associated with fiercest lightning and hazardous tornadoes. This is an end-member case where an eruption generates its own severe weather, which in turn controls ash dispersal and hazards.

This paper is dedicated to our dear friend and father of modern volcanology, George Walker, who pioneered and continuously inspired our science for over 4 decades. George recently took ill and is now recovering. Best wishes of recovery George!

6 O — 24/9.20–9.40

Accretionary lapilli and water-rich eruption columns: new data and insights

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When ascending magma encounters an aquifer or external surface water body, a water-rich eruption column is often produced in which ash particles, condensing water droplets, and ultimately ice particles can interact in a complex way and produce a variety of mixed-phase dense aggregates containing ash. Accretionary lapilli (acc-laps) are commonly found in airfall tuffs from such water-rich eruption columns. Yet, the role of water and ice in the formation of acc-laps has not been systematically studied. Laboratory experiments attempting to produce them have provided valuable insights but failed to produce ash balls. We examined acc-laps from airfall tuffs in the field and in the lab, described their shapes, aspect ratios and previously unreported knobbly features on their outside surfaces, determined their size distributions and that of the constituent particles, reevaluated their texture under the SEM and drew insights from the comparison between severe thunderstorms and hailstones, and water-rich eruption columns and acc-laps. All qualitative (e.g. presence of air bubble layers; acc-laps' shapes) and quantitative constraints (e.g. the size distribution of these air bubbles; the acc-laps' aspect ratio values) demonstrate that acc-laps form in a similar way to hailstones with few differences including that the water-drops that coalesce to form larger drops are charged with ash, that the proportion of cloud supercooled water is likely to be less than in thunderstorms and that the maximum size that can be reached in an eruption column is less than in a severe storm. Apart from those differences, there are mostly similitudes indicating that acc-laps are volcanogenic hailstones. In addition to providing constraints on eruption column dynamics, one immediate application is for volcanic hazard assessment: acc-laps' maximum sizes in a sequence of tuff layers can provide information on eruption column height and its variation from one layer to the next.

***9 O** — 25/9.20–9.40*

The ontogeny of the Messel maar — a topic of interest for geotourism and recent research

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The maar basin of Messel 30 km south of Frankfurt is one of the most important fossil sites of Eocene age and a UNESCO world heritage site. The heritage status, an origin as volcano, extraordinary fossil remains as well as an eventfull history and its position in the crowded Rhein-Main area make Messel an attractive place to present geosciencifiic topics to a broader public.

Public interest was already one of the main reasons to prevent Messel from a fate as waste disposal and accompanies the scientific work for about thirty years now. Therefore a long tradition of interaction between public and geoscientists exists at this place. Guided tours for groups upon request were the main offers that have been provided so far. The tours were carried out by a country museum with honorary guides and by the research institutes working on Messel. Although very successfull, the kind of public work done so far has abundant shortcomings. Especially for pupils and families or single persons almost no visiting facilities exist and the information provided at a viewpoint is not sufficient. As a consequence a visitors centre is in preparation now. At the moment the scientific fundamentals for the visitors centre, with emphasis on recent scientific work, are prepared by geoscientists.

The presentation shows the origin and "ontogeny" of the Messel maar basin as an example for the scientific base, provided for various purposes like animated films, posters, among others. Main goal is to ilustrate important processes that characterise the individual developement of the Messel Basin. For this purpose 25 figures were drawn and short explanations added. For presentation in the visitors centre the they still have to be fit to the concept by a graphic.

The demand of scientific accuracy posed several problems for drawing the figures. One of them is the scale of the various processes. The eruption cloud for example can have a height of several kilometres, whereas the root zone is situated about 2 kilometres below surface. In contrast even rock fragments of up to 4 m in diameter are extremly small. As a consequence the figures represent a compromise between representability and scientific corectness and they are highly generalised. A second important problem concerns the scientific base, since recent research modifies the basin model continuously. For this reason the figures have to be actualised by the scientists within relativly short time spans. A continuous actualisation of the drawings is expensive but can rise the attraction of the visitors centre for the local population in keeping people curious by often providing new information. It also helps to involve the public in the process of scientific research, which — as our experiences proves — is higly attractive, since it makes scientific work better understandable. The drawing process itself revealed a variety of problems with the existing models of the maar and its surrounding. It is therefore also of scientific interest.

***7 P** — 24/17.00–18.00; 25/16.00–17.00*

δ^{13}C- and δ^{18}O-values of siderite — a tool for the reconstruction of mixis in ancient lakes

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Authigenic siderite is abundant in Palaeogene maar lake deposits of central Europe. This siderite is mainly restricted to oil shale and always of early diagenetic origin. It has probably precipitated in a depth from directly to several centimetres below the sediment water interface. Nevertheless, with a combination of δ^{13}C- and δ^{18}O-values, duration and frequency of mixing events effecting the complete water column can be reconstructed. At least three mixing types could be distinguished between the fossil lakes.

1. In shallow, open lakes and swamps experiencing frequent mixing of the complete water column (polymictic), siderite has intermediate to low δ^{13}C-values (–5 to +10‰). Due to a high water exchange rate the δ^{18}O-values are low and in a narrow range (–2,4 to –1,2‰). As a consequence the δ^{18}O-values could be used to recalculate a water composition that nearly represents riverine and precipitation imput.

Polymixis is assumed for lake "Prinz von Hessen" where the presence of coal points to an open system as well.

2. Siderite of meromictic lakes has high δ^{13}C- (+6 to + 20‰) and δ^{18}O- (0 to +5 ‰) values. In some cases, a faint covariance was observed. It is very likely that the high δ^{18}O-values are caused by a kind of hydrologycal closure of the stagnant monimolimnion. High to very high δ^{13}C-values result from the imput of abundant organic matter which favours methanogenesis, causing δ^{13}C-values up to +20 ‰. It is supposed that the covariance might result from variations in the size of the monimolimnion. The reason is, that the residence times of water and CO_2 are high in a large monimolimnion resulting in a significant rise of CO_2-partial. We suggest that one consequence of this is the formation of soluble $Fe(CO_3)_2$-complexes, which have to be decomposed by CO_2 removal, before siderite precipitation can start. This removal usually takes place via methanogenic CO_2-reduction, a process favouring δ^{13}C-values higher than +15‰, whereas other methanogenic processes produce values hardly exceeding +15‰.

Meromixis was reconstructed for the deep and large maar lakes of Enspel, Messel and Baruth.

3. In lakes with changing mixis frequency and duration, the δ^{13}C- and δ^{18}O-values of siderite are highly variable. Short mixis (days) compared to stagnant phases (months to years) are characterised by low δ^{18}O-values, due to the "frequent" imput of fresh water. The δ^{13}C-values remain high because mixing events are too short to significantly influence methanogenesis. If mixis oxygenises the sediment water-interface more often or for longer time periods, a rising influence of sulfate reduction and methane oxidation in the zone of siderite precipitation can cause intermediate to very low δ^{13}C-values (–20‰).

Eckfeld, an intermediate size maar lake, not as deep as the large ones shows changing mixis (mero- to maybe polymictic). Lake level fluctuations, that are also assumed from the fossil record, have probably caused variations in the depth of mixing.

7 P — 24/17.00–18.00; 25/16.00–17.00

Sideritic biolaminates in the oil shale of Palaeogene maar lakes

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Authigenic siderite is abundant in the oil shale of various maar lakes and mainly forms laminae to lenses strictly conformable to sediment lamination. Nodular shaped siderite is present as well but restricted to resediments and the vicinity of fossil remains. Whereas nodular shaped siderite was clearly regarded as diagenetic product, most previous workers supposed the laminae to have resulted from water column precipitation. Our presentation is based on a detailed siderite study, using petrographical and geochemical methods as well as a literarature revue and provides the first detailed model for the formation of siderite laminae in the Palaeogene maar lakes of Central Europe.

A line of evidence like the replacing growth of siderite-crystals, the formation of aggregates, intergrowth with microfossils and crystal zonation proves, that the siderte is a product of diagenesis. The missing compaction of microfossils within siderite laminae indicates, that their formation was a precompactional, very early diagenetic process.

In all investigated lakes the sediment is rich in organic matter. Therefore abundant CO_2 must have been produced by microbial degradation and in consequence always have been present in sufficient amounts for siderite precipitation. The suggestion that Fe was the limiting element and had to be introduced to the lakes from their surrounding is supported by the fact, that siderite lamiae often either cover turbiditic resediments or are present in land plant rich sublaminae. The fact that the settling velocity of Fe-bearing particles is often much greater than the reduction rate explains why siderite preciptiated in the sediment and not in the water column.

A line of evidence, like high (up to +20‰), methanogenic δ^{13}C-values, siderite aggregates with an oval central cavity about 3–4 mm in diametre and the shape of the lamine itself point to a microbial origin, which explains the stromatolite like shape of abundant of siderite laminae. Another argument for precipitation within microbial mats is the missing cement between single siderite crystal aggregates which cannot explain the mechanic properties of the laminae. It is assumed, that EPS has been present at the time of siderite formation and been decomposed very soon after the death of the microbial mat. Dead bacteria rather than living ones serve as nucleus for authigenic minerals, since mineralisation of living bacteria would probably result in problems with cell metabolism. It is assumed that the siderite genesis took place in the zone of highest microbial activity, possibly when some of the bacteria of the mat died since the nutrients they need were exhausted, while other bacteria in the mat were still alive. The microbes probably lived at and dierctly beneath the sediment.water interface.

The lateral extent of a microbial mat reflects the nutrient distribution on the lake floor and therefore also the sediment texture. When sufficient Fe^{2+} and HCO^{3-}-ions were present, siderite laminae and lenses could form.

7 P — 24/17.00–18.00; 25/16.00–17.00

Lake Messel: The imprint of the basin origin on the sedimentary and fossil record

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Oil shale bearing maar deposits are among the most important Palaeogene, lacustrine fossil sites of Central Europe. Eocene lake Messel is even a UNESCO world heritage site. Apart from geological work for industrial purposes the research on Messel concentrated on the extraordinary fossil record until about 1990. Only within the last two decades geological and geophysical methods came into the scientific focus. As a result an excellent data basis for the reconstruction of the former maar lake exists now.

For several decades the origin of lake messel was intensly discussed. A majority of authors favoured a tectonic origin of the basin, whereas only a minority regarded a volcanic genesis as more likely. With a combination of geophysical, geological and palaeontological methods it is now possible to provide a largly consistent model of the lake basin and its origin. The presented model is based on a literature review (a list is available on request) in combination with our own results.

The first hints to the volcanic origin of the lake basin were provided by geophysical investigations, because maars with a sedimentary basin fill are often characterised by a negative gravimetric anomaly, which is accompanied by a magnetic anomaly. Additional seismic investigations proved that a variety of intrabasinal faults, which had been interpreted from old wells, do not exist. The reinterpretation of the about 900 wells showed that instead coarse clastics interlock with the oil shale, especially near the basin margins. The description of new, marginal drill cores provided abundant lapilli in the debritic resedients. An external source for the lapilli could not be excluded at the beginning, since a variety of basaltic cinder cones are situated in close vicinity. Only a 433 m deep drilling, sunk in 2001, penetrated the sedimentary basin fill as well as a phreatomagmatic lapillituff of more than 100 m thickness and reached a diatreme breccia. These deposits clearly proved the phreatomagmatic origin of the lake basin.

The maar origin determined the lake morphology in leaving a small and deep basin, rimmed by a crater wall during most of the lake history. Knowing this, a variety of phenomena concerning sedimentary and fossil record could be explained much better than before. These are for example:

— The finely laminated oil shales represents a lake history of up to more than one million years with a low and very continuous sedimentation rate. No sign for a significant riverine input exists.

— Large fossils, with the exception of crocodiles that lived in the lake, are missing. This points to the absence of stronger intrabasinal currents, so only small corpses could be transported.

— Plants representing lake shore or shallow water vegetation, as well as animals of these realms, are rare in the fossil record and were probably restricted to small deltas or the narrow lake margins.

7 P — 24/17.00–18.00; 25/16.00–17.00

Extra-Andean crater lakes from southern Patagonia, Argentina — actuo-limnology and palaeoclimate reconstruction

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Crater lake sediments from the extra-Andean Pali Aike and Pampa Alta volcanic fields of southern Patagonia, Argentina represent an excellent archive for the reconstruction of palaeoclimatic and palaeoenvironmental changes at higher latitudes of the southern hemisphere, a key region for the understanding of the global climate system. Interdisciplinary high-resolution multi-proxy studies were carried out on sediment cores from Laguna Azul, Laguna

Potrok Aike and Laguna Cháltel. While the latter two are typical maar lakes, Laguna Azul exhibits a more complex eruptive history with a conspicuous lava lake phase. Detailed actuo-limnological studies on the lake's physico-chemical properties, biology and sedimentology help to obtain a better understanding of the lake system and thereby improve the interpretation of the proxy-data. Although located within the same steppe environment, Laguna Azul and Laguna Potrok Aike feature very different depositional environments. Water temperature profiles reveal that the 56 m deep Laguna Azul displays a stratified water body during austral summers, while the 100 m deep Laguna Potrok Aike is entirely mixed during the whole year. The absence of any stratification can be explained by the size of the lake (Ř: 3470 m) in combination with the exposure to extremely strong westerly winds. Only in the exceptional wind-poor austral summer of 2004 several short intervals with weak stratification were observed. Laguna Azul is more wind-protected due to higher crater walls and the smaller size of the lake (Ř: 560 m). The organogenic sediments of Laguna Azul predominantly consist of diatomaceous ooze and organic matter. The absence of any inflow and a very small catchment area impede a higher contribution of clastic input. In contrast, at Laguna Potrok Aike pronounced gully erosion and a large catchment provide mainly minerogenic sediments. Climatically induced autochthonous calcite precipitation yields a highly sensitive record of the regional water balance and of lake level changes.

8 O — 24/14.30–14.50

Submarine volcanism in Oas-Gutai Mts, Eastern Carpathians, Romania

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Oas-Gutai Mts are part of the inner volcanic chain of Eastern Carpathians. Their volcanic evolution is directly connected to the Miocene tectonics of the Carpatho–Pannonian Region. Two types of volcanism developed in Oas-Gutai Mts: a felsic type of explosive origin and an intermediate one of both effusive and explosive origin and intrusive as well.

The intermediate volcanism represents the main phase of the volcanic activity, responsible for most of the outcropping volcanic structures of both Oas and Gutai Mts. It had developed between 12.0–9.5 My in Oas Mts. and 13.4–7.0 My in Gutai Mts, respectively. In Oas Mts, it had been connected to a major dome-building phase developed in submarine setting. Domes, dome-coulees and complexes of domes, mostly composed of acidic volcanics are typical for Oas Mts. In Gutai Mts, the intermediate volcanism had a complex evolution. Volcanic structures are less obvious and difficult to reconstruct because of the active syn- and postvolcanic erosion and tectonics. However, extrusive domes and fissure-fed lavas evolved subaqueously, at least in the southern part of the mountains, filling the deep subsident graben controlled by the E–W transcrustal fault Carlibaba–Carei.

The submarine evolution of volcanism in Oas and Gutai Mts is proved by typical volcaniclastic deposits and spatial interconnections with marine sediments. Both lava flows and domes are laterally connected with in situ hyaloclastites sometimes transformed to further emplaced mass flow resedimented hyaloclastic breccias. Volcaniclastic debris flow deposits have frequently been identified in the geological record. They suggest the submarine sin- or postvolcanic gravity driven failure of lavas and form thick and coarse breccias in proximal facies, distally evolving into different mass flow volcaniclastics. Such submarine erosional processes involved more or less explosive events. The sudden release of volatiles gave rise to minor pyroclastic products, pumice or crystal rich deposits; a stronger explosive interaction between hot lava and cold water seem to had been responsible for some phreatomagmatic deposits. Unfortunately they have been identified only as components of the debris flows or as thin layers containing accretionary lapilli, most of them reworked; they suggest rootless explosions rather than major hydrovolcanic events.

All these combined processes, the quench fragmentation, submarine lava failure and associated phreatomagmatic explosions are reflected by the components of the different mass flow volcaniclastics. They form thick sequences interlayered with sedimentary deposits filling extensive and deep volcano-tectonic depressions maintained by active subsidence.

Besides the previously mentioned products, the mineralized structures from Oas and Gutai Mts show some evidences of phreatomagmatic explosions: breccia veinlets, breccia dykes and breccia pipes have been identified in many ore deposits. They suggest the interaction between hot rising magma and subsurface or surface water or waterlogged sediments. The epithermal systems were "opened" during ore formation controlled by tectonic and volcanic events (such as those triggered by the Carlibaba–Carei strike slip fault in the southern part of Gutai Mts) involving subaqueous environment.

7 O — 24/10.30–10.50

Environmental and depositional history of Late Oligocene maar lake Enspel (Westerwald, Germany) via geochemical and mineralogical sediment analysis

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During the Upper Oligocene, intense volcanic activity in the Westerwald area formed a maar crater under subtropical climate conditions. The crater was filled up with sediments and the lake succession was terminated after approx. 100–300 ky by a basaltic flow, which flowed into the lake basin and preserved the sediments and organic matter from degradation. In 1996 a research well was drilled in the geophysically predicted lake centre. This well recovered a lake sequence of about 140 m of sediments. The sediment sequence consists of organic-rich, partly laminated black pelites interbedded with clastic redeposition sections (slumps) and volcanic layers. The high amount of redepositional layers indicates a deep lake basin with steep slopes, surrounded by ring walls of tuffites. This morphology prevented the ventilation of the lake. The water column was permanently stratified (meromictic) and the hypolimnion was mainly anoxic. Short-time variations in the redox conditions only occurred by redepositional processes. About 76 samples were analysed in sections with cycles of black pelites, but also in some transitions from volcaniclastics to black pelites. Geochemical and mineralogical methods provide a division of the environmental history of the palaeo-lake Enspel into five phases. In general, the sediments show the interplay between productivity, redox conditions, siliciclastic and volcaniclastic input. The clastic input is dominated by volcanic material, which is indicated by high feldspar, amphibole and smectite contents. The supply of the Devonian hinterland is characterized by quartz, illite, and kaolinite and is probably connected with heavy rainfall events. These events caused variations in the redox conditions of the hypolimnion and influenced the pyrite and siderite formation. The occurrence of opal is correlated to diatom-rich layers. Algal blooms mainly occurred after volcanic events, which resulted an increase in nutrient supply. The observed mineralogical trends are also confirmed by the geochemical composition of the sediments.

9 P — 24/17.00–18.00; 25/16.00–17.00

Nature protection and tourism propagation in the Cerová vrchovina Highland

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The Cerová vrchovina Highland extends next to the Hungarian border south of the Lučenec and Rimava Tertiary Basins. The highland has been formed by Pliocene–Quaternary uplift contemporaneous with alkali basalt volcanism. Rolling hills and broad valleys are modelled in a complex of the Early Miocene sandstones and siltstones, while highest ridges are capped by basalt lava flows and scoria cones. Erosion of the uplifted area has exposed maars, diatremes and necks. Thanks to the natural beaty, peculiar fauna and flora as well as preserved volcanic phenomena the Cerová vrchovina Highland has been given in the year 1989 the status of the Natural Protected Area (NPA). Since that time the NPA Headquaters in Rimavská Sobota take care of conservation and overlook economic activities in the Area. Their aim is to protect both, living as well as nonliving parts of the Nature. From 35 natural reserves in the area 13 are devoted to geological phenomena. These include stratotypes and sections of the Early Miocene sedimentary succession, the famous Bone Gorge near Hajnáčka with bones of mamals in maar sediments, diatremes Šurica, Hajnáčka and Šomoška, tuff cone in Fiľakovo and lava flows of the Mačacia plateau. Other geological localities will be included in the near future. Natural protection and protection of geological localities involves an interaction with mining activities – some of the best geological exposures are abandoned as well as active basalt quaries. To help management of the NPA a comprehensive database of natural phenomena and economic activities is in preparation. Promotion of tourism in the NPA is one othe ways how to help the local economy. Geological Survey of Slovak Republic has compiled and published a geoturistic map of the area. Hedquaters of the NPA are active in building educational trails. The ones at Šomoška and Fiľakovo Castle are in operation, other ones are in preparation.

5 P — 22/17.00–18.00, 23/17.00–18.00

Geophysical investigations of a Tertiary maar near Bayerhof (Bavaria/Germany)

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In autumn 2000 the 178 m deep research borehole Bayerhof (Bavaria/Germany) revealed a unique sediment profile for the north-eastern part of Bavaria. The drilled lacustrine sediments and volcanoclasts gave hint to a maar structure. The phreatomagmatic explosion took place between 23.3 and 21.7 million years ago, as known from K-Ar dating of cored volcanic tuff-breccia and two basalt occurrences in the vicinity of the drill site.

A gravity survey in the surrounding of the drill site revealed a negative Bouguer anomaly of 3.5 mGal within a strong regional gradient. The half-width of the gravity anomaly of 430 m gives a maximum depth of the expected lacustrine maar sediments of about 215 m by approximating the maar by a vertical cylinder. This is close to the known depth of the lacustrine sediments of 157 m. Furthermore, from the observed gravity the diametre of the maar can be estimated to be 450 m.

From an earlier 3-D seismic survey in the surrounding of the continental deep drilling "KTB" data sets of thickness and seismic velocities of the weathering layer were extracted. An area of low seismic velocities (1900 m/s) indicating a sedimentary deposit of 160 m coincides with the observed gravity low near Bayerhof.

Downhole logging in the Bayerhof research borehole confirms the lithostratigraphical and structural division into peat, brown coal, and laminated lacustrine sediments of this Tertiary sequence. The lacustrine sediments have low densities (1.3 g/cm^3), low magnetic susceptibility (0.0002 SI) and low seismic velocities (1600 m/s). All these values are typical for maar sediments known from other sites.

5 O — 23/15.20–15.40

Interpretation of the potential field anomalies above the maars of Baruth (Saxony/Germany) and Messel Pit (Hesse/Germany)

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In the vicinity of Baruth (Saxony/Germany) a detailed gravity survey was carried out to determine the depocentre of the lacustrine sediments in an assumed maar. A nearly circular Bouguer anomaly of about –6.6 mGal with a diametre of approximately 1100 m was observed. From the half-width of the gravity anomaly a maximum depth of the expected lacustrine maar sediments of 400 m is obtained by approximating the maar by a vertical cylinder. Magnetic measurements revealed a positive anomaly with an amplitude of 320 nT, its diametre is about 600 m. The centre of the magnetic anomaly does not coincide with the gravity low but is situated about 500 m to the south.

Within the Messel Pit (Hesse/Germany, UNESCO world heritage site) — an abandoned open cast mining — also local gravity and magnetic surveys were carried out. The residual gravity anomaly is about –7 mGal and has an elliptical shape; its diametre is about 1500 m in north–south direction and 1100 m in east–west direction. After removing spurious data due to industry, the resulting magnetic anomaly is nearly circular with a diametre of 1000 m and an amplitude of about –320 nT. The centre of the magnetic anomaly is located about 200 m south of the centre of the residual gravity field.

The locations of the absolute gravity minimum at both sides were chosen for a drilling site. In combination with seismic surveys, logging data and rock magnetic investigations the gravity and magnetic anomalies from both areas can be interpreted by 3-D forward modelling, giving a high resolution image of the maar structures. Especially gravimetric models enable the estimation of volumes and masses of the different lithologies. Unambiguous information concerning the structure and density of the diatremes can not be derived by the potential field data.

1 P — 22/17.00–18.00; 23/17.00–18.00

The Quaternary tephra-tuff deposit of Mýtina (southern rim of the western Eger Graben/Czech Republic): Indications for eruption and deformation processes

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The profile (approximately 4 m thick) of an excavation of volcaniclastic deposits near Mýtina (southern edge of the western Eger Graben/Czech Republic) was studied. It consists of clayey material (weathered bedrock) at the base, tuff (lower unit with three sequences: UFa, UFb, UFc) and overlying tephra (upper unit, three sequences: OFa, OFb, OFc). The tuff is well stratified with average layer thickness of 1–3 cm. The middle part of the lower unit (UFb) contains a lot of bedrock fragments with a maximum dimension of 60×40×40 cm. The lowermost part of the tephra (OFa) shows cross-bedding. Stratigraphy, composition and textural features of the tuff-tephra deposit are typical indications for deposits at the rim of maar volcanoes. The scoria cone of Železná Hůrka — about 1.5 km to the south — is the only known nearby Quaternary volcanic vent. Up to now it is not clear, if the pyroclastic deposits near Mýtina and west of Železná Hůrka were erupted from an initial maar beneath the scoria cone. Probably the volcanic vent coincides with a topographical depression (diametre cca. 500 m, depth cca. 50 m) northwest of Železná Hůrka. To answer this question further geological and geophysical investigations are necessary.

The strongly preferred orientation of two joint-directions within the tuff correlates with neighbouring regional faults and implies an initiation of the joints by vibrations along these faults, which have transferred the pulses into the tuff-tephra-cover. Due to this trigger-mechanism small joints of dm- to m-scale were formed. The fractographic features of the joint surfaces (cyclic arrest lines) support this assumption. The most common trigger-source are seismic waves which originate probably from volcanic earthquakes (palaeo-swarm earthquakes).

1 P — 22/17.00–18.00; 23/17.00–18.00

Seismic and petrological studies of the crust and uppermost mantle beneath the earthquake swarm region Vogtland/NW Bohemia

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The Vogtland/NW-Bohemian area is well-known for its occurrence of intraplate earthquake swarms which are normally associated with volcanic activity. Two scoria cones in the western Eger rift are the evidence of Quaternary volcanic activity in the region, however recently active CO_2 emissions in mofettes and springs point to ongoing magmatic activity in the lower crust and upper mantle. In this contribution we want to combine results from different seismic methods (receiver functions, reflection seismology) and studies on xenoliths from a tephra deposit near the Eisenbühl/Železná Hůrka scoria cone. This deposit is the only known "Quaternary outcrop" of lower crust and upper mantle rocks within 250 km radius. Upper mantle xenoliths are dominated by wehrlites, clinopyroxenites and hornblendites, latter possibly representing cumulates of the host melt (melanephelinite). Further, the deposit contains a lot of olivine, clinopyroxene, amphibole and phlogopite megacrysts. Crustal xenoliths are dominated by rock types similar to crystalline country rock in the surrounding (quartzites, phyllites, mica schists), only sparse lower crust samples could be found up to now.

Seismic studies show an anomalous crust-mantle boundary (Moho), indications for a seismic discontinuity at 50–60 km depth and several reflectors within the uppermost mantle beneath the CO_2 degassing field. Preliminary p-T results from electron microprobe investigations indicate the depth origin of mafic-ultramafic xenoliths within the lower crust and uppermost mantle.

1 O — 22/11.30–11.50

An example to Quaternary maar volcanism in Cappadocian Volcanic Province: Cora Maar, Central Anatolia, Turkey

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This study presents the preliminary results of an ongoing research project on Cora Maar, a Quaternary volcano located to the 35 km north-west of Erciyes Mountain in Cappadocian Volcanic Province, Turkey. Cora crater is 100 m deep, has a diametre of cca. 1200 m, and was excavated within the andesitic lava flows. Base surge tephra is approximately 40 m thick, and not indurated. Base surge layers display well-developed antidune structures indicating the direction of the transport. Bomb sags and channel structures are also common, and in some cases channels are filled by lithic and juvenile clasts. Ejecta from the Cora crater comprise juvenile (scoria) and lithic clasts, and ash-lapilli size tephra. The size of average maximum scoria clasts ranges from 1.3 to 17.0 cm, while this range is 7.0–55.0 cm for the lithic clasts. Lithic clasts are generally volcanic in origin, and may reach up to 1.0 m in diametre. Some cauliflower scoria bombs contain lithic inclusions. Another important feature of the Cora Maar tephra is the widespread occurrence of accretionary lapilli, up to 2 cm in diametre.

Petrographic studies reveal that both the scoria and the lithic clasts have a similar mineralogical composition, namely olivine+pyroxene+plagioclase+hornblend. Disequilibrium textures are common to both groups, such as sieved plagioclase; skeletal olivine; embayed pyroxene; and reaction rims on hornblend crystals.

Unlike many other maar deposits in the literature, Cora Maar tephra is calc-alkaline in nature. Scoria clasts are basaltic andesitic, and lithic clasts are dacitic in composition.

4 P — 22/17.10–18.00; 23/17.00–18.00

Boron concentration in different maar-diatreme volcanic environments

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Mio/Pliocene alkaline volcanic rocks occur in a post-extension, intra-plate environment in the Bakony-Balaton Highland Volcanic Field (BBHVF). Phreatomagmatic to magmatic eruptions of basaltic magma resulted in various volcanic forms, including maars, tuff rings, cinder cones, and shield volcanoes, when the rising magma interacted with variable amounts of external water. Volatile content, magma composition, and the degree of magma/water interaction are the main parametres that control changes in the eruption style which result in the different volcanic forms. The origin of the magmatic volatiles can be determined using B concentrations. Boron, a fluid-mobile, incompatible element, is enriched in subduction-related volcanic rocks (~35 µg/g) [compared to the mantle (0.1 µg/g)] originating from the subducted oceanic slab and sediments (80–120 µg/g). Most of the B leaves the slab during metamorphic dehydration, although it is partly recycled into the mantle with other fluid-mobile elements. These volatiles reduce the melting point of the minerals, initiating partial melting. Depending on the B content of ground waters and on the interaction with the arising melts, B can leave or enter the magma.

We report the first B concentration data (by PGAA) of volcanic rocks from phreatomagmatic volcanoes of the BBHVF. These data provide information about the magmatic source for these volcanoes and the relationship between B content and maar settings. The data are compared with the B content of other geographically distinct maar volcanic rocks (New Zealand/Waipiata, Otago and Mexico/Pinacate, Sonora). B concentration is above 6 µg/g at the BBHVF whereas it is below 5 µg/g in the other areas. We conclude that the alkaline, under-plated basaltic melts of the BBHVF are relatively enriched with mobile, incompatible elements showing a subduction fingerprint. In addition, ground water is not significantly influencing the B content of the volcanic rocks.

7 O — 24/10.50–11.10

Crater lake sediments in the Pliocene Pula maar (Western Hungary)

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Pula maar forms a distinct depression with a thick lacustrine sedimentary infill, a crater rim remnant of phreatomagmatic pyroclastic units and reworked coarse-grained volcaniclastic units. The pyroclastic successions are rich in fragments from Triassic formations (± carbonate matrix/cement) indicating that the explosion locus was as deep as the Triassic units. The karst-water from the Triassic formations is inferred to have been the major source to fuel the magma/water interaction after exhausting the water source from the Neogene porous media aquifers topping the limestone. In the Pula maar the central facies of maar lake sediments is exposed in an open cast mine. These sediments, a so called "*alginite*", are exploited for amelioration of soils. The *alginite* is composed of clay minerals, calcium carbonate crystals, phosphate crystals, diatom frustels, *Botryococcus* colonies, pollen grains, plant detritus, charcoal fragments etc. The exposed section corresponds with the upper part of lake deposits known from other former maar lakes. Due to the lack of a prominent relief – the tephra ring wall was stabilized at this stage – the sediment is mainly autochthonous in origin, but the amount per year is very low (starving sedimentation). Excellent lamination without any disturbance would be typical for upper maar lake sediments together with siderite layers fitting into the lamination. Both features are missing in the Pula *alginite*. Therefore we suggest that the Pula maar lake had not developed a meromictic division of the water body during the deposition of the presently exposed *alginite*.

Event layers, which dominate the first stage of the maar lake development, are rare and very thin in the upper maar lake sediments. Only one prominent layer in the middle of the exposed *alginite* section disturbs the quite sedimention in Pula. This 6 cm thick event layer is composed of many thin turbidites rich in tephritic volcanic glass shards and one last striking turbidite. The load of this last turbidite generated dewatering of the previous sediments and sand volcanoes on the sediment surface. The resulting structures are very impressive in cross section and originate from different levels.

5 P — 22/17.00–18.00; 23/17.00–18.00

Geophysical, geomorphological, and lithological implications for a special type of phreatomagmatic volcanoes

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In the Quaternary Westeifel Volcanic Field several percent of the approximately 270 eruptive centres consists of so-called scoria rings. Scoria rings are maar-like volcanoes characterized by an intense scoria production during the final phases of eruptive activity. The scoria production causes the filling of the maar crater, and are deposited on the ring wall which consists of maar pyroclastics. In 2000 to 2003 we carried out a geophysical survey for the investigation of the architecture of small volcanological aquifers in order to identify the underground cachtment areas. Succesful volcanological aquifers are those volcanoes which show productive phreatomagmatic phases during their eruptive history. They are characterized by a large crater and a underlying diatreme.

The first case study "Geißhecke" show a circular strong positive magnetic anomaly sourrounded by very high magnetic anomalies with small extents. The central anomaly indicates a large scoria cone as the result of a final scoria eruptive phase after the initial intense phreatomagmatic phase similar to the scoria ring volcano type. The small anomalies indicate small scoria cones and/or dykes cut in the initial phreatomagmatic tephra and partly also the scoriaceous beds. The second case study „Eselsberg" represents a similar feature. Only the eruptive history is different. So we find a thick phreatomagmatic sequence, interrupted by several small scoriaceous phases. At the end of this eruptive cycle a strong scoriaceous phase took place followed by a strong final phreatomagmatic phase. The third case study "Ringseitert" represents probably the biggest volcano in the Westeifel Volcanic Field. The formation of the central volcano is similar to a scoria ring. Small and big scoria cones surround the structure.

Till now maar formation interrupted by small scoriaceous phases and/or a relatively strong final phase such as scoria rings are well-known. In the case of the investigated locations, we found complex volcanoes with a big central crater surrounded in a ring-like fashion by scoria cones and/or dykes. During our presentation we will decribe this type of volcanoes in detail and we will introduce a classification.

7 P — 24/17.00–18.00; 25/16.00–17.00

Ostracods of the Eocene maar lakes Eckfeld and Grube Messel — Palaeontological implications

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The Middle Eocene maar lakes Messel and Eckfeld show a comparable topography and an analog hydrology at least in the early lake development: a small catchment area, meromixis, and connexion with little bodies of flowing water. Despite of the age differences, the cover vegetation was covered by zonal elements and shows numerous accordances.

In the laminated maar lake deposits of the Eckfeld Maar (Volcanic field of the Tertiary Hocheifel) and the Messel Pit (Volcanic Field of the Sprendlinger Horst) ostracods are found. At Eckfeld Maar, five ostracod taxa described, at the Messel Pit so far only one taxon of uncertain stratigraphic correlation is found. More than 90% of the ostracods of Eckfeld belong to the species *Cavernopsis eckfeldensis*. Ostracods in Eckfeld exclusively appear in very thin layers. This indicates, that these taxa inhabited the lake only temporarily. The occurrence of the mono-specific accumulations of *Cavernopsis eckfeldensis* may thus possibly be referred to short termed increase of the electrolyte-content (salinity) within the aerobic surface-water. In the Mainz Basin and Hanau Basin the ostracod genus Cavernopsis is known from brackish sediments, not of freshwater sediments. The episodic mixing of the water column is likely the result of temporary toxication and an increase of the physiological active electrolyte-content. Therefore the settlement of aquatic organisms was restricted. In the extreme case, stenotopic limnic species got extinct. Euryhaline species transitionally flourished as unrivalled primary producers or consuments. This would explain the wealth of *Cavernopsis eckfeldensis* as the sole aquatic arthropods.

1 P — 22/17.00–18.00; 23/17.00–18.00

Formation of collapse structures during phreatomagmatic eruptions: a field study from a complex maar volcano in the West Eifel volcanic field, Germany

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Phreatomagmatic eruptions at maar volcanoes found the formation of an explosion chamber below the earth surface. Shock waves, generated by water–magma interaction, result in brittle failure and intensive fragmentation of the surrounding country rock. Ongoing phreatomagmatic explosions bring about the progressive excavation of the explosion chamber and produce an increased negative mass balance with depth. Both processes cause instabilities and as a consequence the passive collapses of wall fragments of the overlying country rock and the tuff wall into the maar diatreme. The stratigraphy and tectonic of the pyroclastic deposits were studied along the northern rim of this complex maar volcano in the central part of the West Eifel volcanic field. Several 30 to 50 m thick well-exposed deposits show the intensively faulted maar pyroclasts. Within the maar tephra, Strombolian deposits of two scoria cones are intercalated. They were formed syn-volcanically at spots along the ring faults of the maar. The vents were also cut by normal faulting while phreatomagmatic activity occurred. The fault zones show the development of conjugate shear faults. They represent collapse structures that were generated during the incrementally subsidence of wall fragments of the maar crater. The geometry of the conjugate shear faults shows good insights in the history of the collapse processes and the inference of the intensity of main phases of volcanic activity. Complex volcanoes, in which Strombolian deposits are intercalated or overlying phreatomagmatic deposits, occur quite commonly in the West Eifel volcanic field. It is found that some of them were falsely described as scoria rings. It is proposed to call them complex maar volcanoes. They are characterised by phreatomagmatic activity and the generation of a typical maar diatreme with simultaneous or subsequent magmatic activity and the formation of scoria cones within and at the rim of the volcanic vent.

10 O — 25/11.30–11.50

Tectonic control and rapid ascent of Patagonian lavas

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The occurrence of Crater Basalt Volcanic Field (CBVF) in Northern Patagonia is related to a very significant tectonic feature, the Gastre Fault System (GFS). This fracture, a continental-scale lineament, extends from the Pacific coast at 38° S to the Atlantic Ocean, at 45° S, separating two different geological domains. The length and long-term existence of GFS suggest that this main structural feature propagates deep in the crust.

In the CBVF area, the NW trending fractures delimit the 30 km wide Gastre trench. Most of the CBVF was poured out within the trench. Other eruptive centres are located in the South-west limit of the graben. Kinematic analysis reveals a sinistral transcurrent fault behavior for the GFS, allowing to propose the existence of a transtensional trench in this segment of the fracture system. Significant movements occurred during upper Cretaceous, with reactivations in Late Neogene and Quaternary. Presuming a simple shear deformation, CBVF eruptive centres are aligned following the tension and synthetic shear fault directions of an ideal deformation ellipse. Although the synthetic shear faults do not constitute a primary tensional system, they are crust weakness zones that eventually can behave as tension fractures during an episode of compressional relief.

The calculated crystallization temperatures close to 1200 °C for the CBVF lavas are also found at the base of the lithosphere. The lack of a conspicuous zonation in olivines and the lack of exsolution textures in pyroxenes, are evidences of rapid cooling. On the other hand, the lack of crust contamination and differentiation indicators in the geochemistry of CBVF basalts can mean that there was no magmatic chamber related to this volcanism. The rapid ascent through the crust could be favored by the existence of deep fractures like GFS that would reach the base of the lithosphere inducting tectonic decompression and melting.

9 P — 24/17.00–18.00; 25/16.00–17.00

The Kemenes Volcano Park in Western Hungary — A proposal

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Geoparks could play and important role to conserve and exhibit geological heritages. The European Geoparks Network (EGN) was established in 2000 and presently it includes 17 geoparks in Europe. The EGN has an active role also in the economic development of the regions through enhancement of a general image linked to the geological heritage and the development of geotourism. Volcanic fields are one of the important natural heritages of Europe. Some of them are still active (e.g. Mediterranean region, Iceland), whereas others (e.g. Massif Central, Eifel, Pannonian Basin) provide a good opportunity to have an insight into the processes of volcanic eruptions through the preserved volcanic phenomena in the volcanic formations. In the Carpathian-Pannonian Region various volcanic activities occurred during the last 20 My. Among these, eruption of alkaline mafic magmas formed several monogenetic volcanic fields with more than 100 volcanic centres from 11 My to 0.5 My. They include various basaltic volcanic edifices from maars and tuff rings to large shield volcanoes. Remnants of these basaltic volcanoes contribute to the beautiful landscape of Western Hungary. Physical volcanologic studies in a small — about 5×10 square kilometre large — basaltic volcanic field (the Kemenes Volcanic Field) in Western Hungary revealed complex volcanic evolution including initial phreatomagmatic eruptions followed by Strombolian- and Hawaiian-type volcanic activities and effusive eruptions. In the remnant outcrops, various volcanic features can be observed, such as textures and depositional characters of different types of volcanoclastic rocks, bomb sags with ballistic bombs, columnar jointed feeder dykes, lava lake basalts and mixing of subaqueous basaltic lava with unconsolidated sediments, among others. This year, we submitted a proposal to establish a volcano park here that can show the public how volcanoes work, can protect the natural heritage of the area and can enhance the geotourism in Western Hungary.

2 O — 22/15.50–16.10

Geology of the Hearne kimberlite pipe, North-west territories, Canada: magmatic kimberlite emplacement

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Canada is characterised by diverse types of kimberlite pipes with contrasting emplacement processes. Three main types have been identified: (1) saucer to bowl-shaped pipes filled with bedded pyroclastic lapilli tuffs, (2) steep-sided pipes infilled with well-bedded resedimented volcaniclastic kimberlite, and (3) steep-sided pipes containing massive so-called tuffisitic kimberlite (TK). The main example of Group 3 comprises the four eroded <2 ha. Cambrian kimberlite pipes located at Gahcho Kué in the southern Slave Craton. The composite geological model based on the investigation of 243 drillholes shows that the pipes are exceptional examples of the transition from TK-infilled diatremes to the underlying HK-infilled root-zones as seen, and defined, in southern Africa. This paper focuses on this transition in the dominant phase of kimberlite in one pipe, Hearne. This kimberlite displays an igneous textural gradation from TK at surface to HK with depth. The transition zone, defined by the limits of uniform TK and uniform HK, is 115 m wide and characterised by patchy and/or oscillating textures. In situ modification of the magma occurs in patches on all scales varying from millimetres to metres and includes the visible development of pelletal textures until, as the surface is approached, the whole magma has been modified to pelletal TK. This shows that the diatreme zones are formed by intrusive magmatic processes. Other supporting evidence includes the decrease in groundmass crystallinity and proportion of primary groundmass carbonate, the correlation of textures with variations in the concentration and alteration of the xenoliths, as well as the presence of juxtaposed phases of kimberlites with contrasting textures and diamond grades. All the observed features offer strong support for the interpretation that the TK forms by the depressurisation after breakthrough of a single intrusive magma column with the transition zone representing a "frozen" degassing or fluidisation front.

10 P — 24/17.00–18.00; 25/16.00–17.00

Anomalous mantle structures beneath the Bakony – Balaton Highland Volcanic Field: revealed from xenoliths in maar deposits

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The Pannonian Basin system, a back-arc basin of the Carpathian arc with anomalously thin lithosphere, was formed at late stages of the Alpine orogeny. The tectonic process undoubtedly affected the subcontinental lithospheric mantle resulting in deformation of the lower lithosphere. After the locking of subduction and extension, post-extensional alkali basaltic volcanism occurred sporadically in the Pannonian Basin, carrying large amount of upper mantle peridotites. In this work we study some special (flattened equigranular) peridotite xenoliths from Szigliget and Szentbékkálla (Bakony – Balaton Highland Volcanic Filed [BBHVF], Central Pannonian Basin) that yield to qualitatively describe deformation processes occurring in the upper mantle. Moreover, the detailed geochemical and microstructural analysis of these peridotitic mantle fragments provides valuable information on the quantity of physical parameters (stress, strain, temperature, etc.) characterizing the deformation suffered by the upper mantle during basin formation at the central part of the Pannonian Basin. The studied xenoliths provide evidence on well-defined structural domain (~20–50 km horizontal dimension), which was crossed and sampled by the ascending basaltic magmas. These magmas outcropped during explosive hydrovolcanic eruptions in the BBHVF. The mantle has specific anisotropic fabric resulting in considerable seismic anisotropy. The anisotropic character of the studied upper mantle rocks is suggested to largely influence percolation and residence time of metasomatic melts and fluids in the lithospheric mantle. Moreover, the domains may have important role in controlling the timing and volumetric pertinence of volcanic episodes.

10 P — 24/17.00–18.00; 25/16.00–17.00

The late-collision basaltic volcanism in the north-eastern part of the Armenian Highland

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The Alpine stage of orogeny and continental collision of the southern segment of the Caucasian segment of the Alpine–Himalayan belt was accompanied by a strong pulse of Late Pliocene — Quaternary basaltic volcanism (including the Holocene). Products of this volcanism have been found across almost the entire area of Armenia, and also in the south-western Georgia, East Anatolia and north-western Iran. Combination of diverse tectonic regimes determined the typology, facies, and composition of volcanic eruptions.

(1) The fissure-linear type of eruptions tends to be associated with near-meridian extension structures in western and central parts of Armenia. (Doleritic) basalts form lengthy flows and lava fields corresponding to calc-alkaline and sub-alkaline series. A petro-geochemical model of origin suggests that these were melted out of an exhausted mantle substratum under conditions of "dry", high-temperature melting. The eruptions proceeded without any delays in intermediate chambers, and left no traces of crustal assimilation.

(2) The monogenetic basaltic volcanism was controlled by north-western and north-eastern structures in central areas of Armenia. The eruptions took place from numerous (up to 500) volcanic centres with progressively larger scales, alkalinity and melanocraticity trends observed toward the south-east. Their origin model is apparently determined by the leading role of partial melting of a mantle source enriched by water-containing phases with a contribution of significant fluid phase, arriving from great depths. Petro-geochemical features of basalts (basanites) located within activated structures in the south-east of Armenia (the Kapan block of Mesozoic consolidation) are in marked contrast with others in this type. The origin model suggests their melting out of a deep mantle substratum metasomatically enriched with Am and rare-earth elements.

As a whole, the evolution of late-collision basaltic volcanism in Armenia is defined by various (subduction, rifting) geodynamic regimes and heterogeneity of mantle sources. The volcanism is controlled by active faults and often located in young pull-apart basin type structures of various scales. Data of remote sensing, seismotectonic, historical and archaeological, and other studies show that Armenia and adjacent areas of the Armenian Highland form a region of intense and young basaltic volcanism, which, along with other hazards (earthquakes, landslides etc.), can be regarded one of natural risk factors.

7P — 24/17.00–18.00; 25/16.00–17.00

The maar lake of Mahenge (Tanzania) — Single evidence of Eocene terrestrial environments in Sub-Saharan Africa

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The fossil record for the Palaeogene of Africa is poor compared to that of Europe and Asia. The palaeolake of Mahenge is an old maar structure situated at the fringe of a Mesozoic peneplane west of the small town Singida (Central Tanzania). The lake formed in the crater of a kimberlite diatreme and has a diameter of 400 m. Phreatomagmatic activity in the area is dated 46.0±0.3 which corresponds to an early Middle Eocene age. Most likely the lacustrine series which are preserved in the centre of the diatreme are almost contemporaneous or only slightly younger. Recent expeditions to Mahenge which were carried out by German, North American and Tanzanian teams have greatly increased the information concerning the Palaeogene (Middle Eocene) fauna and flora of this part of Africa.

The Mahenge shales comprise at least 20m of finely laminated, carbonaceous deposits, some of the layers are heavily silicificed. The sedimentological evidence indicates, that the bottom of the former lake was anoxic. The Mahenge shales thus have an excellent preservation potential for vertebrate and plant remains. The fossil fauna is predominated by a large diversity of fish taxa, with the Cichlidae being the most diverse group. It is believed, that they represent the oldest known Cichlid species flock. Mahenge has further yielded a fossil species of the fish family Denticipitidae, which is endemic to Africa, and the only extant genus is considered a living fossil. From Mahenge the osteoglossomorph *Singida*-also endemic to the region- was described. The fossil flora is dominated by leaves with a preponderance of legumes, among them the oldest known representative of the genus *Acacia*. The flora indicates a comparatively dry environment. The climate thus may have been similar to today's conditions in the region.

Mahenge is especially important because it provides the only evidence of an entirely terrestrial Eocene environment in Africa south of the Sahara. Its fauna and flora is unique, and sheds light on the evolution and biodiversity of African biomes in this rarely sampled geographic as well as temporal window. The study was funded by the DFG (German Research Foundation).

8 P — 24/17.00–18.00; 25/16.00–17.00

Transition from phreatomagmatic to Hawaiian eruptions with evidence for water level — a case study on the Ság Hill, Hungary

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The Sághegy is a small monogenetic volcano, situated in the north western area of Hungary. The region (Little Hungarian Plain, LHP) belongs to the western part of the Pannonian basin system. The basin is predominantly filled with lacustrine to fluviatile siliciclastic sediments;bedrock occurs below 1.5 km depth. The studied volcano was active during the Late Miocene (5.9 My), producing alkaline basalts and related pyroclastic deposits. In the LHP alkaline volcanism also occurred at a couple of other monogenetic volcanoes in that time. The edifice of the Sághegy volcano is exceptionally well exposed in a quarry. Its activity can be subdivided into 6 stages. Volcaniclastic flows, phreatomagmatic base surges and phreatomagmatic as well as strombolian fallouts occur. The lowermost deposits are subaquatic, with overlying ones subaerial. In the last stage hawaiian lava fountaining generated three scoria cones. The palagonitization rate of pyroclasts was generally high but varied between the deposits of individual stages, predominantly according to different contact with external water. In the subaquatic-subaerial transition zone there are uncommon sedimentary structures of centimetre thick layers of fine quartz sand intercalated with poorly stratified tuff and lapilli tuff. These sediments and other finely stratified volcaniclastic units are located at medium and high levels in the volcanic edifice, and indicate a shallow subaquatic environment of possible regional relevance. Ultimately, the crater was completely filled by effusing lava that formed a lava lake and was intruded as sills and dikes. Three subunits of the lava lake have distinctive cooling joints, reflecting lave viscosity and flow regime. Interaction between pyroclastic rocks and sill basalts is documented both by peperitic structures and smooth contact margins.

2 O — 22/14.00–14.20

Magmatic versus phreatomagmatic eruption of kimberlite magma in the upper crust and at surface

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A polarized debate on the near-surface emplacement of kimberlite magma has emerged over the past 30 years. One model favours volcanic processes and products resulting from the degassing of magmatic CO_2 and H_2O, and the other model invokes the interaction of kimberlite magma with groundwater, resulting in phreatomagmatic processes and products. Kimberlite discoveries in the past 15 years indicate a much wider variation in body morphology and geometry exists than previously thought. Exploration of these new kimberlite bodies indicates many do not resemble the ‘idealized model of a kimberlite magmatic system', which was developed during the interval 1956–1996 (based on observations in South Africa, Tanzania and Botswana). In order to reconcile these new observations with the old, an examination and review of the three most relevant topics (kimberlite physical properties, host rock rheology, palaeohydrology) to near surface kimberlite emplacement is presented. The available physical property (temperature, density, viscosity, volatile solubility) data for kimberlite and broadly similar melts (e.g. olivine melilitite) at low pressures (0.1–500 MPa) is reviewed. This information is used in conjunction with typical host-rock rheology data to examine the influence of fluid overpressure in vent development and near surface magma emplacement in the absence of ground water. From this analysis, it is suggested that vent development must start near the surface, with the foci of explosive volcanism migrating downward with time due to decreasing overlying load pressure, concomittant with vent excavation. The subsequent influence of palaeohydrology in conjunction with host rock lithology is examined by comparing kimberlite emplacement models developed for which the palaeoenvironment at the time of kimberlite magmatism is relatively well constrained (*i.e.* Fort à la Corne, Saskatchewan; Lac de Gras, NWT). An important new conclusions which can be drawn from this work is the recognition that observed sedimentary features and volumes of resedimented kimberlite (*e.g.* at Fort à la Corne, Botswana, Lac de Gras), is consistent with pyroclastic eruptions forming positive relief tephra cone deposits of significant size/volume. Further, it can be recognized that the 'idealized model of a kimberlite magmatic system' is a composite model, based on high level kimberlite vent and volcanic edifice deposits from Tanzania and Botswana, and deep level vent and root zone deposits from Kimberley. However, the main conclusion to be drawn is that palaeohydrology is the most important factor in near surface emplacement, as kimberlite-groundwater interaction can have the largest influence on the eruption and vent development, but that this factor is often the most poorly understood. Variation in host rock lithology and rheology is not only important in understanding near-surface emplacement, but also has a direct influence on palaeohydrology. The emplacement of Kimberley area kimberlites is revised; magmatic volatiles alone cannot explain diatreme formation and these pipes must be considered to have formed by phreatomagmatic processes. In Lac de Gras and in Saskatchewan, variation in pipe morphology is explained by a combination of magmatic volatile degassings and groundwater interaction.

***2 O** – 22/16.10–16.30*

Maars and diatremes of the Southern Slovakia alkali basalt volcanic field

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Alkali basalt volcanism took place during the Pliocene to Quaternary time (6.5–1.1 My) in the area, where a one km thick cover of the Early Miocene sedimentary rocks rests over the Hercynian basement. Water in sediments upon contact with ascending magma caused phreatic and phreato-magmatic activity leading to the evolution of maars and diatremes. A general pattern has been recognized in their evolution: (1) Mostly phreatic eruptions within underlying sedimentary rocks were characteristic for the initial stage — blowing out of fines along propagating fractures being the main process. Diatreme filling of this stage is formed of sedimentary rock blocks and fragments in sandy matrix. Xenotuffs with sedimentary rock fragments deposited by fall and surge mechanism represent corresponding maar deposits. (2) A transition to phreato-magmatic eruptions was marked by an increasing proportion of juvenile vesicular palagonitized glass particles. Edifice was enlarged by slumping of surrounding sediments into diatreme at the expense of blown out material. (3) Phreato-magmatic eruptions and subsidence of blocks of maar filling into the diatreme are characteristic for the next stage. Palagonitized vesicular glass particles and tuffaceous material with fragments of baked sediments dominate in diatreme filling. Corresponding maar/tuff-ring deposits are stratified, textures indicating fall and wet/dry surge processes. (4) Elimination of the water-magma interaction at the deeper level. A transition to the Hawaiian/Surtseyan-type eruptions is indicated in diatremes by vertical zones of elongated scoraceous fragments in palagonite tuff matrix. Corresponding stratified palagonite tuff deposits in maars include scoria fragments and flat volcanic bombs. (5) The final evolutionary stage involves the Hawaiian-type eruptions represented in diatremes by dykes, in maars by spatter cones, lava flows and/or lava lakes. The Surtseyan-type eruptions preceed or alternate with the Hawaiian ones in the case of the maar lake presence, giving rise to palagonite tuff or mixed tuff/scoria cones.

4 O — 23/14.20–14.40

A complex evolution of the Bulhary maar, Southern Slovakia

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During activity of alkali basalt volcanism in Southern Slovakia (6–1 My) a number of maars was created. The Bulhary maar 3 km NE of Fiľakovo demonstrates a complex multistage evolution, governed by the water–magma interaction in the depth as well as in the maar lake. The following evolutionary stages have been distinguished: (1) The initial maar formation by phreatomagmatic eruptions owing to water–magma interaction in the underlying Tertiary sedimentary complex. Maar filling of this stage is represented by fine to coarse palagonite tuffs with variable sand/silt admixture. (2) No more water–magma interaction at the depth. The upraise of a large volume of basaltic magma to the base of the maar filing resulted in the emplacement of irregular laccolith-like intrusive body, strongly bulging up and deforming preexisting maar filling. Interaction of basalt lava with water saturated maar deposits caused a formation of hyaloclastite and peperite breccias at contacts of the basalt intrusion. (3) The expanding intrusive body eventually pierced through maar filling and went into a direct contact with water in the maar lake. Hyaloclastite breccias with the evidence of boiling and related phreatic palagonite tuffs were created (similar to secondary phreatic cones observed with the lava flows entering a shallow water environment). Altermativelly under dry conditions the Hawaiian type fire fountaining created spatter accumulations. (4) A continuing supply of basalt magma into the maar, with a rather shallow and spatially limited lake at this stage, resulted in several cycles of the Surtseyan- and Hawaiian-type eruptions giving rise to a succession of alternating palagonite tuffs, breccias and lava flows. (5) A final elimination of the maar lake due to accumulation of volcanic products resulted in the Hawaiian type eruptions giving rise to the capping horizon of cinder and spatter and related lava flows.

10 P — 24/17.00–18.00; 25/16.00–17.00

Evolution of volcanic activity in the Southern Slovakia alkali basalt volcanic field

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The Southern Slovakia alkali basalt volcanic field (extending N Hungary) is a typical monogenetic volcanic field of numerous necks, scoria cones, lava flows, maars and diatremes spread over the area of 1 500 km^2. A systematic K/Ar dating of alkali basalts has been carried out since the end of 70's. Based on this work 6 phases of the alkali basalt volcanic activity have been distinguished. Lava flows and maars belonging to the 1st phase (Podrečany Basalt Formation) are in the NW part of the Field. They are of the Early Pontian age and very closely related to the fluvio-limnic environment of the sedimentary Poltár Formation. One of the two known lava flows (Podrečany) shows the age 6.44±0.24 My, the maars (Jelšovec and Pinciná) are unsuitable for dating. The 2nd to 6th volcanic phases (Cerová Basalt Formation) occupy a greater area in the southern part of the Lučenec Basin and Cerová vrchovina Upland. They are of the Pliocene to Pleistocene age. Scoria cones accompanied by lava flows or small lava plateaus were formed. Erosion related to the contemporaneous updoming exposed locally roots of these volcanoes — maars, dykes, necks and diatremes). Distinguished volcanic phases (2nd: 5.43–3.74 My; 3rd: 2.75–2.45 My; 4th: 2.25–1.6 My; 5th: 1.5–1.1 My) are separated either by a distinct break in volcanic activity, or by the appearance of new volcanic forms. During the 6th volcanic phase two maars were formed (Hodejov, Fil'akovo). Their material is unsuitable for radiometric dating. According to their position in respect of the river terraces they are of the Late Pleistocen age (approx. 0.8–0.4 My). As the time which elapsed since the latest activity is shorter than some of the breaks in the past, we still can expect new eruptions to take place.

9 O – 25/9.00-9.20

Proposed protection and conservation strategies of volcanological features in a monogenetic volcanic field in the western Pannonian Basin: a perspective of Balaton Uplands National Park, Hungary

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It is hard to sum up in a few words what Balaton Uplands National Park is famous for. We think its speciality is variegation: in the 580 km^2 protected area there are bog- and fen-meadows, rocky grasslands, ruins of medieval castles, submontane beech forests, vineyards with old press houses, a buffalo reserve, relics of traditional rural architecture, bird rarities, unique geological and geomorphic phenomena, etc. Among the latter – that is why this area is one of the field trip sites of the conference – highly varied rocks and landforms can be found here, formed by the Late Miocene - Pliocene intracontinental alkaline basaltic volcanism. Buttes, remains of lava and pyroclastic flows, maars, scoria cones and diatreme remnants are dominant elements of the landscape in the central areas.

In the national park – founded seven years ago near the largest lake of Central Europe – there are six conservation regions: three of them, which are adjacent to each other, can make up a highly varied geopark. We think the complex objectives of a geopark can be realized in this area since it can give not only geological, but also cultural, historical and ethnographic information to visitors. On the western part of the 325 km^2 proposed geopark, Keszthely Mountains deserve attention with their Triassic carbonate units (strictly protected caves within them) and Neogene basaltic volcanics. A highly detailed geological conservation evaluation was carried out on Kál Basin (the eastern part), which has 28 geological landmarks/geotopes, many volcanological features among them. Topographically in central position, Tapolca Basin is a 'treasury' of volcanological landforms and geomorphic phenomena. In this region, at the Pond Cave (formed in Miocene limestone) of town Tapolca could be the centre and main demonstration site of the geopark. Plans of a complex study trail – near the shore of Lake Balaton, on the gentle hills of Szigliget – are under construction.

5 P – 22/17.00-18.00; 23/17.00-18.00

Geological-geophysical exploration of maar structures in Slovakia

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The southern Slovakia alkali basalt field of the Pliocene to Pleistocene age consists of a great number of lava flows, scoria cones, maars, diatremes and lava necks. Positive results of the geophysical-geological exploration at the Jelšovec and Pinciná maars with argillite-diatomite and alginite sediments initiated investigations in other parts of the field. The first step included geological mapping and preliminary magnetic measurements (using the total vector of magnetic field) to select favourable structures. Maars and underlying diatremes show distinct magnatic anomalies. 3 localities were selected for further investigation: Hajnačka, Hodejov (Čokovo) and Poltár. At these localities a detailed geomagnetic and geoelectric exploration was carried out along several profiles. The reason for application of geoelectric measurements was the fact that sedimentary filling of the maar structure is characterised by very low resistivity, almost by an order of magnitude lower than volcanic complexes. Symmetrical resistivity profiling two spans of saturating electrodes was applied in such a way that we obtained resistivities of the measured zone at horizontal direction to the depths of 30 and 50 m. Vertical electric sounding (VES) to the depth of about 50 m was applied too. Magnetic measurements determined near-surface volcanic complexes – localised the supposed basalt ring structures and divided the volcanic complex into basalts and their pyroclastic rocks. Subsequent drilling at the locality Hodejov proved a near-surface accumulation of brownish-black clays. Though the content of organic substances in clays is rather low (up to 1.54%) a high content of smectite was confirmed. Clays posses technological parameters favourable for sorption of lead and mercury, what is a significant factor for usage of this material in ecological applications as sorption agent of heavy metals.

2 O — 22/14.40–15.00

Root zone processes in maar-diatreme volcanoes

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The understanding of processes within the root zone of a maar-diatreme volcano is important for the interpretation of the geology and volcanology of the entire volcano. In the phreatomagmatic model of pipe formation the root zone functions as the engine for pipe formation while the overlying diatreme is seen as a relatively passive sinkhole-like body reacting to processes in the root zone. In this model the pipe develops over a period of time from a series of many single thermohydraulic explosions in the root zone. Depending on the groundwater environment, the centre of the explosions starts close to the surface and progressively moves downwards during volcanic activity.

Thermohydraulic explosions, which fragment the magma and the country rocks, mostly occur within the bottom part of the root zone, forming new explosion chambers. After expansion and ejection of the explosively produced tephra in a feeder channel piercing through the volcaniclastic diatreme fill, unconsolidated country rock debris and tephra from the overlying diatreme as well as country rock debris from the side walls of the root zone subside into the partially emptied explosion chambers and fill them with debris. Magma continues to intrude the root zone and comes into contact with groundwater seeping in and injected from joints and newly formed fractures in the side walls resulting in renewed thermohydraulic eruptions. Thus, each new eruption includes one or several thermohydraulic explosions, fragmentation of magma and country rocks, vaporization of groundwater, expansion of the solid-liquid-vapour system and ejection of tephra-material through the diatreme into the atmosphere. The overlying diatreme therefore represents a passively reacting sinkhole structure which feeds material into the downward migrating root zone. As a consequence of this process a diatreme does not only progressively penetrate downward, but also grows laterally by upward migrating wall rock collapse induced by arcuate faults and spalling.

6 P — 24/17.00–18.00; 25/16.00–17.00

Basalt/sediment mingling in the root zone of the Shiprock diatreme, Arizona

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Thanks to the classical paper by Howel Williams Shiprock in the NW corner of New Mexico is one of the famous diatremes of the world. It is of the Pliocene age. A younger uplift and erosion of surrounding soft sediments is the reason that former underground filling of the diatreme forms now a castle-like rocky cliff upstanding 500 m above the surrounding plane. Most of the diatreme filling shows a low to moderate sorting and inward dipping irregular stratification. It is composed of fine to medium grained palagonite tuff with variable admixture of sand. Coarser beds include angular fragments of glassy basalt and angular to rounded fragments of sedimentary rocks and granites. Apparently enough water was available for the water/magma interaction to turn most of lava into palagonite tuffs and at the same time to chill part of lava to form glassy angular fragments. However at one place I have managed to find big blocks which show a very intimate mingling of unsolidified basalt lava with fluidized system of sedimentary material. Narrow bands and wedging out streaks of fluidized sediments in deformed basalt imply that it was the fluidized sediment that was injected into liquid lava. Apparently in this case a locally low water/magma ratio resulted in the limited extend of fluidization and absence of chilling — lava remained liquid and available for mingling.

5 P — 22/17.00–18.00; 23/17.00–18.00

Geophysical exploration of maar localities in Upper Lusatia, Germany

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In the last ten years a few Tertiary maar structures were investigated in Upper Lusatia. They all were found by geophysical measurements. This region was explored for the first time by magnetics and gravimetry in 1962 and 1963 by Bunzler, Bormann and Lindner. A small concentric gravity minimum, lower than 10 mGal, was detected near the village of Kleinsaubernitz. The borehole KLS 1/70 in the centre of the minimum recovered typically maar crater sediments more than 300 m in thickness. The anomaly was clearer after compressing the point distances to 100 m (BÖHNERT 1986). Consequently, we have carried out are interpretation. A joint inversion model is derived by integration of the accompanying small magnetic anomaly. The result is a funnel filled by characteristic maar crater sediments inside of crystalline rocks. The magnetic anomaly is interpreted by basic material in the deeper part of the structure and on the SE area of the maar.

Near Weigsdorf, in the southern part of the Lusatian massif, we carried out new gravimetric and magnetic measurements inside a one point minimum detected in 1963. The result yields a conformity between gravity and magnetic minima. A typical maar crater was realized by joint inversion. The depression is assumed to be filled by unconsolidated material of 120 m thickness, accompanied by inversely magnetized basic rocks at depth. In the neighbourhood there occurs another magnetic minimum, detected by aeromagnetics. Our new measurements are showing a very sharp anomaly smaller then –1300 nT. After the modelling an inversely magnetized basalt is assumed to have intruded. The gravity measurements show only a small minimum caused by redeposited granodiorite. Because of the anomalies we assume a flat maar depression.

5 P — 22/17.00–18.00; 23/17.00–18.00

Preliminary results of geophysical studies over the Tihany Volcano at the Tihany Peninsula, Hungary

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The Tihany Paleovolcano is one of the earliest alcaline-basaltic volcanoes of the Bakony – Balaton Highland Volcanic Field located in western Hungary. It was a maar-diatreme type complex volcano active during the Miocene. We carried out geomagnetic surveys to localize the eruption centres and map the aerial extent of volcanic bodies. First, the large scale features of the peninsula were determined by measurements made on a rectangular grid with 200 m spacing using a high-precision Overhauser magnetometer. Later, detailed magnetic surveys were accomplished in the anomalous areas, which were completed by magnetic susceptibility measurements. The results show a large positive anomaly with an amplitude of 1000 nT occupying a 2 km^2 area in the western part of the Lake Külső accompanied by a smaller negative anomaly north of it. The structure of the anomaly is typical for a normally magnetized vertical cylinder. According to the graphical estimation method the depth of the cylinder is in 300–400 metres and its diameter is about 1 km. Probably, it represents the root zone of the main eruption centre of the maar. Additionally, in the northern part of Tihany Peninsula two smaller volcanic centres with diameters of few hundred metres were identified in the Óvár and the Diós–Gödrös areas. Both have a geomagnetically reverse polarity. In these areas the magnetic field varies in short distances (~20 m) with high amplitude (~300 nT). The magnetic susceptibility measurements revealed that here the susceptibility of tuffs is orders of magnitude higher than in the other parts of the peninsula. These observations suggest that in the northern part of the peninsula the tuffs originate from different eruptions than the main one. The south, south-eastern part of the peninsula does not show magnetically anomalous regions, so, there are no evidences of volcanic rocks in the deep.

5 O – 23/16.00–16.20

Contrasting geophysical characteristics of maar volcanoes in the Auckland Volcanic Field, New Zealand

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The Auckland Volcanic Field (AVF) comprises about 50 basaltic monogenetic volcanoes of Quaternary age. Maars, scoria cones and lava flows occur throughout the field and some volcanic centres exhibit all three of these. The Auckland volcanoes erupted through relatively low-density, non-magnetic sedimentary rocks and hence provide ideal geophysical case studies. The striking similarity in the form and dimensions of maar volcanoes in the AVF is not reflected in their geophysical signatures, which show marked contrasts. For example, the Domain, Waitomokia, Pukekiwiriki and Pukaki volcanoes are associated with residual gravity anomalies ranging from +32 to –6 gu and residual aeromagnetic anomalies of 280 to 0 nT. Pukekiwiriki and Pukaki are similar maar volcanoes with tuff rings, however detailed 3D geophysical modelling shows that a substantial basalt body underlies the former but not the latter. The Domain and Waitomokia maar volcanoes, which both have a central scoria cone, are also underlain by substantial volumes of basaltic rocks. The subsurface bodies modelled beneath these volcanoes have dimensions comparable with the inner diameters of their tuff rings and thicknesses ranging from about 50 to 150 m. These differences in subsurface structure are interpreted in terms of the balance of available volumes of magma and groundwater, and appear not to be related to near-surface lithology. At the Domain Volcano, a binary plumbing system is modelled with the main subsurface basaltic core being displaced some 400 m from the location of the central scoria cone; this suggests a more complex eruption history than is apparent at the surface where products from the later vent buried an earlier, more significant site of activity.

9 O – 24/16.00–16.20

Syneruptive and posteruptive hazards of maar-diatreme volcanoes

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Maar-diatreme volcanoes erupt subaerially when magma of any composition interacts repeatedly and explosively with groundwater on continents and islands. According to recent and fossil maar eruptions, syneruptive hazards are volcanic earthquakes, up to cca. M: 4–5, several 10 to several 1000 eruptions during days to more than 10 years, eruption clouds rising to maximum heights of economic air travel, ejection velocities, ejection distances and maximum size of ballistic tephra clasts of up to 400 m/s, respectively up to 4 km, and cca. 8 m, base surges travelling at speeds of tens of to possibly 100 m/s and up to distances of several km building a tephra ring of ten to in excess of 100 m in height and to a distance of up to 4 km (from centre of crater). Thin distal tephra fall deposits may extend to more than 100 km. All these processes may lead to destruction of buildings and transport lines up to distances of 4–6 km. Downward penetration of the locus of phreatomagmatic explosions leads to formation of the diatreme which is a subsidence structure and of an overlying subsidence crater, the maar crater. Growth of maar craters during maar-diatreme activity results in repeated collapse of crater walls, lahars, and a crater diameter of 100 m to up to several km (2–3 km). Inside the diatreme subsidence of tephra, country rocks and buildings may reach depths of possibly 1000–2000 m. Posteruptive compaction of the diatreme fill results in longlasting (up to millions of years) continuous and possibly discontinuous subsidence of posteruptive crater sediments, leading to slumps, rock falls, turbidites, and exsolution of gases dissolved in deep crater lake water with possibly lethal effects on fauna and flora.

7 O — 24/11.30–11.50

A dynamic model for the meromictic Eckfeld Maar lake (Middle Eocene, Germany) based on biostratinomical and sedimentological data

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Since 1987 the Middle Eocene Eckfeld Maar near Manderscheid, Vulkaneifel/Germany, has been investigated by the Landessammlung für Naturkunde Rheinland-Pfalz/Naturhistorisches Museum Mainz. Based on annual excavations and cores from 7 drill holes a multidisciplinary research programme has been organized in cooperation with colleagues from other institutions.

During the excavations a wealth of taphonomical data has been registered with high resolution for both aquatic and terrestrial biota. These data have resulted in a detailed picture of the vertical distribution of fossils within the central part of the excavated sedimentary record which is covering a time span of approximately 6000 years of lake development. Independently, the maar lake sediments have been studied intensively as well. These sedimentological investigations are comprising various aspects of, e.g., microfacies analysis, organic geochemistry, and isotopic composition of authigenic siderite.

Correlating these different data sets helps in deciphering the biostratinomical processes that controlled the composition of the taphocoenosis and their variations in time. This allows to formulate a dynamic model for the rather early stage of development of the meromictic maar lake of Eckfeld. This model can also be applied to meromictic (maar) lakes in other Tertiary volcanic fields, as, e.g., Messel (Sprendlinger Horst), Sieblos (Rhön), and Randeck (Swabian Alb), all in Germany.

9 P — 24/17.00–18.00; 25/16.00–17.00

Studying tuff rings and volcanic hazards in a tropical setting: the case of the Batoke Tuff ring, Limbe Region, SW Cameroon

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In subtropical volcanic environments, there are often few accessible outcrops. These are often highly weathered, of very poor quality. Soil development is rapid (1 cm/y) and small eruptions are unlikely to be preserved in the geological record. Reconstructing past eruptions and assessing hazards is a challenge. Here we studied a tuff ring outcroping only along one road (very poor, incomplete section) and one beach cliff (up to ca. 5–10 m high) at Batoke, to the SW of Mt Cameroon volcano. Mt Cameroon has a few tuff rings, currently of unknown ages, near the SW coast of Cameroon. In the Batoke case, the sequence is dominated by parallel-beded tuffs varying in the proportion of lithics, juvenile clasts, and accretionary lapilli (acc-laps). Several beds are close-packed with acc-laps of up to 10–15 mm diameter. Part of the section is gullied by mud flow deposits. The rocks are highly weathered but differential weathering enhances relationships. Quantitative data can be extracted from a detailed study of outcrops' external surfaces. The preserved section is close to where the deposits were initially thickest and where acc-laps were most abundant and largest. There is an empirical correlation between maximum acc-lap size in the thickest outcrop and eruption column height. This and the deposit features suggest that the Batoke eruption was pulsating but dominated by fallout, with a water and ice-rich eruption column reaching 10–15 km high. Recycling of water-drops and ice-coated fine ash accumulated during eruption. At switch off, wholesale gravitational collapse of this material produced the mud flows which gullied the previously-laid down deposits. Such mud flows can represent a substantial hazard, e.g. they can gully down through towns and roads and cut evacuation routes, e.g. as happened during the 1937 and 1994 Rabaul eruptions (30 m deep gullies). This study illustrates how, at subtropical tuff rings, it is possible to extract key data needed for hazard assessment from only 1–2 poor outcrops.

4 O — 23/13.40–14.00

Magma/wet sediment interaction in crater lakes and vent zones of monogenetic volcanoes in Mio/Pliocene volcanic fields of western Hungary

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The Little Hungarian Plain and the Bakony – Balaton Highland Volcanic Fields (LHPVF, BBHVF) in the Pannonian Basin, Hungary, comprise several Miocene/Pliocene volcaniclastic successions that are penetrated by numerous mafic intrusions. Peperite formed where basaltic magma intruded/extruded and mixed with tuff, lapilli-tuff, and non-volcanic siliciclastic sediments. Peperites are more common in the Pannonian Basin than generally realised and are likely to be important in settings where sediment sequences accumulate during active volcanism. At Hajagos-hegy, a maar volcano in the BBHVF, basanite feeder dykes intruded unconsolidated sediments in the maar basin and formed peperite. Similar peperite developed in Kissomlyó (LHPVF) when dykes invaded lake sediments that formed within a tuff ring. Lava foot peperite on the southern hillside of Hajagos-hegy (BBHVF) and Kissomlyó (LHPVF) were formed when small lava flows were traveled over wet sediments. At Ság-hegy (LHPVF), a large phreatomagmatic volcanic complex, peperite formed along the margin of a coherent intrusion. Peperite comprises two main types such as globular and blocky peperite and in the studied fields they occur together regardless of the host sediment in respect of its origin, grain size or structure.

10 P — 24/17.00–18.00; 25/16.00–17.00

Sedimentary interaction between pyroclastic flow deposits of the Poris Member from the Las Cañadas and monogenetic volcanic fields in a beach setting near Montaña Roja scoria cone, Tenerife Sur, Spain

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Pyroclastic flow deposits from the Diego Hernandez Formation have been identified and assigned to be part of the Quaternary (0.276±0.016 My) Poris Member near the Montaña Roja scoria cone on the Atlantic shoreline of southern Tenerife. A complex pyroclastic-epiclastic stratigraphy has been identified behind the scoria cone facing the Las Cañadas caldera in about 20 km distance. The scoria cone is built up by red, slightly agglutinated scoria lapilli beds, forming steeply bedded 15–25 cm thick beds mantled by 1–5 cm thick fine ash on its flanks. Beds gradually change to a central pyroclastic breccia that is rich in dense to highly vesicular spindle bombs. The scoria cone is mantled by phonolitic pumiceous pyroclastic deposits on its northern flank, which indicates that the cone itself pre-dates the deposition of the pyroclastic flow deposits. The lowermost pumiceous pyroclastic deposits are rich in cauliflower shape phonolitic pumice fragments hosted in altered ash matrix. Mafic lithic fragments as well as red scoriaceous lapilli are common. According to the textural characteristics of this unit it is interpreted to be distal part of the Abona Ignimbrite. Above 5 to 10 m of the present sea level this unit is overlain by a thick (1 to 15 m) cross bedded, sandy volcaniclastic unit interpreted as beach sand that developed in shallow subauqous environment. The occasional interbeds of glass shard rich zones in the beach sand indicate that this epiclastic unit developed shortly after the emplacement of the Abona Ignimbrite and the exposed zone is a mixing region of the ignimbrite emplaced in shallow subaqueous environment. The large number of scoriaceous lapilli in the Abona Ignimbrite suggest that the pyroclastic flow had a significant erosive energy to be able to pick up large chunks of scoria of the Montaña Roja cone, and possible partially destroy its unwelded rim. In the beach sand several zones of dm-size dewatering and/or gas escape pipes often in m-length, fluidization channels, and sand volcanoes indicate active degassing from the previously emplaced ignimbrite. This would imply a fast burial rate of the pyroclastic flow deposits after emplacement. The beach sand is overlain by a pumiceous, lithic rich pyroclastic flow deposits rich in banded pumices, all characteristic for the Quinta Ignimbrite. These pumiceous lapilli tuff units are also rich in picked up red scoriaceous lapilli from the underlying cinder cone as well as irregular blobs of epiclastic beach sand. This textural characteristic indicates that the Quinta Ingmibrite also had

significant erosional power more than 20 km away from its source, suggesting high potential destructive volcanic hazards. In addition, the exposure level of the intercalated beach sand indicates about 20 m uplift of the region over the past 300 ky as a realistic estimate.

4 O — 23/11.10–11.30

Shallow subsurface sill and dyke systems associated with an alkaline basaltic intracontinental volcanic field, western Pannonian Basin

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Neogene alkaline basaltic rocks in the western Pannonian Basin are eroded remnants of former maars, tuff rings, tuff cones, scoria cones and lava fields. The erosion level of these volcanoes is deep enough locally to expose diatreme zones associated with the phreatomagmatic volcanoes. West of the Bakony – Balaton Highland Volcanic Field the erosion level is deeper yet, exposing shallow subsurface dyke and sill swarms related to former intra-plate volcanoes. The basanitic sills are irregular in shape and their lateral extent is highly variable. Individual sills reach a thickness of a few tens of metres and they commonly form dome-like structures with rosette-like radial columnar joint patterns. The largest sill system identified in this region is traceable over kilometres, and forms a characteristic ridge running north-east to south-west. Elevation differences in the position of the basanitic sills within an otherwise undisturbed "layer cake-like" siliciclastic succession indicate emplacement of the basanite magma at multiple levels over kilometrescale distances. The margins of sills in the system are irregular at a dm-to-mm-scale. Undulating contacts of the sills together with gentle thermal alteration in the host sediment over cm-to-dm distances, indicate the soft, but not necessarily wet state of the host deposits at the time sills intruded. Parts of the sill complex show a complex relationship with the host sediment in form of peperitic zones and irregularly shaped, disrupted, peperite textures. This is interpreted to reflect inhomogeneities in water content and rheology of the siliciclastic deposits during intrusion. The current summit of this ridge preserves a small diatreme that seemingly cut through an otherwise disk-like sill indicating to some degree the temporal relationship between sill emplacement and phreatomagmatic explosive eruptions. A complex pyroclastic-to-lava succession is exposed in a large, still active quarry in the eastern part of an area inferred to represent a maar basin that was filled by post-maar lava flows, volcanic debris avalanche deposits, and by ingrown scoria cones.

1 P — 22/17.00–18.00; 23/17.00–18.00

Quaternary phreatomagmatic volcanoes of Southern Tenerife, Spain: Montańa Pelada tuff ring and Caldera del Rey maar

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Quaternary monogenetic volcanoes in southern Tenerife are part of a rift zone extending from the *Pico del Teide* to the south. In this rift zone scoria cones are often clustered into smaller volcanic massifs form an extensive volcanic field. In the southern margin of this rift zone, near the Atlantic shoreline 2 phreatomagmatic volcanoes are known. *Montańa Pelada* is a tuff ring 1.2 km across and stands about 100 m above the sea level. The pyroclastic succession of the tuff ring is very monotonous and consists of accidental lithic rich bedded lapilli tuff. The pyroclastic rocks in the base are richer in accidental lithic fragments derived from pre-tuff ring lava than in the upper section. A gradual transition to a more bedded texture of the pyroclastic units is prominent. In the upper section of the unit dm thick beds rich in cauliflower bombs and scoriaceous lapilli indicate that the vent of the volcano has been cleared by this time of the eruption. The crater of the *Montańa Pelada* is filled with massive lapilli tuff forming m-thick units that are inferred to be intra-crater lahars. Above the reworked pyroclastic units immature soil horizon indicates terrestrial conditions in the tuff ring crater. Within the tuff ring two pyroclastic flow units are preserved indicating their high momentum to allow the ignimbrite to overrun the tuff ring and destroy a small scoria cone that occupied the tuff ring crater.

Just 15 km to the west a large maar, *Caldera del Rey* forms a ~150 m deep, rift parallel elongated double depression. The pyroclastic succession of the maar is about 70 m thick in the crater rim. In near-vent position thickly bedded, accidental lithic rich lapilli tuff units are inferred to have been deposited from high concentration laminar flows e.g. pyroclastic flows. These units are mantled by thin base surges. In these units, impact sags are rare. In the upper section of the tuff ring deposits an increased number of impact sags, dune-bedded base surge deposits and slumping structures indicating gradual change of the eruption mechanism of the maar. About 800 metres away from the crater rim, behind obstacles, fine tuff with rim-type accretionary lapilli are prominent. About 1600 m from the crater the thickness of the phreatomagmatic deposits decreases to 30 metres. The deposits there are entirely formed by dune bedded base surge beds often truncated by large accidental lithic lapilli and bomb that cause deep asymmetrical sags. The presence of the young phreatomagmatic volcanoes in the southern region of Tenerife, which is the host area for major touristic developments, indicates that this type of volcanism could pose significant devastating volcanic hazards especially near the shore line and further studies would be desirable.

***4 P** — 22/17.00–18.00; 23/17.00–18.00*

Growth of scoria cones from the western Transmexican Volcanic Belt, near Volcán Ceboruco, Mexico

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Ejecta construct growth modelling focuses on the role of ballistic (no-drag) ejection that often are termed Strombolian activity as a result of weak-intensity, strongly intermittent activity. This is often associated with bursting of large gas bubbles extending across much of the vent, and producing ballistic emplacement of clasts larger than 10 cm. Particles with a size less than 10 cm are normally unable to follow ballistic trajectories instead depositing from eruption clouds with characteristic jet dynamics (e.g. subplinian). Observations of eruptions indicate that ballistic model only applies to late-stage weak-intensity events and/or to rare coarse-grained cinder cone eruptions. The volcanic field near the andesitic-dacitic Volcán Ceboruco in the Neogene San Pedro – Ceboruco graben includes peripheral fissure fed flows, domes, and monogenetic scoria cones (0.5–0.01 My). Scoria cones and lava domes form two NNW–SSE alignments. The southern chain is made up by more roundish and heavily vegetated cones and domes suggesting higher erosion probably due to their older age. The material of scoria cones near Ceboruco consists of normal (proximal) to inverse (distal) graded welded and/or unwelded scoria lapilli and loose coarse ash. Commonly fluidally shaped blocks and bombs are characteristic and randomly distributed but they are volumetrically insignificant. The median grain size of the deposits is well below 10 cm. The grain size pattern observed from scoria cones at Ceboruco is not consistent with the classic ballistic (no-drag) model of cone growth. Instead it is more consistent with recently proposed model where cones grow by accumulation of clasts falling from a sustained eruption column. Ceboruco cones are inferred to have grown at a rapid rate first by fallout from the margin of an eruption column followed by coeval mass redistribution by grain flows on the growing cone as indicated by the characteristic inverse graded tephra beds in the marginal areas of the cones.

***1 P** — 22/17.00–18.00; 23/17.00–18.00*

Eruptive mechanism of phreatomagmatic volcanoes from the Pinacate Volcanic Field: comparison between Crater Elegante and Cerro Colorado, Mexico

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The Pinacate Volcanic Field is located just near the northern end of the Gulf of California (Sea of Cortez) in Sonora, Mexico. Extensive lava flows cover an area similar to 2000 km^2 which is cut through by more than 400 vents, predominantly scoria cones. Eight of the vents are maars that erupted immediately after emplacement of pre-maar lava flows, which are exposed in the crater wall. Two of the phreatomagmatic vents are especially spectacular by their size and volume, and their contrasting architecture; Crater Elegante and Cerro Colorado. Crater Elegante is about 1600 m across with a crater that is about 250 m deep, which is surrounded by a few tens of metres complete crater rim. Its age is inferred to be 0.15 My, and its pyroclastic deposits are dispersed more than a km away from the crater rim. They form a gentle sloping blanket over pre-maar lava flows exhibiting plastering effect over obstacles such as pressures ridges and lava blisters of the pre-maar lavas. Pyroclastic units are predominantly lapilli tuffs that are rich in fine silt, sand and angular, non-vesicular sideromelane glass shards tephritic in composition. The fine lapilli tuff and tuff units about a few hundred metres away from the rim are especially rich in angular quartz fragments that are loosely packed. Scour fills in the pyroclastic succession are calcite cemented. There is a notable trend in a quick reduction in the volume of large volcanic accidental lithic fragments derived from the various pre-maar lava flows in the lapilli tuffs from the crater rim toward distal areas. Bedding characteristics of the pyroclastic succession are predominantly massive to well bedded in near-vent settings that quickly change to dune bedded successions with dunes having a few dm amplitude over metres wavelength. These are characteristics of deposition from sudden blast triggered base surges. The Cerro Colorado is just ~8-km to the NE from Crater Elegante and forms a ~100 m positive volcanic landform. The crater floor is just a few tens of metres below the inferred syn-volcanic surface and forms a ~600-m wide, flat depression. The crater inner wall is mantled by collapsed blocks of tuff breccia and lapilli tuff that feed small reworked volcaniclastic fans. The pyroclastic succession of Cerro Colorado is significantly coarser grained, and thicker bedded than the Crater Elegante succession. Lapilli tuffs and tuffs are rich in amoeboid shaped moderately-to-highly vesicular sideromelane lapilli and coarse ash tephritic in composition that are rimmed by gel palagonite. Intact gravel/pebble of mud and/or silt are the main accidental lithic fragments. The distinct differences in size, vesicularity, shape and alteration effect of the sideromelane shards, the ratio between juvenile to accidental lithic fragments reflect the difference of the depth of fragmentation and/or source of water interacted with the magma.

6 O *— 24/9.00–9.20*

The hydrodynamics of magma–water mixing and its effect on fragmentation and eruptive violence

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Pyroclastic products of hydromagmatic eruptions tend to be finer-grained and contain more abundant blocky, poorly vesicular fragments than those of dry magmatic eruptions. The fine fragmentation is thought to accelerate heat transfer from magma to water, which drives rapid steam expansion. Partly for these reasons, volcanologists frequently use the term "explosion" to describe violent magma–water mixing, and attribute such explosions to molten fuel-coolant interactions (MFCI's), in which the passage of a shock wave through a coarse dispersion of melt in water strips away a layer of steam separating the materials, forcing them into direct contact. In laboratory experiments, MFCI's generate true explosions; in nature, however, the best-observed magma–water mixing events that generate fine tephra, at Surtsey and Kîlauea, involve sustained turbulent jets rather than explosions. In industrial applications, turbulence is used to reduce droplet size in sprays and ensure fine-scale mixing in ventilators and fuel injectors. With increasing Reynolds number, turbulence intensity increases and the size of the smallest eddies (which control the scale of mixing) decreases. I hypothesize that turbulent magma–water jets promote fragmentation by breaking magma apart within eddies and by increasing the frequency at which chilled margins on magma clasts grow and peel off. I am studying these processes experimentally by injecting a jet of hot (150 °C) glass-forming liquid into liquid nitrogen, under flow conditions that range from laminar to turbulent. Preliminary results suggest that average fragment size decreases with increasing injection rate (*i.e.* with increasing turbulence), and that clast shapes change from dominantly droplet- or coarse-thread (Pele's hair) morphology under low injection rate, to more complex and fracture-dominated morphology under high injection rate. The generation of fine, fracture-bound fragments in high speed jets in both controlled experiments and in subaqueous eruptions suggests that turbulent mixing may be an important fragmentation mechanism in both cases.

8 O — 24/14.50–15.10

Crustal xenoliths in the 6220 BP Søfell tuff-cone, south Iceland: evidence for an unusually deep, diatreme-forming, Surtseyan eruption

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About 400 lithic clasts (<15 mm) from the Søfell tuff-cone on the island of Heimaey (Vestmannaeyjar archipelago, south Iceland) were investigated for this study. They were collected in an 80 m high and 1.5 km long section. The section has 7 well-characterized xenolith-rich layers interbedded with predominantly planar- and cross-bedded, fine to medium grained vitrified alkali basaltic ash. From each layer 70 clasts were collected and classified into 4 categories: juvenile, Vestmannaeyjar-type (i.e. cpx-free basalts), sedimentary rocks and cpx-bearing basalts. Most frequent clasts, throughout the studied section, are of the Vestmannaeyjar-type (varying between 60 and 80%). However, we observe a clear correlation amongst the other clasts categories with height in the section. In the lowermost section of the tuff cone, only two clasts types are present, Vestmannaeyjar (80%) and juvenile (20%). Sedimentary xenoliths, occasionally fossiliferous, appear in the second lower clasts layer (35%) and continuously decrease to about 3% in the last xenoliths rich layer at the top of the section. Cpx-bearing basaltic xenoliths only appear in the uppermost two layers (where they constitute 7 and 4% respectively).

The basement stratigraphy of Heimaey is known from a 1565-metre borehole that was drilled on the island in 1965. The borehole stratigraphy shows that the island is underlain by 177 metres of alkali basaltic lava and tuffs (cpx-free and belonging to the Vestmannaeyjar volcanic system). An approximately 640 metre thick pile dominated by diagenised marine- and glaciogenic sediments. Cpx-bearing basalts does first appear at depths below 820 metres.

The distribution of crustal xenoliths in the Sæfell tuff-cone is reverse to the observed borehole stratigraphy. This indicates that the initial explosions were shallow-seated and progressively penetrated the crust as the eruption continued. We therefore suggest that the Søfell tuff-cone is underlain by a major diatreme exceeding 800 metres in depth.

10 O — 25/10.50–11.10

Temporal and spatial relations of the formation of monogenetic explosive vents in cone fields

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Explosive eruptions from monogenetic vents differ in many ways from those from large composite cones and shield volcanoes, but when taken as a group, they have a surprisingly similar pattern of development. Because the proposed site for a nuclear waste repository at Yucca Mountain, Nevada, lies with in a small field of vents of this kind, much recent research has recently been focused on their patterns of eruptive activity. The studies have made it possible to calculate the probabilities of future eruptions, both in space and in time.

There are several regions in the United States and Mexico where clusters of dozens or hundreds of vents have been formed over periods of one or two million years. Most are normal basaltic cinder cones, but maar-type vents are often common. The latter are invariably located in areas of shallow lakes or abundant groundwater. The compositions of the magmas are normally basaltic or andesitic, but in some instances, as in the Coso Field of California, they make up a bimodal assemblage of basalt and rhyolite.

The Springerville field of 409 vents in eastern Arizona is probably the best example. Studies by Charles Connor and his co-workers have provided an excellent analysis of how these fields develop and decline with time. They have shown that the frequency of eruptions gradually increased until it reached a more-or-less steady state of about one new vent every 7 or 8 thousand years. Vents formed in clusters that shifted from place to place over periods of a few hundred thousand years. The rate of vent formation then tapered off and ended after a period of about 2.5 million years. The duration of activity for the field as a whole is of the same order as that of large composite cones and shield volcanoes and has been related to the same types of regional tectonic features, but the reason why the volcanism takes such different forms is poorly understood.

8 O — 24/15.10–15.30

Evolution of the Sterkspruit Complex, South Africa: a composite maar crater-complex developed during Lip volcanism

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The onset of continental flood basalt volcanism is often marked by a suite of rocks that record fluvial, lacustrine and/or eolian sedimentation plus explosive and effusive volcanism overlapping in space and time. In South Africa, the earliest magmas of the Karoo Large Igneous Province (LIP) rose into sand and sandstone of the uppermost Karoo Basin before erupting at the surface to form locally thick volcaniclastic deposits and lava flows.

One volcanic centre formed during the early history of the Karoo LIP is the Sterkspruit complex, comprising a suite of volcaniclastic rocks and lavas filling a broad crater (>40 km^2) cut into country rock and surrounded by a blanket of distal bedded volcaniclastic rocks. This large crater is composed of overlapping remnants of small phreatomagmatic and strombolian debris-filled vents spaced a few hundred metres apart. The volcaniclastic rocks filling these small vents show steep, abrupt contacts with host rocks at deep levels but show mainly low-angle, diffuse contacts with the deposits of adjacent centres at shallow levels. Craters housing these vents grew mainly via collapse of their margins rather than by downward quarrying. Widespread pillow lavas plus reworked and lacustrine sediments point to an abrupt end to explosive volcanism in the Sterkspruit Complex and flooding of the lowest part of the crater, with the change upsection to thick, extensive subaerial flood basalt flows recording inundation of the landscape by lava. The 50-100 m thick distal blanket of mainly bedded, fine-grained deposits records a variety of fall, flow and reworking processes beyond the crater-complex. The Sterkspruit Complex records (1) shallow-level explosive phreatomagmatic and strombolian eruptions, (2) shallow intrusion and effusion of basalt, (3) lateral growth of large craters via coalescence of many small vents by crater-margin collapse, and (4) transport of debris beyond the complex to blanket pre-eruption topography.

9 P — 24/17.00–18.00; 25/16.00–17.00

The San Pablo Maars in Southern Luzon, Philippines

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The San Pablo Maar Field (SPMF) consists of more than 100 maars and tuff rings but only seven of these were deep enough to form lakes. The SPMF is part of the South Luzon Volcanic Field, which includes the active volcanoes Taal and Banahaw Volcanic Complex as well as a number of stratovolcanoes and scoria cones. These volcanoes were active in the Quaternary time. The Macolod Corridor, a northeast-southwest extension zone is believed to control the location of these volcanoes. Maar deposits are of basaltic to andesitic composition.

The San Pablo Maar Field is being surrounded by densely populated towns and a city and is in close proximity to fast developing commercial and industrial zones. These are at risk of being affected by hazards associated with phreatomagmatic eruptions during maar formation. The question is: What is the potential for future eruptions in the San Pablo Maar Field? If so, where would the next eruption in the Maar Field possibly occur?

9 O — 24/16.40–17.00

Landslide hazard in maar and caldera lakes

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Maar and caldera crater lakes tend to have concentric ring faults, and very steep internal slopes that are inherently unstable. We illustrate that this is so through a case study. Field, bathymetric and 3D seismic surveys of Lac Pavin (Auvergne, France), a typical holocene-age, volcanic crater lake have been carried out. The surveys of the 7000 y old, 750 m diameter and 93 m deep lake reveal that Pavin was violently and perhaps recurrently perturbed by landslides. The last major landslide took place at ~1000–1500 y BP and involved ~2–3 106 m^3 of lava and tuffs. This resulted in 5–6 m of perturbed lake palaeoenvironmental records, as indicated by an 11 m-long sediment core, in a possible lake outgassing and life extinction event suggested by a peak in organic carbon and nitrogen, and in reseting of the lake gas build-up trend. The slide caused a tsunami, accounting for the 500 m wide, 50 m deep N breach into the crater rim. A major flood of ~2–106 m^3 of water and sediment was produced into the nearby valley. This is consistent with a local pre-medieval legend according to which "whenever local people dared to throw rocks into the lake, it would become angry, avenging itself into a huge flood and drowning them…", and with Pavin's name which means "ghastly" in latin. On-land surveying indicates the risk of further 106–107 m^3 slides, justifying geotechnical study and mitigation. There are numerous steep volcanic flooded craters or calderas worldwide with inherently unstable slopes, some of them important repositories of palaeoclimate and palaeoenvironment data, and some heavily populated or visited. For those, landslides are a 10–1000 y scale primary perturbation or recurrent flood and possible outgassing hazard (e.g. Nyos, Monoun).

3 O – 23/9.00-9.20

Volatile degassing, dike initiation and propagation and xenolith entrapment by alkaline magmas

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Mantle derived xenoliths and their host alkaline magmas show evidence that they originate at depths of tens and even hundreds of kilometres in the Earth's mantle. Limited reaction between xenoliths and magma, steep diffusion profiles and experimental data on xenocryst dissolution rates, all suggest fast ascent of kimberlites and alkali basalts from source to surface, over a timescale of hours to days.

The fast ascent rates, as well as the physical size of the xenoliths indicate rapid magma transport in dikes for most of the ascent. However, the high strength of the rocks and the difficulty to accumulate stresses in the hot ductile mantle should suppress the initiation of dikes and cracks at such depths. This raises the questions of how to initiate a dike in hot, ductile rocks and how to break the wall rocks of the dike and form xenoliths.

We suggest that nucleation of bubbles in volatile-supersaturated magmas produces pressures that are high enough to initiate tensile cracks in hot mantle rocks. The supersaturation needed for nucleation of CO_2 bubbles in basanitic melt is of the order of 200 MPa (2 kbar). After nucleation, bubbles grow rapidly and elastically deform the surrounding rocks until the radial stress in the rock compensates the excess pressure in the bubbles. We solve the problem of bubble growth in a deformable media, and show that: (i) bubble expansion and pressure buildup in a deformable rock occurs over a short period, and (ii) the rock is stressed by a sizeable fraction of the supersaturation pressure (tens of MPa). The tensile stresses formed by the nucleation event are high enough to initiate cracks. The factors controlling the degree of loading are the bulk modulus, the solubility law, the ambient pressure and the critical supersaturation.

The role of volatiles is not limited to the initiation of dikes and cracks. Melt inclusions in phenocrysts in kimberlites are rich in volatiles relative to the erupted composition. Experimentally measured solubility of CO_2 in kimberlitic magmas is also very high. These data suggest that at depth, alkaline magmas carry high contents of carbonates, chlorine and, perhaps, water. Exsolution of volatile components during most of the ascent is important in propagating the tip of the ascending dike and propelling the magma through it. The release of CO_2 must also affect the composition of the melt. As the carbonate-rich melts release CO_2, the Mg and Ca of the carbonates remain in the melt and associate with the silicates, leading to the development of the highly mafic character of kimberlites and related alkaline magmas.

9 O — 25/10.00–10.20

Pedagogical and didactical methods in the Geopark concept in the demonstration of volcanic processes associated with monogenetic volcanic fields in Hungary: the Montessori method as a viable alternative

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The Montessori Method is a successful education method worldwide that is predominantly used in kinder gardens to lower elementary schools. However, the method itself is developed further and used in a few cases up to the secondary school education. One of the many basic principals of the Montessori Method is to start every educational approach from the concrete experiences to more abstract concept of our environment. In the Montessori Method the education for the sustainable development, to demonstrate the complex interrelationships between animal, plant and non-living environments that are in good concert with basic ideas of many organisation to develop educational programmes to learn living with and in our cosmic environment. In this point of view there is a good connection with the Geopark concept developed under the UNESCO very recently. Through the creation of a world network of natural parks with significant geological features, labelled UNESCO Geopark, UNESCO promotes the twin goals of conserving a healthy environment and enhancing sustainable economic development. Geoparks are designed to become a tool for a better understanding of the geological heritage and wise use of the Earth's crust, by increasing public awareness for a balanced relationship between humankind and the earth. In spite of this reasonable goal, here we demonstrate some case study from recent development of educational programmes in Hungary as a future base of proposed Geopark networks in Hungary that needs significant pedagogical input to reach a level of well-functioning systems in the local and broader communities. Here a preliminary approach is presented how Montessori pedagogical method maybe able to help to develop long living, scientifically alive, up to date and multi level programmes, e.g. to demonstrate the variation of volcanic features associated with monogenetic volcanic fields, that are well exposed in Western Hungary. Here we also emphasize the need that the a major scientific organisations of earth sciences in a region like Hungary such as the Geological Survey (GSH) and Geological Institute of Hungary (GIH) would be the perfect sites to manage these programme in close collaboration with the national parks, trained educational experts as well as other research organisations from universities. This role of the GSH–GIH in this respect is a natural one since these organisations have the authority as well as the scientific merit to stand behind these programmes and promote their well established standards.

1 P — 22/17.00–18.00, 23/17.00–18.00

Anisotropy of magnetic susceptibility and sedimentary fabric studies of phreatomagmatic surge deposits, Hopi Buttes, Navajo NE Arizona

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The Hopi Buttes volcanic field is a group of late Mio-Pliocene volcanic vents characterized by hydrovolcanic activity. The volcanism at the Hopi Buttes produced ~300 maar and diatreme volcanic landforms scattered within an area of 50 km in diameter. The maars formed from phreatomagmatic explosions involving the interaction of liquefied lower Bidahochi sediments, groundwater, and possibly lake water with erupting monchiquitic and nephelinitic magma. Phreatomagmatic eruptions produce a spectrum of pyroclastic density currents, "pyroclastic flows" or "pyroclastic surges/hydrovolcanic surges". The latter of which is the scope of this study. The direct products of these violent eruptive events are gas and particle clouds, which, over distances, gain and/or lose competency due to a decreasing energy budget or palaeotopographic controls. Palaeotopographic reconstructions of the Hopi Buttes volcanic field reveal a playa type environment, which at most has a 1–2° regional dip. This affords the opportunity to study individual surge deposits on the microscopic scale to determine the emplacement dynamics of the eruptive events without the complications of topographic interference.

Anisotropy of magnetic susceptibility and sedimentary analysis will be used to examine the internal microscopic fabrics of individual surge deposits at proximal, medial, and distal locations from the eruptive vent. These techniques may give insight on the flow and depositional processes of the transient hydrovolcanic surges. Preliminary data suggest a distinct segregation of microscopic fabrics (both AMS and sedimentary fabrics) within these surge deposits at proximal, medial, to distal facies. These observations may be attributed to downcurrent flow transformations, variable flow regimes, and degrees of wetness result in complex lateral and vertical facies changes. These preliminary results indicate a favourable outcome for new techniques to examine flow and depositional processes. With further work on the Hopi Buttes surge deposits we may find a proxy for bridging the gap between theoretical modelling and physical volcanology.

3 O — 23/10.00–10.20

Preliminary facies studies at the merale uranium prospect, Mio-Pliocene Hopi Buttes Volcanic Field, Navajo Nation NE Arizona: implications for volcanic processes, volcanic palaeoenvironments, and mineral exploration

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As a part of a masters thesis, I have undertaken a field-based, detailed investigation of complex interactions between magmatic and phreatomagmatic processes in the conduit, transport processes in the vertical and lateral currents, and depositional processes at the Merale Uranium prospect, which is located north Holbrook, AZ. This prospect is situated within Hopi Buttes volcanic field; a group of late Mio-Pliocene volcanic vents characterized by hydrovolcanic activity.

Historically, several mineral exploration programmes have been conducted throughout the southwest to evaluate its potential for uranium and other trace metal mineralization.

Unfortunately, the generally small size of sub-volcanic conduits relative to their volcanic products commonly makes them difficult to recognize, especially in highly eroded volcanic sequences. Thus, detailed facies mapping in volcanic sequences is also and essential part of determining vents proximal volcanic environments.

I have undertaken detailed mapping (1:500 scale to 1:600) of the physical characteristics of extremely well preserved, phreatomagmatic vent and surge deposits at the Merale prospect. I used anisotropy of magnetic susceptibly (AMS) and sedimentary fabrics to correlated proximal, medial and distal surge facies.

The detailed mapping has also aided in the identification of several surge deposits that can be seen undergoing vertical and lateral facies changes. These regions represent the volcanic vent sites from which these surge deposits are produced. In several vent-proximal locations, travertine and lacustrine deposits are containing anomalous uranium values. Thus, our results support the relationships between proximal volcanic environments and uranium mineralization in phreatomagmatic sequences.

The results suggest that in phreatomagmatic surge sequences, AMS characteristics may be used as an indicator of proximity to volcanic vents. This has significant implications for mineral exploration, as this measurement can be easily and completed in laboratory analysis, and may provide an effective meant to identify regions within volcanic sequences that are likely to contain mineralization.

5 O — 23/16.20–16.40

Origin of magnetic anomalies in volcaniclastic units of the Messel maar-diatreme (Germany)

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The Messel Pit near Darmstadt (Hesse, Germany) is worldwide one of the most important locations for fossils of animals and plants. Geophysical studies and a cored borehole in autumn 2001 (up to a final drilling depth of 433 m) proved the phreatomagmatic origin approximately 48 million years ago, revealing a typical maar volcano. A characteristic feature of the Messel maar-diatreme structure is a distinct negative anomaly of the earth magnetic field. Below the fossil-bearing oil-shales volcaniclastic sequences, mostly lapilli tuffs, have been drilled. It has been shown by downhole magnetic measurements in combination with rockmagnetic studies on core samples that these sequences contribute significantly (~60%) to the observed magnetic anomaly. Juvenile volcanic components are represented by mm- to cm-sized lapilli and are mixed with clasts of the host rocks (metamorphic basement and cover sediments). Small-sized titanomagnetites with a magnetite-near composition are disseminated within the lapilli and have been identified as main carriers of rockmagnetic properties. The (titano)magnetites occur as small individual grains in the lapilli matrix as well as rims around cores of Cr–Al spinels and frequently show skeleton-like textures. Rockmagnetic studies allow a subdivision of the magnetic anomaly into subunits characterised by significant differences in the intensity of natural remanent magnetisation (NRM). It is suggested that recorded differences in the NRM are controlled by a (partial) thermoremanent magnetisation and variations in the depositional temperature, respectively. We assume that the lower part of the volcaniclastic material has been deposited at temperatures of 300 °C or more.

2 O — 22/16.30–16.50

Vent alignments at maar volcanoes

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Many maars are elongate, with aligned vents carving out the oblong shape. Two maars in the Serdan-Oriental Basin in the eastern Mexican Volcanic Belt, Atexcac and Tecuitlapa, have several aligned vents. Tecuitlapa is a <20ka basaltic maar in the Serdán-Oriental Basin in the eastern Mexican Volcanic Belt. The 1.5-km-diameter crater is approximately 100 m deep, with a 5-m-deep lake in the western portion of the crater. An east–west aligned series of cinder/spatter cones occurs in the crater, with the highest cone ~50 m above the crater floor. Groundwater saturates the toba café, a predominantly silt, mostly of loess origin, at shallow depths, and this water-saturated silt provided the coolant for the fuel/coolant interaction (FCI) at the maars. Duneform orientations, combined with impact-sag orientations and facies variations, indicate that the eruptive vent migrated from the eastern part of the crater to the western part during the phreatomagmatic portion of the eruption. The cinder cone vents then migrated back to the east, forming at least four inset craters. As the eruption excavated deep into and possibly beneath the toba café, the country rock became coarser and possibly more indurated. Toba café ash in the matrix decreases as the vents migrated away from a site, as well as upward through the sequence. Atexcac maar formed in basement rocks varying from lavas, limestone, cinder cone, and breccias. The vent also moved during the eruption, varying in explosivity based partly upon what the substrate rock type was.

Many maar volcanoes in the Hopi Buttes volcanic field of northern Arizona, USA, also form lineations, and some of these are clearly coeval volcanoes. Explosivity varies along the lineations, due, at least in part, to how much coolant was available for fuel/coolant interactions. The two Ukinrek maars, Alaska, USA, also show evidence of alignment. The west maar is elongate with the orientation of the Bruin Bay Fault, which cuts through the area. The east maar is less elongate, but observations during the eruption show that it had two active vents during much of the eruption, and the eruption ended with strombolian fountaining.

Water and magma movement are controlled, in part, by local and/or regional faults and fractures. In consolidated substrate, water gains access to the magma along these planar features, and explosions enlarge and brecciate the areas at the ends of the dikes. As water is used up, the explosivity declines and the vent commonly moves back toward a single site. In unconsolidated substrates, it may be that deeper structural controls affect the orientation of the ascending dike, while interactions with the mud occur nearer to the surface. As the water or mud is exhausted in one location, the FCI moves to another part of the ascending dike, and the explosivity is maintained. At some point, the mud or water has largely been drained along the dike, and the eruption dries out. The products of these eruptions can vary from “dry” to “wet” at the same time, as different parts of the dike undergo these changes.

7 P — 24/17.00–18.00; 25/16.00–17.00

Fish remains from a Pliocene maar lake (Pula, Hungary); and their conservation methods

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In the Transdanubian Range of Hungary several Pliocene basaltic tuff rings (maars) are known. These are mostly isometric eroded craters and four of these maars (Pula, Gérce, Várkesző, Egyházaskesző) contain alginite in a various thickness. Alginite deposits at Pula contain well preserved fish fauna. From the summer of 2000 we have collected numerous fish remains. The conservation of fossils gave us much trouble because the preservation of fossils is generally good only in wet condition, while after drying they gradually break into pieces. To avoid this problem we have contacted the research group of the Hessischen Landesmuseum in Darmstadt (Germany) who had the same problem with the fossils of Messel. Nowadays we use the replacing method which means that all of the enclosing rock material will be replaced by synthetic resin.

The cranial elements and the structure of the caudal fin are the most important diagnostic characters of the fossil bony fishes. After the preparation of fossils we investigated the following distinguishing characters: the size, shape and the connection of opercular, pre-, sub- and interopercular in the skull. In the caudal region the position and number of epurals, uroneurals and hypurals have specific dependent variations. On the basis of these characters we could identified 2 genera and 4 species of this fish fauna, namely *Perca* sp. 1., *Perca* sp. 2., *Perca fluviatilis* LINNEAUS, and *Leuciscus cephalus* CUVIER. Based on diatoms, vascular plants and chemical analysis the temperature of the water of the lake was approximately 10–15 °C, and the pH varied between 5 to 9. The presence of these fish taxa support these estimated ecological factors.

7 P — 24/17.00–18.00; 25/16.00–17.00

Maar lake sediments in Java — a tropical climate archive?

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Tropical climate archives in the vicinity of the West Pacific Warm Pool are important for reconstructions of the El Niño-Southern Oscillation (ENSO) phenomenon. In East Java, maar volcanoes are restricted to the lower slopes of the Lamongan Stratovolcano and the Tengger Caldera. At least 18 dry maars and 14 maars with a crater lake surround the Lamongan Volcano. A single maar, Ranu Klindungan, is located on the northern slope of the Tengger Caldera. From the diameter to depth ratios of the craters, from historical and geological observations the ages of the craters are estimated as some hundred years up to more than 10 000 years. Climate in Java is characterized by a distinct rain and dry season. Interannual variations are influenced by ENSO, with warmer and dryer years during the El Niño phase. The lakes are thermally stratified during most time of the year (oligomictic lakes). At several lakes short sediment cores were retrieved. The sediments consist of diatomaceous and calcareous gyttja. Profundal sedimentation rates have been calculated from the depth of historical ash layers, ^{210}Pb-excess datings and warve counting as 2.5 to 8 mm/yr. From Ranu Klindungan sediments, elemental profiles measured with an ICP–MS–LA at a vertical resolution of 0.1 mm are presented. Strongly magnetized terrigenous layers, especially turbidites, are rich in Al, Si, Fe, P, whereas weakly magnetized biogenous layers, with frequent diatoms and calcite crystals, are rich in Ca, Si/Al. The increase in La and Pb values towards the top of the sediments points to the human impact onto the lake ecosystem by the use of fertilizers and atmospheric pollution by traffic. During wetter La Niña years the terrigenous input is higher, visible in thicker turbidites and higher magnetization, compared to El Niño years. Within the lake sediments recovered so far, about 200 years of ENSO are documented.

2 O – 22/14.20 – 14.40

Release of greenhouse gases in hydrothermal vent complexes causing global warming

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Hydrothermal vent complexes are pipe-like structures formed by explosive release of liquids and fluids during magmatic sill emplacement in sedimentary basins. We have recently completed an extensive seismic mapping of Palaeocene/Eocene sills and hydrothermal vent complexes in the Vøring and Møre basins offshore mid-Norway. The extent of the mapped sill complex is >80,000 km^2, with an estimated total volume of 0.9 to 2.5×104 km^3. We have further mapped 765 hydrothermal vent complexes connecting the sill intrusions with the palaeosurface, but we estimate that at least 2–3000 vent complexes are located in the basins. New biostratigraphic dating reveals that the sill and vent complexes were formed at the Palaeocene/Eocene boundary, near the start of the initial Eocene thermal maximum (IETM). The magma emplacement caused heating of the surrounding sedimentary strata and production of greenhouse gases. These gases were released through hydrothermal vent complexes. We have calculated that the total methane production potential in metamorphic aureoles in Vøring and Møre basins is in the rage 0.3 to 3.3×10^{18} g

CH_4 assuming that 0.5 to 2.0 wt.% organic carbon was converted to methane. The methane production potential in the entire NAVP is estimated to be about five times greater. The total volume of methane produced in metamorphic aureoles in NAVP is larger than the volumes required to explain the IETM and the associated light carbon isotope excursion. However, the greenhouse gases have to be produced and released in a short time (~10^4 years) to be able to explain large global warming events. Field and seismic data, combined with melt modelling, show that very voluminous sill complexes can be intruded and solidified in a short time span (>1000 years) during the initial phase of volcanic activity. Similar large-volume intrusive complexes are also associated with other global warming and mass extinction events, *e.g.* the Siberian Traps and the Permian–Triassic boundary.

***9 P** — 24/17.00–18.00; 25/16.00–17.00*

The Joya Honda maar, San Luis Potosi, Mexico: integration of a GIS for its proposal as geosite

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In contrast to some European countries where geoconservation is actively pursued, there is in Mexico little consideration for record of natural monuments. In the central part of the State of San Luis Potosi, Mexico, several maars have been identified. One of them, the Joya Honda Maar (JHM), is well known and the most spectacular. We intend here to present the JHM and the bases for its proposal as geosite. The JHM is a large, elliptical crater (greater axis: 1335 m; smaller axis: 955 m) with nearly vertical walls. The maximum relief from the floor to the top of the rim is ~300 m and the excavated crater itself, from the pre-volcanic surface to the bottom of the maar, is ~220 m. These above average parameters make the JHM a unique volcanic form in a country where volcanoes are widespread. Several characteristics lead us to considerer the JHM potentially as a good geosite. Firstly, this spectacular and well preserved landscape, located in a desertic zone, gives an aesthetic value to the site. Secondly, the JHM also presents a scientific value because it displays an example of mantle xenoliths and its volcano-stratigraphic sequence is comprehensive and well preserved; in addition, the contact between the pyroclastic sequence and the Cretaceous limestone basement is clearly exposed. Thirdly, the volcanic products have buried fossils of greater vertebrates like mammoths and horses that could help to reconstruct the palaeoenvironments that existed 1 My ago. Finally, the JHM shelters a fragile desertic ecosystem composed of endemic species such as cactus. We present here a first GIS of the JHM which integrates all the information available on the site, in order to analyse and to support the proposal of JHM as geosite.

***1 P** — 22/17.00–18.00; 23/17.00–18.00*

Accretion temperatures of thephra deposits of the Messel structure derived from rockmagnetic investigations

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The phreatomagmatic origin of the Messel maar-diatreme structure near Darmstadt (Hesse, Germany) is proven by the Messel 2001 drilling project. A combined interpretation of surface geophysical measurements, the results of the downhole logging and the lithological core information confirms a maar-diatreme model for Messel. The Messel 2001 borehole penetrates a magnetised body, as it can be seen in downhole (magnetic total field anomaly, susceptibility) and core (susceptibility, remanent magnetisation) logging data. Surprisingly only the lower part of the drilled 133 m thick tuff unit is strongly magnetised (up to 10 A/m), and therefore source of the observed magnetic anomaly at the surface. The upper part of the tuff is characterised by significantly lower magnetisations (< 500 mA/m). It is quite common in many eruptive cycles for parts of a tuff to be welded, and thus magnetised in place, and other parts deposited as air-fall with little alignment of the individual magnetic moments. But preliminary petrological observations do not show distinct petrological differences for the whole tuff unit. Therefore other reasons must be found to explain the differences in the magnetic properties within the tuff body. Variations in the magnetic susceptibility can not cause the observed intensity discrepancy. Laboratory produced thermoremanent magnetisations indicate that the deposition temperature of the volcaniclastics is a relevant parameter for the observed variation in the intensity of the natural remanent magnetisation. We assume that the stronger magnetised lower part of the tuff unit has been deposited at temperatures of 300 °C or more. The contribution of rock magnetic experiments for revealing the depositional history of the Messel maar-diatreme will be discussed.

1 P — 22/17.00–18.00; 23/17.00–18.00

Heterogeneous complex of rocks in kimberlite occurrences' craters of north-east of Angola

Rotman, A. Y.[1], Ganga,J.[2], Zintchouk, N. N.[1], Nosyko, S. F.[2], Somov, S. V.[2], Cherny, S. D.[2], Vuiko, V. I.[2], Shimupi, J.[3] and Stegnitsky, Y. B.[1]

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Most kimberlite occurrences of north-east of Angola are distinguished by availability of craters among which the largest in area of diatremes are Camafuka-Camazamba (150 ha) and Catoca (65.7 ha). Crater part of pipe Catoca is one of the most studied targets and in geometry it represents a funnel 250–270 m deep with dip angles of crater slopes' variations from 85–88 to 40–50 degrees in the direction from periphery to its centre. Position of the latter coincides with the centre of the diatreme.

More than 80% of its area is overlapped by Calahari formation sediments and interformational sands terrane of Palaeogene–Neogene age including a layer of gritstone and conglomerate blocks, which is observed only within the crater depression. Total thickness of sedimentary sequence fluctuates from the first metres to 130 m. Country rocks are represented by Pre-Cambrian gneisses and to a small degree by schists.

Crater rocks are rather variable in genesis, composition and include kimberlitic volcanoclastic (pyroclastic or explosive-fragmental) and sedimentary-volcanogenic formations, volcanogenic-sedimentary (synchronous and non-synchronous eruptions) and sedimentary (epiclastic) formations with kimberlite material impurity. The whole row of genetic types is distinguished in the last group and in nonsynchronous to eruption volcanogenic-sedimentary rocks: eluvial–dealluvial, alluvial–dealluvial, temporary flows, gravity (cave, slide rocks and landslide deposits), dealluvial–colluvial, deposits of feet, proluvial and lacustrine deposits. Along contacts of volcanogenic-sedimentary rocks and volcanoclastic kimberlites sharp boundary is absent, as a rule. Usually complicated relationship with gradual transition into each other is observed between them. Among the rocks of the crater one can distinguish heterogeneous breccias (dealluvial breccias, tuff breccias etc.) in lithology with broad fluctuations of fragment sizes, psephite (gritstones, tuff gritstones, tuffites, tuffs, and xenotuffs) and psammitic (sandstones, tuff sandstones, psammitic tuffites, tuffs and xenotuffs) formations, siltstones and mudstones. They differ in the quantity of kimberlite material: from insignificant and subordinated share in epiclastic deposits to prevailing one in sedimentary-volcanogenic and volcanoclastic rocks. The latter, as a rule, are confined to edges of the crater and reflect to the utmost mineralogical-geochemical properties of kimberlites including diamond distribution. Epiclastic deposits infill the depression of the crater lake and are distinguished by the least diamondiferousness. Characteristic indications of the crater rocks are variegated (greenish-grey, bluish-green, purple and reddish-brown) colouring and volcanogenic-sedimentary and epiclastic deposits comprise expressed to various degree layered textures with the thickness of layers from shares of cm to 7- expressed 10 cm and more. All layers are dipped to the centre of the crater. The borders between interlayers are different: between psephite-psammitic varieties they are usually gradual, and with mudstones they are sharp. Similar in structure and content crater sections are registered in other diatremes having variability in erosion degree and internal composition.

Under heterogeneous formations of the crater kimberlite breccias of diatreme facies occur. The rocks of the crater differ from diatremes kimberlites both by petrographic and mineral and chemical composition and petrophysical parameters.

3 P — 22/17.10–18.00; 23/17.00–18.00

Diamond placers in diatreme craters of near-equatorial Africa (Angola)

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Formation of kimberlite craters is characteristic of near-equatorial Africa, including Angola; one of the countries with a large potential for diamond mining. Kimberlite diatremes (Camazamba, Catoca, Camutuye and Camachia fields) form a band along the Lucapa corridor of Angola and provide most of the country's diamond resources. These occurrences lie within the Kasai-Lunda diamondiferous area, embracing the south-western region of Republic Zaire and the north-east part of Angola. Limited erosion is a remarkable feature of the regions kimberlites. Together with known Cretaceous and Quaternary diamond placers deposits, the diamond-bearing nature of kimberlite crater deposits has also been revealed, which may constitute a mining target. The Catoca pipe is the best example; at present it is the only operating primary diamond deposit in Angola. This pipe is the largest in kimberlite field "Catoca" where 24 kimberlite pipes are known. The complicated structure of the Catoca pipe has been established, as noted by the preservation of kimberlite crater deposits. Sedimentary deposits with admixture of kimberlite material, kimberlite volcanogenic-sedimentary, sedimentary-volcanogenic formations and volcanoclastic kimberlites are present in the crater deposits. They constitute a cup-like body stretching to 250–270 m depth from the present day land surface. Sedimentary and volcanogenic-sedimentary formations are the most variable. Their genesis is related to destruction and falling of the crater walls, and deposition and multiple redeposition both of kimberlite and extraneous material according to the conditions of sedimentation. Observed rock types include heterogeneous breccias, psephitic and psammitic formations, siltstones and mudstones. They indicate various fixed quantity of kimberlite material: from the lowest proportions in epiclastic deposits, to prevailing proportions in sedimentary-volcanogenic (but with rather heterogeneous distribution) and volcanoclastic rocks. Analysis of diamond distribution in the crater part of the Catoca pipe indicates broad dispersion in heterogeneous formations at the highest concentration (up to 2 c/t, rarely higher) in volcanoclastic kimberlites of near-edge part and secondary kimberlite breccias, and at the lowest concentrations in epiclastic sandy-aleuritic deposits of the crater depression. The diamond grade of crater formations in other kimberlite diatremes of the region is not sufficiently studied at present; but it is significantly lower and these deposits may not be of economic interest. It is notable that diamonds and their indicator minerals, in spite of being close to the source, have indications of roundness in volcanogenic-sedimentary and sedimentary formations. On the whole placer formation in craters of kimberlite diatremes has complicated their polygenic and polichronic character. Processes of kimberlite rocks destruction and accumulation of kimberlite minerals were repeatedly interrupted by processes of their material dilution of the hosting metamorphic sequence and burial by fragmental sediments. Such placers, despite relatively small average level of diamondiferousness (with increase of diamond concentrations on individual sites), require attention due to significant volumes of mining mass which is subjected to excavation during stripping of primary kimberlites.

4 P — 22/17.00–18.00, 23/17.00–18.00

Phanerozoic volcanic associations of the Siberian platform's east

Rotman, A. Y.

YaGEER&D CNIGRI ALROSA Co. Ltd., Russia

Volcanic occurrences in eastern part of the Siberian platform are represented by a rather broad set of various in facies formations the age of which embraces the range from Riphean to Cretaceous. Phanerozoic volcanic associations including the bodies of diamondiferous kimberlites cause special interest. The earliest here are Middle Palaeozoic basic rocks occurrences related with rift-like structures (the covers in their internal parts, dyke complexes in edges with subordinated development of sills). There are frequently basic rock volcanic pipes, stock- and laccolith-like bodies are spread insignificantly. The listed morphological types of volcanic bodies are composed by heterogeneous basic rocks of normal and increased alkalinity. More diverse is petrographic and mineral composition of volcanic pipe breccias revealed during verification of magnetic anomalies of "pipe" type and forming groups and linear trains. These rocks differ by brecciated, taxitic, ball, sometimes spherolitic texture and predominantly agglomerate structure.

The content of related rocks debris (polyphyric and plagiophyric basalts) constitutes from 5 to 90% (30–55% in average), and xenoliths of sedimentary cover — 2–30% of the volume. The most remarkable feature — vertical petrographic zoning of volcanic pipes with broad range of petrophysical parameters variations, detection of globular clastolavas and hyaloclastites in individual sections.

One can confidently state availability of three facies representatives in kimberlite occurrences of Yakutia — hypabyssal (subvolcanic), diatreme (volcanic), and crater (explosive). The first one is represented by porphyric kimberlites (PK), infilling dykes and stocks. Diatremes are composed by kimberlite breccias (KB), as a rule, and by autolithic kimberlite breccias (AKB). Fragments of crater parts are filled by kimberlite tuffs (KT) and tuff breccias (KTB). Encountered in individual bodies fragments of crater parts are filled by kimberlite tuffs (KT) and tuff breccias (KTB). Between the main varieties of different facies affiliation one can sometimes observe breaking contacts, as well as the presence of some of their debris in others, which allow distinguishing two phases of kimberlite bodies development — subvolcanic (intrusion phase I) and volcanic (intrusion phase II) with formation of corresponding rock facies. Sometimes one can observe extrusive derivatives — taxitic autolithic kimberlite breccias (TAKB). AKB is the most spread variety in all kimberlite diatremes of the province without exception. AKB possesses the largest productivity relative to PK of subvolcanic phase in industrial diamond deposits, and average- and low-diamondiferous pipes indicate the contrary tendency.

Rock masses of central type Tomtor and Bogdo are related with the same stage, being composed by melilitolites, jacupirangites and melteigites, ijolites, nephelinic and alkaline syenites, phoscorites, carbonatites — in Udzhinskaya rift-like system.

The largest volumes of magmatic formations are referred to Late Palaeozoic – Early Mesozoic stage. Practically uninterrupted section of different in facies derivatives of Tungusskaya syneclise tholeiite-basaltic formation is most remarkable here, composing the foundation of East Siberian trappean province. Mesozoic volcanic phases have also relation with kimberlites and alnoites of eastern and south-eastern parts of Anabar anteclise.

The stated above shows the existence of various conditions in Phanerozoic and, consequently, various types of volcanic activity, which caused the formation of heterogeneous occurrences of volcanic rocks.

7 O – 24/11.50 – 12.10

Time-series analysis of the Oligocene Baruth Maar laminites (Eastern Germany) — first results

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Deep maar lakes provide excellent conditions for the preservation of climatically sensitive sediments. This study deals with the detection of palaeoclimatic information in seasonally laminated maar lake depositions.

The investigations are based on algal laminites from drill cores of the Upper Oligocene Baruth Maar (Germany, Saxony). The lamination is due to light and dark layers. Light layers almost completely consist of centric diatoms derived from algal blooms. Dark layers represent the background sedimentation. They are composed of pinnate diatoms, but additionally contain chrysophyte cysts, clay and authigenic minerals. The intensity of algal blooms is climatically influenced. Therefore variation of lamina thicknesses indicates palaeoclimatic changes.

The topmost 20 m of laminated sediments are nearly undisturbed. Based on an average sedimentation rate of 200 µm/a, the data set contains a 100 000 a lasting climate archive. For further investigations a 1 cm broad and 20 m long drill core strip was scanned with high resolution and treated with an automated data processing approach (Adaptive Template Method). Several disturbances interrupt the signal. Thus single data sequences range between 50 and 700 a.

Temporal analyses concentrate on the reconstruction of sedimentation rate and the detection of layer characteristics with the help of explorative statistics. For analysis in frequency space both classical non-parametric methods (e.g. periodogram), parametric methods, and subspace algorithms (SSA) are used.

Analyzed data show a wide variety of different frequencies. Some periodicity classes occur with higher frequencies: 80–90a, 40–50a, 30–35a, 22a, 15–16a, 11a, 6–8a, and 4–5a. Investigated periodicities can be related to several forcing mechanisms. Variations of solar irradiance occur both as classical 11-year sunspot cycles (Schwabe cycle) and as multiple elements (22a Hale cycle, 88a Gleisberg cycle). These frequencies are possibly linked with periodicities of the analyzed lamina thicknesses in the algal laminites. Cycles on yearly to century scales may be forced by coupled atmosphere-ocean oscillations.

7 P — 24/17.00–18.00; 25/16.00–17.00

Time-frequency patterns of the Oligocene Baruth Maar laminites (Eastern Germany)

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Seasonally laminated, lacustrine algal deposits of the Upper Oligocene Baruth Maar lake provide a 100 000a lasting, high resolution climate archive (for further information see Rupf et al. this volume). This sedimentary record is treated with sophisticated time-series methods to detect cyclic/quasiperiodic elements and longer trends of climate development.

To identify climate-driven periodicities, the core sections are analyzed with the help of several non-parametric and parametric spectral estimates. Computed diagrams show a large variety of different frequencies. Some periodicity classes occur with higher frequencies: 80–90a, 40–50a, 30–35a, 22a, 15–16a, 11a, 6–8a, and 4–5a. One main drawback of this method class is, that it does not provide information about the time-development of frequencies. To distinguish between significant cycles and short-term events, advanced time-frequency techniques are needed. Besides the classical windowed Fourier transform (Gabor transformation), tools like Evolutionary Power Spectra (EPS), and Wavelet transforms are able to extract information about the time-frequency development from the signals. Analysis of the Baruth Maar data sets show both simple frequency paths (e.g., at periodicities near 11 and 22 years) and complex time-frequency patterns with bifurcation phenomena. The second category occurs at higher periodicities around 6–8a, 4–5a, and 3a.

Cycles at 11a, 22a, and between 80–90a are probably forced by solar irradiance (e.g., the 11-year sunspot cycle and multiple elements, like the 22a Hale cycle or the 88a Gleisberg cycle). They exhibit simple, slowly varying time-frequency patterns. Periodicities at 15–16a, 6–8a and 4–5a may be linked with coupled oceanic-atmosphere oscillations. They show a quasiperiodic behavior with several stable frequency modes. Recent to subrecent oceanic-atmosphere oscillations, like ENSO or NAO, indicate similar patterns. In general both Tertiary and Holocene complex time-frequency structures seem to be forced by similar mechanisms.

7 P — 24/17.00–18.00; 25/16.00–17.00

Reconstruction of the Paleoenvironmental Evolution of the Bone Gorge Maar near Hajnáčka (southern Slovakia)

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Remnants of the Bone George maar are situated approximatelly 1.5 km to SE of Hajnáčka village (Rimavská Sobota district, southern Slovakia) in the territory of the palaeontological site Hajnáčka I, which belongs to the Cerová Basalt Formation (5.03 to 1.16 My). The maar was formed by both phreatic and phreatomagmatic activities. Pre-volcanic basement of the maar is formed by Eggenburgian sandstones of the Fiľakovo Formation. The maar fill consists of lapilli tuff and fragments of sedimentary rocks in its lower part and lapilli tuff alternating with sandy layers in its upper part (fossiliferous layers). Sporadically, calcified laminated sediment remnants of the primary maar filling can be found too. The loam-sandy deposits of the Late Pleistocene represent the youngest part of this sedimentary sequence.

An abundant fossil assemblage (especially mammals) has been found in the fossiliferous layers. On the basis of the occurrence of *Mimomys* advanced species, Fejfar, Heinrich (1987) placed the Hajnáčka fauna in the Late Pliocene MN 16a biozone (2.8 to 3.3 My), what corresponds to the middle part of the Gauss magnetochron (C2An) with normal polarity. The Hajnáčka mammal assemblage can be subdivided into three main ecological groups: (1) inhabitants of aquatic and semiaquatic environments; (2) forest inhabitants; and (3) inhabitants of open land. Current knowledge enables the various stages of the environmental evolution of the area around the Bone Gorge maar (Hajnáčka I site) to be reconstructed:

– Phreatic explosions began to form the depression of the Bone Gorge maar at the beginning of the Gauss magnetochron (C2An, approx. 3.55 My ago). Ejected sandy material from disintegrated Eggenburgian sandstones accumulated as a layer at the bottom of the maar.

– Successive phreatomagmatic eruptions formed the tuff ring. Gravity driven slides transported tephra from the inner slopes of the ring to the lower levels of the maar depression.

– After phreatomagmatic eruptions finely laminated sediments accumulated in the central part of the maar lake under eutrophic conditions. Whereas unicellular heterotrophic peridinioid dinoflagelates dominated the lake itself, a forest mainly consisting of thermophilous coniferous taxa, but with sporadic occurrences of angiosperms, grew farther away from its shores.

– At approximately 3.3 My ago the tuff ring was partly destroyed and eroded due to a domatic uplift of the Cerová vrchovina Highland. As a result, sediments of the primary maar filling were removed and replaced by the ones of the secondary maar filling (limnic sand, sandy tuffite, reworked lapilli tuff and limonitic sandstone fragments). These accumulated in the lake, which by now possessed an inflow and outflow. The area around the lake was covered in bushy, humid (but not swampy) primeval forest (Lindsay et al. 1997), with steppe or open grassland areas present. Tapirs, mastodons, rhinos and cervids dominated the forest, whereas representatives of hyaenas, machairodontids, lagomorphs and some rodent species were present on the warm, open steppe.

– The extinction of the Hajnáčka fauna and flora was probably caused by the eruption of a nearby volcano. During the next period (the third volcanic phase: 2.92 to 2.60 My ago), volcanic activity in proximity to the site continued and the entire area was uplifted. The sediments of the secondary maar filling, and the vertebrate skeletons they contained, were reworked, most probably by water erosion.

– During the Quaternary erosion, solifluction and repeated landslides destroyed what remained of the maar and redeposited its sediments elsewhere.

5 P – 22/17.00–18.00; 23/17.00–18.00

Discussion of the diatrem under the maar of Kleinsaubernitz in east-saxony by gravimetrical calculations

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The maar structures in East Saxony were discovered by the enormous local gravimetrical minimum of about 10 mGal which was found near the village Kleinsaubernitz in 1967. First the minimum was misinterpreted as a granite body with lower density as the granodioritic country rock. In 1970 a 500 m core revealed only Tertiary sediments. The investigation of another minimum nearby the village Baruth pushed the discussion upon their origin. To solve the problem two drills were placed in 1998 and some geophysical investigations were done to optimize the drilling locations. Some of the important information was produced by special gravimetric measurements.

Using all gravimetrical data from the minima of Kleinsaubernitz and Baruth it was possible to interpret both anomalies as maars. The focal point was the determination of the margin of both maars by using the second vertical derivative and a 3D-calculation-model with prismatic rectangles and various densities. The result was a good correspondence of measured data and calculated data. But there was one difference, which raised new questions in geology.

By placing a diatrem with an angle of incidence of 82 degrees under the Maar and varying the diameter and the difference of density to the granite rock in the neighbourhood various combinations have been calculated. As a result of these calculations a good correspondence of some models with the local Bouguer-anomaly could be noticed, for example for a diatrem with a diameter of 500 m, a depth of 2350 m and a density-difference of 400 kg/m^3 or for a diatrem with a diameter of 700 m, a depth of 3000 m and a density-difference of 300 kg/m^3.

The gravimetric model-calculation that combines the classic maar-model with a diatrem-model revealed a better correspondence, of the diatrem-model with the gravimetric anomaly.

5 O – 23/16.40–17.00

Detailed investigation of preserved maar structures by combined geophysical surveys

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The detection of completely preserved maar structures is important not only for underground mapping but also for palaeoclimate research because the fine-laminated lake sediments represent a very detailed archive of climate history. Objective evidence for the existence of such structures can only be provided by geophysics or boreholes. The combination of gravity and magnetic ground surveys appears to be an excellent tool to detect and identify buried maar structures. Their distinguishing properties are an almost circular gravity minimum corresponding to a crater filled with limnic sediments of low density, and a magnetic anomaly caused by a tuffic or basaltic body in the diatreme which indicates the volcanic character. Seismic measurements provide the most detailed information about the internal structure of the maar sediments. Zones of low seismic reflectivity and very low density represent sediments of the late stabilised maar lake period. The early lake period is indicated by debris flows and turbidity currents represented by seismic reflectors. The seismic sections clearly reveal the bowl-like structure of the maar. Outside this bowl-like structure there are only a few reflections, which represent the basement. Taking into account the shape of the gravity anomaly, seismic information allows geometrical modelling of the maar structure. Optimal drilling sites can be selected based on the results of geophysical surveying. Comparing the results of combined geophysical surveys above two maar structures of different ages yields a marked similarity in their geophysical pattern.

1 P — 22/17.00–18.00; 23/17.00–18.00

Diluted pyroclastic density currents produced during the 1982 eruption of El Chichón volcano, Chiapas, Mexico: transport and depositional processes

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After twenty years of the March 28 – April 4, 1982 catastrophic eruption of El Chichón volcano, Chiapas, Mexico, new outcrops exposing a more complex sequence of deposits have become available due to erosion. The last phases of the eruption occurred on April 4 and lasted few hours. They were characterized by a complex interplay between magmatic and phreatomagmatic processes, that were responsible for the generation of concentrated and diluted density currents and fallout. Revision of the stratigraphy indicates that the interaction between magma and water (mixed with acid fluids derived from an active hydrothermal system), played an important role. Density currents were widely dispersed, mainly to the East (up to 9.5 km NE and 10.5 km to the ESE) and secondarily to the SW (up to 8.5 km). The distribution coincides with the main directions of tropospheric (E–NE) and stratospheric winds (W–SW) at the time of the eruption, as determined by the dispersal of fallout deposits. This observation suggests that near-ground winds were strong and blowing in the same direction as high altitude winds, thus enhancing the dispersion of the diluted pyroclastic density currents. Mixed transport processes (vertical and lateral) operated simultaneously in some cases, as confirmed by the different nature of the ash aggregates found in pyroclastic surge horizons.

4 P — 22/17.00–18.00; 23/17.00–18.00

Miocene ultrapotassic volcanoes in south-eastern Spain — an association of phreatomagmatic and magmatic products

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A series of small-sized Miocene (7.6–5.7 My) ultrapotassic (lamproitic) volcanic rock occurrences cover a large area in the south-eastern Spain. They are associated with basins filled by Neogene deposits in the Betic and Subbetic areas. Some of them have represent volcanic structures at Cancarix (Sierra de las Cabras), Calasparra and Barqueros, Cerro de Monagrillo, Jumilla, Vera, whereas the other are small-scale intrusions. The volcanic centres at Cancarix, Calasparra and Barqueros have been investigated. They show initially phreatomagmatic eruptions as a result of subaerial volcanic activity during which tuff-rings resulted. The subsequent activity consisted of plug (dome) extrusion in the vent area or by Hawaiian explosions, followed by extended lava flows.

Calasparra and Cancarix are relatively symmetric monogenetic tuff-cone volcanoes filled by late stage massive central vertical plugs. Barqueros was initially a tuff-ring volcano, which passed to Hawaiian-type activity with spatter accumulation and clastogenic lava flows building up a cone at Cabezo del Morron and finished with extensive lava flows at the base of the cone, which covered a large area toward the northern part of the edifice. The evolution of ultrapotassic volcanoes was influenced by the regional tectonic and specific local hydrogeologic conditions. Pre-eruptive crystal content of magmas was an essential controlling factor of volcanic structure evolution, setting conditions of higher viscosity at Calasparra and Cancarix and lower viscosity at Barqueros.

5 P — 22/17.00–18.00; 23/17.00–18.00

Prospection of the productive groundwater potential of maar volconoes and scoria cones in the Westeifel Volcanic Field (Germany) with gravity and geomagnetic survey

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Unconsolidated tephra of phreatomagmatic and magmatic volcanic edifices have a high potential as aquifers. In the Westeifel Volcanic Field, Germany, 270 Quaternary eruption centres are known. However, the whole potential of these volcanoes for groundwater production is largely unknown. One reason for this is the difference between the surficial catchment area of volcanic structures from their subaerial catchment area. The second reason is, that in several cases the amount of phreatomagmatic formation of scoria cone is unknown. We applied geophysical potential methods beside the geological mapping for an estimation of the lateral and vertical extent of porous deposits of complex volcanoes. On the quit different three case studies Gees, Eselsberg and Geisshecke we will present the complexity of the geophysical prospection campaigns.

The density contrast between Devonian country rocks and Quaternary tephra and scoria is in the order of 0.5 g/ccm. The observed negative gravity anomalies range between –2.2 and –3.0 mgal in the centres of the circular to oval shaped Bouger anomalies. From modelling we estimate the dimension of the volcano structures: dephts range from 100 to several of hundred metres and diameters ly between 0,8 and 1,2 km. The anomalies of the total magnetic intensity range between +800 and +1300 nT relative to the country rocks, with highest anomalies located in the centre (Gees Maar) or at the margin (Eselsberg, Geißhecke) of the gravimetrically defined craters. These values are typical for Quaternary scoria of the Westeifel. The modelling of the sedimentary filling of the maar volcanoes with central or marginal scoria cones was performed by a combination of gravimetrical and magnetic modelling, supported by an analysis of tephra and scoria outcrops.

Taken together, these observations allow to differentiate between a maar with final scoria eruptions (Gees Maar), a maar with intermediate scoria eruptions bordered by scoria cones and dykes (Eselsberg) and a scoria ring with initial maar volcano eruptions and marginal scoria cones and dykes (Geißhecke).

4 O — 23/14.00–14.20

Mechanisms of formation of cored ash-lapilli and elongate fluidal ash-lapilli during hydrodynamic mingling with sediment

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Textural analysis of juvenile ash-lapilli clasts in fluidal peperite is important as it can provide insight into the controls on magma fragmentation during MFCI pre-mixing and on hydrovolcanic tephra clast morphology. A textural study of ash-lapilli in basaltic fluidal peperite clasts incorporated in vent-fills and associated debris-flow deposits from the base of the Karoo LIP, South Africa records evidence of repeated ductile tearing and annealing of dm and cm-scale, poorly vesicular, magma domains during hydrodynamic mingling with an actively granulating silt to medium-sand poorly-consolidated host. Fold structures indicate that deformation of magma domains during rotational flow was an important process, with compression against rigid sediment clasts, phenocrysts and fluid bubbles. Fragmentation of these large-scale domains was accompanied by abundant ash-lapilli generation along their margins. The most common type of ash-lapilli clast are thin (<3mm) fluidal elongate clasts with globular, ragged and smooth curvilinear edges. These were mostly generated when sediment-water was injected along multiple concentric ductile tears that propagated close to and commonly parallel with the domain margins. Sediment-cored ash-lapilli are also common and were probably generated when larger sediment grains were trapped along a tear and/or when larger grains were coated during magma streaming. Smooth curvilinear fractures on some ash-lapilli were derived by their subsequent brittle fragmentation during quenching, or by mechanical fracturing during deformation of the unconsolidated peperite mix.

8 P — 24/17.00–18.00; 25/16.00–17.00

Evolution of an emergent tuff-cone: A depositional study of the Capelas tuff-cone, São Miguel, Azores

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The Capelas tuff cone is located on the northern coast of São Miguel, the largest island in the Azores archipelago. The Capelas tuff cone is assumed to belong to the Picos Volcanic System dominated by Holocene basaltic eruptions related to the NW–SE Terceira Rift that crosscuts the western flank of São Miguel.

Initially the tuff cone was built up by Surtseyan-type eruption and ended with an effusive phase creating a scoria cone and a lava pond inside the crater. Marine erosion has reduced the tuff cone volume by about 50%. The rim layers steeply dip (38°) into the crater and the outer layers dip 31° away from the crater, changing to 1–6° down section. The south-west side of the medial and distal deposits is underlain by a scoria cone and several lava lobes mantled by two pumice layers.

Initial explosive activity generated a 9–12 cm thick coarse-grained layer mostly composed of juvenile, pumaceous and aphyric clasts that discordantly cuts the pre-existing pumice-layer. The early proximal facies are dominated by crude and diffuse planar stratified lapilli-tuff, composed of 30% pumice fragments and abundant shell fragments. The medial facies at the lower part of the crater rim are dominated by diffuse, planar stratified and reversed graded bedding of finer grained lapilli-tuff. Resedimented deposits are characterized by massive lapilli-tuff lenses and poorly sorted U-channel deposits suggesting a wet environment. Preliminary data suggests that the U-shaped channels are both modified V-shaped fluvial channels and primary erosive base-surge structures. The distal facies are mostly composed of planar stratified tuff-lapilli with dominant normal grading.

The abundance of massive and undulating fine-grained layers increases towards the vent. More than 250 individual layers were investigated and approximately nine percent contain more than 5% xenoliths (>1 cm) dominated by aphyric, olivine+pyroxene-phyric and olivine+plagioclase-phyric xenoliths.

10 P — 24/17.00–18.00; 25/16.00–17.00

Searching for maar structures in the Persani Mts, East Carpathians, Romania

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Alkaline basaltic volcanism in the Persani Mts represents, besides Ciomadul Massif in the South Harghita Mts, the closing episode of the Neogene/Quaternary East Carpathian volcanic activity. It developed during latest Pliocene and Pleistocene times (cca. 2.25–0.5 My, according to K–Ar datings) and is represented by a field of monogenetic volcanoes. Four stages of volcanic activity have been identified throughout the Persani Mts, represented by four sequences of partly overlapping volcanic products: (1) lower phreatomagmatic sequence, (2) lava flow sequence, (3) upper phreatomagmatic sequence, and (4) cinder-cone sequence. The studied Hoghiz–Bogata–Bârc–Trestia area, located in the southern part of the volcanic field, shows the most complex structure. Volcanic centres of scoria-cone type have only been identified so far. They form easily recognizable prominent topographic features. However, the abundance of phreatomagmatic deposits in the area strongly suggest that maar-type centres should also be present. A pair of maar structures have tentatively been located on previous maps without positive evidence of their presence there. Our study, based on careful field examination of pyroclastic deposits, including base-surge deposits, attempts to provide evidence for location of maar structures in the southern Persani Mts. Criteria for location of phreatomagmatic volcanic centre(s) included: (1) interpretation of pyroclast transport directions from (1a) bomb-sag asymmetry and (1b) depositional structures of base-surge deposits, and (2) spatial distribution of clast size of ballistically emplaced products. Statistical evaluation of these indicators strongly suggest that at least part of the investigated pyroclastic deposits originated from a maar-type phreatomagmatic centre located south of Hoghiz village. Nonvolcanic lithoclast composition is consistent with basement lithology of the deduced volcanic centre location. Although no typical ring-like topographic features are preserved, as examination of aerial photographs show, the present-day flat topography of the site could reflect lake sediment filling of the original maar depression. Further investigation with drillings is needed to confirm, or reject, this hypothesis.

2 P — 22/17.00–18.00; 23/17.00–18.00

The submarine "Costa Giardini" Diatreme (Monti Iblei, Sicily)

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The "Costa Giardini" Diatreme (CGD), one of several diatremes studied volcanologically and petrologically, evolved in 3 different phases in a complex interplay of shallow marine phreatomagmatic eruptions, volcaniclastic sedimentation, patchreef growth, local tectonics, block subsidence and relative sea-level change at the onset of the "Messinian Salinity Crisis". Water depth varied from a few m in the north to >100m in the south. A submarine origin is evidenced by benthic foraminifera in the volcaniclastics, high carbonate content (40–80%) in the matrix and lava/carbonate mud peperite. Eruptive phases are separated by bioherm growth.

Phase I: (fully submarine) A basal 10 m massive extra-diatreme deposit of mafic lapilli in a matrix of former micritic carbonate mud is sharply overlain by volcaniclastic "debris jet" deposits (25 m thick) characterized by abundant bedrock clasts reflecting sudden onset of bedrock fracturing (initial diatreme formation), continuing throughout diatreme evolution. The downward migration of the fragmentation level may have been restricted to less than 200 m due to hydrostatic pressure of a permanent water cover.

Phase II: A palaeosol on top of the tephra ring and the sudden appearance of antidunes, accretionary lapilli and armored lapilli in the extra-diatreme volcaniclastics are characteristic for the second eruptive phase. The partly emergent tephra ring is interpreted to have caused a change to partly subaerial phreatomagmatic eruption dynamics. The diatreme deepened when the hydrostatic pressure on the fragmentation level was lowered due to a restricted water supply in the enclosed lagoon.

Phase III: The poorly exposed third phase is characterized by relics of a hyaloclastite cone and peperite-like mingling of lava and carbonatic sediments reflecting eruptions close to the water/sediment interface in the diatreme with intrusion of dikes into still water-saturated carbonatic sediments.

7 P — 24/17.00–18.00; 25/16.00–17.00

Event sedimentation in the Baruth maar lake

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In 1998 a core was drilled through the sediments of an Oligocene maar lake in Germany. The nearly complete core allows the reconstruction of the lake history. After the eruptions the crater filled with groundwater and a maar lake existed until it silted up after several 100 000 years.

Due to their special morphology maar lakes are small, deep and isolated from the surrounding drainage pattern by the tuff ring. The strong relief together with earthquakes or heavy rainfalls or the increase of subsidence in the centre causes gravitational redeposition into the deep lake. In Baruth the amount of those event deposits is 100% at the beginning and nearly 0% at the end of the record.

The sedimentation started with a collapse breccia (rock fall) which is a consequence of the gravitational arranging of the crater subsequent to the phreatomagmatic explosions. The allochthone sediment is mainly transported via debris flows and turbidites. The debris flows – restricted to the lower half of the sequence – are much coarser and not graded. Slumping structures occur irregulary in the profile.

During the early lake stage the turbidites consist of disintegrated mineral particles of the country rock (granodiorite). The turbidites higher in the profile also bear reworked lake sediments and pyroclastics. Increasing amounts of kaolinite in the turbidites show the progress in weathering of the ring wall.

7 O — 24/11.10-11.30

Subsidence within and above maar-diatreme volcanos

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Maar-diatreme volcanoes are cone shaped, up to 2 km deep structures mostly filled with unconsolidated primary and redeposited pyroclastic material. The diatreme fill is usually overlain by maar lake sediments, which are very soft and porous due to their organic origin. Diagenesis of the deep diatreme fill and the overlying sediments causes a long-lasting compaction within the maar-diatreme by reduction of the pore space. Mineral alteration is another possibility for the decrease in volume. All these processes result in a remarkable subsidence of the maar-diatreme fill. Since maar-diatreme volcanoes are often eroded to different levels, the subsidence is not obvious.

In the case of the Guttau volcano group (East Saxony) the Oligocene maar-diatreme structures of Kleinsaubernitz and Baruth and their maar crater lake sediments are covered by younger sediments (Lower to Upper Miocene), including well dated lignite seams. Above both structures the thickness of the overlying sediments is greater than in the surrounding area. Stratigraphic correlation of the deposits above and outside both maars allowed estimation of the amount of subsidence in the maar-diatreme structures in space and time.

We conclude that the sediments above the maar crater floor of Kleinsaubernitz record a subsidence of more than 200 m since the beginning of the Miocene at 23.8 My. Due to the different size of the maar structures of Kleinsaubernitz and Baruth the amount of subsidence in the smaller (latter) structure was less. Even after 27 My subsidence is still going on today as is indicated by Holocene depressions above both structures.

For the interpretation of the environment of maar lakes — e.g. the famous Eocene fossiliferous maar crater lake deposits of Messel and Eckfeld — it is important to realize that the present position of maar lake sediments is different from their position at the time of deposition.

1 P - 22/17.00 - 18.00; 23/17.00 - 18.00

Cock's tail jets and their deposits

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The transport mechanisms of phreatomagmatic deposits in general and those of maars in particular, are commonly interpreted in terms of (1) base surges, (2) fallout and, in some cases also (3) cool pyroclastic flows and debris flows. One transport mechanism that has received surprisingly little attention is that by debris jets. Debris jets are populations of particles varying widely in grain size and are thrown out by what is often referred to as cock's tail jets in low angle trajectories hitting the ground at shallow angles. Owing to their momentum the debris after impacting the ground can spread horizontally along the surface for many metres to decametres before the energy is dissipated. During the 1983 Miyake-jima eruption, video and photographs showed that the complex mixed eruption process by base surge cloud, phreato-strombolian and several hundred metres of cock's tail jet cloud occurred simultaneously. The characteristics of these deposits are shown by (1) irregular isopach contours resulting in ray-like elongated fans, (3) tongue-shaped microtopography showing fronts with randomly oriented trees (3) sorting ranging from poor to good, (4) block sag structure, water-chilled bombs, pockets of water-chilled scoria being found as ballistic deposits. The relative ratio of juvenile vs accidental fragments varies widely depending on the eruptive environment. Water-rich jets resulted in muddy matrix, sandy matrix reflected low water content.

We briefly comment on similar occurrences of debris jet deposits, notably Bandama crater on Gran Canaria (Canary islands), Laacher See (Germany) and the 1968 eruption of Arenal eruption (Costa Rica).

2 O — 22/15.30–15.50

Formation and evolution of hydrothermal piercement structures in volcanic basins: constraints from the Karoo Basin in South Africa

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Mud volcanoes, blow-out pipes, diatremes, and hydrothermal vent complexes represent important piercement structures in sedimentary basins, with the potential to act as permanent fluid flow perturbations. More than 550 hydrothermal vent complexes are identified in the Karoo Basin in South Africa. Hydrothermal vent complexes represent pipe-like structures that are rooted in contact aureoles around sill intrusions in sedimentary basins. Here, we present field, petrographic, and geochemical data from two end-member types of vent complexes in the Karoo Basin: (1) sediment dominated, and (2) basalt-dominated. Borehole and outcrop-studies of the complexes show that they are composed of sediment breccias and basalt-breccias, respectively. The sediment breccias are cutting and overlying tilted sediments, and are comprised of fragments of mudstone and sandstone with rare boulders of dolerite. The basalt breccias contain vesicular basalt boulders up to several metres in size, with intercalated sediments. Zeolite mineralization and stable isotope analysis of carbonate from the vent complexes show that hydrothermal fluids affected the rocks in the vent complexes. Information on the root zones of the hydrothermal vent complexes has been obtained from breccia pipes in the western parts of the Karoo Basin. More than 200 pipes composed of contact metamorphic sediment breccias are mapped, and boreholes verify that they are rooted in contact aureoles within very organic-rich shale. We propose a model where hydrothermal vent complexes originate in contact aureoles around sill intrusions due to heating of pore fluids and maturation of organic material — resulting in rapid pore pressure build-up and phreatic eruptions, producing a breccia conduit zone to the surface. Consequently, the hydrothermal vent complexes represent conduits for gases to the atmosphere. The gases driving the eruptions were carbon-rich if the sills intruded sediments rich in organic material. This may have caused global warming, and could represent the missing link between large igneous provinces and global climate changes.

10 O — 25/11.50–12.10

Neogene–Quaternary time-space distribution patterns of monogenetic mafic alkaline volcanism in the Carpathian–Pannonian Region. Implications for mantle processes

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A number of mafic alkaline volcanic fields, mostly consisting of monogenetic volcanoes, developed during Neogene–Quaternary times within the Carpathian-Pannonian region (CPR), in a back-arc type tectonic setting following the Miocene continental collision of the Alcapa and Tisia–Dacia blocks with the European plate. The volcanic centres are spatially clustered in volcanic fields scattered throughout the whole CPR. Their general spatial distribution shows a notable disparity between different parts of CPR: the number and size of volcanic fields and the density of their respective volcanic centres are much higher in the western Pannonian Basin corresponding to the Alcapa block (4 large volcanic fields) than in the eastern CPR, where the Tisia/Dacia block hosts monogenetic volcanic fields only along its southern margin, with only 2 small volcanic fields in the south-eastern half of CPR. A data base of 527 K-Ar age determination, including isochrone ages, on whole rock samples, and their various magnetic and density fractions, from Hungary, Slovakia, Austria and Romania, allows for an overall reconstruction of its time-space evolution patterns. The overall age range of the mafic alkaline volcanism in CPR is between 11.5 and <0.2 My. The inception of mafic alkaline volcanism, starting in space from cca. 350 km behind the calc-alkaline volcanic front, shows north-eastward and eastward younging as a general trend, postdating calc-alkaline volcanism in each specific occurrence area with cca. 3 My. In contrast, no such trend can be pointed out for the cessation of volcanic activity. Calc-alkaline and mafic alkaline volcanism converge in space in two areas: Nógrád–Central Slovakia and Eastern Transylvania. In the former case, long-lived high production-rate volcanism focused within an area of cca. 200 km radius, including an earlier stage of calc-alkaline volcanism (21–8 My) immediately followed by a late stage of mafic alkaline volcanism (8–<0.2 My);

involvement of a mantle plume, active during the last 21 My, is suggested here. In the latter case, both space and time convergence can be pointed out at the south-eastern termination of the East Carpathian volcanic chain, where coeval small-volume and low production-rate calc-alkaline and mafic alkaline volcanism occur in the South Harghita and Persani Mts, respectively, during the last cca. 1.5 My. Spatial shift of the focus of volcanic activity from west to east is obvious along the southern margin of the Tisia–Dacia block between 4–0.6 My, interpretable in terms of eastward mantle-flow processes. The youngest mafic alkaline volcanic activity took place within the two spatial convergence areas in CPR: Putikov Vrsok volcano erupted 130–140 Ky ago in the Central Slovakia Volcanic field, while the last eruption in the Persani Mts (Eastern Transylvania) occurred cca. 650 Ky ago. According to the observed space-time evolution patterns and their interpretation in terms of mantle processes, further volcanic activity, and related volcanic hazard, cannot completely be ruled out in CPR.

3 P — 22/17.00–18.00; 23/17.00–18.00

The structural setting of the Rosia Montana maar-diatreme compex, Alba, Romania

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The Rosia Montana gold deposit is located within the Southern Apuseni Mountains in western Romania. The deposit is a low-sulphidation style epithermal system, hosted in Tertiary age dacitic domes situated within phreato-magmatic breccias in a maar-diatreme complex. The host stratigraphy of the area is dominated by Early Cretaceous flysch sequences, an arenite-rich basal unit overlain by a shale-dominated unit. Neogene structures are related to Tertiary dextral motion on the Zlatna strike-slip fault (ZFZ) to the south of the area, which was locally the principal focus of deformation associated with eastward extrusion of the Tisza–Dacia block. A conjugate set of NNE–SSW and NE–SW structures developed concurrently and these appear to be the major controls of Middle to Late Miocene maar-diatreme development, volcanism and porphyry intrusion. The western end of the shear zone is accommodated by a system of W-vergent thrusts in Mesozoic seafloor rocks, while a mirror-image system of E-vergent Neogene thrusts that forms the eastern accommodation of the ZFZ shear is seen to the east of the Rosia Montana study area. It is probable that the system of NNE–SSW and NE–SW conjugate faults in the Rosia Montana and Rosia Poieni areas was formed initially as a set of Riedel R' and R" (synthetic and antithetic) shears in association with the ZFZ. It is therefore inferred that early dextral motion occurred along the NNE–SSW fault that bounds the Rosia Montana dacite body to the east. This would explain the pattern of N–S trending sigmodial veins found in the Rosia Montana and Bucium mineralized areas. The final motions on the NNW–SSE and NE–SW conjugate faults were vertical. The block containing the Rosia Poieni porphyry mine has been uplifted and unroofed (probably by 1–2 km) relative to the block to the west, where andesite flows are still preserved on the hilltops north of Rosia Montana.

3 O — 23/9.40–10.00

Epithermal gold mineralization hosted in maar-diatreme complexes, Apuseni Mountains, Romania

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Within the southern Apuseni Mountain region of western Romanian epithermal precious metal (Au-Ag) mineralization is known to occur at economic grades within two maar-diatreme complexes, the Rosia Montana and Rodu-Frasin systems. The two systems occur as Tertiary age dacite domes hosted within phreato-magmatic breccias situated in structurally controlled maar-diatreme complexes. The two systems occur within 5 kilometres of each other with a NW structural corridor. The gold-silver mineralization outlined at both Rosia Montana and Rodu-Frasin is interpreted to represent shallow level, low sulphidation epithermal systems. Mineralization is dominantly disseminated, with associated stockwork veining and breccia hosted gold-silver mineralization. Associated alteration in both maar-diatreme complexes consists of an early pervasive quartz-adularia assemblage with later overprinting carbonate-clay (illite-smectite)±silica alteration, and disseminated pyrite and associated carbonate-quartz-sulphide veining and brecciation. Neogene structures associated with the emplacement of the complexes are related to Tertiary dextral motion on the Zlatna strike-slip fault to the south of the maar-diatreme complexes. A conjugate set of NNE–SSW and NE–SW structures developed concurrently and these appear to be the major controls of Middle – Late Miocene maar-diatreme development, volcanism and porphyry intrusion. Recent exploration of the deposits has outlined a total resource (measured, indicated and inferred) of 400.41 million tonnes at an average grade of 1.3 grams per tonne gold and 6.0 grams per tonne silver for a total contained resource of 16.1 million ounces of gold and 73.3 million ounces of silver at Rosia Montana and a total resource (indicated and inferred) of 35.2 million tonnes containing 1.2 million ounces of gold and 2.9 million ounces of silver at Rodu-Frasin.

10 O — 25/14.10–14.30

Geochronology and hydromagmatism at the Alban Hills, Italy: The maars that did not want to be dated

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The ultrapotassic magma of the Alban Hills Volcanic District (hereafter AH) fed mostly large (order of 10 km^3) ignimbrites, occasionally with a hydromagmatic component, from around 560 ky to 355 ky, resulting into caldera formation. Subsequently, a minor intra-caldera stratocone formed and eccentric effusive and hydromagmatic activity dominated. In particular, the most recent activity of AH, as young as 35 ky, produced mono- and polygenetic maars. To identify cycles of eruptive activity at AH, we performed extensive $^{40}Ar/^{39}Ar$ age analyses of crystals from the entire volcanic succession. Among all AH volcanics, maar products proved to be the most problematic to date.

Maar products at AH range from typical dry and wet pyroclastic surge beds with subordinate fallout beds, to extremely indurated beds and layers of both surge and flow origin. Typically, they include abundant lava and sedimentary lithic clasts, along with vesicular to very poorly-vesicular, often rounded, scoria clasts. Scoria clasts enclose leucite, clinopyroxene, phlogopite, garnet, and occasional sanidine and calcite crystals, which also occur in the ash matrix of the deposits.

$^{40}Ar/^{39}Ar$ age analyses were performed using preferably leucite crystals from scoria, commonly regarded as a juvenile component of pyroclastic deposits. In a few cases, analyses were performed on individual crystals selected from the deposit matrix. Ages were determined by either single-crystal total-fusion or, subordinately, multiple-crystal total-fusion analyses.

By combining crystal age data and deposit stratigraphy, we were confronted with three different situations:

1. All crystals yield statistically indistinguishable ages consistent with the stratigraphic position of the deposit, and thus reliably record the age of the eruption.
2. Crystals from the deposit matrix have variable ages, which often match those of older AH large ignimbrites. In this case, the youngest crystal age may likely approximate the eruption age, whereas older crystals are to be considered as xenocrysts. These are common in pyroclastic deposits, although in some AH maars we found xenocrysts only, possibly indicating that no fresh magma was involved in these eruptions.
3. Crystals within scoria clasts, the main component of fallout and surge beds, have stratigraphically inconsistent ages, which often correspond to those of older large ignimbrites. Ruling out stratigraphic uncertainties or analytical errors, we are left with two equally puzzling possibilities: (i) scoria clasts from older deposits were entrained in the eruptive mixture extensively; (ii) non-erupted portions of the magma reservoirs that fed older large eruptions were mixed with the new magma before or during hydromagmatic fragmentation.

We remark that this dilemma only occurs for smaller-scale monogenetic maar deposits, while xenocryst contamination affects to a minor extent more energetic hydromagmatic eruptions, like those from the Albano multiple-maar. Note that, without extensive regional stratigraphic and geochronologic constraints, the above problems would have been overlooked, leading to incorrect dating.

9 O — 24/16.20–16.40

Potential threat of lahar-induced catastrophic flooding to the Taipei Metropolis, Northern Taiwan

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The Taipei Metropolis (population >6 million) is located in a Late Quaternary intramontane basin (Taipei Basin) fringed with a group of dormant volcanoes (Tatun volcanoes) in the north. In the past, the Tatun volcanoes were not seriously considered as a source of volcanic hazards because of the lack of historical eruptions. However, recent borehole stratigraphic analyses revealed that the Taipei Basin was once dammed into a deep freshwater lake by a lahar derived from the Tatun volcanoes. This dammed lake is characterized by a widely distributed layer of laminated mud, which is stratigraphically and lithologically unique in the fluvial-dominated Taipei Basin deposits. The laminated mud is underlain by a north-thickening lahar in the north-western part of the Basin that can be traced into the Tatun volcanoes. Integrated stratigraphic and radiochronoligical data show that the dammed lake formed at 180 Ky and lasted till 160 Ky. The dammed-lake event demonstrates that Tatun volcanism is capable of causing catastrophic flooding in the Taipei Basin if the outlet of the drainage system is blocked. Since the Tatun volcanoes are presently underlain by a detectable magma chamber and are fraught with hydrothermal activities, the possibility of future eruptions cannot be ignored. In fact, tephrastratgraphic studies of the Taipei Basin deposits show that two major eruptions had occurred at 360 Ky and 180 Ky, with a minor eruption at 20 Ky. All these eruptions produced voluminous lahars near the only outlet of the basin drainage systems in the northwestern Taipei Basin. Should the past be an indicator to the future, the probability of a forthcoming major eruption is looming large and the potential of catastrophic flooding needs to be carefully evaluated.

1 O — 22/11.10–11.30

Shallow crustal xenoliths in continental basalts and implications for magma ascent dynamics

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As magma rises through the lithosphere it may entrain wall rock, depending on the local hydrodynamic regime of the magma, the extent of interaction of magma with groundwater, and the mechanical properties of the wall rocks. Wall rock entrainment results in local flaring of dikes and conduits, which in turn affects the hydrodynamics of magma ascent and eruption. I report data on upper-crustal xenoliths erupted from small-volume basaltic volcanoes of the Lucero and San Francisco volcanic fields (New Mexico and Arizona) that allow assessment of the relative importance of various entrainment mechanisms during hydrovolcanic, Strombolian, and effusive processes. Total xenolith volume fractions range up to ~0.9 in hydrovolcanic facies to $<10^{-4}-10^{-2}$ in Strombolian facies. The volcanoes erupted through well-characterized sedimentary sequences, so that xenoliths can be correlated with sedimentary units and hence depth ranges. The abundance of xenoliths from a given subvolcanic unit is divided by that unit's thickness to obtain an average entrainment rate (xenolith volume fraction derived per unit depth in the conduit). Shallow (<c. 500 m) entrainment rates are very sensitive to the degree of hydrovolcanic activity. Deep entrainment is more sensitive to the mechanical properties of the wall rocks, and in the cases studied here is thought to depend mainly on brittle failure related to offshoot dikes, pore pressure buildup, and thermal stresses. The entrainment rate can be used as a source term in multiphase numerical models of conduit flow. Based on the data presented here, theoretical models of conduit flow and erosion are justified in neglecting the contribution of mass and momentum from entrained material during basaltic eruptions driven by magmatic volatiles, but not in eruptions driven by hydrovolcanic processes.

4 O — 23/11.30–11.50

Controls on maar volcanism: Evidence from sills and dykes of the Silurian Eastport Formation, Maine, USA

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The Eastport Formation of the northern Appalachians is part of the Coastal Volcanic Belt, one of the largest bimodal volcanic provinces in the world. Folding, faulting and erosion provide a three dimensional view of the volcanic stratigraphy and associated intrusions, allowing insights into volcanic processes. This study examines the various volcanic facies, their field relations, and implications for controls on styles of volcanism. Volcanism is primarily subalkaline basalt to basaltic andesite, with within plate affinities. There is significant evidence for phreatomagmatic volcanism in the deposits and their fragments. In one well-exposed section feeder dykes and sills are exposed. In some cases, sills form mega-breccias, or mega-peperites, where the sill has interacted with wet tuff to form internally brecciated, subspherical lobes several metres in diameter. In other cases internally brecciated dikes presumably represent feeders to the overlying flows and tuffs. Magma supply rates increase upward in the sequence such that explosive volcanism gives way to effusive volcanism forming a series of intercalated tubes. Mafic sills in contact with water can produce highly explosive eruptions. In this case, field relationships provide evidence for fragmentation with and without eruption. Whether eruption occurs is dependant upon a number of factors such as confining pressure, and the ratio of water to magma. In this case, the confining pressure and strength of the overburden was sufficiently low to allow steam to escape and to accommodate the diapiric rise of the magma to form a sill with bulbous lobes within the tuff, but high enough to control the shape of the protrusions (similar to pillows). The middle part of the section was formed by extrusion onto an unstable slope with variable supply rates forming sheet and internally brecciated bulbous flow lobes. Upward in the section supply rates increased and water availability decreased, and effusive volcanism prevailed.

3 P — 22/17.00–18.00; 23/17.00–18.00

Economic minerals of maar lakes sedimentary fill, Southern Slovakia

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The basalt maars of Southern Slovakia are filled beside tuffs by alginite and diatomite (diatomite clay). Both fine grained sedimentary rocks are laminated, rarely they show a massive or brecciated structure. The Pincina maar is filled by alginite. Alginite is a laminated rock of clay appearance, grey in colour. Dark laminae are rich in Algae (*Botryoccocus brauni*) and organic matter, while light laminae are of anorganic composition (clay minerals as smectite) with fragments of Diatomacea siliceous cells. Alginite is rich in humus. The contents of plant nutrients K, P, N, Mg, Ca and the micronutrients as B, Mo, Cu, Zn, Mn as well as Se and Co in alginite are increased. The water retention capacity is extremely high as well as the cation binding and ion exchange capacity. Alginite may be used to fertilise poor sandy soils, to protect crops against drought, to trap ammonia and other nutrients in soil, or to serve as a deodorant in farmer's stables, pigsties and sheep-folds. Alginite also reduces transfer of N, P and K from the soil into the ground and surface waters. Furthermore, it is friendly to the environment, what is appreciable especially in the areas of heavy agricultural activities. The maar at Jelšovec village SW of Lučenec is filled by diatomite and diatomitic clay. Diatomite is laminated or crushed into breccia. The colour of rock is light grey. The application of diatomite in building industry was tested. The technological analyses have been carried out on the mixture of homogenised diatomite with woody saw-dust. Different types of tiles and bricks at firing temperature 950–980 °C were tested. The technological parameters are as follows: bulk density 669 $kg.m^{-3}$; compressional stremght 2.3 Mpa; $\lambda = 0.157$ $W.m^{-1}.K^{-1}$; radioactivity 38.8±5.8 $Bq.kg^{-1}$. The bricks or tiles may be used as building material in general and especially to obtain environmentally friendly thermal and acoustic insolation of buildings.

7 O — 24/12.10–12.30

Sedimentology and palaeoecology of Southern Slovakian basalt maar lakes

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In the Southern Slovakia two basalt maars of the Podrečany Formation, Pontian in age (Late Miocene, about 7 My) are preserved including soft fine maar lake sediments deposited in their central part. The maar at Pincina village (E of Lučenec) is filled by alginite. The maar at Jelšovec village (SW of Lučenec) is filled by diatomite. The common sedimentary feature of both rocks is a fine lamination, but they reflect different palaeoecology. The Pincina maar is relatively small and simple. The depth of the maar lake was less than 50 m. It was invaded by the yellow-green Algae (*Botryococcus brauni* KÜTZ.) having the specific ecological claims. The lake water was worm, aprox. 30 °C. It's salinity was about 3‰ and pH of water was between 7–8 (MEZESI-MUZSI, NAGY, HAJÓS, fide SOLTI in RUSSELL ed. 1990). In such conditions being well supplied by nutrients from weathered tuff of the maar ring the yellow-green Algae flourished in the lake photic zone causing a strong eutrophisation of the lake. The photic zone crowded by the Algae colonies was dynamically inactive and the water column in the lake was stratified. The upper water layer was supplied by the oxygen just enough to be eutrophised by the *Botryococcus brauni* taxa. The lower water layer was anoxic and stagnant. Because of it the bottom biologic activity completely absented and the bottom sediments — the alginite, is rich in algal organic matter and the laminate structure is not disturbed at all. Alternation of dark laminae rich in Algae and light laminae poor in Algae testifies the seasonal sedimentation. The Jelšovec maar was relatively large and complex. At least two maars overlap each other. The depth of the maar lake was shallower. The life conditions were different, more convenient for the less pretentious Diatomaceae. The water was relatively cold, not stratified, well oxygenated and sediments deposited in the lake are free of any organic matter. Only inorganic siliceous Diatomaceae cells are preserved. The diatomite lamination (alternation of white laminae rich in Diatomaceae cells with grey clay laminae) is witness of seasonal sedimentation.

7 P — 24/17.00–18.00; 25/16.00–17.00

The Fuentillejo maar lacustrine record (Campo de Calatrava volcanic field). Preliminary scientific activities for the palaeoclimatic reconstruction of the Quaternary in Central Spain

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This work is part on the strategies and scientific protocols designed for a first stage of the project *'Maar Programme for the Central Spanish Volcanic Field. An initiative for the study of Quaternary Climatic Change'*. The Fuentillejo maar is located in the Campo de Calatrava Volcanic Field in Central Spain. The explosion took place among the slates and quartzites of the Lower Ordovician which are intense fractured and allowed the development of local aquifers. The volcanism of the Campo de Calatrava shows at least two stages. The first and least important was of an ultrapotassic character during the Upper Miocene and has been dated as 8.7 to 6.4 M.a. The second stage was an alkaline and ultraalkaline volcanism between the Pliocene–Pleistocene, with a main activity phase from 3.7 to 1.75 My.

The maar lake lies at an altitude of 638 m a.s.l. and has an area of 12.15 hectares. The waters of the modern temporary lake are currently alkaline, pH 9.7 to 9.9. Three electrical resistivity tomography (ERT) profiles indicate the presence of low resistivity deposits over 100 m thick. Twin boreholes were drilled in 2002 recovering a 142 m section (FU-1 core) and a 96 m section (FU-2 core). This work focuses on the sedimentary record of the FU-1 core, which was divided into 22 units based on the observation of macroscopic features and microscopic observation of sedimentary components. The main facies are: i) medium to thin bedded graded clastic sediments (lithic sands, silts and minor gravels); ii) laminations of micritic carbonate mud, sapropel and clastic silts; iii) medium bedded and laminated sapropelic C_{org}-rich sediments; iv) laminated alginites and bituminous silts; vi) very thin bedded evaporite sediments (euhedral gypsum, chicken wire gypsite, salts and carbonates), vii) thin bedded blue clays and micritic carbonate mud (calcite, dolomite, ankerite). AMS-14C date at 18.40 metres depth has an age of 42620±1490 years B.P.

1 P — 22/17.00–18.00; 23/17.00–18.00

The phreatic deposits of the Strombolian-Hydrovolcanic structure of Mt Avital, Golan Heights

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The complex of Mt Avital, northern Golan Heights, includes a tuff ring located between two cinder cones, arranged along a 3 km-long N10W line. The explosive history of the structure started with the construction of the southern scoria cone on top of an earlier effusive structure and followed by the eruption of the northern cone. Hydrovolcanic activity commenced during the late stage of eruption at the northern cone. Its lithic-rich products arrived at the top of both cones and interbedded with bomb-rich scoria layers at the northern cone. This was followed by the effusion of several small lava flows and by small phases of Strombolian activity and then by an intensive phreatic activity, which terminated by a collapse and creation of a 1 km-long crater at the centre of the structure. The shift from Strombolian to hydrovolcanic activity is probably the result of a rise in the water level of a nearby lake and the intrusion of its water into the magma conduit.

The phreatic deposits appear in three different modes: 1. surges, which vary between well-sorted tuff to lithic-rich lapilli-tuff layers, all show typical structures like cross-bedding and anti-dunes; 2. well sorted, lapilli size, solely lithic fall deposits; 3. lithic tuff with high content of large blocks, no bedding observed. All phreatic deposits have relatively little content of juvenile ash, implying a high water/magma ratio during this phase of eruption. On the other hand, the lithic tuff of the early hydrovolcanic phase has relatively higher content of fine-grained juvenile material. The accidental clasts are almost exclusively from nearby surface basalts, implying a very shallow explosion, in agreement with the scenario of lake-water intrusion. The frequent alternation between high content of large blocks and ash size tuff probably reflects rhythmic change in the intensity of the eruption.

4 O — 23/10.50–11.10

Magmatic and phreatomagmatic deposits at Sinker Butte, a large Pleistocene volcano in the Western Snake River Plain, Idaho, USA

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The western Snake River Plain is a Neogene intracontinental rift basin located in south-western Idaho. Two major episodes of basalt magmatism took place within and adjacent to this basin, the first at 9–7 My and the second at 2–0.4 My. We focus on the Sinker Butte volcano, a large basaltic centre which formed during the second episode and produced thick and laterally extensive deposits of phreatomagmatic tephra and numerous lava flows. Sections through the medial deposits of this volcano expose about 100 m of tephra which were deposited on a stack of vesicular lava flows, some of which are pillowed at their base. The tephra is in turn capped by lava flows which are inferred to have spilled over or broken out from crater-filling lava lakes. Although the lower basalts were previously believed to predate the tephra-forming eruptions by as much as 2 million years, their petrographic and chemical affinities to the tephra-capping flows suggest that the entire sequence may have been erupted from a single large volcano. The pyroclastic section contains a wide variety of primary and secondary deposits; however, it can be divided into two broad units everywhere it is exposed: (a) a lower sequence dominated by reworked tephra deposited in fluvial or shallow lacustrine environments, and (b) an upper sequence dominated by base surge and fall deposits. Juvenile particles in the lower tephras are typically vesicular whereas those in the upper deposits are commonly blocky and lack vesicles. We propose a scenario in which lava flows disrupted and dammed the ancestral Snake River, causing water to rise and mix with the magma column. This resulted in a prolonged episode of phreatomagmatic eruptions. A return to normal water levels or sealing of the vent allowed the system to revert back to a magmatic eruptive style.

2 O — 22/16.50–17.10

Pyroclastic precursors to flood-basalt eruptions, Coombs and Allan Hills, Transantarctic Mountains, Antarctica

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A complex of coalesced maar-diatreme vents underlies flood basalt of the Ferrar Group in Coombs Hills and Allan Hills. Coombs Hills is largely an assemblage of intertwined and mutually crosscutting lapilli tuff and tuff breccia bodies with blocks and rafts of country rock, cut by syn-volcaniclastic peperitic dikes and plugs. Tuff-ring deposits locally overlie this assemblage, but broken remnants of bedded tuff locally containing surge-dune bedforms are present at lower levels. At adjacent Allan Hills, additional lithofacies include a substantial debris-avalanche deposit shed from adjoining country rock, and widespread layered deposits with accretionary lapilli. Large blebs of basalt in the avalanche deposit suggest avalanche initiation by magmatic intrusion. One higher complex margin grades from unbroken sandstone, to fractured *in situ* sandstone with clastic injections, to rotated-block sandstone breccia with sand matrix. Immediately overlying the avalanche deposits, and adjoining the higher gradational margin, are deposits similar to the Coombs Hills assemblage. Further from the complex edge, subsided tuff ring fragments occupy the same level as the avalanche facies, and are overlain by widespread layered deposits comprising thick beds of poorly sorted lapilli tuff containing ragged, fluidal basalt clasts. Higher layers contain a horizon of large blocks and thin layer of large accretionary lapilli (both also present dispersed in the thick beds).

We infer that complex-wall avalanches were important fragmentation and mass-transport processes during eruption. Lateral transition from sandstone breccia to unbroken country rock suggests that shocks and vibration originating from explosions and movement in the complex's tephra fill fractured the complex wallrock. Avalanching of this broken rock was inhibited where it was buttressed by the tephra fill itself. Syneruptive subsidence disrupted tephra rings on the complex's crater floor. Widespread layered deposits are from voluminous pyroclastic flows, co-flow ash and overlapping block-fall showers, from multiple vents active late in the complex's history.

10 P — 24/17.00–18.00; 25/16.00–17.00

Basalt chronostratigraphy of NE Iceland: implications for the Geomagnetic Polarity Time Scale

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The flood basalts exposed in the Jökulsá á dal Valley in north-east Iceland show normal magnetic field directions consistent with emplacement during the Gauss Chron, and reversed magnetic field acquired during the Matuyama Chron. In the lower Matuyama basalts, an apparently continuous horizon containing normally magnetized flows has been recognized that was defined as belonging to the Olduvai event (Wensink 1964). A separate normal flow above the Olduvai was interpreted as the Gilsá event. The age of this event was established at 1.61±0.05 My by K-Ar dating of samples from the Hnjuksá Valley, a small streambed draining into the main river from the basalt plateau to the west (McDougall and Wensink 1966). This age was revised to 1.62 ±0.08 My in a subsequent study (Watkins et al. 1975. Both results have been recalculated to be consistent with current conventions concerning the decay constant and isotopic abundance of ^{40}K). Based on the original palaeomagnetic field work and the K-Ar results McDougall and Wensink (1966) suggested an average periodicity in the rate of basalt eruptions of once per 40 ky, and implied regional continuity of individual flows. In a more recent paper, Udagawa et al. (1999) dated normally magnetized flows in the lower Matuyama in the main Jökulsá á dal river bed cca 10 km upstream from the original Hnjuksá section applying the conventional K-Ar dating technique. They found ages of 1.61 My for the normal flows, which they interpreted to be consistent with the Watkins et al. (1975) results from the Hnjuksá section, and thus belonging to the Gilsá event. We independently resampled the Hnjuksá section and a second, parallel section along the Hnappá streambed 3 km north of the Hnjuksá section. Palaeomagnetic analysis indicates that both sections contain normal flows in the lower Matuyama at cca 500–550 m altitude, which could be interpreted as confirmation of the Olduvai subchron. There is no evidence for a separate normal flow above the Olduvai indicating a younger Gilsá event. We applied high resolution ^{40}Ar/^{39}Ar laser incremental heating to selected flows of both the Hnjuksá and the Hnappá sections. We found that the normally magnetized flows of the Hnjuksá Valley yielded ages of 1.82±0.03 My and 1.71±0.04 My. This age is consistent with emplacement of these basalts during the Olduvai Normal Subchron. As our results are based on well defined plateaus and isochrons, we conclude that in the original type section of the Gilsá Subchron, our new $^{40}Ar/^{39}Ar$ ages of the normal flows disproves the existence of a separate Gilsá event. The ages of the normal flows in the adjacent Hnappá section turned out to be even older: 2.01±0.05 My and 2.26±0.06 My, which would be at a 95 percent confidence level consistent with the Réunion Subchron. From our analysis we draw two main conclusions: 1. In the type section, the normal flows previously attributed to the Gilsá event, can be reconciled with emplacement during the Olduvai Subchron, and 2. Event at short distances the flood basalt flows in the Jökuldalur area are discontinuous, and cannot be correlated using magnetostratigraphy alone. This questions the conclusion of UDAGAWA et al. (1999) who argue that they identified flows belonging to the Gilsá Subchron at much larger distances from the type section.

4 P *— 22/17.00–18.00; 23/16.00–17.00*

$^{40}Ar/^{39}Ar$ geochronology of a Mio/Pliocene phreatomagmatic volcanic field in the western Pannonian Basin, Hungary

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Neogene alkaline basaltic volcanic fields in the western Pannonian Basin, such as the Bakony – Balaton Highland and the Little Hungarian Plain Volcanic Field are intracontinental clusters of erosional remnants of small-volume volcanoes often considered to be monogenetic. These volcanic fields consist of moderately to strongly eroded maars, tuff rings, scoria cones, and associated lava flows. The absolute age of these volcanic rocks is considered to span from 8 My to 2.3 My according to previous K/Ar dating, suggesting a long lasting small-volume magma output rate type of intracontinental volcanism through the Late Miocene until the Late Pliocene. In this study, for the first time in this region, high resolution $^{40}Ar/^{39}Ar$ incremental heating experiments were carried out on 14 samples to determine the age and life span of the western Pannonian Neogene intracontinental volcanic province. The samples were carefully selected from those sites (1) where peperite has been identified in contact between coherent basanite lava and host sediment such as former tephra rings or pre-volcanic or post-tuff ring mud and silt, (2) where remnants of lava lakes or flows clearly mark geomorphological marker horizons, and their age may bear significant information from the erosion history of the landscape, and (3) where periodic eruption in the same location has been suspected or the source of the emplaced lava flows should have been confirmed by isotopic ages. The new $^{40}Ar/^{39}Ar$ age determinations confirm the previously obtained geochronology based on K/Ar radiogenic isotope ages, in the sense that no systematic biases were found between the two data sets. However, the study also serves to illustrate that the inherent advantages of the $^{40}Ar/^{39}Ar$ technique, such as greater analytical precision, internal tests for reliability of the obtained results will allow better constraints on reconstructions of the magmatic evolution of the volcanic field in the western Pannonian Basin.

9 O *– 25/9.40 – 10.00*

Meeting the learning needs of a more diverse population: applying universal design to volcanology, petrology and hazards education

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Universal Design has its origins in the field of architecture, but is now being applied in educational arenas where it is defined as "the preparation of curriculum, materials and environments so that they may be used appropriately and with ease, by a wide variety of people." Universal Design for Instruction provides a framework during curriculum design (or re-design) in order to reach a broader audience of learning styles and achieve better inclusion of persons with disabilities. Achieving equal access for students with disabilities is an ongoing challenge, particularly in the sciences. We are actively seeking better ways to include persons of many diverse backgrounds. Improving teaching strategies fosters the scientific growth of our adult students. UALR Earth Science has partnered with Disabilities Support staff through a grant supporting "Universal Design." Our collaboration has helped us gain both focus and momentum due to the pooling of our collective content and support expertise. We interact with students without disabilities and students with learning, vision, hearing, and physical mobility disabilities in our undergraduate and graduate programmes. Presenting geoscience information through interlacing activities using tactile and graphical "visualizations", sound, and sub-captioning are the tip of the iceberg for effective pedagogical means to engage students with and without disabilities. Further, Universal Design can be used to create ongoing, accessible assessments that are embedded into curriculum. Therefore, such "accommodations" can be better addressed and are really "universal designs" appropriate for the broader learning audience. Several simple and relatively inexpensive universal methods can be incorporated into curricular activities. Colleagues in volcanology, petrology and hazards education can become part of the early adopters in the international community by applying Universal Design into their new efforts or as retrofits to current activities.

4 P — 22/17.00–18.00; 23/17.00–18.00

Pleistocene Potrillo volcanic field, Southern Rio Grande Rift, USA and México: spatial and geochemical distributions through time

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The Pleistocene Potrillo volcanic field resides within the southern axis of the Rio Grande Rift near the eastern extent of the Basin and Range Province. Its alkaline mafic volcanism has resulted in several hundred cones, flows and at least 5 identified maars. Three of the five maars have brought peridotitic mantle and lower to upper crustal xenoliths to the surface; several older, non maar-related flows from the west half of the field host ultramafic clots. Stratigraphic relationships, ^{3}He surface exposure dating and $^{40}Ar/^{39}Ar$ methods confirm this area has been active since 1 My ago to as recently at 20 ky ago. Elemental and isotopic signatures indicate source heterogeneity coupled with varying degrees of partial melting and polybaric crystal fractionation events. Melts underwent early clinopyroxene fractionation within the mantle, but then the easternmost complexes experienced a second, shallow-level olivine fractionation history. Fundamental differences existing between the east and west halves of the field are further established by $^{87}Sr/^{86}Sr$ (0.703087–0.703917), $^{143}Nd/^{144}Nd$ (4.4–6.7 eNd), $^{206}Pb/^{204}Pb$ (18.363–19.081), and magmatic $^{3}He/^{4}He$ (5–15 R/R_a) isotopic data for ten lavas. Five phases of volcanism are recognized, two isotopic groups are observed and at least three mantle reservoirs may have contributed to the melts. We present a magma dynamics model integrating temporal, spatial and chemical evidence in light of magma emplacement and neotectonics parameters. The punctuated volcanic activity, presence of both monogenetic and polygenetic centres, and evidence for shifting eruption foci across 30 km lateral distances during $\sim10^{6}$ year time frames are explained in terms of crack coalescence. These findings for the Potrillo volcanic field are all causes for concern with respect to prediction of future activity trends within small mafic fields in intraplate extensional settings.

3 P — 22/17.00–18.00; 23/17.00–18.00

Pleistocene Potrillo volcanic field, Southern Rio Grande Rift, USA and México: remote sensing, cybermap visualisations and morphometric evaluation

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Studies of the Potrillo volcanic field have resulted in robust datasets for morphology, geochemistry, and geochronology used to model magma dynamics by incorporating physical, spatial, temporal, and chemical attributes along with emplacement mechanisms. Our current spatial study uses geographic information systems and remote sensing techniques that include Enhanced Thematic Mapper Plus (ETM+) and Advanced Space-borne Thermal Emission Reflectance Radiometer (ASTER) integration along with Digital Elevation Map (DEM) analyses. We are at an early phase of cybermapping select volcanic centres. Cybermapping integrates three major components to generate 3D photorealistic surface models. These are high-resolution topography generated by high-resolution ground-based

Light Detection and Ranging (LIDAR) data, colour information derived from high-resolution digital photography, and GPS information relating the surfaces to global coordinates. A 3D photorealistic outcrop is derived through a mapping process that "glues" the photograph of that outcrop onto the terrain surface. Remote sensing and digital model co-registration and draping process takes place at a centimetre accuracy and resolution. We utilize newly developed high resolution multi-spectral mapping at the mafic volcano fields with camera-mounted narrow band filters. High spectral resolution infrared spectra will allow us to extract ground-based information about mafic mineral composition and content from diagnostic absorption bands, thus facilitating lithologic mapping of basalt types (*e.g.* deposit extent and degree of alteration) for refined correlation with land-, air- and space-derived data. Our goal is exploration using an immersive environment (*i.e.* virtual reality centre). Small volume basaltic centres do display a range of morphologic features similar to those interpreted from Mars Orbital Lander Altimeter (MOLA) topographic data: suspected hydromagmatic features, shields and flows. Better understanding of Mars planetary volcanism through terrestrial analogues can be gained by integrating remote sensing, temporal, geochemical and geologic spatial information. Therefore, presented are observations of the Potrillo field for use as a terrestrial analogue.

10 O — 25/14.30–14.50

A character and distribution of the arc-type basaltic andesite to andesite volcanism in the East Slovakian Neogene volcanic region, Slovakia

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The arc-type basaltic andesite to andesite volcanism is represented by extrusive-shallow intrusive domes, stratovolcanoes (dominantly), scattered monogenetic volcanoes and necks in the middle-northern part of the East Slovakian Neogene field. The products of the subjected volcanism are occur in definable segments in the time-span of magmatic activity that is between 14,5 My and 9,5 My. The innermost segment is characterised by the andesite stratovolcanoes of the northern-middle part of the Slanske vrchy Mts and buried volcanics inside East Slovakian Neogene basin was formed from Late Badenian to Late Sarmatian. The volcanism of this segment is characterised by volcanic activity of the larger and smaller andesitic stratovolcanoes Zlata Bana, Strechovy vrch, Makovica, Bogota, Rankovske skaly etc. as well as the monogenetic volcano Kosicky Klecenov. The development of monogenetic volcanoes in this segment is very scatterred. The origin of this volcanism is interpreted as a combined effect of the mantle uplift and subduction processes. The other segment of the volcanic arc is represented by extrusive domes, shallow intrusions of pyroxene andesites, garnet bearing pyroxene-hornblende andesites of the Lysa Straz-Oblik and Vinne Complexes as well as extrusions, necks and dykes of pyroxene andesites near to Ladomirova village, Beňatina village and Bystra village that occur near the Pieniny Klippen Belt or inside the Flysch Belt. The volcanism of this segment was formed during Middle Sarmatian and Late Sarmatian, whose origin is interpreted as a combined effect of the mantle uplift and subduction processes. The outermost segment formed during Late Sarmatian and Pannonian characterizes larger and smaller basaltic andesite-andesite polygenetic volcanoes of the Vihorlatske vrchy Mts. These stratovolcanoes are related to two fault systems namely NW–SE striking faults (the stratovolcanoes Morske oko, Diel, Popriečny) and NE–SW running fault system (the stratovolcanoes Kamienka, Vihorlat, Sokolsky potok and Kyjov). The origin of this volcanism is interpreted by subduction processes.

5 P — 22/17.00–18.00; 23/17.00–18.00

Geological and geophysical evidences of volcanic products of the Kosický Klecenov tuff cone, Slanske vrchy Mts, Slovakia

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The Slanske vrchy Mts volcanic field (Eastern Slovakia) are dominantly represented by significant morphologically contiguous andesitic polygenetic volcanic structures. They belong to the arc type basaltic andesite to andesite volcanics mostly. The volcanic field includes except of stratovolcanic edifices also some extrusive complexes and rarely monogenetic volcanoes. The Kosicky Klecenov monogenetic volcano (in our interpretation tuff cone) is situated in the middle-southern part of this volcanic field. On the basis of morphology, lithology and mechanisms of products we indicate its phreatomagmatic eruptive activity. The assemblages of volcaniclastic material, ejected by weak hydrovolcanic eruptions early at an aquifer and later in shallow water conditions of lake, were protruded by basaltic andesite body (Upper Sarmatian age, 11,5±0,4 My) in last period. Depositional processes in the tuff cone except of fallout deposits were dominated by relatively wet base surges formed of collapsed eruption columns, which are provided by the presence of accretionary lapilli and small wood as well plant fragments. Geophysical investigations within the volcanic area of the Kosicky Klecenov tuff cone were focused on application of geoelectric and geomagnetic methods for interpretation of Neogene basement of volcano, extent and thickness of younger volcanic products like Neogene nonvolcanic sediments and course of fault tectonics. From the geoelectric and geomagnetic methods we used following methods: vertical electric sounding (VES), electrical profiling (Schlumberger array), very low frequencies (VLF) and magnetic survey. Each of both profiles traversing across volcanic structure is characterized by technical parameter of measuerments, textural explanations to geological and geophysical interpretation. On the basis of geophysical methods made in two profiles, we assume at the northern side of volcanic structure the tectonic fault coursing SSW–NNE. Thickness of volcanic products reaches 200 m on the average. The volcanic centre is characteristic by the positive magnetic anomaly.

9 P *— 24/17.00–18.00; 25/16.00–17.00*

Geosites, nature protection, geoturism and geological-educational map of the Vihorlatske vrchy Mts, Slovakia

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The Vihorlatske vrchy Mts volcanic field, located in the eastern part of Slovakia and near the border area with Ukraine, extends over the area exceeding 500 km^2. In geological approach, the volcanic field represents easternmost volcanic mountain of Slovakia. From the geological point of view this area represents volcanic mountain, which originated in Tertiary — during Neogene, when the calc-alkaline lavas erupted. The eruptions, as well as the andesite lava effusions formed the several larger and smaller andesitic stratovolcanoes. Prominent volcanic activity was a very important geological factor shaping the relief of massif that has been controlled by denudation, erosion and fluvial processes. The Vihorlatske vrchy Mts are very important from a viewpoint of the geological heritage and abounds with interesting geosites, but only several of them have been registered and have already obtained status of geoconservation. The declared large- and small-area protected areas (landscape, botanical etc.) comprise the Vihorlat Protected Landscape Area as well as Zemplinska Sirava Protected Areal, national nature reserves, nature reserves and nature monuments. Well-equipped tourist and educational trails give visitors a deeper knowledge of the Vihorlat area nature beauties. The geological-educational map of this area comprises map and booklet with explanations. The front side of the map presents the geology of the region. Tourist routes, ethnographic curiosities and other remarkable sites of this beautiful region are outlined. The reverse side includes an information on geological setting of the region and some of its volcanological aspects as well as on fauna and flora and regional ethnography. Illustrative parts of the map are represented by photographs, schemes and thematic maps. The booklet provides text explanations to the map, imparting information on living and inorganic nature and descriptions and schemes of the Vihorlatske vrchy Mts. An information on recreation and tourist opportunities, as well as thematic dictionary, are also provided.

2 O *— 22/13.40–14.00*

The maar engine — a review

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General agreement amongst (most) volcanologists is, that Maar volcanoes are the product of phreatomagmatism. Uprising magma meets sub surface water in such way, that both media interact explosively. These thermohydraulic explosions lead to fragmentation of magma, water, and host rock (diatreme formation), the consequent formation of steam leads to phreatomagmatic eruptions (tephrawall formation), and finally the underground mass deficiency results in subsidence (Maar crater formation).

During the last decade experiments on magma–water interaction have been refined in such way, that the fragmentation mechanisms of magma and host rock are now pretty well understood. So far, so good.

However, many questions are still pretty open: Why do most Maar volcanoes show permanent phreatomagmatic eruptions, how is the system "recharged"? What is the nature of conduits within diatremes? What is the role of impure water? How do different magma types (and their physics) influence the mechanism?

Some of these questions can be tackled by experiments, most of them will need specific field work. Furthermore, the results of recent experimental studies on one hand need to be verified by field observations on the other provided some tools for a more quantitative approach to the interpretation of maar tephra.

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Organizing Commettee of the 2IMC (from left to right): Károly Németh, Peter Suhr, Vlastimil Konečný, Volker Lorenz, Ulrike Martin, Jaroslav Lexa and Kurt Goth.

(Photo was taken in Szigliget, 2002.)