

**PRAGUE CENTRE OF
MATHEMATICAL GEOPHYSICS,
METEOROLOGY, AND THEIR
APPLICATIONS
(MAGMA)**

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SECTION 1 MANAGEMENT AND RESOURCE USAGE SUMMARY

1.1. Objectives of the reporting period

The general goal of MAGMA Centre is to increase international recognition of Geophysics and Meteorology at the Charles University in Prague and finalizing their inclusion into the European research area. The field of interest covers dynamic phenomena of the solid Earth and atmosphere. The Centre should promote a unifying mathematical viewpoint, and develop a multi-disciplinary approach, with application to European environmental problems.

In the first year of its existence, the main objectives were to better visualize in Europe the geophysical and meteorological studies at the Charles University, to attract as much visitors as possible, and to increase interest in co-operative efforts across borders of the disciplines, and across state borders as well. To this goal, a variety of activities was planned, including two conferences in the Czech Republic, several working stays in Prague (PhD, postdocs, senior researchers) and web page opening.

1.2. Progress made

Briefly, six activities of MAGMA in 2003 should be underlined, which are detailed below:

1. Two international conferences organized within WP1-WP3 and WP8.
2. Mobility to MAGMA Centre counting 8 man-months in long stays and 11 man-months in short stays.
3. Co-submission of several new 6th framework EC projects, acceptance of three of them.
4. Annual seminar and training course in Prague with representatives of major oil companies.
5. Almost 50 internal seminars to interact with research and practice in the Czech Republic.
6. Constantly upgraded web page, including free availability of seismic data gathered within MAGMA.

The Gantt chart attached to this section illustrates the main 2003 activity of the individual work packages as a function of time. Financial data are included in another table, see the Cost Statement attached to this report.

1.3. Milestones and deliverables

In this section we present deliverables arranged according to the individual work packages. For a detailed description (e.g. the meeting reports, the dates and duration of the visitors' stays, as well as topics of their research), see Section 3.

WP1 Thermal convection

D1.1 European meeting: done. The 8th European Workshop on Numerical Modeling of Mantle Convection and Lithospheric Dynamics, September 13–18, 2003, Castle of Hruba Skala, Czech Republic. From 96 participants, almost 1/2 of which were PhD students and postdocs, 37 were supported by MAGMA Centre.

D1.2 Lecturing of the short-stay visitors in Prague: done (H. Schmelling, A. Galsa, B. Sule; see also D2.1).

D1.3 Long-term stays: done (M Karpytchev, G. Pelfrene); combined with D2.3.

D1.4 Twinning agreement with ENS Lyon: partly done, preparation started, signing expected in 2004.

D1.5 A combined Czech-French PhD study: done (O. Sramek co-supervised in Prague and Lyon).

WP2 Viscoelastic response

D2.1 Minisymposium: done; merged with the WP1 activity D1.1; see Section 3.

D2.2 Lecturing of the short-stay visitors: as in D2.1 (K. Regenauer-Lieb, L. Fleitout and G. Spada).

D2.3 Long-term stays: done (M Karpytchev, G. Pelfrene), combined with D1.3.

D2.4 Submission of a new EC project: merged with WP6 proposal AEGEAN-QUAKE (to promote interdisciplinary link between geodynamics and seismology).

- D2.5 Twinning agreement with Urbino: not yet done.
D2.6 Prague-Lyon networking: done (agreement under ERASMUS under preparation).
D2.7 Benchmark for modeling viscoelastic relaxation: done (completed in relation with D1.1).

WP3 Temporal changes of the gravitational field

- D3.1 Mini-symposium: partly done; several posters included in D1.1.
D3.2 Lecturing of the short-stay visitors: same as D3.1.
D3.3 Long-term stays: done (J. Hagedoorn).
D3.4 Cooperation agreement with GFZ Potsdam: applied in its existing form.
D3.5 Participation in related projects: SEAL, GRACE (Z. Martinec).

WP4 Seismic waves: Theory

- D4.1a Annual seminar with major oil companies: done (Shell, Texaco, Petrobras, etc.; Prague, June 9–10, 2003).
D4.1d Annual training course: done (Prague, June 12, 2003).
D4.2 Lecturing of the short-stay visitors in Prague: done (E. Iversen).
D4.3 Long-term stays: agreed for 2003, but postponed to 2004 due to delays on the side of the guests.

WP5 Seismic waves: Observations

- D5.1 Twinning agreement with Patras: substituted by joint participation of Patras and Prague in the new EC project 3HAZ-CORINTH.
D5.2 Visits from Prague to Patras: done; 3 visits to Patras in connection with our instruments there.
D5.3 Database on Internet: done, see <http://seis30.karlov.mff.cuni.cz>, and continually upgraded.
D5.4 Dissemination of data: done and continually upgraded. Data are free and we send them upon any e-mail request. Automated communication through ORFEUS is still an open task which needs a great organization efforts in Patras, out of direct influence of MAGMA. Besides the plan, also a section of free software has been open at the above web page.
D5.5 Inclusion of two seismic stations into an EC project: done; two stations put at disposal of the new 6th framework project 3HAZ-CORINTH (instead of the formerly planned DGLAB project).

WP6 Earthquakes

- D6.1 Mini-symposium: the mini-symposium planned for 2004 moved to 2005 as a part of a large international conference co-organized by MAGMA Centre WP4 and WP6 (a major activity additionally integrated into the former plans of MAGMA proposal).
D6.2 Lecturing of the short-stay visitors in Prague: done (K. Irikura, A. Caserta, A. Emolo).
D6.3 Long-term stays: done (E. Sokos).
D6.4 Cooperation with related EC projects: done; project SAFE and, mainly, the finished project PRESAP (the latter included also a benchmark of the Italy project by M. Cocco).
D6.5a Cooperation agreement with IPG, Paris: instead such a bilateral agreement we became a contractor of a new 6th framework EC project 3HAZ-CORINTH, coordinated by IPG.
D6.5b Submission of new EC projects: MAGMA staff became a contractor of the Marie Curie RTN SPICE (accepted) and participated in submission of another RTN, AEGEAN-QUAKE (under evaluation). Participation in two proposals which were not accepted (NERIES, SWARM).

WP7 Climate system

- D7.1 This deliverable is planned for 2004 and 2005.
D7.2 Lecturing of the short-stay visitors in Prague: done (M. Fuellekrug)
D7.3 Long-term stays: done (I. Lisaridis).
D7.4 Dissemination of research results on Internet: partly done; a paper on web page of American Meteorological Society, http://ams.confex.com/ams/84Annual/techprogram/paper_70977.htm, while the own web page of WP7 is under preparation.

WP8 Air quality

- D8.1a European meeting: The 4th International Conference on Urban Air Quality, March 25-27, 2003, Prague. From about 140 participants, 5 of them were supported by MAGMA Centre.

D8.2 Long-term stays: not planned in 2003.

D8.3 Dissemination of research results and database on Internet: under preparation.

WP9 Research and technical management

D9.1 Internal seminars: done (almost 50 seminars, see the list in attachment).

D9.2 Meeting of the Advisory Board: partly done; meetings with the external members were performed on individual basis and they will be asked to provide written comments to this report.

D9.3 Coordination of mobility to Prague: done (58 short visits and 5 long-term stays in Prague, all together counting 19 man-months for WP1-WP9). Mobility out of Prague: done (3 short visits within WP5).

D9.4 Web page of MAGMA Centre: done since the starting date, and continually upgraded; see <http://geo.mff.cuni.cz/magma>; emphasis on related links, e.g. abstracts, presentations, training materials, etc.

D9.5 Activity reports: this report.

1.4. Deviations from the work plan

As shown in the above deliverable list, the mini-symposia planned in D2.1, D3.1 were merged with the major event, D1.1, since they concerned nearly the same attendees and topics. It is also the case of the mini-symposium planned for the 2nd year (2004) in D6.1, which will be merged with a larger international conference in the Czech Republic co-organized by MAGMA in 2005 (an addition to the former work plan). Twinning and co-operative agreements planned in D5.1 and D6.5, representing bilateral contact, were substituted by a better, multi-lateral agreement, covered by a new (accepted) EC project. Twinning planned in D2.5 was not realized because existing informal cooperation is quite efficient. Long-term stays in D4.3 were correctly planned, but postponed on the side of the visitors. Impact of these deviations on the project was positive in two respects: (i) no duplication of activity and travel, (ii) more efficient use of funds.

1.5. Communication activities

This part is described in detail in Section 3, according to the individual work packages. Here is an abbreviated summary.

Meeting 1: The 8th European Workshop on Numerical Modelling of Mantle Convection and Lithospheric Dynamics (Castle of Hruba Skala, September 13–18, 2003), co-organized with the Geophysical Institute, Czech Acad. Sci. Four main topics of the workshop were: (i) subduction slabs and related topics, (ii) mantle convection and chemical mixing, (iii) plumes and related phenomena, and (iv) postglacial rebound. The meeting aimed at bringing together leading personalities focussed on modeling lithosphere and mantle dynamics, along with young scientists just entering the field (almost one half of 96 participants were PhD students or postdocs). The interdisciplinary links, one of the major concerns of the MAGMA projects, were emphasized. The environmental problems were also addressed (global warming, sea-level changes, even crustal deformation and its relation to nuclear waste deposits). The workshop was an excellent platform for finishing old and starting new benchmarks, informing about PhD and postdoc positions; preparing new, either formalized or informal projects; creating new links, etc. The financial support from MAGMA budget was used for 37 participants: the foreign members of the organizing committee, for most of the invited speakers and for selected students. For more details, see <http://geo.mff.cuni.cz/workshop> and the MAGMA web page.

Meeting 2: The 4th International Conference on Urban Air Quality, UAQ4 (Prague, March 25-27, 2003), co-organized with the Institute of Physics, London, and the University of Hertfordshire, United Kingdom. The main topics covered all aspects of urban meteorology, such as measurement, modelling and management. There were of about 140 participants; financial support from the MAGMA budget was used for 5 participants from Estonia, Bulgaria, Hungary, and Romania. For more details, see <http://physics.iop.org/IOP/Confs/UAQ4> and the MAGMA web page.

Short visits: There were 58 short-stay visitors with the total stay length of 319 days. From this number, 42 visitors belonged to the above mentioned meetings. For names of the visitors, terms of their stay, the related research topics see Section 3; for short abstracts, see the MAGMA web page.

Long-term stays: There were 5 long stays of the total duration of 8 months. For names of the visitors, terms of their stay, the related research topics see Section 3; for short abstracts, see the MAGMA web page.

Seminars: Complete list of almost 50 internal seminars organized by MAGMA to interact with research and practice in the Czech Republic is in the attachment. All seminars attended by the staff and the students, as well.

Co-operation with other 5th framework EC projects: DGLAB (WP5), SAFE (WP6), PRESAP (WP6), SOLICE (WP7).

Participation in submission of new 6th framework EC projects: NERIES (not accepted), 3HAZ-CORINTH (accepted), SPICE (accepted), SWARM (not accepted) - all these in WP6, AEGEAN-QUAKE (submitted) - jointly WP6 and WP2, and ENSEMBLES (accepted) - WP7.

Co-operation with non-EC international projects: SEAL and GRACE.

Industry, environment, society: Annual seminar and training course of WP4 for major oil companies (Shell, Texaco, Petrobras, etc.), June 9-10, 2003, Prague. Contacts (a small meeting, discussion, attendance of a seminar etc.) with several representatives of industry, environmental protection, municipality, as follows: (i) Contact with representatives of the Czech Ministry of Living Environment, the Czech agency for nuclear waste (SURA). (ii) Contact with the Institute of Rock Structure and Mechanics, Czech Acad. Sci. as regards environmental aspects of the underground gas storage in Pribram. (iii) Contacts with coal mining specialists at the Institute of Geonics, Czech Acad. Sci. of the Czech Republic, Ostrava and at the Mining Institute, Technical University of Ostrava. (iv) Contact with the emergency management team of the firefighter and rescue brigade, Prague, about the hazardous and explosive material leakage, and its effect upon the urban population.

Education outreach: 4 PhD, 7 MSc and 3 BSc students successfully defended their theses in 2003.

Attendance of international conferences: MAGMA staff members and their students attended several conferences, worldwide (financed by grants other than MAGMA). Besides research aspects, these trips served also to advertise this project. Let us mention the most important ones: EGS (Nice, France), IASPEI (Sapporo, Japan), AGU (San Francisco, USA), SEG (Dallas, USA), EAGE (Stavanger, Norway), EAGE/SEG (Trieste, Italy), SAGA (Blairgowrie, South Africa), SBGf (Rio de Janeiro, Brasil). For titles of the presentations having published abstracts, see the Research Overview 2003 in attachment.

1.6. Difficulties

No major difficulties were encountered. In fact, the 1st year was "smoother" than we had expected. Some small difficulties were connected with the fact that researchers in Europe are overloaded by administrative matters, thus it is not easy to agree with them a term of their visit, or they postpone the already agreed trips. To solve this problem, for 2004 year we issued considerably more invitations than is the number of the planned man-days. If, by chance, we get more guests in 2004 than planned above in Section 1.2, the difference can be compensated in the last year, 2005.

MAGMA 2003
Gantt chart of the main activities

Visitors	Months												Person days			
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec				
WP1: Galsa Atilla																4
WP1: Schmeling Harro																2
WP1: Sule Balint																4
WP1: 27 persons (Hruba Skala)																158
WP2: Fleitout Luce																14
WP2: Karpytchev Mikhail																31
WP2: Pelfrene Gilles																45
WP2: 8 persons (Hruba Skala)																48
WP3: Hagedoorn Jan																80
WP3: McCreadie Heather																5
WP3: 2 persons (Hruba Skala)																12
WP4: Iversen Einar																11
WP4: 6 persons (Prague)																18
WP5: Zahradnik Jiri, Plicka Vladimir																14
WP5: Zahradnik Jiri																5
WP5: Jansky Jaromir, Plicka Vladimir																12
WP6: Caserta Arrigo																5
WP6: Emolo Antonio																10
WP6: Irikura Kojiro																6
WP6: Sokos Efthymios																39
WP7: Fuellekrug Martin																4
WP7: Lisaridis Iraklis																52
WP8: 5 persons (Prague)																18
WP9: 48 seminars (Prague)																-
Persondays:																
long visits	0	0	0	0	6	25	0	17	58	36	59	46				247
short visits	0	0	2	0	0	5	0	14	15	10	15	4				65
workshops	0	0	18	0	0	18	0	0	218	0	0	0				254
visits to Greece	0	0	0	0	0	12	5	0	0	0	10	0				31
total	0	0	20	0	6	60	5	31	291	46	84	50				597

Assignment Key

- = long visit
- = short visit
- = workshop, seminar
- = visit to Greece

SECTION 2 EXECUTIVE PUBLISHABLE SUMMARY

Contract No:	EVG3-CT-2002-80006	Reporting period:	Jan 1 – Dec 31, 2003
Title:	PRAGUE CENTRE OF MATHEMATICAL GEOPHYSICS, METEOROLOGY, AND THEIR APPLICATIONS (MAGMA)		
<p>Objectives</p> <p>The MAGMA Centre aims at increasing international recognition of Geophysics and Meteorology at the Charles University in Prague. The Centre should contribute to coordination of research and education in dynamic phenomena of the solid Earth and atmosphere by adopting unifying mathematical viewpoint. The Centre should apply a multi-disciplinary approach and application to European environmental problems, such as climate change, pollution transport, earthquake hazard, as well as the energy problems, such as the oil exploration.</p> <p>Achievements</p> <p>The main instrument of the MAGMA Centre is inviting PhD students, post-doctoral researchers and senior researchers to Prague, organizing scientific meetings, and participating in EC projects (including submission of the new ones). Research behind the above mentioned mobility is focused on the following tasks: Thermal convection, Viscoelastic response of the Earth, Temporal changes of the gravitational field, Seismic waves, Earthquakes, Climate system, Air quality. Dissemination of results is effectuated through scientific journals, conference contributions, seminars and web. Main results of the first year of MAGMA Centre comprise the following activities:</p> <ul style="list-style-type: none"> • Two international conferences were co-organized by MAGMA in the Czech Republic. 42 participants were supported by the MAGMA Centre. Besides that, there were 21 visitors to MAGMA which, all together, spent 11 months at the Charles University during 2003. • Research was tightly linked with the 5th framework EC projects (DGLAB, SAFE, PRESAP, SOLICE). The MAGMA staff participated in submission of several 6th framework projects, 3 of them were accepted (3HAZ-CORINTH, SPICE, ENSEMBLES). • Constantly upgraded web page enabled a rapid dissemination of all information related to MAGMA activities and achievements. Valuable seismic data, gathered by the MAGMA seismic stations in Greece, have been freely available from the web page, too. <p>Socio-economic relevance and policy implications</p> <p>Knowledge transfer to industry was realized through an (annual) seminar and training course, organized in Prague for representatives of major oil companies. Moreover, there were contacts with research institutes, state organizations and municipality concerning environmental tasks such as coal mining, nuclear waste, leakage of hazardous materials, etc. Almost 50 internal seminars proved to be an efficient way of research and societal interaction between the Centre and the other research institutes in the Czech Republic. The seminars also improved awareness of potential employers about our students, and <i>vice versa</i>. Four PhD, seven MSc and three BSc students successfully defended their theses in 2003. MAGMA activity received publicity through two TV interviews, an exhibition and web. Role of MAGMA has been strongly appreciated on several occasions by the University officials, including the Rector, the Dean, and the Vice-Deans. A representative of the French Embassy in Prague has been interested in our work, too.</p>			

Conclusions

The first year of the MAGMA Centre life was exciting and challenging. With MAGMA, new horizons have been open. Indeed, our working and thinking style has undergone a significant change. More attention is now paid to a closer co-operation between formerly separated groups and tasks. Awareness of societal needs increases, hence interest of researchers and students in environmental applications is growing. Last but not least, MAGMA improves recognition of the Charles University as a useful partner abroad, and we better recognize possibilities and importance of the European research networking.

Keywords

Earth interior and dynamics. Thermal convection. Post-glacial uplift. Seismic waves. Earthquakes. Climate system. Air quality. Oil exploration. Data and software. Workshops. PhD and Post-Doc mobility.

Publications

Counting both published and submitted papers, research output by the MAGMA staff in 2003 comprises 26 refereed journal papers (12 of which are in impacted journals), 3 research reports, 27 papers in proceedings, 12 conference abstracts and 14 theses (see Research Overview 2003 and publication list, linked with the MAGMA web page and attached in printed form to this report, too). Two monographs were co-authored by members of the MAGMA staff. Most of these publications are closely related with the above objectives and achievement. However, as MAGMA is not a research project, but an Accompanying Measure focused on mobility, the only publications strictly related to MAGMA (and thus also including acknowledgement) are those arising from visitor's stay and work at the Charles University, either completely, or partially. Obviously the percentage of such a production will always be just a small fraction of the whole MAGMA staff production.

Reviewed journal papers with acknowledgement to MAGMA

- Zahradnik, J., Serpetsidaki, A., Sokos, E., and Tselentis, G-A.: A double event interpretation of the 2003 Lefkada earthquake, Greece. *Bull. Seism. Soc. Am.* (submitted in January 2004).

Other publications and outreach material

- Research Overview 2003 and publications of the MAGMA staff: <http://geo.mff.cuni.cz>.
- Four PhD theses, seven MSc theses, three BSc theses.
- Seismic data freely available at <http://seis30.karlov.mff.cuni.cz>.
- Abstracts from visitors' lectures and seminars at <http://geo.mff.cuni.cz/magma>.
- Training materials: <http://geo.mff.cuni.cz>, link Teaching/Study Texts.

SECTION 3

DETAILED REPORT ORGANIZED BY WORK PACKAGES

Important remarks:

Each work-package report has the same content: objectives, achievements, and plan. Each WP plan lists the names of visitors agreed by the day of writing this report. Where the socio-economic relevance has a specific form, it is also discussed in the corresponding work package. However, a lot of aspects of the socio-economic relevance goes across the work packages, and those are detailed in the WP9 (management) report.

WP1 Thermal convection

The main scientific objective of WP1 is multidisciplinary study of the Earth mantle convection, including complex mineralogical, rheological and geochemical information, and the corresponding networking of European researchers.

The WP1 activity was open in March by the visit of Harro Schmeling, professor at the Institute for Meteorology and Geophysics, Frankfurt am Main, Germany, who gave a talk on modeling magmatism of the Iceland plume. H. Schmeling is very active in the European research project of the Iceland plume. Besides that, in Germany, he is organizing research of temporal variations of the global gravity field related to tectonic processes, mantle convection and postglacial uplift. Possibilities of participation of Czech scientists in this type of research, including exchange of students and mutual testing of software, were considered. H. Schmeling was also one of the scientific organizers of the 8th European Workshop on Numerical Modelling (see below) and the local organizers in Prague took opportunity of his stay to discuss details of scientific programme of the forthcoming meeting.

The most important activity of the work packages 1 and 2 was The 8th European Workshop on Numerical Modelling of Mantle Convection and Lithospheric Dynamics (Castle of Hrubá Skála, September 13–18, 2003). After successful meetings in The Netherlands, Germany and France, this workshop was the first one organized in an "eastern" country. As the previous ones, this meeting was aimed to bring together leading personalities focussed on modeling lithosphere and mantle dynamics, along with young scientists just entering the field (almost one half of 96 participants were PhD students or postdocs). The programme included general scientific discussions, as well as discussions of technical issues related to numerical modeling. The interdisciplinary links, one of the major concerns of the MAGMA projects, were emphasized. The environmental problems were also addressed (global warming, sea-level changes, even crustal deformation and its relation to nuclear waste deposits). A significant amount of time was devoted to informal discussions which developed from the invited presentations and posters. The location, timing and makeup of the posters were designed to optimize discussions within small groups. The workshop thus became an excellent platform for informal working activities (finishing old and starting new benchmarks; informing about PhD and postdoc positions; preparing new, either formalized or informal projects; creating new links, etc.). Besides MAGMA Centre, the other institutions supported the workshop, too: it was the Czech Ministry of Living Environment, the Czech agency for nuclear waste (SURA), the Geophysical Institute of the Czech Academy of Sciences, and the French Embassy in Prague. The financial support from MAGMA budget was used for the foreign members of the organizing committee, for most of the invited speakers and for selected students (for more details, see <http://geo.mff.cuni.cz/workshop> and the MAGMA web page).

A visit of Attila Galsa and Balint Sule, two gifted students of Eötvös University in Budapest, Hungary, which followed in November, was arranged during the above workshop. Both young men are former students of Laszlo Cserepes, an outstanding Hungarian geophysicist who died in 2002. During their 3-day visit, they gave excellent talks and presented results of their PhD projects. The visit was a first step to establish more intensive co-operation in future. This co-operation would be very desirable because the geophysical departments in Prague and Budapest are the only two institutions dealing with mantle convection modeling in the former Eastern block.

Beside the above activities, fruitful co-operation continued with the geophysical laboratories at Ecole Normale Supérieure in Paris and Lyon, including exchange of researchers and students. A joint supervision of a PhD student, O. Sramek, is to be especially emphasized (co-supervised by O. Cadek in Prague and Y. Ricard in Lyon). Visitors from these institutions are expected to come to Prague next year. Since the French-Czech programme of scientific co-operation „Barrande” was strongly restricted due to the changes in France, some effort has been spent to formalize the co-operation between the department in Prague and the ENS in Lyon on an alternative basis (most likely in the framework of ERASMUS project). The effort should be finalized in 2004.

Activities planned for 2004

Short-term visits:

- Luce Fleitout, ENS Paris; topic: modeling gravity response of a convecting system using finite elements
- Neil Ribe, IPG Paris; topic: models of bending in fluid dynamics

Long-term stays:

- Balint Sule, PhD student, Eötvös University, Budapest, Hungary; topic: modeling mantle plumes in 3D; expected month of arrival: April
- Jan Matas, senior researcher, ENS Lyon, France; presenting series of lectures on thermodynamics and mineral physics with applications in geodynamics; month of arrival: March
- Arie van den Berg, senior researcher, University of Utrecht, The Netherlands; topic: modeling subducting lithospheric slabs using a finite element code; month of arrival: March
- Yann Krien, PhD student, ENS Paris, France; topic: modeling gravity response of a convecting system; expected month of arrival: October

WP2 Viscoelastic response

The main scientific objective of WP2 is viscoelastic modeling in complex 3D models of the Earth, and the corresponding networking of European researchers.

The long-term stays of Mikhail Karpytchev (senior researcher at University of La Rochelle, France) and Gilles Pelfrene (PhD student at Ecole normale supérieure, Paris, France) as well as the two-week visit of Luce Fleitout (research director at Ecole normale supérieure in Paris) were mainly focussed on solving particular aspects in modeling the postglacial rebound. Both M. Karpytchev and L. Fleitout have been in touch with the geodynamics group in Prague for more than six years and their stays were well prepared and very intensive. Gilles Pelfrene is a student of Luce Fleitout, and he closely co-operates with O. Cadek from Prague on solving his PhD project.

Mikhail Karpytchev, University of La Rochelle, France, came to Prague on May 26, 2003, and spent one month here. His stay was a good opportunity for the Prague modelers to compare different numerical approaches to solving the problem of viscoelastic relaxation of the Earth with laterally variable viscosity. Besides this activity, possible ways to model the deformations related to recent changes of ice in Antarctica were discussed. These deformations are now measured by GPS methods with relatively high accuracy and they might indicate the contemporary trends in melting the Antarctic glaciers. The ways of how to include oceanography and glaciology data in the postglacial rebound modeling were evaluated.

The two-week stay of Luce Fleitout (August 17–30, 2003) was a continuation of previous research activities, effectuated mainly in the framework of the Czech-French project “Barrande”. Her stay, partly overlapping with the stay of her student G. Pelfrene, was mainly focused on developing and testing codes to model the viscoelastic deformation in a general 3-dimensional earth model. Besides the role of lateral viscosity variations on the postglacial uplift, effects of a highly compressible

transition zone were discussed and tested. Possibilities of future co-operation, including exchange of young researchers and common supervision of PhD students, were considered.

Gilles Pelfrene spent six weeks in Prague (August 15–September 28, 2003) during which he intensively worked on his PhD project related to viscoelastic deformation of a compressible earth. The stay helped him to understand different techniques used for viscoelastic modeling, and to compare his codes with those developed by L. Hanyk in Prague.

The mini-symposium, planned for the first year of the MAGMA project, was finally included in the 8th European Workshop on Numerical Modeling of Mantle Convection and Lithospheric Dynamics, organized in the framework of the work package 1. The list of participants, related to the viscoelastic part of the workshop, included names of researchers and students from INGV in Rome, University of Bologna, University of Urbino, ENS in Paris and other institutions (for details, see <http://geo.mff.cuni.cz/magma>). One quarter of the invited lectures of the workshop were focussed on viscoelastic modeling and related problems (K. Regenauer-Lieb, L. Fleitout and G. Spada), and one afternoon was officially devoted to posters on postglacial rebound. Besides these activities, informal micro-sessions dealing with 3D viscosity models and accurate implementation of the sea-level equation were organized, with the aim to create small groups working in future on different benchmarks related to postglacial rebound modeling.

Activities planned for 2004

Mini-symposium on postglacial rebound modeling will be held in Prague in September 2004, 3-5 days, 10-15 researchers and students:

- Italy (C. Giunchi, INGV Rome, G. Spada, University of Urbino, and their co-workers)
- France (L. Fleitout, ENS Paris, and her students)
- Germany (D. Wolf, GFZ Potsdam, and co-workers)
- The Netherlands (Bert Vermeersen, Delft University)

Short-term visits:

12 participants of the above mini-symposium

Long-term stays:

- Gilles Pelfrene, PhD student at ENS Paris (4-6 weeks in autumn)
- A PhD student from INGV in Rome or University of Urbino (1 month in September, the name has not yet been agreed)

WP3 Temporal changes of the gravitational field

The main objectives of WP3 include theory and interpretation methods for satellite gradiometric observations, studies of post-glacial viscoelastic relaxation, and the corresponding networking of European researchers.

There were two visits at the MAGMA Centre under activity of this work package. At the beginning of September 2003, Heather McCreadie, a researcher from GeoForschungsZentrum (GFZ) Potsdam visited us for 5 days. She was invited to act as an external examiner for the PhD thesis defense of Jakub Velimsky, the internal PhD student of MAGMA Centre. The contribution of H. McCreadie to scientific discussion during the defense was important since her scientific interest has been mostly oriented to the collection, processing and analyzing geomagnetic data. These topics are less studied at our Department, and, hence, the discussions were inspiring not only for the future Jakub's work, but also for many of the other staff members and students.

Jan Hagedoorn, a PhD student from GeoForschungsZentrum Potsdam, visited us for 3 months, starting from the October 5, 2003. His stay was oriented into the three issues. First, he continued in his PhD work on glacial isostatic adjustment (GIA). Particularly, he set up the benchmark study on the

numerical implementation of on sea-level equation in glacial isostatic adjustment, see <http://geo.mff.cuni.cz/gia-benchmark>, and has invited us, as well as the other scientists, to contribute to this benchmark study. Second, he focused on the prediction of GIA-induced deformation and changes in the Earth's rotation on GPS and tide-gauge measurements. For this purpose, he installed his numerical software for modeling GIA coupled with sea-level equation and rotational deformation at one of our most powerful computers. This software can be used in MAGMA Centre for scientific purpose in future. Finally, Jan took part in the course "Selected chapters from partial differential equations", taught for undergraduate students of Geophysics at our Faculty by C. Matyska. He appreciated the high theoretical level of the lecture, which helped him to understand details of the GIA formulation developed at our Department.

In the framework of WP3 we also participated in the main event of WP1 and WP2 - The 8th European Workshop on Numerical Modelling of Mantle Convection and Lithospheric Dynamics (Castle of Hruba Skala, September 13–18, 2003). Within WP3, the workshop participation of two colleagues from GFZ Potsdam was supported, Kevin Fleming and Jan Hagedoorn, who actively participated in the poster session of the workshop.

Z. Martinec, coordinator of WP3, actively participated in the other projects, SEAL and GRACE, during his long-term stay in Germany. The satellite mission GRACE is just in its beginning, and although at least two more years are needed to get enough data, the project has already attracted large scientific interest. Besides other, it will provide a valuable constraint on the viscosity models of the Earth. Z. Martinec is devoted to development of mathematical theory necessary for correct interpretation of the GRACE data.

Activities planned for 2004

Mini-symposium:

A mini-symposium on external gravitational field and GPS observations, in relation with the glacial isostatic adjustment (GIA), is under negotiations with potential attendees from several countries of Europe.

Long-term stays:

In the second year we plan to continue in long-term visits of researchers from GFZ, Potsdam:

- Volker Klemann should stay in Prague for 7 weeks starting on March. His research will be oriented towards continuation of his work on glacial isostatic adjustment (GIA). He will work on implementing nonlinear rheologies, like power-laws, into already existing numerical codes of viscoelastic field theory of GIA. Discussing the influence of a non-linear viscoelastic stratification of the lithosphere on GIA will be also welcome.
- The long-term stay of Kevin Fleming is under negotiation.

WP4 Seismic waves: Theory

The main objective of WP4 is development of new theoretical methods for seismic wave propagation in complex 3D heterogeneous and anisotropic media, the corresponding networking of European researchers, and transfer of the knowledge towards oil industry.

A two-day seminar with representatives of major oil companies, designed to disseminate theoretical results, and discuss mutual cooperation was held on June 9-10, 2003, at the Department of Geophysics, Charles University, Prague. For details of the programme, see web page of the Consortium of Seismic Waves in Complex 3D media (SW3D) at <http://sw3d.mff.cuni.cz>. Participants from EU and associated countries: Peter M. Bakker, Shell, Netherland, Einar Iversen, NORSAR, Norway, Ronit Strachilevitz-Levy, Paradigm Geophysical, Israel. Participants from non-EU countries: Alcides Aggio Sobrinho, Petrobras, Brasil, Guy W. Purnell, ChevronTexaco, USA, Troy Thompson, BHP Billiton, Australia. The stay of the participants was not covered from MAGMA sources.

Immediately following the above meeting and for the same participants, a one-day training course was held on June 12, 2003, at the Department of Geophysics, Charles University, Prague. The training course was devoted to the latest software developed at MAGMA Centre during the last year, and to the discussion of the underlying numerical algorithms.

Einar Iversen from NORSAR (Norway) visited the MAGMA Centre for 11 days, from November 24 to December 4, 2003. The mutual discussions were primarily devoted to the problems of seismic wave propagation in anisotropic structures and to the coupling ray theory. We discussed the isotropic and anisotropic common ray approximations and anisotropic-ray-theory ray as the reference frame for the coupling ray theory. Considerable attention has been devoted to parametrization and interpolation of the propagator matrix of the coupling equations for S waves, both in spatial and frequency domains, and to a possibility to define and apply the Hermitian 2x2 matrix of coupling-ray-theory travel times. The visit resulted in the schedule of future research cooperation between NORSAR and the MAGMA Centre in the field of seismic wave propagation theory and algorithms.

It is to mention that closely related to these MAGMA activities, one PhD students of our group (K. Zacek, supervised by L. Klimes) was invited to visit Chevron Texaco, San Ramon, California, where he spent 3 months in 2003.

Activities planned for 2004

Seminar and training course with major oil companies in Prague: analogous to that of 2003.

Long term stays:

- Giancarlo Dal Moro, Exploration Geophysics Group, Department of Geological, Environmental and Marine Sciences, University of Trieste, Italy, March 1 - March 31, 2004
- Leo Eisner, Schlumberger Cambridge Research, Cambridge, United Kingdom, March 15 - April 18, 2004
- Tijmen-Jan Moser, Jason, Amsterdam, Netherlands, 2 months
- Dirk Gajewski, Institute for Geophysics, University of Hamburg, Hamburg, Germany, 1 month

WP5 Seismic waves: Observations

The main objective of WP5 is development of the Charles University seismic stations in Greece, collecting and processing data essential for research in WP6, and their integration into the European framework.

The Charles University stations were deployed in Greece in 1997. Their successful work would not be possible without intensive and extensive, long-lasting co-operation with the Seismological Laboratory, University of Patras (A. Tselentis, professor of geophysics and head). Presently, our network comprises four sites, each one equipped with a weak-motion broad-band velocigraph CMG3-T and a strong-motion accelerograph CMG5-T. The stations Sergoula and Mamousia (existing in the previous period, too) are situated on the northern and southern coast of the Corinth Gulf, in its western part. The third (new) site is Loutraki, at the eastern edge of the Corinth Gulf. The fourth site (also new) is Pylos, close to Kalamata city, on the south-west of the Peloponnese. Thanks to massive financial support of the Seismological Laboratory, Patras University, the Loutraki and Pylos stations have got the satellite data transmission to Patras (Libra system, from the Nanometrics company) during the year 2003. The selected data are available from <http://seis30.karlov.mff.cuni.cz>, updated every 3–4 months.

Three short working visits to our stations in Greece were effectuated in 2003: in June (V. Plicka, J. Zahradnik), in July (J. Zahradnik), and in November (V. Plicka, J. Jansky). During all three visits, standard operations were performed, such as disk exchanges, fixing small technical problems, data download, and their posting on Internet. In addition, and from viewpoint of MAGMA perhaps even more importantly, all visits were extremely efficient in strengthening the scientific contacts with the

staff of the Seismological Laboratory in Patras. For example, joint research on location was thoroughly discussed with A. Serpetsidaki, a PhD student in Patras. Finite-difference method was discussed with another PhD student in Patras, P. Paraskevopoulos. Instrumental problems, as well as the seismic source inversion were the main topics solved with E. Sokos, who also worked with us in Prague for 6 weeks in September within WP6. Management tasks were mutually solved by J. Zahradnik and A. Tselentis (leaders of the two co-operating parties) during visit in July.

The June visit to Patras had a still another dimension. We were invited by F. Cornet and P. Bernard (IPG, Paris) to join a meeting of the 5th framework EC project of the Corinth Rift Laboratory, taking place in Egion, Greece. In fact, it was assumed during MAGMA project preparation that we join this EC project (in particular, its part called DGLAB) within a special call dedicated to extension of existing projects by groups from Newly Associated States. Unfortunately, that extension of DGLAB did not pass in Brussels. On the other hand, we were feeling obliged to do the work we proposed (even though we faced financing difficulties), thus we operated our older station (Sergoula), and added another station exactly based on the requirements of DGLAB at Mamousia, and the Aegion meeting was an opportunity for us to document this work. An oral presentation was given by J. Zahradnik, focused on interesting differences between seismic records from co-located 3T and 5T instruments.

Fortunately, during 2003, P. Bernard, IPG Paris, invited us to be one of contractors in a new 6th framework project submission (project 3HAZ-CORINTH), which finally has been approved. It means that since 2004 the stations Sergoula and Mamousia are an official part of this exciting interdisciplinary project, which gives us a unique chance to tightly link the MAGMA Centre efforts with a broad European consortium.

As the University of Patras is another contractor of the 3HAZ project, and 3HAZ project properly formalizes the tight cooperation between Prague and Patras teams in all research and organization aspects (joint operation and management of seismic stations, joint research and publications, personal exchanges), it was not necessary to make the Twinning Agreement with Patras, originally planned in the MAGMA proposal.

Already at present, all data from our seismic stations are freely available. MAGMA Centre has a specialized web page (<http://seis30.karlov.mff.cuni.cz>) where selected data are displayed and we are proud to say that actually there is a significant interest in our data (e.g. by H. Lyon-Caen, ENS, Paris; A. Deschamps, UMR Geosciences Azur, CNRS/UNSA, Valbonne, A. Kiratzi, Univ. of Thessaloniki). Although any data can be requested by e-mail, we try to separately display the most important events for immediate direct download. In 2003, it comprised first of all the high-quality broad band waveforms of the damaging August 14 earthquake (magnitude 6) at Lefkada Island, and its largest aftershocks.

A new section advertising earthquake software developed by our group has been established at <http://seis30.karlov.mff.cuni.cz>. Although the software is only partially documented, it has yet attracted a significant attention. There have been so many requests (e.g. the finite-difference code FD2002, or the focal mechanism inversion ASPO and strong-motion simulation PEXT) that we had to make a disclaimer that no assistance can be provided, as regards the use of the codes at other institutions.

The satellite connection to the two new stations, Loutraki and Pylos, constructed in 2003, is a very positive and promising feature. The continuous data transmission works quite reliably, but, as with any new technology, we now face technical difficulties of the starting period, e.g. problems with new software, but also problems of the security of the Internet connection. It is understandable, that in solution of these problems we are fully dependent on our Greek colleagues in Patras. For the same reason we can say that there is a big potential now to directly send the data in real time to the European data Centre Orfeus (as agreed with T. van Eck), we are very close to this challenging task of MAGMA Centre, but it cannot be done before solving the above mentioned internal problems in Patras. We hope in faster solution of the problems after return of E. Sokos to Patras (E. S. is now

employed at the National Observatory of Athens), but there are some administrative delays of his return.

Based on our activity in WP5, we received invitation from our colleagues from France (H. Lyon-Caen and Mary Ford) and Greece (A. Kiratzi) to join their submission of a proposal for a Marie Curie Research Training Network AEGEAN-QUAKE. Compared to the SPICE RTN (discussed in WP6), this is a more geologically and more practically oriented RTN, thus we accepted the invitation with pleasure and worked hard on our part of the proposal, devoted to source studies of selected earthquakes in Greece. And here is another moment where MAGMA Centre and its long-range objective on interdisciplinary cooperation had a strong impact on our thinking. Indeed, as a result, we agreed to extend our planned purely seismological participation also by topics from geodynamics (related to WP1 and WP2 of MAGMA). It means that, if AEGEAN-QUAKE is accepted, we will try to investigate relations between earthquakes, lithospheric plate motion and mantle convection in a single target region of the Aegean.

Activities planned for 2004

Short-term visits:

- Three or four regular visits to the Seismological Laboratory in Patras, depending on the status of our joint research work and on the technical status of the instruments, approximately scheduled for April, August and November
- Short visit (2 weeks) of MAGMA Centre in Prague by E. Sokos of the Seismological Laboratory in Patras

Web page:

The database on web will be continually upgraded. The same web page will include also the latest publications and software advertisement.

WP6 Earthquakes

The main research objective of WP6 is to synthesize different approaches of earthquake modeling (the so-called integrated modeling), and to promote multidisciplinary studies of the earthquake strong-ground motions in the European framework.

This objective has two aspects: research and organization. Both were addressed within WP6 in 2003. As for scientific results, the reader is referred to Research overview 2003, attached to this report. As for research exchanges, the activity concentrated onto three short visits in Prague and one long-term postdoc stay. Besides that, we participated in submission of several new EC projects.

Visit of A. Caserta, researcher of the National Institute of Geophysics and Vulcanology (INGV) in Rome, realized in June, was a continuation of our long-lasting contacts from 90's when he worked together with J. Zahradnik and V. Plicka in Prague on 2D numerical simulation of the ground motion. Presently, A. Caserta is interested in 3D modeling and wants to contribute by its array and borehole measurements of noise and earthquakes in Rome. His goal is non-standard description of noise as a chaotic process and contribution to earthquake hazard assessment in the capital. Equally well, he is interested in numerical and large-scale computational aspects. Perhaps surprisingly, he decided to get his second doctoral degree with us, and started his PhD study at the Charles University in Prague in 2003. His two seminars talks within MAGMA Centre were devoted to site effects during the 1997 Colfiorito, Italy, earthquake, and to finite-difference simulations.

Antonio Emolo, researcher of the University in Naples, who visited MAGMA in October 2003, is specialized in the finite-extent kinematic source inversion. He gave two talks, one about the method, the other about an interesting application, i.e. how to explain historical observations of the damaging 1930 Irpinia earthquake in Italy. He had inspiring discussions mainly with two PhD students in Prague, F. Gallovic and J. Burjanek. They agreed to continue their co-operation by trying to model the same

data set, independently in Italy and Czech Republic. It was also (preliminarily) agreed to have A. Emolo for at least 1 month in Prague in 2004.

A unique chance to invite K. Irikura, former director of the Disaster Prevention Research Institute, University of Kyoto, Japan, presently the Vice-President of the same university, culminated in September 2003, when K. Irikura attended a symposium in Slovakia and, after that, made a short stop in Prague. Formally, due to administrative problems, we could not support K. I. from MAGMA budget, but we managed to find another source. MAGMA Centre profited from his excellent lecture (posted in its full form as a presentation on our web page) and from numerous discussions about various strong-motion simulation methods, their validation against earthquake observations in Japan, on empirical Green functions, etc. It is to mention, that before his visit to Prague, K. Irikura hosted in his institutes two PhD students from Prague, J. Burjanek and F. Gallovic, for 4 months. The stay, besides other, enabled them to actively participate at IASPEI conference in Sapporo. Later in 2003, another young staff member of MAGMA was invited by K. Irikura for 5 months (I. Oprsal, now on its postdoc stay at ETH, Zurich). In other words, we have got a good reputation in Kyoto, which may be very useful in a future submission of an EC proposal of a kind enabling cooperation outside Europe.

The 6-week postdoc stay of E. Sokos, our main contact person in Patras, Greece (see WP5), presently employed at National Observatory of Athens, started in September. His preliminarily agreed topic was to cooperate with J. Zahradnik, to develop a new, user friendly software for the seismic source inversion in regional distances. However, on August 14, 2003, a damaging earthquake occurred at Lefkada Island, Greece, so the stay was not only devoted to the new software, but also to joint work on the broad-band regional data from 5 stations in Greece (4 NOA stations, and 1 of the stations operated jointly by Charles University and Patras University, Sergoula). Another favorable fact was that J. Zahradnik has worked since July 2003 on his new Fortran code for the multiple point-source moment tensor inversion, thus E. S. started to link that Fortran code with his Matlab graphic user interface, and both were immediately applied to the Lefkada earthquake. Exactly during last hours of the stay of E. S. in Prague, an extended abstract was submitted for a small conference in Athens, where 13 papers were later in November devoted to the same event. Our paper was also immediately posted on the web page of the European Seismological Mediterranean Centre. This was an exciting study, in which E. S. and J. Z. suggested that the Lefkada earthquake consisted in fact from two relatively distant fault segments, one at Lefkada, and the other at Cefalonia Island. The work attracted reaction (both positive and negative) in Athens. A journal paper is now in the preparation. It would be great to repeat E. Sokos' stay in Prague also in 2004, but may be that his family needs him more than us.

Three different methods for numerical modeling of the strong-ground motions were developed at MAGMA Centre during 2003 within 5th framework EC project PRESAP, coordinated by J. McCloskey, professor of geophysics at the University of Coleraine, Northern Ireland. The Prague group was responsible for the strong-motion modeling work package in PRESAP. For details, see Research overview 2003. The project culminated by a blind experiment aimed at testing predictability of strong aftershocks in connection to Coulomb stress transfer, and simulation of the strong motions due to the aftershocks. The results were collectively reported at AGU in San Francisco (Scotti et al., 2003). The project was formally closed by final meeting in September 2003, but a continuation is planned, so we hope that our excellent contacts created with the PRESAP teams will continue. For example, C. Berge and D. Baumont of the Institute of Nuclear Safety and Protection, Fontenay-aux-Roses, France are our contact for transfer of the knowledge into practice of the earthquake hazard mitigation (C. Berge is an external member of the MAGMA Advisory Board). As another example, M. Cocco, director of the Department of Seismology and Tectonophysics at INGV Rome accepted our invitation to visit MAGMA as a distinguished lecturer in 2004. In 2003 we had a cooperation with him on comparing strong motion simulation techniques for the 1997 Colfiorito, Italy earthquake, but his visit will go beyond this task, and will help to introduce us into a new research field. Indeed, we hope to discuss with M. Cocco mainly numerical modeling of faults and dynamic triggering of earthquakes. Besides research, PRESAP was useful also because two students of our department have their PhD thesis tightly linked with that EC project.

Close cooperation with 5th framework EC project SAFE, coordinated by M. Sebrier of the University Pierre et Marie Curie, Paris 6, was accomplished thanks to I. Oprsal from Prague, who is on his postdoc stay at ETH and works there in SAFE on seismic scenarios for the city of Basel. I. O. is developing his hybrid finite-difference technique. Therefore, together with PEXT strong-motion simulation of J. Zahradnik, and with data provided by A. Serpetsidaki and A. Tselentis of Patras University, we all together investigated 3D seismic response of a site in Athens, heavily damaged during the 1999 earthquake. I. Oprsal presented his results at IASPEI meeting in Japan, where he become a member of the IASPEI/IAEE working group on Effects of Surface Geology, as successor of J. Zahradník who worked in that W. G. for more than 10 years.

In the beginning of 2003, a huge project proposal on literally pan-European seismology was organized by ORFEUS data centre (EC project NERIES). We proposed a part on strong-motion simulation techniques. Unfortunately, the project has got a too critical evaluation, and a re-submitted version has to be prepared likely in 2004.

On behalf of MAGMA, O. Novotny participated also in preparation of the EC project SWARM, coordinated by Gerhard Jentzsch, professor at the University of Jena, Germany. This is Multi-risk analysis: Interaction of earthquake swarm activity, fluid migration and CO₂-emission in natural laboratories, focused on the interesting West Bohemia-Vogtland region. Unfortunately, the project was finally not accepted.

On the other hand, another big project including MAGMA staff participation, was submitted and already accepted. It is 6th framework Marie Curie Research Training Network SPICE, coordinated by H. Igel, professor of geophysics at the University of Munich. According to the proposal, on which we intensively worked in 2003, our participation is targeted exactly on the main topics of WP4, WP5, and WP6 of MAGMA, to provide synergy: finite-difference and hybrid modeling of seismic waves, and finite-extent seismic source simulation and inversion. The 36 PhD student months and 22 postdoc months are planned for Prague within SPICE for the next 4 years. Thus SPICE represents an ideal extension of MAGMA, since it directly links us with the other 13 European groups.

Activities planned for 2004

Mini-symposium:

The mini-symposium planned for 2004 moves to 2005. It will be merged into a bigger event, co-organized by MAGMA WP4 and WP6 (together with the Geophysical Institute, Czech Academy of Sciences). This will be an international conference on Seismic Waves in Laterally Inhomogeneous Media (June 2005, Castle of Hruba Skala, Czech Republic).

Short visits:

- A 5-day stay, discussions and invited lecture on dynamic triggering by M. Cocco, director of the Department of Seismology and Tectonophysics at INGV Rome; preliminarily scheduled for late spring
- Martin Valee, currently at postdoc stay in the Marie Curie Centre at the Univ. of Naples, and Martin Mai, ETH Zurich, both on finite-extent seismic source modeling and slip inversion, strong-motion simulations

Long-term stays:

- The 6-weeks stay of A. Emolo, University of Naples, devoted to finite-extent seismic sources and strong motion modeling is expected in the September-October period.
- The post-doc stay of A. Serpetsidaki, University of Patras, devoted to earthquake location problem and our joint research in Greece. The term depends on the date of her PhD defense, not yet fixed during writing this report.
- Invitations have been issued also to P. Paraskevopoulos, University of Patras, and to the group of A. Kiratzi, professor at the University of Thessaloniki, Greece (seismic-source inversion). A one-month stay in May of Christoforos Benetatos, a PhD student of A. Kiratzi, has been negotiated.

WP7 Climate system

The main research objective of WP7 is development of mathematical models for modeling the climate system, with emphasis on the Czech Republic and Europe.

Martin Fuellekrug, professor at Institute for Geophysics, University of Frankfurt am Main, Germany, visited MAGMA Centre in the period September 15-18, 2003, on the occasion of 3rd IAGA/ICMA Workshop on Solar Activity Forcing of the Middle Atmosphere at the Institute of Atmospheric Physics, Czech Acad. Sci. He delivered a lecture entitled "Global remote sensing of the atmospheric electromagnetic environment and its relation to climate change". This visit enriched MAGMA by another aspect of the climate change, *viz.* the connection with atmospheric electricity. The atmospheric electricity in global electric circuit is very sensitive to changes in temperature and, therefore, it can be a good indicator of the global climate change.

The long-term stay of Iraklis Lisaridis, PhD student at Aristotle University of Thessaloniki, Greece (November 2 –December 23, 2003) was focused on the regional climate modeling. The title of his talk was "Learning and practicing on RegCM". During this visit the guest was trained on regional climate modeling. He learnt the basic principles of RCM RegCM3, and tested several configurations of the model for different purposes. He analyzed sensitivity of the model results with respect to choice of domain size.

Further cooperation concerned EC projects. In 2003, we joined the project SOLICE (5FP, Solar Influence on Climate and the Environment, EC, EVK2-CT-1999-00001), dealing with analysis of the solar activity impact on atmospheric processes with emphasis on long term changes in composition of the atmosphere, temperature, global circulation etc. In March 2003, we joined the activity around the proposal ENSEMBLES (ENSEMBLE-based Predictions of Climate Changes and their Impacts, EC, FP6-2002-Global-1, 505539), dealing with regional climate changes and their impacts on Europe using multi-model ensembles prediction and regional climate simulation with high resolution. The project was accepted, and will represent an important part of our activity in the next 5 years.

Activities planned for 2004

Workshop:

Workshop on Regional Climate Modeling, autumn 2004, Prague.

Short visits:

- S. Sommot, researcher at MeteoFrance, Toulouse; spring
- A. Berger, professor at LLN University, Louvain-La-Neuve; autumn

Long-term stays:

- Kleareti Tourpali, assistant professor at University of Thessaloniki; autumn
- John Hampson, postdoctoral research associate, the group "Dynamics and Climate of the Middle Atmosphere" at Service d'Aéronomie (CNRS), Paris

WP8 Air quality

The main research objective of WP8 is numerical atmospheric modeling with emphasis on local air pollution in the Czech Republic and Europe.

One of the largest events of MAGMA in 2003 was The 4th International Conference on Urban Air Quality – Measurement, Modelling and Management, UAQ4 (March 25-27, 2003), co-organized with the Institute of Physics, London, and the University of Hertfordshire, United Kingdom (Prof. R. S. Sokhi). The conference took place at the Charles University in Prague and the audience was about 140 participants. Topics of the conference included the following items:

- Urban meteorology
- Measurement and monitoring of urban air pollutants on local and urban scales
- Sampling techniques and instrumentation
- Transformation and dispersion processes
- Emission models and inventories
- Source apportionment studies
- Local and Urban scale modelling
- Early warning systems and forecast modelling
- Roadside air quality modelling including street canyons
- Wind tunnel and physical modelling studies
- Modelling evaluation and sensitivity studies
- Use of remote sensing and satellite data assimilation for urban air quality
- Personal exposure and environmental and health impact of urban air pollution
- Urban air quality management systems (AQMS) and decision support systems (DSS)
- Urban air quality databases, information systems and data archiving

From aspects most closely related to MAGMA, let us mention synthetic approach to diverse problems, such as measurements and monitoring on one side, and modeling on the other side. Our main interest was in meso- and micro-synoptic model approaches, and usage of the (Computational Fluid Dynamics, CFD) models. Of particular practical importance for MAGMA was inclusion of the aspects related to the environmental management. The financial support from MAGMA sources was used for 5 participants from Estonia, Bulgaria, Hungary, and Romania. All of them had oral contribution or poster.

In 2003, the MAGMA staff cooperated also with the Meteorological Institute of the University of Hamburg. Another cooperation with Institute for Tropospheric Research, Leipzig, Germany, has been under preparation.

In 2003, a photochemical model inter-comparison campaign occurred, called CityDelta (see web page <http://rea.ei.jrc.it/netshare/thunis/citydelta>), organized by the Joint Research Centre, Ispra, Italy. The Czech Republic was represented by the MAGMA WP8 responsible, J. Brechler. He took part in two meetings, one in Valencia (Spain), and the other in Matera (Italy).

Last but not least, it is to mention an important contact with municipality. Indeed, J. Brechler, met twice (in August and September) with the emergency management team of the firefighter and rescue brigade, Prague, discussing possibility of a model study devoted to the hazardous and explosive material leakage, and its effect upon urban population.

Activities planned for 2004

Workshop:

The workshop devoted to nesting of the air-quality models with the meteorological forecast models. Under preparation for the autumn or winter 2004.

Long-term stays:

Stay of 1 or 2 researchers from Italy is under negotiation (3 to 6 months). Result is dependent also on a competition related to the researchers in Italy.

WP9 Research and technical management

The main objective of WP9 is to manage synchronization among work packages, and to co-ordinate communication of the MAGMA Centre with research and industrial partners in the Czech Republic and Europe.

Start of MAGMA Centre management was characterized by establishing *modus vivendi* within the Faculty of Mathematics and Physics, where the Centre like this has been quite unique, and highly appreciated, in particular by the Dean, the Vice-Dean for Physics, and by the Department of Foreign Affairs. Together with the Economic Department, these Faculty officials have provided a considerable help in the commencement period, harmonizing the EC contract requirements with everyday university practice, in particular as regards proper form of written agreements with the individual MAGMA visitors, their legal status, their payment, accounting rules, etc.

Web page of the MAGMA Centre was created as soon as in January 2003 and, since that it is continually updated, e.g. after each event. In order to keep the main MAGMA page easily readable, specialized web pages were linked with it, so the whole system is as follows:

- the MAGMA home page, <http://geo.mff.cuni.cz/magma>
- home page of the Department of Geophysics, i.e. the main site to post the research summaries going across the individual work packages, training materials, etc., <http://geo.mff.cuni.cz>
- home page of the Consortium of Seismic Waves in Complex 3D media, including mainly the WP4 activities, publications, software, etc., <http://sw3d.mff.cuni.cz>
- home page of the Seismic stations of the Charles University in Greece, WP5 and WP6, its database, publications, software, etc., <http://seis30.karlov.mff.cuni.cz>
- home page of the Department of Meteorology and Environmental Protection, <http://kmop.mff.cuni.cz>

The main MAGMA web page has been devoted mainly to information about our current activities: meetings and visitors. A very important decision was made in order to increase the information value of the page: For each visit, not only basic facts are posted, such as duration of stay, research topic, etc., but also a link is made to more detailed materials related to the visit and/or the visitor himself. It includes, for example, abstracts submitted to a conference as a result of the stay at the MAGMA Centre, a related teaching material, a link to visitor's own research web pages, etc. One of the most valuable contributions is a complete lecture by K. Irikura, professor of geophysics of the University of Kyoto (a PowerPoint presentation), delivered while K. I. was our guest in Prague.

Probably the most important management activity was a nearly everyday contact of the WP leaders (internal members of the Advisory Board) with each other, during which all activities (both forthcoming and past) were thoroughly discussed. Lot of time was spent on thinking how to optimize impact of the visits on our students. E.g., how to link the lectures delivered by visitors with our lecture courses and internal seminars, how to organize the accompanying exchange visit of our students to foreign laboratories, etc. Key role in this activity has been played by the MAGMA Centre seminars. The goal was not only to have lectures of our visitors, but also (during their visit) to make them familiar with research made by our staff and our students. Another goal was to co-operate among work packages. The seminars have been also major occasion for the contacts between MAGMA Centre and the related research institutes in Prague, mainly the Geophysical Institute, and the Institute of Rock Structure and Mechanics (both belonging to the Czech Academy of Sciences). Two seminars, nearly every week in both semesters, were organized, one by the geodynamics group (WP1-WP3), the other by the seismology group (WP4-WP6), meteorologists (WP7 and WP8) participated in the so-called Meteorological Talks, the seminars organized by the Czech Meteorological Society, Prague. See the list in attachment.

Great management efforts were devoted to linking the individual WP tasks with each other. As a result, not only members of the geodynamics group were attending the seismology seminars more often than in the past, and *vice versa*, but we were also trying hard to transfer new mathematical methods from one sub-group to the other. This trend is not easily "visible" in the report, but can be traced in the seminar list and publication output (Research overview 2003), attached to this report.

Everyday interaction among the internal members of the Advisory Board was already discussed above. We had also written or personal contacts with several external members of the Advisory Board. Some of them were mentioned above. Now let us mention contacts with the two external members of the

Advisory Board providing main research supervision: R. Madariaga, professor at ENS, Paris, and A. Berger, professor at the University of Louvain-La-Neuve, who have been permanently interested in our work. The MAGMA representatives met with R. Madariaga during the start meeting of the newly open SPICE project in Germany, just few days before writing this report. For 2004, the Prague visit of A. Berger is planned in WP7. Therefore, to save time and money, and since the work was progressing quite smoothly during the year, we decided not to meet formally all together. Moreover, a reasonable meeting needs a good written material, and the first document of such a type produced by MAGMA is just the present report. Therefore, this report will be sent to all members of the Advisory Board, and a short letter of comments and suggestions will be requested. If necessary, plan of 2004 will be modified according to those comments during spring of 2004. In case of very critical comments from them, or from EC, we will have to organize a meeting of the complete Advisory Board.

Links with EC projects were mentioned in the detailed reports of the work packages. Here, let us admit, that MAGMA plays a significant role also in the preparation of national projects. In particular, a new 6-year framework research plan is to be submitted in 2004 by our Faculty for approval at the Ministry of Education, Youth and Sports. The whole Faculty of Mathematics and Physics will submit only 6 framework plans, in total. MAGMA will be a part of one of them, entitled "Research of the Earth and Universe by advanced physical methods". This huge project is coordinated by J. Bednar, professor of meteorology and head of the Department of Meteorology and Environmental Protection, a member of the MAGMA staff. This is how inter-disciplinary aspects of MAGMA positively affect the large-scale research and life of the whole Faculty of Mathematics and Physics.

Last but not least, outreach to education should be mentioned. During the year 2003, the following theses, supervised at MAGMA Centre, were successfully defended:

PhD Theses

- T. T. Nam: A semi-Lagrangian semi-implicit limiter-area forecast model (supervisor: M. Batka)
- V. Plicka: Modeling of finite-extent seismic sources by empirical Green's functions (supervisor J. Zahradnik)
- F. Vana: Le schema d'advection semi-Lagrangienne avec atténuation contrôlée – une formulation alternative de la diffusion horizontale non-linéaire dans un modèle numérique de prévision du temps; in French/Czech (supervisor: M. Batka)
- J. Velimsky: Electromagnetic induction and heterogeneous Earth's mantle: time-domain modeling (supervisor Z. Martinec)

MSc Theses

- M. Belda: Adaptation of photochemical smog model for actual situations; in Czech (supervisor T. Halenka)
- J. Beran: Modeling of mesosynoptical scale; in Czech (supervisor J. Brechler)
- P. Kolinsky: Dispersion of seismic surface waves along selected Eurasian paths; in Czech (supervisor O. Novotny)
- L. Kostal: Free oscillations of Maxwellian models of the Earth; in Czech (supervisor C. Matyska)
- H. Kyznarova: Radar observation of tornados; in Czech (supervisor P. Novak)
- R. Lechner: Atmospheric radiative transfer, trace gases and aerosols; in Czech (supervisor T. Halenka)
- P. Skalák: Global ocean – An important part of the climate system; in Czech (supervisor J. Kalvová)

BSc Theses

- J. Mazanek: Algorithms for radar detection of dangerous meteorological phenomena; in Czech (supervisor J. Kracmar)
- M. Sova: Vertical profiles of wind velocity in boundary layer; in Czech (supervisor J. Bednar)
- K. Svehlova: Evapotranspiration in the lower Ohre river basin; in Czech (supervisor I. Sládek)

An important management issue is also the internal computer network. Using MAGMA funds, the network was upgraded with two main objectives: to guarantee excellent working conditions for our

guests, and to help students to get closer to research by allowing them to work together with us, right on the premises of the MAGMA offices. Therefore, new computer components were installed both in the computer laboratory, and in PC's used by our guests. The list of hardware available within the MAGMA Centre at the end of 2003 is as follows:

Linux-based servers for scientific computing and data storage

10 computers including 4 with CPU 2.4-2.6 GHz,
total RAM 8 GB,
total size of hard disks 800 GB,

HP, SGI and Sun Unix-based servers for scientific computing, mailing and printing

10 computers including 1 with parallel CPUs;

MS Windows-based free-access workstations in PC laboratory

5 computers with CPUs from 800 MHz to 2 GHz,
total RAM 2 GB,
total size of hard disks 200 GB,
graphics cards suitable for 3D visualization,

MS Windows-based personal workstations

more than 30 computers with CPUs from 500 MHz to 2.4 GHz,

laser printers

2 shared color printers,
3 shared black & white printers,
10 personal black & white printers,

and other hardware, including data projectors, an A0 plotter, inkjet printers, copiers, scanners, tablets, CD and DVD recorders, ZIP drives and streamers.

Contacts with industry were maintained by the meeting with representatives of major oil companies, see the WP4 report. (One of the participants of the meeting, P. M. Bakker, Shell, The Netherlands, is an external member of the MAGMA Advisory Board.) Also the seismology seminars mentioned above were partly oriented toward this goal. As an example, the seminar by J. Malek, head of the seismology group at the Institute of Rock Structure and Mechanics, was an excellent opportunity to learn about possibilities how to combine seismic research with the environmental aspects of a huge underground gas storage, situated in a newly built subsurface cave system close to the old deep mines of the historical city of Příbram. Good contacts with J. Malek resulted, besides other, in employment of one of our former students, as well as in a part-time employment of a PhD student of MAGMA; there is also a close co-operation with Malek's group on related research seismic projects by two members of our staff. These events appeared as a positive by-product of MAGMA activity, not planned in the preparation stage of the Centre.

Another important contact with industry was effectuated within The 8th European Workshop on Numerical Modelling of Mantle Convection and Lithospheric Dynamics (Castle of Hrubá Skála, September 13–18, 2003), see WP1-WP3 report. In fact, environmental aspects of slow tectonic motions were discussed with representatives of the Czech agency for nuclear waste (SÚRAO). Implications of MAGMA work for seismic hazard assessment were discussed in connection with PRESAP and the WP6 activity with D. Baumont and C. Berge of the Institute of Nuclear Safety and Protection, Fontenay-aux-Roses, France (C. Berge is an external member of the MAGMA Advisory Board). On April 1, O. Novotny, member of MAGMA staff, delivered a lecture (co-authored by J. Malek) with practical impact at a mining-oriented conference, organized by the Institute of Geonics, Czech Acad. Sci. of the Czech Republic, Ostrava. The paper was published in proceedings issued by the Mining Institute, Technical University of Ostrava. Other contacts with mining industry were kept also through V. Rudajev, former head of the Institute of Rock Structure and Mechanics (an external member of our Advisory Board) with whom we met several times during MAGMA seminars. Importantly enough, from the point of view of employment of our students, V. Rudajev is also an official member of the state examination commission for geophysics, nominated by the Ministry of Education, Youth and Sports. There were also frequent personal contacts between J. Bednar (head of the Department of Meteorology and Environmental Protection) and I. Obrušnik (director of the Czech Hydrometeorological Institute, and external member of the MAGMA Advisory Board), oriented towards continuous improvement of the curricula, including the PhD curriculum at the Charles University. This

is because the Czech Hydrometeorological Institute is the most important employer of our meteorology students, and, because the institute is representing WMO in the Czech Republic, the cooperation like that is important for MAGMA from viewpoint of international co-operation, too. Last but not least, J. Brechler, leader of WP8, was contacted by the crisis management team of firefighter and rescue brigade, Prague, to discuss a possible model study about the hazardous and explosive material leakage, and its effect upon urban population.

Public relations of MAGMA had a variety of forms. At the academic level, the most important event was delivery of the Gold Medal of the Charles University to V. Cervený, professor emeritus, and leading personality of the Faculty of Mathematics and Physics. On this occasion, on April 24, 2003, a small informal celebration was organized by the Rector; the Dean, and the Vice-Dean participated, too. MAGMA project was mentioned several times, and its role was highly appreciated. On March 18, 2003, during the opening ceremony of the exhibition "Historical earthquakes in old engravings" (collection of J. Kozák, Geoph. Inst., Czech Acad. Sci.), which took place in historical Carolinum, the Dean emphasized tradition of the Earth sciences at our Faculty, as well as growing European interactions, such as MAGMA, too. On February 12, 2003, Mr. D. LeMasne, the scientific *attaché* of the French Embassy in Prague, visited us on the premises of MAGMA. He took part also in the above mentioned exhibition and, later, in The 8th European Workshop on Numerical Modelling of Mantle Convection and Lithospheric Dynamics at the Castle of Hrubá Skála (co-sponsored by the French Embassy), again. Madam J. Kalvová, climatologist, member of the MAGMA staff, helped us to overcome academic borders of our work. She had two interesting interview and discussion sessions on the major public TV channels, on January 20, and December 11, 2003, concentrated on climate change and its impact on living conditions and society.

Activities planned for 2004

The same management activities as in 2003 (co-ordination among the work packages, mainly through seminars, co-ordination of meetings and visits, co-ordination of educational, industrial and societal outreach, web sites).

LIST OF ATTACHMENTS

- A** **Research Overview 2003**
- B** **Publications in 2003**
- C** **Seminars in 2003**

Attachment A RESEARCH OVERVIEW 2003

The MAGMA centre, i.e. the Prague Centre of Mathematical Geophysics, Meteorology, and their Applications, supported by the European Commission, has started in 2003 its first year of existence with at a quite exciting "rate". The geophysical group profited from short visits of 10 senior researchers, as well as from 4 stays of PhD students and post-doctoral researchers, each stay lasting more than 1 month (7 man-months together). Moreover, two international meetings were co-organized in our country (the geophysical one being described below). For more details, see <http://geo.mff.cuni.cz/magma>. Simply speaking, MAGMA helps to shape our Department into a truly European dimension. Indeed, in a close relation with MAGMA, we successfully finished our work package of the 5th framework EC project PRESAP, oriented to practical aspects of earthquake-hazard prediction. We also participated in several 6th framework EC project proposals focused on the Earth research, its environmental aspects, and, in particular, on natural hazards (NERIES, 3HAZ-Corinth), as well as the proposal improving mobility and continuing education of young scientists (the Marie Curie research training networks SPICE and AEGEAN-QUAKE). Intensive cooperation with major oil companies has been strengthened, too.

Similarly to the previous years, research at the Department of Geophysics was carried out in three directions: Geodynamics, Theory of seismic waves, and Earthquake and structural studies.

Geodynamics

(reported by Ctirad Matyska)

European Workshop

The 8th European Workshop on Numerical Modeling of Mantle Convection and Lithospheric Dynamics was organized by our department (O. Čadek), in cooperation with the Geophysical Institute, Academy of Sciences, and took part in the Castle of Hrubá Skála, Czech Republic, from September 13 to September 18, 2003. There were 96 participants from 12 countries (including overseas), and 37 from them were supported by the MAGMA project. Four main topics of the workshop were:

- (i) subductin slabs and related topics
- (ii) mantle convection and chemical mixing
- (iii) plumes and related phenomena
- (iv) postglacial rebound.

Electromagnetic induction

Recent low-orbit satellite missions Oersted and CHAMP offer an opportunity to improve models of electrical conductivity of the Earth's mantle. Forward modeling of electromagnetic induction response of the Earth to Dst signal was carried out by Velínský et al. (2003). In cooperation with Mark Everett from Texas A&M University, the time-domain, spectral finite-element approach to transient 2-D geomagnetic induction in a spherical heterogeneous Earth was created and published (Martinec et al., 2003). Another paper, describing the time-domain spherical harmonic finite-element approach to transient 3-D geomagnetic induction was submitted by Velínský and Martinec. Special attention was devoted to the response of the realistic Earth's models to simulated geomagnetic storms (Everett and Martinec, 2003). The effect of heterogeneous surface conductance under ionospheric Sq excitation on satellite-observed responses was also studied. Preliminary results were submitted by Velínský and Everett. The cooperation with Mark Everett resulted in the stay of Jakub Velínský at Texas A&M University as a Post-Doc.

Geodetic problems

The research was completed on finding an adequate mathematical tool for inverting satellite gradiometric data into information on the external gravitational potential of the Earth (Martinec, 2003). These data will be available since 2006, when the GOCE gradiometric mission will be launched. We managed to solve gradiometric boundary-value problem in terms of Green's functions that were expressed in spectral form as series of tensor spherical harmonics. This form of the solution can be applied to develop the gravitational field in terms of spherical harmonics from the GOCE data. The ellipsoidal Stokes boundary-value problem was studied to compute the geoidal heights. The disturbing potential was split into a low-degree reference potential known from global geopotential models, and a higher-degree potential obtained by solving the ellipsoidal Stokes problem in the form of surface integrals (Ardestani and Martinec, 2003a). The far-zone contribution was added in the other paper (Ardestani and Martinec, 2003b). The approach to the solution of the Dirichlet and the Stokes boundary-value problems on the Earth's ellipsoid was commented by Grafarend and Martinec (2003). The theory of the Bouger anomaly in spherical geometry for determination of precise geoid was developed in a submitted paper by Vanicek et al. (2003).

Dynamics of the Earth's mantle

Modeling of the non-hydrostatic geoid focused on the role of lateral viscosity variations in the boundary layers, namely in the top 300 km of the mantle and in the core-mantle boundary region (Čadek and Fleitout, 2003). The authors solved the inverse problem for laterally dependent viscosity in D'' , and found large-scale regions of a very high viscosity at the CMB that correlate well with the surface distribution of hotspots. The stability of layered thermal convection models with hypothetical chemical interface at a depth of 1000 km was studied by Čížková and Matyska (special issue of Phys. Earth Planet. Inter., in press). They found that a density increase of about 3% is sufficient to maintain the layered convection for a time of hundreds of million of years. Kukačka and Matyska (special issue of Phys. Earth Planet. Inter., in press) incorporated a rheological weakening into subduction modeling in a new self-consistent manner. The output of their non-linear models points to a crucial role of the rheological weakening to the dip angle and heat dissipation during subduction. Matyska (2003) created a new way of describing the seismic wave field generation and coseismic static deformation due to finite-extent source in depth-dependent elastic models. His approach is based on a direct decomposition of the displacement field, without employing the usual Green function formalism. (The latter is an important step towards linking together the geodynamic and seismic research at our department, one of major and most difficult goals of the MAGMA project.) Hanyk et al. (in preparation) studied energy jumping into the Earth's mantle generated by glacial forcing, and found that for abrupt changes of the forcing function the dissipation of heat below the lithosphere can reach a magnitude substantially higher than the radiogenic heating, namely under the presence of a low viscosity layer (asthenosphere). Košťál (MSc thesis, 2003) studied the mathematical properties of the free oscillations of the Earth's models with maxwellian rheology, and demonstrated why these models are numerically ill-posed. Inovecký (MSc thesis, 2003) created a new weak formulation of equations describing the postglacial rebound, and showed the numerical applicability of finite elements to this formulation, for models with strong lateral variations of viscosity.

Several other papers were submitted in 2003: Employment of the knowledge of the full magnetic induction vector from satellite missions to get a model of mantle electrical conductivity with higher resolution than models obtained from surface data is described in Martinec and McCreddie (2003). Viscoelastic relaxation of the Earth for a glacial loading of Fennoscandian extent was studied in the framework of 2-D models of mantle viscosity, enabling to capture the influence of continental roots (Martinec and Wolf, 2003). Several spatial and temporal contributions resulting in changes of the geoid above Greenland, namely those due to ice loading in North America and those resulting from the Greenland Ice Sheet, were evaluated by Fleming et al. (2003).

Theory of seismic waves

(reported by L. Klimeš)

Most of work reported in this section belongs to the consortium "Seismic Waves in Complex 3-D Structures" (coordinated by Prof. V. Červený). This is a framework of our long-lasting cooperation with the research departments of major oil companies, worldwide.

Seismic waves in viscoelastic anisotropic media

Considerable attention has been devoted to harmonic plane waves in viscoelastic anisotropic media (Červený 2003a, 2003b, 2003c, 2004; Červený & Pšenčík 2003a, 2003b).

Reflection/transmission coefficients

Explicit equations for approximate linearized reflection/transmission coefficients at a generally oriented weak-contrast interface separating generally anisotropic media have been derived and published (Klimeš 2003a).

Derivatives and perturbations of amplitudes

The equations for calculating the first-order and higher-order spatial and perturbation derivatives of amplitude in both isotropic and anisotropic media have been derived (Klimeš 2003d).

Anisotropic ray theory

The caustic identification algorithm for isotropic media has been generalized to anisotropic media, and the rules for the phase shift of the anisotropic-ray-theory wavefield due to caustics have been derived (Klimeš 2004b).

Coupling ray theory

The equations for the second-order perturbations of travel time have been applied to the estimation of the errors due to the common-ray approximations of the coupling ray theory (Bulant & Klimeš 2003c; Klimeš & Bulant 2003, 2004). The errors due to the common-ray approximations of the coupling ray theory and the errors due to other quasi-isotropic approximations of the coupling ray theory have been demonstrated on numerical examples (Bulant & Klimeš 2003a, 2003b, 2004; Klimeš & Bulant 2004). Isotropic ray theory, anisotropic ray theory and various kinds of the coupling ray theory for weakly anisotropic models have been studied and compared with the exact solution derived for the "simplified twisted crystal" and "oblique twisted crystal" models (Bulant & Klimeš 2003a, 2003b, 2004; Bulant, Klimeš, Pšenčík & Vavryčuk 2003; Klimeš 2004a). Equations for the numerical common S-wave ray tracing and for the corresponding dynamic ray tracing in a smooth elastic anisotropic medium have been proposed (Klimeš 2003e).

Velocity macro models and numerical ray tracing

The equations derived for the estimation of the average Lyapunov exponents, describing the ray chaos due to heterogeneities in the velocity model, have been applied to the construction of velocity models suitable for ray tracing and other high-frequency asymptotic methods (Bulant 2004). The designed algorithm of constructing velocity models has been compared with the smoothing methods of other authors and tested on various 2-D and 3-D synthetic structures (Bucha, Bulant & Klimeš 2003a, 2003b, Bulant 2004). Capabilities of the ray tracing software developed at our department have been further extended (Bucha & Bulant 2003a, 2003b; Klimeš 2003e). Numerical ray tracing has been tested on various 3-D synthetic structures, including the smoothed SEG/EAGE Salt Model (Bucha 2003; Bucha & Bulant 2003a, 2003b).

Inversion of seismic data

Particular attention has been devoted to the sensitivity of seismic waves to the structure (Klimeš 2003b, 2003c; Žáček & Klimeš) and to the physical meaning of velocity macro models (Bucha, Bulant & Klimeš 2003a, 2003b).

Gaussian-packet prestack depth migration

The decomposition of the time sections into optimized Gaussian packets is of key importance in the Gaussian packet migration. The equations for the decomposition have been derived and the decomposition was numerically tested (Žáček 2003a, 2003b).

Earthquake and structural studies

(reported by J. Zahradník)

Dissertations

The PhD dissertation by Plicka (2003), devoted to modeling of finite-extent seismic sources by empirical Green's functions, was successfully defended. In MSc thesis by Kolínský (2003), devoted to the dispersion of seismic surface waves, various methods of the frequency-time analysis were discussed, and a new computer code for computing group velocities was presented. The code includes also retrieval of the filtered time series, corresponding to a selected branch of the dispersion curve. The method was applied to surface waves along some Eurasian paths recorded at the seismic station Praha.

Seismic stations of the Charles University in Greece

The stations, jointly operated with the University of Patras since 1997, were further upgraded. The present network comprises four sites, each one equipped with a weak-motion broad-band velocigraph CMG3-T and a strong-motion accelerograph CMG5-T. The stations Sergoula and Mamousia (existing in the previous period, too) are situated on the northern and southern coast of the Corinth Gulf, in its western part. They will be used, besides other, in a new EC project 3HAZ-Corinth, coordinated by P. Bernard. The third (new) site is Loutraki, at the eastern edge of the Corinth Gulf. The fourth site (also new) is Pylos, close to Kalamata city, on the south-west of the Peloponnese. Thanks to massive investment of the Seismological Laboratory, Patras University, The Loutraki and Pylos stations have got the satellite data transmission to Patras (Libra system, Nanometrics company). The selected data are available from <http://seis30.karlov.mff.cuni.cz>, updated every 4 months.

The 3D hybrid earthquake modeling

The 3D modeling based on a hybrid combination of the source, path and site effects, methodically developed in 2002, has been applied in practice. The focus of our attention was one of a few site in Athens (the Ano Liosia

suburb), where the 1999 earthquake had the largest intensity, IX. The source and path effects were modeled by the composite-source model and the discrete wavenumber method (method PEXT of J. Zahradník), while the local sedimentary basin was modeled by the 3D finite-difference method (I. Opršal). The hybrid modeling proved to be an efficient tool up to frequency of engineering interest. As such, it enabled explanation of the damaging ground motions at the Ano Liosoa site as a combined effect of the source directivity and lateral heterogeneity of the site. The true ground motion during mainshock was not recorded at the site, but the calculations indicate that the horizontal acceleration was as large as $> 0.5g$. It is essential that the model is at least partly justified, since the same source model provided synthetic accelerograms which are in a very good agreement with the measured strong motions in the other sites of Athens. The work was presented in Japan (Opršal et al., 2003), where the first author became a member of the IASPEI/IAEE working group on Effects of Surface Geology, as successor of J. Zahradník who worked in that W.G. since its commencement. After improving the geological model, the paper will be prepared for publication jointly with the co-authors from Greece. Present version is available at <http://geo.mff.cuni.cz/students/oprsal/geophys/geophys.htm>.

Strong motion simulation methods

All three methods developed in 2002 for numerical modeling of the strong ground motions were during 2003 applied within the EC project PRESAP, in which our team was responsible for the corresponding Work Package (W.P. 4). The project culminated by a blind experiment aimed at testing predictability of strong aftershocks in connection to Coulomb stress transfer, and simulation of the strong motions due to the aftershock. The results were collectively reported at AGU in San Francisco (Scotti et al., 2003). The kinematic method based on representation theorem, the k^{-2} stochastic slip distribution with k -dependent rise time, optionally including also asperities was re-submitted after revision, thus two papers can be expected to appear soon (Galovič and Brokešová, submitted a,b). The composite source model of Jan Burjánek, based on fractal distribution of subevent sizes, came through further development. Significantly different directivity was found when treating subevents as point sources or finite sources. The Green function interpolation scheme over the fault plane was also developed, and increased numerical efficiency of the calculations. It was also shown how to benchmark synthetics and their peak values against the empirical attenuation curves with objective to determine a free parameter of the model, viz. the maximum slip velocity, or the effective stress drop. Significant progress in both methods was made while J. Burjánek and F. Galovič were at the University of Kyoto, upon the invitation of Prof. K. Irikura. The work was presented both at IASPEI in Japan, and later (including results obtained during the stay in Japan, with Prof. Irikura as a co-author) at AGU in USA (Burjánek et al. 2003; Galovič et al., 2003). A specific question, how to compare an observed strong motion record with the whole suite of the synthetics, provided by any method including a stochastic part (hence including a variety of "realizations") was addressed in a journal paper by Galovič and Zahradník (submitted).

The Egion $M_w=4.3$ earthquake of 2001, Corinth Gulf

Two papers devoted to this event, and submitted in 2002, were accepted after re-write. The depth instability of location methods without S waves was clearly demonstrated. Trade-off between origin time and depth was eliminated by an innovating technique, the so-called station-difference method (Janský et al., in press). Problems with first-motion polarity method to retrieve the focal mechanism resulted in a recommendation to use gradient models (instead the usual models of constant velocity layers), and to employ the waveform inversion as much as possible. The resulting focal mechanism has its T axis consistent with the regional direction of extension $\sim N10^\circ$. However, none of the two nodal planes can be associated to the known tectonic structures. The paper, in which we considerably profited from co-operation with Greek and French colleagues, will appear soon in 2004 (Zahradník et al., in press).

The $M_w=6.3$ earthquake of 2003, Lefkada, and a new source inversion code

The moment tensor inversion for multiple point sources, based on Kikuchi and Kanamori (1991), was extended to full waveform data at regional (or local) distances. The new code proved to be efficient for retrieving major source contributions of the 2003 Lefkada, Greece earthquake. The source model was derived from five 3-component regional stations (epicentral distances < 140 km), at periods 10-20 seconds. The model consists of two fault segments, well explaining two aftershock clusters: one at the Lefkada Island, and the other one at the Cefalonia Island, nearly 40 km apart. The Cefalonia segment started its rupture 14 seconds later. Each segment is described by two closely spaced asperities (at about 5 km from each other). The earthquake proved to be a complex rupture process, not only as regards its space-time development, but also as regards the focal mechanism. Large deviations from pure double couple (DC) were found, but interpreted as artifacts. The DC-constrained mechanism is predominantly right-lateral strike slip along of an SSW-NNE orientation, but the individual subevents had slightly different focal mechanisms. The uncertainty estimates were derived by repeatedly excluding one of the five stations. The new software name is ISOLA, to stress the interest in the Isolated Asperities. It includes not only the Fortran code (author J. Zahradník), but also the Matlab graphical user

friendly interface (author E. Sokos). Dr. Sokos worked on his code with us in Prague for 6 weeks as a guest within the EC project MAGMA. The results were reported on the web pages of the European Mediterranean Seismological Centre (EMSC), <http://www.emsc-csem.org> (Zahradník et al., 2003), and a journal paper is being prepared for submission.

Free software

A new section advertising earthquake software developed by our group has been established at <http://seis30.karlov.mff.cuni.cz>. Although the software is only partially documented, it has yet attracted a significant attention.

Seismology related geodetic problem

The expansions proposed by Thomas (1965) for computing geodetic arc lengths and azimuths on a reference ellipsoid were analyzed, and a more accurate approach was proposed for computing azimuths (Novotný and Málek, 2003).

Structural studies

A review of previous deep seismic soundings in the Bohemian Massif was performed, and factors influencing accuracy of seismic interpretations were discussed (Novotný and Málek, in press). Special attention was paid to the use of quarry blasts as seismic sources, and to the application of the Wiechert-Herglotz method. It was recommended to interpret the observed data separately for the individual geological units, to apply topographic reductions, and to use suitable methods of smoothing the travel-time curves. The travel times of P-waves, measured in the West-Bohemian region during the CELEBRATION 2000 refraction experiment, were used to derive one-dimensional models for the following geological units: plutons, crystallinum, and the Mariánské Lázně Complex. Characteristic features of the derived models are as follows: relatively low P-wave velocities at the surface, and prominent velocity increase at a depth of about one kilometre (Málek et al., submitted). It was demonstrated by Novotný et al. (submitted) that the Wiechert-Herglotz method can be used even in geologically complicated regions if the observed data are grouped according to geological units, and smoothed considerably. For the smoothing, polynomial and rational approximations were analyzed in detail. The procedure was applied to P-wave travel times from a refraction profile in western Bohemia.

Attachment B PUBLICATIONS IN 2003

Published in 2003

V.E. Ardestani, Z. Martinec (2003)

Far-zone contribution in ellipsoidal Stokes boundary-value problem

Studia Geophysica et Geodaetica, 47, 4, 719-723

V.E. Ardestani, Z. Martinec (2003)

Geoid determination through ellipsoidal Stokes boundary-value problem by splitting its solution to the low-degree and the high-degree parts,

Studia Geophysica et Geodaetica, 47, 4, 73-82

M. Baer, N. Deichmann, J. Braunmiller, F. Bernardi, C. Cornou, D. Fah, D. Giardini, S. Huber, P. Kastli, F. Kind, U. Kradolfer, M. Mai, S. Maraini, I. Opršal, T. Schler, D. Schorlemmer, S. Sellami, S. Steimen, S. Wiemer, J. Wossner, A. Wyss (2003)

Earthquakes in Switzerland and surrounding regions during 2002

Eclogae Geologicae Helveticae, 96, 2, 313-324

J. Bednář (2003)

Meteorology. Compendium of Air Quality Protection. Part I.

Ochrana ovzduší, 15 (35), 2, 1-19

J. Bednář (2003)

Ice in Clouds

Vesmír, 82/133, 10, 583-583

J. Bednář (2003)

Meteorology. Introduction to atmospheric processes studies

Textbook, Portál, Praha, pp. 223

J. Bednář (2003)

Weather Forecasting - Lasting Problem.

In *Možnosti a hranice růstu*, ed. Štefan Morávka, ÚMS ZUP, E15-E18

K. Bezpalcová, Z. Jaňour, B. Leitl, M. Schatzmann (2003)

Street Scale Problem

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Attachment C SEMINARS IN 2003

Geodynamics Seminar

- Feb 19: M. Kukačka (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Does water in a lithospheric slab influence its dip angle?
- Feb 26: J. Matas (ENS Lyon, France)
Thermodynamics of phase interfaces
- Mar 5: L. Vecsey (Geophysical Institute of Czech Academy of Sciences)
Wavelets and their application
- Mar 12: J. Velímský (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Time-domain modelling of electromagnetic induction
- Mar 19: M. Pauer (Department of Geophysics, Faculty of Math. and Phys., Charles University)
What do we know about dynamic processes in Venus?
- Mar 26: E. Petrovský (Geophysical Institute of Czech Academy of Sciences)
Magnetomineralogy and its application to environmental studies
- Mar 27: H. Schmeling (University of Frankfurt)
Iceland plume modelling
- Apr 2: R. Inovecký (Faculty of Mathematics and Physics, Charles University)
Weak formulation of equations for viscoelastic response of the Earth
- Apr 16: J. Šafanda (Geophysical Institute of Czech Academy of Sciences)
Impact of climate changes on underground temperature field
- Apr 23: J. Laštovička (Institute of Physics of Atmosphere, Czech Academy of Sciences)
Role of human activity and solar effects in long-term changes of asthenosphere and ionosphere
- Apr 30: D. Uličný, L. Špičáková (Geophysical Institute of Czech Academy of Sciences) and M. Rajchl (Faculty of Sciences, Charles University)
Sediments as indicators of tectonic and surface processes
- May 7: J. Laurin (Geophysical Institute of Czech Academy of Sciences), B.B. Sageman (Northwestern University, Evanston, US) and D. Waltham (Royal Holloway, University of London, UK)
Orbitally controlled sea level changes during cretaceous: New arguments from a combination of field data (Colorado Plateau) and numerical models
- Oct 15: M. Pauer (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Gravitational field and topography of Venus
- Oct 22: J. Hagedoorn (GFZ Potsdam)
Glacial isostatic adjustment and recent sea-level change
- Oct 29: L. Vecsey (Institute of Geophysics, Czech Academy of Science)
High Rayleigh number thermal convection
- Nov 5: L. Inovecky and T. Pergler (Faculty of Mathematics and Physics, Charles University)
Weak formulation and finite element approximation of viscoelastic response of the Earth to postglacial and postseismic loading
- Nov 12: A. Galsa and B. Sule (Eotvos University, Budapest)
Thermal convection modelling in Budapest
- Nov 26: A. Spicak, J. Vanek and V. Hanus (Institute of Geophysics, Czech Academy of Science)
Deep structure and seismotectonics of convergent lithospheric margins obtained from the analysis of global seismic data
- Dec 3: L. Hanyk (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Dissipation heating in the Earth's mantle induced by glacial forcing
- Dec 10: C. Matyska (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Bullen's parameter in the Earth's mantle
- Dec 17: M. Behounkova (Department of Geophysics, Faculty of Math. and Phys., Charles Univ.)
Tomographic inversion of synthetic data

Meteorological Talks

(seminar of Czech Meteorological Society, Prague, with participation of MAGMA members)

- Mar 4: J. Kalvova (Dept. of Meteorology and Env. Prot., Fac. of Math. and Phys., Charles Univ.)
Climate change and what we can expect from up to date global climate models?
- Oct 21: T. Halenka (Dept. of Meteorology and Env. Prot., Fac. of Math. and Phys., Charles Univ.)
Regional climate modeling in Czech Republic – how to go ahead?

Seismology Seminar

- Feb 21: P. Kolinsky (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Group-velocity dispersion of surface waves from earthquakes in Europe and Asia
- Feb 28: K. Zacek (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Depth migration by Gaussian packets
- Mar 7: J. Zahradnik (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Discussion on the uncertainty estimates in seismology inverse problems
- Mar 14: F. Gallovic (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Discussion on synthetic attenuation curves
- Mar 21: J. Burjanek (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Composite models of the finite-extent seismic source
- Mar 28: T. Fischer, J. Horalek, Z. Hudova, A. Plesinger (Inst. of Geophysics, Czech Acad. of Sci.)
West-Bohemia earthquake swarm 2000: Source parameters of stronger events and structure of the fault plane
- Apr 4: V. Plicka (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Empirical Green function method (the EGD version) and its application in Western Bohemia
- Apr 25: J. Malek (Institute of Rock Structure and Mechanics, Czech Academy of Science)
Induced seismic events in vicinity of the underground gas storage in Pribram
- May 2: J. Jansky (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Location of the 2001 earthquake sequence close to city of Aegion, Greece
- May 9: K. Rezba (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Point-source inversion of teleseismic earthquake records using SYN4 code, IASPEI software library
- May 16: B. Ruzek (Institute of Geophysics, Czech Academy of Science)
Seismic profile experiment CELEBRATION 2000, and preliminary application of the VISTA software
- Jun 17 and Jun 18: A. Caserta (Istituto Nazionale di Geofisica e Vulcanologia, Roma, Italy)
Interaction of earthquakes and noise with near-surface geological structures: data analysis and numerical modeling
- Sep 5: K. Irikura (Disaster Prevention Research Institute, University of Kyoto, Japan)
Recipe of strong motion prediction for future earthquakes
- Oct 3: E. Sokos (National Observatory of Athens and the University of Patras, Greece)
User-friendly software for the seismic-source inversion; linking Fortran, Matlab and GMT
- Oct 7: A. Emolo (University of Naples, Italy)
Non-linear seismic-source inversion of high-frequency data
- Oct 10: A. Emolo (University of Naples, Italy)
Source mechanism of the 1930 Irpinia earthquake, Italy, based on a kinematic model
- Oct 17: J. Zahradnik (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Instrumental problems of CMG-3T and CMG-5T seismographs, the Charles University stations in Greece
- Oct 24: F. Gallovic, J. Burjanek and J. Zahradnik (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Blind experiment on the aftershock prediction (in the framework of EC project PRESAP), and our results in the experiment
- Oct 31: J. Zahradnik (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Inversion of regional seismic data (moment-tensor, multiple point-source model); new code and its application to the 2003 Lefkada earthquake, Greece
- Nov 7: V. Vavrycuk (Institute of Geophysics, Czech Academy of Science)
Anisotropy of subduction zone in Tonga region from moment tensors of deep earthquakes
- Nov 14: J. Burjanek (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Composite-source model; effects of finite-extent subsources and the so-called effective source parameters; application in strong-motion simulation of the 2000 Tottori earthquake, Japan
- Nov 14: J. Malek and M. Broz (Institute of Rock Structure and Mechanics, Czech Acad. of Sci.), J. Jansky and O. Novotny (Department of Geophysics, Faculty of Math. and Phys., Charles Univ.)
Investigation of the upper-crustal structure using quarry blasts
- Nov 28: K. Rezba (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Point-source inversion of teleseismic earthquake records using SYN4 code, IASPEI software library – part
- Dec 12: J. Zednik (Institute of Geophysics, Czech Academy of Science)
Professional ANTELOPA software for data acquisition and analysis; its use in the Czech national seismic network
- Dec 19: V. Plicka (Department of Geophysics, Faculty of Math. and Phys., Charles University)
Slip inversion by the Patch Method (after M. Vallee and M. Bouchon)