Minutes

of the Meeting of the

IASPEI Commission on Seismological Observations and Interpretation

Friday, July 4th 2003, 18:00 to 19:30

Royton Sapporo, Room Emerald A

Agenda

1	Approval of minutes from meeting in 2001 (Appendix 1)
2	Approval of agenda and suggestions for new points
3	Introductory remarks: J. Havskov
4	Status at international data centers: ISC, NEIC, IMS, and others
5	Working group on magnitudes, J. W. Dewey (Appendix 2, Annex 1)
6	Working group on standard phase names, D. Storchak (Appendix 2, Annex 2)
7	Working group on event location using multiple events, P. Richards (Appendix 2, Annex 4)
8	Working group on reference events, B. Engdahl (Appendix 2, Annex 3)
9	Improving station locations (Appendix 3)
10	Proposal for new working groups
11	Suggestions for 2005 IASPEI symposia and workshops
12	Other matters

TOP 0:
The Chairman, J. Havskov, welcomed the participants (List of names and addresses is attached as Appendix 5) and opened the session.

TOP 1:
The minutes from the meeting in 2001 were approved without changes.

TOP 2:
Participants accepted the agenda for the meeting after hinting to a few inconsistencies in the Chairman´s draft agenda with respect to the numbering of topics, WG titles etc. The agenda reproduced above incorporates these corrections. No additional agenda items were proposed. Although in the following deliberations the Chairman preferred to change for some topics the sequence of reporting, the minutes below follow the order of the approved agenda.

TOP 3:
The Chairman urged to finish the meeting by 19:30 according to the schedule because of other obligations of several participants and requested the Secretary, P. Bormann, to take notes of the proceedings.

TOP 4:
R. Willemann said that there have been no changes in the procedures at the ISC since 1967 and that the IDC up to now uses the J-B travel-time curves. Responding to a question by the Secretary he confirmed that the ISC accepts for its Ms calculations amplitude data within the period range 10-60s.

J. Dewey gave a short status report for the NEIC. The NEIC currently reports the locations and magnitudes of about 27,000 earthquakes per year. Slightly more than half of the hypocenters catalogued by the NEIC are contributed by regional networks and not recalculated by the NEIC, although the NEIC may associate with these events additional data that were not used by the regional networks. The remaining hypocenters are calculated from arrival-times interpreted at the NEIC and arrival-time data contributed to the NEIC. The NEIC publishes magnitudes that are contributed to it and also calculates magnitudes from amplitude/period data interpreted at the NEIC or contributed to the NEIC. Currently, the NEIC bulletins publish arrival-time data for about 2000 stations and magnitude data for about 450 stations. In 2002, the NEIC stopped routine distribution of paper copies of its catalogues and bulletins. All catalogues and bulletins are now distributed electronically. Some of the data are available at the NEIC web-site (http://neic.usgs.gov/). Other of the data are available by anonymous FTP; instructions for downloading the FTP data are given on the NEIC web-site.

There was no representative of the IDC or other data centers attending the meeting. No other reports by such centers had been submitted to the Chairman or the Secretary.

TOP 5:
The Chairman of the Magnitude WG, J. Dewey, reported on the WG's activities during the past two years.

The Magnitude WG has focussed its efforts on developing standards for measuring Ml, Ms, mB, mb, and MLg. The WG presented a written report (Annex 1 of Appendix 2) that had been prepared prior to the IUGG. Dewey emphasized that the focus of the WG has been on recommending standards for A and T measurements and magnitude nomenclature rather than on recommending or elaborating calibration functions. The evening before the CoSOI meeting, the preliminary recommendations embodied in the written report were presented to an open meeting of the Magnitude WG, and a number of recommendations and criticisms of the preliminary recommendations were received from seismologists outside of the WG:

a.) There was concern that the proposed standards for Ml would severely limit the number of earthquakes to which Ml could be assigned in some regions.
b.) It was suggested that the WG's recommendations be made in a positive sense, by specifying the recommended standard procedures rather than by citing examples of procedures that are considered nonstandard.
c.) Representatives of the ISC presented arguments on behalf of retaining IDC amplitude and period measurements in ISC mb calculations, rather than omitting the IDC measurements from ISC mb calculations and simply reporting the mb(IDC)'s as contributed magnitudes.
d.) Everyone agreed that, if the proposed standards are adopted by IASPEI, the ideal solution for the ISC's handling of IDC data would be for the IDC to provide A and T values measured according to the IASPEI standard, in addition to the A and T necessary for the current mb(IDC), which appears to be optimum for nuclear-test discrimination.

e.) There was criticism of the WG suggestion that A/T for Ms and mB might better be made from maximum ground-velocity amplitudes as determined from BB velocity records than from replicating the process of picking A and T from classical seismographs.
f.) An opinion was expressed that the WG should not develop standards for MLg, because MLg had a more restricted range of applicability than the other magnitude types and because many of the functions of MLg can be accomplished by regionally calibrated Ml.
g.) An opinion was expressed that mB might be obsolete in light of Mw assigned from moment-tensor inversions of body waves and that it would be unnecessary to develop IASPEI standards for mB.
h.) A request was made that the final recommendations presented to the CoSOI be "short and sweet," and that detailed documentation of the considerations of the committee, as well as tables of poles and zeroes, graphs of Standard Instrument Response, etc., be reserved for the longer accompanying text.

The Magnitude WG will consider these comments and criticisms as it prepares the final version of its recommendations and accompanying text.

Dewey requested that the life of the WG be extended by two years or more, so that the WG recommendations and accompanying text could be put in final form, publicized in the seismological community, and implemented. The standards would be presented to the seismological community as recommended standards proposed by the Magnitude WG of the CoSOI and would be publicized both by direct communication with magnitude-computing agencies and by publication of a short article/announcement in the "Seismological Research Letters."

Willemann asked whether the WG really intends to publish its recommendations already prior to formal approval by a CoSOI meeting. Dewey reminded that the WG in many points just reconfirms and urges to implement recommendations which had already been approved at earlier IASPEI meetings. They were, however, not or only partially introduced into the practice of the relevant data centers

Havskov asked why more than two years would be necessary to accomplish these goals. Dewey thinks that implementing the standards will be time-consuming, that the need for some adjustments to the standards may be revealed as different agencies attempt to implement the standards, and that the WG should continue to exist as long as dialogue is necessary between those who define standards and those who implement standards. Havskov asked that every attempt be made to complete the work of the WG by the time of the 2005 Santiago IASPEI meeting or even earlier.

(Note: In a follow-up discussion between the Secretary and the Chairman after the meeting the latter shared the view that CoSOI members may also approve the recommendations circulated by the WG by way of correspondence and that there was no need to wait until the next formal meeting at IASPEI 2005.)

TOP 6:
The Chairman of the WG on phase names, D. Storchak, presented his report. The full text is contained in Annex 2 to Appendix 2 of these Minutes. He pointed out that there have been 4 different versions of the proposed phase names. Preliminary earlier versions were widely circulated within the seismological community via e-mail. The final version now proposed by the WG and attached to Annex 2 of Appendix 2 takes into account many comments received from scientists outside the WG. The new phase list with accompanying ray diagrams has been presented in two posters at several meetings and the WG has been invited to submit it as a formal paper for

publication in SRL. Bormann mentioned, that the first draft of this planned publication is already contained as Information Sheet 2.1 in Volume 2 of the New Manual of Seismological Observatory Practice and Storchak added that the list has also been published on the ISC website.

Storchak proposed and read to the audience a draft resolution formulated by the WG in which IASPEI confirms this new phase list as standard and urges data centers, producers and users to apply it. The CoSOI adopted the list and Havskov requested the attending Chairman of the IASPEI Resolution Committee, D. Giardini, to bring the draft resolution on phase names into the proper official language.

Storchak expressed his sincere thanks to the many colleagues who had contributed to the success of the WG, naming in particular B. Kennett, B. Engdahl, J. Schweitzer and P. Bormann. Havskov expressed his thanks to the WG Chairman for the extremely efficient work done and congratulated him for its successful completion.

TOP 7:

The WG Chairman, P. Richards, reported about the development of algorithms for improved location accuracy which are meanwhile widely used by other groups. The focus has been on the relative location of many events at the same time. For improved absolute locations reference events are needed. Richards proposed to develop lists of reference events at a much wider scale and mentioned that new very dense networks operating now in Taiwan and Japan allow to determine new reference events. He mentioned that there are no reference events yet in subduction zones. Richards stressed the need for consensus on criteria for the acceptability of new reference events. The report submitted by the WG Chairman to CoSOI prior to its meeting is attached as Annex 4 of Appendix 2.

In the discussion of this and the following WG report by E.R. Engdahl on reference events it was proposed to merge these two WGs under the name “Reference events from improved locations” and the two Chairman were requested to formulate its aims and membership.

TOP 8:

E.R. Engdahl presented the report of the WG on reference events. The full report had been submitted to CoSOI prior to the meeting and is attached as Annex 3 to Appendix 2 of these Minutes. The WG Chairman said that the list of reference events is accessible on the IASPEI website and that a paper on the procedures and criteria for deriving and selecting reference events has been submitted for publication and passed already the review process. Engdahl recommended to continue the WG but when the proposal came up in the follow-up discussion to merge the WGs on event location and reference events, he agreed.

In the discussion it was also recommended that data on reference events should also be provided to the ISC. Willemann said that the ISC could make such data on request available to users for regions of interest.

TOP 9:
Willemann had submitted a proposal for improving station locations (???) (see Appendix 3 to these Minutes). Havskov said that in his view it should rather be an initiative of CoSOI. Willemann responded that what is needed in this respect is not a new WG but rather a IASPEI resolution. He agreed to draft such a resolution in consultation with P. Richards.

TOP 10:
Under the topic "Proposal for new working groups" R. Musson reported that factually such a WG has already been formed and that a related resolution would be desirable which emphasizes the need for such a WG. Havskov wanted to know the aims of such a WG. Musson mentioned the need to preserve the original historical data/records and to recommend suitable procedures for their archival. Schweitzer added that technical advise and assistance should be given to institutions which own such data and that the WG should review the current situation of the availability of such data, identify existing good solutions for data preservation and archiving and recommending them to others. It was proposed that all stations and data up to 1920 should be within the scope of the WG.

Havskov requested Musson, Schweitzer, Batllo and Dewey should come together, select a chairman of the group and to agree on the objectives of its work. In response to this Musson submitted to the Secretary in August 2003 the proposal which has been added as Appendix 4 to these Minutes.

There were no more proposals for other WGs under CoSOI.

TOP 11:
There have been no specific suggestions for 2005 IASPEI symposia and workshops.

TOP 12:
Under other matters the Secretary of CoSOI, P. Bormann, said that he is retiring from his institute in 2004. This might not allow him in the future to get the financial support required for attending meetings of IASPEI. Therefore, the Chairman of CoSOI should look in due time for a suitable replacement for the Secretary of the Commission.

The Chairman thanked the attending members for their contributions and discussions and concluded the meeting in time.

Appendix 1

Report

on the meeting of the

Commission on Seismological Observation and Interpretation (CoSOI)

(formerly Commission on Practice - CoP)

Thursday 23 August, 2001, 1800 to 1930, ICC – IASPEI Conference Room

TOP 0:
The Chairman, J. Havskov, welcomed the participants (List of names and addresses attached as **Annex 1**), circulated the agenda (**Annex 2**), requested the Secretary, P. Bormann, to take notes of the proceedings, and opened the session.

TOP 1:
The minutes from meeting in 1999 were approved without changes.

TOP 2:
The agenda of the current meeting was approved. No additional items were proposed.

TOP 3:
Introductory remarks by Havskov with respect to the proposed changes of the name and scope of the former IASPEI Commission on Practice. He handed the word over to the president, B. Kennett.

TOP 4:
B. Kennett outlined that in the past there have been, besides CoP, other IASPEI Commissions on related topics which had, however, no effective links with CoP. The scope and structure of the proposed new Commission aims at better reflecting what we are doing and at combining our efforts. We hope that nothing valuable done before is lost but higher efficiency and transparency is envisaged. In 2007, or if needed earlier, we should review how the new commission works and consider changes, if required. In the agenda, several topics have been proposed for this new Commission. They should be considered and along these lines more specific working groups may be proposed. The Secretary General of IASPEI, R. Engdahl, will contact several people and invited their involvement in the work of CoSOI. In general, IASPEI intends to reduce the number of commissions by linking related subjects, e.g., by merging the Commission on Education and the Commission for Developing Countries in a new Commission on Education and Outreach. Some names of some other commission will have to be reconsidered as well. The new commissions should be more thematically oriented and play a greater role in elaborating the scientific programs of future IASPEI meetings and other related activities.

TOP 5:
The new commission should in future practise a closer collaboration with the international data centers. Short reports were given by R. Willemann about the progress made at the ISC and by K. Shedlock about current developments at NEIC (at the moment already 2000 real-time channels coming in, running parallel to the old system; about 30.000 real-time channels, including strong-motion recordings, are planned; currently negotiating some real-time channels also in South

America; The trend is to take full advantage of wave-forms. However NEIC will continue to accept parameter data (analysts reports from stations/networks will override automatically derived parameter determinations). B. Kennett briefed on the current status of the IMS/IDC and the decision that the IDC will produce its own bulletin because of the non-release of data to ISC/NEIC. The IASPEI bureau will push another resolution on this critical issue which jeopardizes the work of the seismological world data centers. The ISC Governing Council will also put forward its own resolution to this effect.

TOP 6:
The CoP working groups report about their activities and related decisions are taken.

6.1: The WG on Content of Seismic Bulletins had initiated the successful Workshop S8.3 at the current meeting in Hanoi. The results will be taken into consideration in the future work of the ISC. The chairman, Ray Willemann proposed to close the WG since he had found it difficult to find other members. It was agreed upon to terminate this WG.

6.2: The WG on Regionalization (WGR) submitted its final report which is attached as **Annex 3** to the Commission report. The partially remaining task of Third (local, national) Level Regionalization was no longer considered to be a task of IASPEI as an interregional scientific organization. Therefore, the Commission decided to terminate the work of the WG. P. Bormann informed the Commission that he had invited G. Leydecker, who had been responsible for the third level regionalization of Germany after unification, to present at the Hanoi meeting a poster and talk on the present statue of third level regionalization in Europe and to prepare for the New Manual of Seismological Observatory Practice (NMSOP) an information sheet on recommended WGR guidelines for third level regionalization. This will assist countries, which have not yet been able to complete this task, to carry it out later in an internationally tested, approved and compatible standard way. John Young was thanked for his many years of work and was given permission to publish the work.

6.3: No report has been submitted by the WG on Standards for Seismometer Testing (chairman B. Hutt) and no activity has become known to the Committee so far. Therefore, it was decided to close this group. The Committee realizes, however, that international standards for seismometer testing, recommended and approved by IASPEI, might be of broader interest, also for manufacturers. The Committee is, therefore, open to consider the reinstallation of such a IASPEI WG if on-going activities and a working plan for the next years are reported to it by B. Hutt.

6.4: The chairman of the WG on Parameter Formats, J. Havskov, briefed the Commission on the various efforts in the past years to develop and agree on a new seismological parameter format which replaces the old, cumbersome and incomplete telex format, makes full use of now generally available e-mail and internet connections, allows unique, more detailed and complementary descriptive parameter reporting to international data centers and is, at the same time, flexible enough to easily accommodate possible future additional requirements for parameter reporting. He welcomed the initiative taken by R. Willemann of the ISC, to develop and test a new IASPEI Parameter Format (ISF), which is compliant with the IMS1.0 standard however more complete and flexible so as to permit the reporting of additional parameters of interest for the broader seismological research community. R. Willemann stated, that the ISC will start using this format if it is approved by the Commission. Following a respective move by the president of IASPEI, B., Kennett, **the Commission approved the ISF as the new IASPEI seismological parameter format**. P. Bormann recommended, that the final version of the ISF, as agreed with R. Willemann, be attached as an information sheet to Chapter 9 of the NMSOP on Formats, Archival and Exchange of Seismological Data. He also requested that the ISC contributes to the NMSOP another information sheet, giving case examples for recommended e-mail parameter reporting to the ISC by seismological stations and network centers in concordance with the approved ISF. R. Willemann informed, that the ISF will also be distributed to all ISC contributors via the ISC bulk-mail. The Commission agreed to close the WG on Formats. It was agreed upon that the ISC would implement future changes as needed, subject to approval at the next Commission meeting. R. Willemann offered that ISC will make a toolbox of subroutines for reading and writing ISF formatted lines so that the new format easily can be implemented into existing processing software.

6.5: R. Engdahl informed about the status of the WG on Reference Events. It has developed the criteria for the selection of such (GT) events, established a website http://lemond.colorado.edu/~copgte) and is now developing the data base of such events. Proposals for suitable reference events can be submitted through the web site. In this context, the President recommended that the Commission develops, as part of the IASPEI homepage, its own web site and provides from it links to the respective websites of its WGs. The Chairman of the Commission will take appropriate steps to this effect.

6.6: P. Bormann reported about the activities of the WG New Manual of Seismological Observatory Practice. His final report is attached as **Annex 4.** The last Workshop session organized by the WG has been scheduled for Thursday, 30 August, at this IASPEI meeting. It is complemented by a two days poster session, which gives an overview about all Manual chapters. Although 3 out of the 13 chapters are still in preparation, the WG chairman recommended, to disband this working group after the Hanoi meeting, since the remaining work to be done is chiefly that of the two editors, namely of P. Bormann for the printed manual version and of E. Bergman for the manual website. Both are planned to be completed by the ESC meeting in 2002 in Genua, Italy. As urgent matters, P. Bormann recommended in his report to agree soonest on IASPEI standard phase names as well as on magnitude measurements and related unique nomenclature. He also emphasized the need, that the Commission continues to take an eye on the new IASPEI manual also in future so as to assure that always competent guidance in the interest of the seismological community is given to the operators and analysts at seismological observatories and network centers. While it will be more easy to keep the website up-to-date, the printed and recommended CD versions should be reissued from time to time as well. The President suggested a review period by the Commission in about 5 years time. J. Havskov expressed his thanks to the chairman and the members of the Manual WG for their great efforts to produce a new IASPEI MSOP.

TOP 7:
The following new WGs have been proposed and adopted for the Commission on Seismological Observation and Interpretation:

- **WG on Standard Phase Names**; Chairman: D. Storchak (ISC), Member: R. Engdahl and B. Kennett (others may be invited or consulted as required);
- **WG on Magnitude Measurements**; Chair(wo)men: K. Shedlock (NEIC), members will be invited by the K. Shedlock.
- **WG on Multiple Event Location;** Chairman P. Richards (Columbia University). Members will be invited by P. Richards.

B. Kennett informed in this context that the subcommission on Heterogeneity (Chairman Ru-ShanWu) should be given some more time to complete its work and its tasks to be integrated later into another relevant WG of the Commission. He also informed that the printed brochure of the Seismological Tables IASP91 are now out of print and stock and that no reprint is considered. Rather, it is planned to provide a Pdf version of both IASP91 and of the ak135 tables and a related program on the web site http://www.iaspei.org by the end of 2001.

TOP 8:
B. Kennett passed a proposal to the Commission chairman, J. Havskov, with suggestions for symposia and workshops at the IUGG/IASPEI meeting 2003 in Sapporo, requesting that it be circulated to members present with this report, inviting comments and feedback (**Annex 5**)

TOP 9: The session was closed at 19:30 h.

Annex 1

List of participants, 2001

Eric Bergman	University of Colorado, USA	bergman@seismo.com
Istva Bondar	SAIC, USA	ibondar@cmi.gov
Johannes Schweitzer	NORSAR, Norway	johannes@norsar.no
Peishan Chen	Beijing, China	chenps@zbs.net
Vasilie Marza	University of Brasilia, Brazil	marza@unb.br
Raymond Willemann	ISC, UK	ray@isc.ac.uk
Brian Kennett	ANU, Australia	brian@rses.anu.edu.au
Paul G. Richards	Columbia University, USA	richards@leed.colombia.edu
Søren Gregersen	KMS, Denmark	srg@kms.dk
Qi-fu Chen	CSB, China	chanqf@seis.ac.cn
Dmitry Storchak	ISC, UK	dmitry@isc.ac.uk
Yochai Ben Horin	NDC, Israel	yochai@soreq.gov.il
Hilmar Bungum	NORSAR, Norway	hilmar@norsar.no
Lars Ottemöller	University of Bergen, Norway	larso@ifjf.uib.no
Kaye Shedlock	USGS, USA	sheclock@usgs.gov
Peter Borrmann	GFZ, Germany	course@gfz-potsdam.de
Dave Jackson	UCLA, USA	djackson@ucla.edu
Bob Engdahl	IASPEI, USA	engdahl@colorado.edu
Margaret Grandison	JSN, Jamaica	maggie@unimona.edu.jm
Jens Havskov	University of Bergen, Norway	jens@ifjf.uib.no

Annex 2

International Association of Seismology and Physics of the Earth's Interior

Agenda

Commission on Seismological Observation and Interpretation
(Formerly Commission on Practice)

Thursday 23 August 1800-1900 ICC - IASPEI Conference Room

1 Approval of minutes from meeting in 1999
2 Approval of agenda and suggestions for new points
3 Introductory remarks: J. Havskov
4 New commission structure: B. Kennett
- Seismic network and data centers
- Seismogram analysis
- Routine determination of earthquake parameters
- Wave propagation in heterogeneous media
- Seismological interpretation

5 Status at international data centers: ISC, NEIC, IMS, and others
6 Work groups, introductory remarks: J. Havskov
6.1 Content of Seismic Bulletins, R. Willemann
6.2 Regionalization, J. Young
6.3 Standard for seismometer testing B. Hutt
6.4 Parameter formats, J. Havskov
6.5 Ground truth events, B. Engdahl
6.6 Manual of seismological observatory practice, P. Borrmann
7 Proposal for new work groups
8 Suggestions for 2003 IASPEI symposia and workshops
9 Closing

J. Havskov

Chairman

Annex 3

IAGA-IASPEI JOINT SCIENTIFIC ASSEMBLY, HANOI, VIETNAM, 2001

IASPEI COMMISSION ON PRACTICE

IASPEI WORKING GROUP ON REGIONALISATION FINAL REPORT

This is the final report of the Working Group and any viewsexpressed are entirely those of the Chairman.

At the last meeting of the Group at the IUGG in Birmingham a number of items were picked for completion by the time of this meeting, as well as the on-going work of third level or "local" regionalisation. Some of these items of work were completed or nearly completed by the time of the successful regionalisation workshop held at the ESC in Lisbon in 2000.It was during the ESC in Lisbon that I was informed of the Commission's intention to "terminate" the Group. Regrettably, the announcement has had a profound affect not only on my ability to allocate time to my duties but also on the morale of myself and the members of the Group. However, the work on the European Third Level Regionalisation is nearly finished and the Group seeks a final approval from the Commission for publication by Elsevier. Any other work completed is now wasted.

The Group was formed by the Commission on Practice at the IASPEI meeting in Tokyo in 1985 under the Chairmanship of Dr. Ted Flinn. The first full meetings of the Group took place at the IUGG in Vancouver in 1987. Soon after, Ted was diagnosed with terminal cancer and died shortly before the next meeting of the Group at the IASPEI meeting in Istanbul in 1989. As I am not a seismologist I was surprised to be asked by the Commission to take on the task of chairman (a task which I now reluctantly relinquish after 12 years). The next meetings of the Group at the IUGG in Vienna in 1991 outlined the work needed to complete the tasks set by the Commission. Yearly meetings of the Group followed until 1997; after 1997 the group decided to meet only every two years. The revised "F-E Code", the so-called Second Level Regionalisation was published in 1996. The Third Level Regionalisation was deemed to have started in 1994 but some work had been done before this date.

The work of the Group remains largely unfinished. I regret that I am unable to continue the task set by the Commission at the Istanbul meeting. Diminished status and lack of funding at Blacknest means my contribution to the Group has been minimal.
I realise that my position is not unique and finding volunteers for Working Groups at this time has never been more difficult. But the lack of foresight and support does not seem to be only the prerogative of Governments.

I cannot finish my final report without thanking the many people who have 'played' a part in regionalisation over the last 20 years either as members of the Group, interested parties, or supporters of the 'cause'. I won't name names; you know who you are. Thank You!

Respectfully submitted,

John Young,
Chairman.

Annex 4

Report

CoP Working Group: New Manual of Seismological Observatory Practice

History

The Working Group was established in 1994. A concept for the New Manual of Seismologi-cal Observatory Practice (NMSOP) was proposed in 1995, the work started in 1996. A web page was established in the same year under http://www.seismo.com in order to make first drafts already available to a wide community and to invited feedback and comments. Also most part of the 1979 edition of the MSOP was put on this website for reference. Officially, the WG finishes its work by 2001, although both the final and reviewed printed version and the web site of the NMSOP will be available only in 2002. The work will be completed by the two editors, P. Bormann (for the printed version) and E. Bergman (for the web site).

Contributors

The completion of the manual was much delayed due to several drop-outs of originally invited contributors, from the USA (4) in particular. Their work had to be taken up, with several years of delay, by the chairman of the WG and other German colleagues. In total there have been 27 contributors from 7 countries: Germany (13), USA (6?), Norway (3), UK (2), Belgium, Slowenia and Czechia (1 each).

Status of work

By the IASPEI meeting in Hanoi, 2001, 10 out of 13 planned chapters have been completed and reviewed (by 2 to 4 external reviewers). This finished material is readily formatted for printing, in total about 550 pages. 3 more chapters are still in preparation, two of them half ready. The introductory chapter can only be written when all other chapters are completed. The same applies to the index, the list of acronyms, list of contents, list of authors etc. In total, the manual, with its annexes, will comprise about 700 to 800 pages.

The website contains at present the first drafts of only partially or not yet reviewed chapters and sections of the manual, about half of the expected total. With the reviews of most chapters now being available, it is hoped that the process of putting the final manual version now on the web could be accelerated and finished by summer 2002. On this matter, the website editor will report separately.

Recommendations

Although the WG will be closed in 2001, the IASPEI CoP and its follow-up Committee and WGs should support the completion of the New IASPEI Manual and ensure, that its website will be kept up-to-date in future as a main IASPEI reference source and public service. Several important issues relevant to future observatory practice are still unresolved and await urgent decisions and clarification by the new Commission, in particular:

- Propagating and promoting the ISOP concept of analyzing and reporting secondary phases and complementary relevant information to international data centers;
- Adoption of the new IASPEI Seismic Format (ISF) and issuing new reporting standards/procedures for seismic stations and networks in tune with it;
- New extended standard phase and magnitude nomenclature which makes full use of the broader reporting capabilities and flexibility of the ISF;
- Future reviews and, if needed, updates of the NMSOP should be a Commission task.

Potsdam, 13.08.2001

Peter Bormann
Chairman of the WG NMSOP

Annex 5

Seismological Observation and Interpretation

Scope: The essence of seismology lies in the observation and interpretation of earthquakes and earthquake-generated ground motions, together with effective data distribution and analysis. We now have a worldwide system of seismograph stations supplemented by diverse deployments of portable instrumentation. There is a continuing need to improve mechanisms for the archiving, dissemination and analysis of these data for the benefit of all researchers and users of seismological information. The classes of information that are extracted from seismograms need to be reviewed and expanded so as to provide the best possible processing in as timely a fashion as possible.

The real Earth varies in three-dimensions and is anisotropic in part. Thus methods for seismogram interpretation need to take account of the complexities which are revealed in the currently available high quality data. The development of seismic modeling and interpretation problems in complex, interrelated earth structures requires intensive computation and has benefited greatly from advances in computer technology. Methods for data inversion are increasingly escaping from the constraints of local linearization and also exploit the power of parallel computer technology.

Contributions are invited for all aspects of the collection, analysis and interpretation of seismological data including:

(1) Developments in seismic networks and data centers - including land, ocean-bottom and planetary networks, multi-parameter observations, early warning systems, large scale portable networks, international data exchange, management of massive data sets.

(2) Comprehensive seismogram analysis at single stations, seismic networks and arrays - requirements, potentials and future developments.

(3) Rapid and routine determination of earthquake parameters including location and source character, particularly in the context of verification and detection associated with the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

(4) Advances in wave propagation in heterogeneous media, including synthetic seismograms and waveform modeling in realistic Earth structures, theory and observations of scattering, attenuation and anisotropy.

(5) Developments in seismological interpretation, including development of inversion techniques, seismic tomography and whole-earth analysis methods.

Appendix 2

Reports from working groups for the period 2001-2003

IASPEI Commission on Seismological Observation and Interpretation (CoSOI)
Working Group (WG) on Magnitudes

I. BACKGROUND

The widespread installation of broadband, high dynamic-range, digital seismographs has greatly extended the range of ground-motions over which traditional earthquake magnitudes, such as *mb*, *Ml*, and *Ms*, can be assigned from a single station, and the instruments have enabled the routine assignment of new types of magnitude such as moment magnitude and energy magnitude. Challenges, however, arise with the use of digital data to calculate traditional magnitudes that were originally defined with data from analog seismographs. The digital data have permitted the introduction of new procedures and instrument responses in the calculation of traditional magnitudes. Some of the new procedures offer the possibility of more rapid or lower variance measurements of traditional magnitude. It appears, however, that some of the new procedures lead to magnitude estimates that are biased with respect to magnitude estimates made with classical analog instruments widely used for several decades. Challenges also arise with cataloging the new types of magnitude. Some of the new types of magnitude, such as Mw, are routinely calculated by many different institutes using different procedures, and the potential exists for biases between different institutes' measurements of what is nominally the same type of magnitude.

The existence of magnitude biases from whatever source pose problems for earthquake-hazard mapping studies, seismicity-based earthquake prediction algorithms, and CTBT monitoring programs. Severe discrepancies in magnitudes reported by different agencies for a destructive earthquake may damage public trust in seismologists' work. Magnitude biases may arise from a number of sources besides the use of different magnitude-measurement procedures, but it seems clear that identification of, and correction for, other sources of magnitude bias will be made difficult by the existence of biases introduced by different measurement procedures.

II. PURPOSE

The immediate purpose of the magnitude WG is to identify standard procedures for making measurements from digital data to be used in calculating several widely-used types of earthquake magnitude. The WG considered the following generic magnitude types, specified by the nomenclature used in the New Manual of Seismological Observatory Practice (Bormann, 2002): *Ml*, *Md*, *Ms*, *mB*, *mb*, *Mw*, *Me*, and *mLg*. The goal of the WG is that different agencies' use of the standard procedures will result in the removal of procedure-dependent biases from cataloged earthquake magnitudes. A special priority is the removal of procedure-dependent biases in amplitudes, periods, and magnitudes that are contributed to the U.S. Geological Survey/National Earthquake Information Center (USGS/NEIC) and the International Seismological Centre (ISC). Another high priority is the removal of large procedure-dependent discrepancies in magnitudes reported to news media in the immediate aftermath of destructive earthquakes. Much of the correspondence of the WG inevitably involved other sources of magnitude bias besides those based on measurement procedures. Several of the WG recommendations will involve standardization of magnitude formulas or other aspects of magnitude reporting.

III. CURRENT STATUS OF RECOMMENDED STANDARD PROCEDURES

The following overview summarizes the WG's current positions on standard procedures or formulas for commonly used magnitudes.

Ml – The WG will recommend a generalization of the original formula of Richter that was proposed by Hutton and Boore (1987). Amplitudes measured from digital data should be scaled from data that are filtered to replicate a standard Wood-Anderson seismogram. The distance parameter is defined as hypocentral distance instead of epicentral distance. Amplitude may be measured from the vertical component as well as the horizontal components. For regions with crustal attenuation properties different than those of Southern California, calibration functions should be scaled in such a way that an event with Ml = 3 corresponds to 10 mm of maximum trace amplitude on a Wood-Anderson (simulated) record at a hypocentral distance of 17 km, as it would be observed in Southern California.

Md – The WG will not recommend a standard procedure for *Md*. For locally recorded earthquakes in regions for which *Md* has not been specifically calibrated, the WG recommends that *Ml* be used in preference to *Md* if the digital signal is not clipped.

Ms – The WG will probably recommend a standard *Ms* procedure that involves measuring amplitudes and periods from digital data that are filtered to replicate seismograms from the WWSSN long-period or Kirnos SKD seismographs. The WG has documented many differences in details of procedures for measuring amplitudes and periods, and there is a difference in the period range used for Ms determination at the NEIC and at the ISC/MOS, respectively. The WG is not aware of strong evidence that these differences produce significant bias in the resulting *Ms* values. The WG must nonetheless undertake further analysis of possible period-dependent biases in Ms estimates before making final recommendation on a standard procedure. The WG will also consider a proposal that the standard *Ms* procedures should be based on maximum ground-velocity amplitudes as determined from BB velocity records.

mB – The WG will repeat a recommendation made by an earlier Committee on Magnitudes at the IASPEI General Assembly in Zürich (1967), that the USGS/NEIC and the ISC be encouraged to compute *mB* and to report intermediate-period body-wave amplitudes and periods. *mB* procedures that are designed to mimic traditional procedures would involve measuring vertical component P-wave amplitudes and periods from digital data that are filtered to replicate seismograms from the Kirnos SKD seismograph.

mb – The WG reviewed evidence that *mb* computed by the Comprehensive Nuclear-Test-Ban Treaty Organization's International Data Centre (IDC) are biased with respect to *mb* computed by the NEIC and *mb* traditionally computed by the ISC. A significant fraction of the bias for larger earthquakes has been demonstrated to be the result of the IDC's use of a different seismograph response and length-of-measurement window than are typical of the average data traditionally processed by the NEIC and ISC. The WG recognizes that NEIC and ISC *mb* have always been computed with data from instruments having a variety of responses, but the WG is concerned that large numbers of data from a few networks with non-traditional measurement procedures are leading to systematic changes in *mb*. Such changes have already occurred with ISC *mb* as the result of ISC's use of amplitudes and periods read at the IDC. The WG has not finished defining a strategy to minimize procedural bias in *mb*, but the final strategy will include the recommendation that amplitudes and periods measured from digital data be scaled from data that are filtered to replicate or approximately replicate a WWSSN short-period seismograph, and that amplitudes and periods correspond to the maximum vertical component trace amplitude in the entire P-wave train rather than in the first few seconds of the P-wave train. The WG will probably recommend that the ISC discontinue use of IDC amplitudes and periods in computing its own *mb*. The WG recognizes that the IDC *mb*, though computed with a non-standard procedure, is a valuable complementary parameter for describing the size of an earthquake and urges that both the NEIC and the ISC report IDC event-magnitudes as contributed magnitudes, denoted *mb(IDC)*. The WG also recognizes that the IDC *mb* procedure may be optimal for discriminating explosions from earthquakes and that the IDC might compromise its mission by changing the current *mb(IDC)* procedure. The WG will propose that the IDC consider computing an *mb* according to the recommended procedure in addition to, rather than in place of, its current *mb(IDC)*.

Mw – The WG proposes that the formula for *Mw* be standardized to

$$Mw = (2/3)\_(\log_{10} M_0 - 9.1)$$

where M_0 = scalar moment in N·m, determined from waveform modeling or from the long-period asymptote of spectra.

There are currently several different formulas in use, which may produce values of *Mw* that differ by 0.1 magnitude unit for the same seismic moment. The proposed standard formula has the advantage that it can be converted exactly for use with M_0 expressed in dyne·cm, without imposing a formula-dependent round-off error. *Mw* was originally defined using the dyne·cm version of the proposed standard formula.

Me – The WG proposes that the formula for *Me* be standardized to

$$Me = (2/3)\_(\log_{10} E_S - 4.4),$$

where E_S = radiated energy in joules.

MLg – There are several, mutually inconsistent, procedures for measuring *MLg* that have become traditional at different seismological observatories. The WG will favor a procedure that involves measuring amplitudes at periods of approximately 1 s.

IV. NEXT STEPS AND RECOMMENDED COURSE FOR COMPLETING AND IMPLEMENTING STANDARD PROCEDURES.

A. Finish definition of standard filters for replicating seismograms from traditional instruments. The WG has found that responses of some of the classical instruments have multiple "poles and zeroes" representations circulating in the seismological community; the WG has not yet determined if the differences are significant in terms of filtered output.

B. Define and test specific recipes for measuring amplitudes and periods (or RMS amplitudes) that do not mimic traditional procedures on analog seismographs but that still produce unbiased results.

C. Finish the long report of WG recommendations and publish it in an electronic medium.

D. Publish a short note or letter in *Seismological Research Letters*, summarizing the work of the WG and notifying the seismological community of the publication of the long report.

E. USGS/NEIC and ISC contact seismological observatories and encourage them to contribute amplitude data that are derived from digital data according to the proposed standard procedures.

F. WG monitors the response of the seismological community to the proposing of standard procedures.

G. WG monitors the effect on USGS/NEIC and ISC magnitudes of some seismological observatories adopting the proposed standards.

H. At next IASPEI, the WG reports to the CoSOI on the experience with the proposed standards and makes recommendations for final standards to be adopted by the CoSOI.

V. RECOMMENDED ACTIONS OF CoSOI

A. Authorize, or define a procedure for authorizing, publication of proposed standards under auspices of the IASPEI Commission on Seismological Observation and Interpretation (CoSOI) Working Group (WG) on Magnitudes, so that the seismological community can review the standards. This authorization would not constitute CoSOI final approval of the standards.

B. Authorize, or define a procedure for authorizing, publication of an article in the Seismological Research Letters that will summarize the proposed standards.

C. Extend the term of the Magnitude WG for another two years.

Working Group on Standard Phase Names

Members: B.Kennet, B.Engdahl, J.Havskov, J.Schweitzer, P.Bormann, D.Storchak, R. Adams.
Chairman: Dmitry Storchak

The Working Group was set up in September 2001.
The previous report (1) was submitted on the 11 March.
Our achivements since that day are described below.
The current phase list is shown at the end.

1. IASPEI bulk e-mail:

Agreed on the Version 3 of the list and distributed it to more than 2000 addresses using IASPEI bulk e-mail system.

2. Final version agreed:

A good number of comments and suggestions was received and implemented in the Version 4, which after short deliberations in the WG has become the final one, awaiting to be approved by IASPEI. This work has been finished by 31 May as planned.

3. NMSOP:

We then concentrated on inclusion of the list into the New Manual of Seismological Observatory practice. A special chapter was written to describe the list, illustrations for all major phases were prepared.

4. ISC:

At it's meeting in June the ISC Executive Committee has recommended the ISC to work towards using the list in the operations. It should become possible as a result of the current development in the centre. The list was put on the ISC web-site.

5. ESC Assembly:

A poster describing the list with numerous illustrations has been presented at the ESC General Assembly in Genoa, September 2002.

6. Training course:

The list was also presented at the Young Seismologist's Training course in Genoa.

We are no longer planning to make any major revisions of the list. Instead we are concentrating now on advertising and making sure that the list is being gradually put into the operations. Our major concern now is how to purswade the authors of well known and used seismological programs to make adjustments to their software. This will allow the fastest adoption of the list by seismological observatories and data centres.

7. Submitted a paper to SRL, prepared a poster for IUGG

Certainly we are looking forward to the list being accepted by the IASPEI. Soon after that the list shall be published in a suitable journal.

IASPEI STANDARD SEISMIC PHASE LIST

After numerous consultations with the seismological community this list was agreed in May 2002 by the IASPEI Working Group on Phase Names, chaired by D. A. Storchak. Other members of the WG were R. D. Adams, P. Bormann, E. R. Engdahl, J. Havskov, B. N. L. Kennett and J. Schweitzer. The list is to be finally adopted by the IASPEI Commission on Seismological Observation and Interpretation (CoSOI) at its meeting in Sapporo, 2003.

Crustal Phases

Pg	At short distances, either an upgoing P wave from a source in the upper crust or a P wave bottoming in the upper crust. At larger distances also arrivals caused by multiple P-wave reverberations inside the whole crust with a group velocity around 5.8 km/s.
Pb	(alt:P*) Either an upgoing P wave from a source in the lower crust or a P wave bottoming in the lower crust
Pn	Any P wave bottoming in the uppermost mantle or an upgoing P wave from a source in the uppermost mantle
PnPn	Pn free surface reflection
PgPg	Pg free surface reflection
PmP	P reflection from the outer side of the Moho
PmPN	PmP multiple free surface reflection; N is a positive integer. For example, PmP2 is PmPPmP
PmS	P to S reflection from the outer side of the Moho
Sg	At short distances, either an upgoing S wave from a source in the upper crust or an S wave bottoming in the upper crust. At larger distances also arrivals caused by superposition of multiple S-wave reverberations and SV to P and/or P to SV conversions inside the whole crust.
Sb	(alt:S*) Either an upgoing S wave from a source in the lower crust or an S wave bottoming in the lower crust
Sn	Any S wave bottoming in the uppermost mantle or an upgoing S wave from a source in the uppermost mantle
SnSn	Sn free surface reflection
SgSg	Sg free surface reflection
SmS	S reflection from the outer side of the Moho
SmSN	SmS multiple free surface reflection; N is a positive integer. For example, SmS2 is SmSSmS
SmP	S to P reflection from the outer side of the Moho
Lg	A wave group observed at larger regional distances and caused by superposition of multiple S-wave reverberations and SV to P and/or P to SV conversions inside the whole crust. The maximum energy travels with a group velocity around 3.5 km/s
Rg	Short period crustal Rayleigh wave

Mantle Phases

P	A longitudinal wave, bottoming below the uppermost mantle; also an upgoing longitudinal wave from a source below the uppermost mantle

PP	Free surface reflection of P wave leaving a source downwards
PS	P, leaving a source downwards, reflected as an S at the free surface. At shorter distances the first leg is represented by a crustal P wave.
PPP	analogous to PP
PPS	PP to S converted reflection at the free surface; travel time matches that of PSP
PSS	PS reflected at the free surface
PcP	P reflection from the core-mantle boundary (CMB)
PcS	P to S converted reflection from the CMB
PcPN	PcP multiple free surface reflection; N is a positive integer. For example PcP2 is PcPPcP
Pz+P	(alt:PzP) P reflection from outer side of a discontinuity at depth z; z may be a positive numerical value in km. For example P660+P is a P reflection from the top of the 660 km discontinuity.
Pz-P	P reflection from inner side of discontinuity at depth z. For example, P660-P is a P reflection from below the 660 km discontinuity, which means it is precursory to PP.
Pz+S	(alt:PzS) P to S converted reflection from outer side of discontinuity at depth z.
Pz-S	P to S converted reflection from inner side of discontinuity at depth z
PScS	P (leaving a source downwards) to ScS reflection at the free surface
Pdif	(old:Pdiff) P diffracted along the CMB in the mantle
S	shear wave, bottoming below the uppermost mantle; also an upgoing shear wave from a source below the uppermost mantle
SS	free surface reflection of an S wave leaving a source downwards
SP	S, leaving source downwards, reflected as P at the free surface. At shorter distances the second leg is represented by a crustal P wave.
SSS	analogous to SS
SSP	SS to P converted reflection at the free surface; travel time matches that of SPS.
SPP	SP reflected at the free surface
ScS	S reflection from the CMB
ScP	S to P converted reflection from the CMB
ScSN	ScS multiple free surface reflection; N is a positive integer. For example ScS2 is ScSScS
Sz+S	(alt:SzS) S reflection from outer side of a discontinuity at depth z; z may be a positive numerical value in km. For example S660+S is an S reflection from the top of the 660 km discontinuity.
Sz-S	S reflection from inner side of discontinuity at depth z. For example, S660-S is an S reflection from below the 660 km discontinuity, which means it is precursory to SS.
Sz+P	(alt:SzP) S to P converted reflection from outer side of discontinuity at depth z
Sz-P	S to P converted reflection from inner side of discontinuity at depth z
ScSP	ScS to P reflection at the free surface
Sdif	(old:Sdiff) S diffracted along the CMB in the mantle

Core Phases

PKP	(alt:P') unspecified P wave bottoming in the core
PKPab	(old:PKP2) P wave bottoming in the upper outer core; ab indicates the retrograde branch of the PKP caustic
PKPbc	(old:PKP1) P wave bottoming in the lower outer core; bc indicates the prograde branch of the PKP caustic
PKPdf	(alt:PKIKP) P wave bottoming in the inner core
PKPpre	(old:PKhKP) a precursor to PKPdf due to scattering near or at the CMB
PKPdif	P wave diffracted at the inner core boundary (ICB) in the outer core
PKS	Unspecified P wave bottoming in the core and converting to S at the CMB
PKSab	PKS bottoming in the upper outer core
PKSbc	PKS bottoming in the lower outer core
PKSdf	PKS bottoming in the inner core
P'P'	(alt:PKPPKP) Free surface reflection of PKP
P'N	(alt:PKPN) PKP reflected at the free surface N-1 times; N is a positive integer. For example P'3 is P'P'P'
P'z-P'	PKP reflected from inner side of a discontinuity at depth z outside the core, which means it is precursory to P'P'; z may be a positive numerical value in km
P'S'	(alt:PKPSKS) PKP to SKS converted reflection at the free surface; other examples are P'PKS, P'SKP
PS'	(alt:PSKS) P (leaving a source downwards) to SKS reflection at the free surface
PKKP	Unspecified P wave reflected once from the inner side of the CMB
PKKPab	PKKP bottoming in the upper outer core
PKKPbc	PKKP bottoming in the lower outer core
PKKPdf	PKKP bottoming in the inner core
PNKP	P wave reflected N-1 times from inner side of the CMB; N is a positive integer
PKKPpre	a precursor to PKKP due to scattering near the CMB
PKiKP	P wave reflected from the inner core boundary (ICB)
PKNIKP	P wave reflected N-1 times from the inner side of the ICB
PKJKP	P wave traversing the outer core as P and the inner core as S
PKKS	P wave reflected once from inner side of the CMB and converted to S at the CMB
PKKSab	PKKS bottoming in the upper outer core
PKKSbc	PKKS bottoming in the lower outer core
PKKSdf	PKKS bottoming in the inner core
PcPP'	(alt:PcPPKP) PcP to PKP reflection at the free surface; other examples are PcPS', PcSP', PcSS', PcPSKP, PcSSKP
SKS	(alt:S') unspecified S wave traversing the core as P
SKSac	SKS bottoming in the outer core
SKSdf	(alt:SKIKS) SKS bottoming in the inner core
SPdifKS	(alt:SKPdifS) SKS wave with a segment of mantle-side Pdif at the source and/or the receiver side of the raypath
SKP	Unspecified S wave traversing the core and then the mantle as P
SKPab	SKP bottoming in the upper outer core

SKPbc	SKP bottoming in the lower outer core
SKPdf	SKP bottoming in the inner core
S'S'	(alt:SKSSKS) Free surface reflection of SKS
S'N	SKS reflected at the free surface N-1 times; N is a positive integer
S'z-S'	SKS reflected from inner side of discontinuity at depth z outside the core, which means it is precursory to S'S'; z may be a positive numerical value in km
S'P'	(alt:SKSPKP) SKS to PKP converted reflection at the free surface; other examples are S'SKP, S'PKS
S'P	(alt:SKSP) SKS to P reflection at the free surface
SKKS	Unspecified S wave reflected once from inner side of the CMB
SKKSac	SKKS bottoming in the outer core
SKKSdf	SKKS bottoming in the inner core
SNKS	S wave reflected N-1 times from inner side of the CMB; N is a positive integer
SKiKS	S wave traversing the outer core as P and reflected from the ICB
SKJKS	S wave traversing the outer core as P and the inner core as S
SKKP	S wave traversing the core as P with one reflection from the inner side of the CMB and then continuing as P in the mantle
SKKPab	SKKP bottoming in the upper outer core
SKKPbc	SKKP bottoming in the lower outer core
SKKPdf	SKKP bottoming in the inner core
ScSS'	(alt:ScSSKS) ScS to SKS reflection at the free surface; other examples are: ScPS', ScSP', ScPP', ScSSKP, ScPSKP

Near Source Surface Reflections (Depth Phases)

pPy	All P-type onsets (Py) as defined above, which resulted from reflection of an upgoing P wave at the free surface or an ocean bottom; WARNING: The character "y" is only a wild card for any seismic phase, which could be generated at the free surface. Examples are: pP, pPKP, pPP, pPcP *etc.*
sPy	All Py resulting from reflection of an upgoing S wave at the free surface or an ocean bottom; For example: sP, sPKP, sPP, sPcP *etc.*
pSy	All S-type onsets (Sy) as defined above, which resulted from reflection of an upgoing P wave at the free surface or an ocean bottom. For example: pS, pSKS, pSS, pScP *etc.*
sSy	All Sy resulting from reflection of an upgoing S wave at the free surface or an ocean bottom. For example: sSn, sSS, sScS, sSdif *etc.*
pwPy	All Py resulting from reflection of an upgoing P wave at the ocean's free surface
pmPy	All Py resulting from reflection of an upgoing P wave from the inner side of the Moho

Surface Waves

L	Unspecified long period surface wave
LQ	Love wave
LR	Rayleigh wave
G	Mantle wave of Love type

GN	Mantle wave of Love type; N is integer and indicates wave packets traveling along the minor arcs (odd numbers) or major arc (even numbers) of the great circle
R	Mantle wave of Rayleigh type
RN	Mantle wave of Rayleigh type; N is integer and indicates wave packets traveling along the minor arcs (odd numbers) or major arc (even numbers) of the great circle
PL	Fundamental leaking mode following P onsets generated by coupling of P energy into the waveguide formed by the crust and upper mantle
SPL	S wave coupling into the PL waveguide; other examples are SSPL, SSSPL

Acoustic Phases

H	A hydroacoustic wave from a source in the water, which couples in the ground
HPg	H phase converted to Pg at the receiver side
HSg	H phase converted to Sg at the receiver side
HRg	H phase converted to Rg at the receiver side
I	An atmospheric sound arrival, which couples in the ground
IPg	I phase converted to Pg at the receiver side
ISg	I phase converted to Sg at the receiver side
IRg	I phase converted to Rg at the receiver side
T	A tertiary wave. This is an acoustic wave from a source in the solid earth, usually trapped in a low velocity oceanic water layer called the SOFAR channel (SOund Fixing And Ranging)
TPg	T phase converted to Pg at the receiver side
TSg	T phase converted to Sg at the receiver side
TRg	T phase converted to Rg at the receiver side

Amplitude Measurement Phases

A	Unspecified amplitude measurement
AML	Amplitude measurement for local magnitude
AMB	Amplitude measurement for body wave magnitude
AMS	Amplitude measurement for surface wave magnitude
END	Time of visible end of record for duration magnitude

Unidentified Arrivals

x	(old: i, e, NULL) unidentified arrival
rx	(old: i, e, NULL) unidentified regional arrival
tx	(old: i, e, NULL) unidentified teleseismic arrival
Px	(old: i, e, NULL, (P), P?) unidentified arrival of P-type
Sx	(old: i, e, NULL, (S), S?) unidentified arrival of S-type

Working group on reference events

Members: E.A. Bergman, Bob Engdahl, Bondar, P. Firbas
Chairman: Bob Engdahl

A paper "Epicenter accuracy based on seismic network criteria" based on the group's work has been accepted for publication in GJI. An updated version can be retrieved at ftp://otto.cmr.gov/pub/docs/ibondar/GTPD/GJI_MS_P124S.pdf. The summary is given below.

István Bondár, Stephen C. Myers, E. Robert Engdahl and Eric A. Bergman

SUMMARY
We establish reliable and conservative estimates for epicenter location accuracy using data that are readily available in published seismic bulletins. A large variety of seismic studies rely on catalogs of event locations, making proper assessment of location uncertainty critical. Event location and uncertainty parameters in most global, regional and national earthquake catalogs are obtained from traditional linearized inversion methods using a one-dimensional Earth model to predict travel-times. Reported catalog uncertainties are based on the assumption that error processes are Gaussian, zero mean, and uncorrelated. Unfortunately, these assumptions are commonly violated, leading to the underestimation of true location uncertainty, especially at high confidence levels. We find that catalog location accuracy is most reliably estimated by station geometry. We make use of two explosions with exactly known epicenters to develop local network location (0°-2.5°) accuracy criteria. Using Monte Carlo simulations of network geometry, we find that local network locations are accurate to within 5 km with a 95% confidence when the network meets the following criteria: 1) 10 or more stations, all within 250 km, 2) azimuthal gap less than 110°, 3) secondary azimuthal gap less than 160° and 4) at least one station within 30 km. To derive location accuracy criteria for near-regional (2.5° - 10°), regional (2.5° - 20°) and teleseismic (28° - 91°) networks, we use a large dataset of exceptionally well-located earthquakes and nuclear explosions. Beyond local distances, we find that secondary azimuthal gap is sufficient to constrain epicenter accuracy, and location error increases when secondary azimuthal gap exceeds 120°. When station coverage meets the criterion of secondary azimuth gap less than 120°, near-regional networks provide 20 km accuracy at the 90% confidence level, while regional and teleseismic networks provide 25 km accuracy at the 90% confidence level.

Work Group on Event Location Using Multiple Events

Members: Eric R. Engdahl, Paul G. Richards, Ray Willemann
Chairman: Paul G. Richards

Main purpose: This Group has the goal of making significant improvements in the accuracy with which seismic events are located, in regions where many seismic events have occurred. Instead of using the traditional method ofevent location, in which events are located one at a time, the Group will explore the merits of methods of locating multiple seismic events all at once.

(1) It may be noted that there are several different algorithms for multiple event location, and that these are being applied quite widely by different groups. The master event methods associated with Joint Epicenter Determination (JED) and Joint Hypocentre Determination (JHD) have been widely applied for decades. Location with respect to a centroid, as done by the Hypocentroidal Decomposition method (HDC), has been applied to numerous clusters of events. In recent years, reviewed publications based on application of the Double Difference method (DD) have presented significantly improved locations for seismicity in broad areas as well as for clusters, in Northern and Southern California (several studies), the Pacific Northwest (Vancouver and Seattle area), Alaska, South America (Chile, Argentina), Japan, Taiwan, China, and Italy.

(2) There have been a few efforts to compare the different algorithms for multiple event location. It appears that these algorithms give quite similar results when applied to a particular cluster of events although there are some differences. When applied to dense seismicity that is spread over a broad area, some of the algorithms require breaking up the seismicity into distinct clusters each of which is studied separately. We have not yet tested the algorithms sufficiently, to reach definite conclusions about which algorithms work best in application to seismicity across a broad area. The poster SS01/03A/D-091 at the 2003 IASPEI meeting in Sapporo will evaluate several of the algorithms, in application to two event clusters in Turkey (Izmit, Duzce). Relevant parts of the abstract for this poster are as follows:

A COMPARISON OF MULTIPLE-EVENT LOCATION METHODS

William RODI(Massachusetts Institute of Technology)
E. Robert ENGDAHL (University of Colorado)
Eric A. BERGMAN (University of Colorado)
Felix WALDHAUSER (Lamont-Doherty Observatory)
Gary L. PAVLIS (Indiana University)
Hans ISRAELSSON (Center for Monitoring Research)
James W. DEWEY (U.S. Geological Survey)

Multiple-event location methods solve jointly for the location parameters (hypocenters and origin times) of seismic events in a cluster and travel-time corrections at the stations recording the events. This paper reports some preliminary comparisons of five such methods that have been developed over the years:
hypocentroidal decomposition (HDC),
double differencing (DD),
progressive multiple-event location (PMEL),
joint hypocenter determination (JHD), and
grid search multiple-event location (GMEL).

We have applied each method to two adjacent earthquake clusters in Turkey: 33 events from the 17 Aug 1999 Izmit earthquake sequence and 41 events from the 12 Nov 1999 Duzce sequence. Previously, Engdahl and Bergman (2001) had applied HDC to these clusters using Pn and teleseismic P arrival times from NEIC and ground-truth (local network) locations for a few of the events. Their data set comprised approximately 3500 arrivals at 640 stations for the Izmit cluster and 3200 arrivals at 600 stations for Duzce. We applied the other multiple-event location methods to the same set of phase picks, using the same phase identifications and fixed event depths that were used in the HDC analysis. While the five algorithms are quite different in their computational approach, our initial results indicate that the methods yield quite similar relative event locations when they are applied with the same data and assumptions. . . . The locations relative to the cluster centroids generally agreed within 5 km, but were on the order of 10 km in some instances. . . .

(3) A central issue, in considering ways to improve the accuracy of seismic event location estimates when events are located one-at-a-time, is how to develop the necessary set of travel times (as a function of depth, distance, and azimuth) to interpret the arrival times for each phase at each station contributing data. There are basically two choices. The first choice, might be to construct a sufficiently good (three-dimensional) model of Earth structure, and then to compute the travel times using ray-tracing in that model. A second choice, is to construct the travel time information from empirical data, when such data are available. In the latter method, travel time information from previously recorded sets of well-located events is used to interpret the arrival times of a new event.

Both choices have been tested in recent years, by a number of investigators. For example, 3D Earth models based on surface wave dispersion studies have been developed by the University of Colorado (obtaining S-wave velocities which are then converted to P-wave velocities), and shown to give an improved fit to travel times associated with clusters of events relocated by the HDC method.

A consortium of institutions, led by the Lamont-Doherty Earth Observatory and helped by many individuals, has shown that the empirical approach can also be very effective. In this case, the sets of well-located events used to provide empirical travel times were themselves derived from the DD multiple event location method, used to give accurate relative locations, combined with additional information (such as accurate fault maps) to obtain accurate absolute locations.

(4) It may be concluded that methods of multiple event location can provide significant improvement upon the traditional method of location in which a standard one-dimensional Earth model is used to locate seismic events one-at-a-time. Methods of multiple event location are also an important part of a procedure by which the traditional single event location method can be improved.

Appendix 3

Proposal for a resolution or a work group to improve station locations.

Several individuals have proposed to take up this topic at the meeting, see thir comment below.

Wille Lee's comments

It seems to me that there are two different issues:

(1) A general resolution calling for improving station coordinates for IASPEI (or even IUGG) to pass.
(2) A joint working group to work out the details.

The first issue has to be done quick, and should be very general in wording nd expressing the desire to form a joint working group (IASPEI, ISC, IIRIS?. USGS? etc.) to work out the details of a procedure so that seismic network operators can follow and really improving the currentsituation. This may take a year or two.

For (1), I propose that Bob draft a resolution for Jens, Ray, and Paul Richards to help finalizing. I know Bob is busy, but since he is an old hand on resolutions,it should not take him more than 10 minutes. Bob, please help.

As for (2), it would be nice for ISC and CoSOI to put in their meeting agendas for discussion.

Ray Willeman's comments

The CoSOI seems to me an obvious place for this to be discussed, but perhaps this is because that is the only IASPEI Commission with which I am familiar.

Do resolutions passed by individual Commissions advance to become resolutions of the Association by some process? Bob Engdahl has written that he would like the IASPEI Resolutions Committee to wrap up its work in the first week. How does that relate to resolutions from CoSOI? (It meets Friday evening?)

Tomorrow ISC Exec Comm and Gov Council chairmen and I plan to talk together by phone. Among many other items I plan to suggest a station-related resolution from the Gov Council. The Council might be motivated at this time to resolve something regarding stations by ISC's growing capability to collect and re-distribute parameter data without individual review for small events.

This motivation suggests that ISC should hope to see data from many more stations with known locations, but still needs only locations accurate to within a few hundred metres. I do not know if this squares with Paul Richards' concern for the station location accuracy that is required to make the best use of high-precision relative arrival times.

Appendix 4

IASPEI WORKING GROUP ON SEISMOLOGICAL ARCHIVES

Formed: July 2003

Membership: RMW Musson, British Geological Survey, Edinburgh, UK (Chairman)
Johannes Schweitzer, NORSAR, Kjeller, Norway
Josep Batllo, Observatori de l'Ebre, Roquetes, Spain
The full membership will be determined in the near future.

Objectives:
Studies of seismic hazard in any region need to devote particular attention to the largest earthquakes of that region; but the largest earthquakes of any region, no matter how active, are almost by definition rare events. Thus it is always desirable to extend the earthquake catalogue for any region as far back in time as possible. This applies as much to instrumental data as to macroseismic data, and it is becoming increasingly realised that the data legacy of the earliest period of instrumental seismology is still of considerable practical importance today. However, the physical manifestations of these data (seismograms, bulletins) are often bulky, delicate and hard to curate. The aim of this WG is to identify the whereabouts of collections, and assist in preserving the data and making them available to researchers.

The principle task in the two-year period 2003-2005 will be to complete, so far as is possible, a survey of the world's seismic data for the period pre-1920. The report to be prepared should list, for each station that operated over this period, whether the seismograms are known still to exist in original or, for special events as published figures, if so, where they are, and at least one location where the bulletins are preserved. The working group will start its search with the collected information on seismic bulletins as published by Schweitzer and Lee in the *International Handbook of Earthquake and Engineering Seismology.*

In addition, the WG will explore the possibility of setting up an archive of last resort that would preserve collections that are in danger.

The following resolution was accepted by the IASPEI Commission on Seismological Observation and Interpretation, to be put before the IASPEI Resolutions Committee. Unfortunately it was not submitted owing to a misunderstanding.

Recognising –

That engineering seismology relies on the study of the largest earthquakes in any region;
That such events are by definition, rare;
That the study of such events therefore necessarily requires as long a possible record;
That this requires access to collections of historical seismological material (bulletins, seismograms);
That such collections are constantly under threat as institutes often lack the ability to maintain them for posterity,

IASPEI recommends –

That members of IASPEI make all possible efforts to preserve historical seismological collections in their country, and facilitate access to these collections for researchers. A new WG of the IASPEI has been formed to support this activity.

Appendix 5

List of participants in the meeting of CoSOI on 04 July 2003 in Sapporo

Name	Organization	E-mail
Jens Havskov (Chairman)	University of Bergen	jens@ifjf.uib.no
Peter Bormann (Secretary)	GeoForschungsZentrum Potsdam	course@gfz-potsdam.de
Roger Musson	British Geological Survey	rmwm@bgs.ac.uk
Raymond Willemann	ISC, UK	ray@isc.ac.uk
Bob Engdahl	IASPEI	engdahl@colorado.edu
John Ebel	Boston College	ebel@bc.edu
Richard Luckett	ISC, UK	Richard@isc.ac.uk
Paul G. Richards	Columbia University	Richards@LDEO.columbia.edu
Brian Kennett	President IASPEI, ANU	brian@rses.anu.edu.au
Sun Ruomei	Inst. Geology & Geophys. CAS	sunrmQyahoo.com.cn
Fred Tugume	Geological Survey, Uganda	seismo@afsat.com
Jaroslava Plomerova	Geoph. Inst. CAS Prague, Czechia	jpl@ig.cas.cz
James W. Dewey	USGS, Denver, Colorado	dewey@usgs.gov
Tormod Kvaerna	NORSAR, Norway	tormod@norsar.no
Josep Battlo	Ebre Observatory, Spain	josep.batllo@upc.es
Johannes Schweitzer	NORSAR, Norway	Johannes@norsar.no
Dmitry Storchak	ISC, UK	dmitry@isc.ac.uk
Zana Ndorboi	D.R.G., Kinshasa	azanan2002@yahoo.fr