Topic	Preliminary guidelines for using the IASPEI standard magnitude reference data set
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1. Introduction

1.) The authors are Co-chairman (P. B.) and member (S. W.) of the IASPEI Working Group on Magnitude Measurement and entrusted with promoting the widest possible implementation and comparative testing of recent IASPEI/CoSOI summary recommendations of standard procedures for widely used magnitude measurements (see **IS 3.3** and http://www.iaspei.org/commissions/CSOI/Summary_WG-Recommendations_20110909.pdf)

2.) The current IASPEI standard magnitude reference data set allows to train yourself in the determination of the four **teleseismic magnitude standards** mb, mB_BB, Ms_20 and Ms_BB. Read these related recommendations thoroughly before embarking on the exercise outlined below. The reference data set and guidelines will in a later version of this IS be amended by data and procedures also for the determination of the two **local-regional magnitude standards** ML and mb_Lg.

3.) Comparing the results of the exercise with those derived by applying your current procedures of magnitude measurements to the same reference waveform data set will give you and your institution a clear understanding of the extent to which the new measurement standards yield results that agree or differ from your own results and to understand the reasons for possible differences.

4.) In this context there is an urgent need that stations and agencies which contribute parameter data to the International Seismological Centre (ISC) and the US National Earthquake Information Center (NEIC) provide an authoritative up-to-date **Documentation of station/agency magnitude procedures.** For your attention and easy response the related questions have been added as Annex 1 to this Information Sheet.

5.) **Note:** Should your agency not intend to introduce the recommended international standards in the future but to continue reporting your agency-specific *different* amplitude-magnitude data to the international data centres, then they need to be "flagged" by an agency-specific nomenclature. This permits data users to consult your documentation of station/agency magnitude procedures, to understand and account for related differences to the international standards and to decide about the suitability for your amplitude, period and magnitude data for their specific task.

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6.) In the case that your institution uses some automatic procedures you should document how they work, e.g.:

- what type of original record data you have, their bandwidth and frequency range, whether displacement-proportional or velocity-proportional;
- which component and wave types are used for magnitude measurement;
- what type of filter (or none) is applied before amplitude, period and magnitude measurements are made;
- definition of time-window within which measurement is made, how the record amplitudes and periods are measured, which magnitude calibration functions are used, etc.).

7.) The current IS 3.4 provides reference data only for determining regional (Ms_BB) and teleseismic magnitudes (mb, mB_BB, Ms_20 and Ms:BB) and related amplitudes, periods and measurement times. IS 3.4 will be amended in the course of 2012 by some more reference data and instructions for determining standard ML and mb_Lg. Also recommendations for using analysis software other then SEISAN may be added in future, provided that these analysis tools permit data filtering and presentation of measured amplitudes, periods, measurement times and magnitudes in a way that is compatible with the standard recommendations.

2. Data and software to be used and to be reported

In order to get an objective and reproducible comparison of IASPEI standard magnitudes with your institutional magnitudes both have to be measured on identical digital records.

With the exception of ML, all other magnitude standards are based on vertical-component recordings only. Therefore, we provide you in this first version of IS 3.4 only with single Z-component unfiltered STS-2 broadband velocity records, sampled at 20 Hz. These data will be complemented in 2012 by some horizontal component waveform files for ML determination. The records cover the whole wave train from the first P onset to the later part of the surface-wave group (respectively Sg-Lg group when ML and mb_Lg have to be determined).

The vertical component reference records have been made in a wide distance range from 2° to 167° from earthquakes with magnitudes between 4.7 to 8.5 (**Figure 1**). This allows you to check, whether differences between results of IASPEI standard procedures and your institutional procedures depend on distance and/or earthquake size.

Annex 1 lists all reference event records, sorted according to epicentral distance, giving besides the record file name also the source region, hypocentral coordinates, epicentral distance of the recording station and the magnitude calibration value Q according to this distance and the source depth for the considered event.

Calibration values Q are given in the reference event list of **Annex 1** only for those magnitudes which can be determined for the given source depth and record distance. According to the recommended standards, no Q values are given for mb, mB_BB and Ms_20 at record distances less than 20° (then only for Ms_BB), for mb and mB_BB at distances > 100° and for Ms_20 and Ms_BB for earthquakes deeper than 60 km.

Further, the list contains columns for entering your measurements of the amplitude and periods used for calculation of the magnitude as well as of the time at which amplitude and period have been measured.

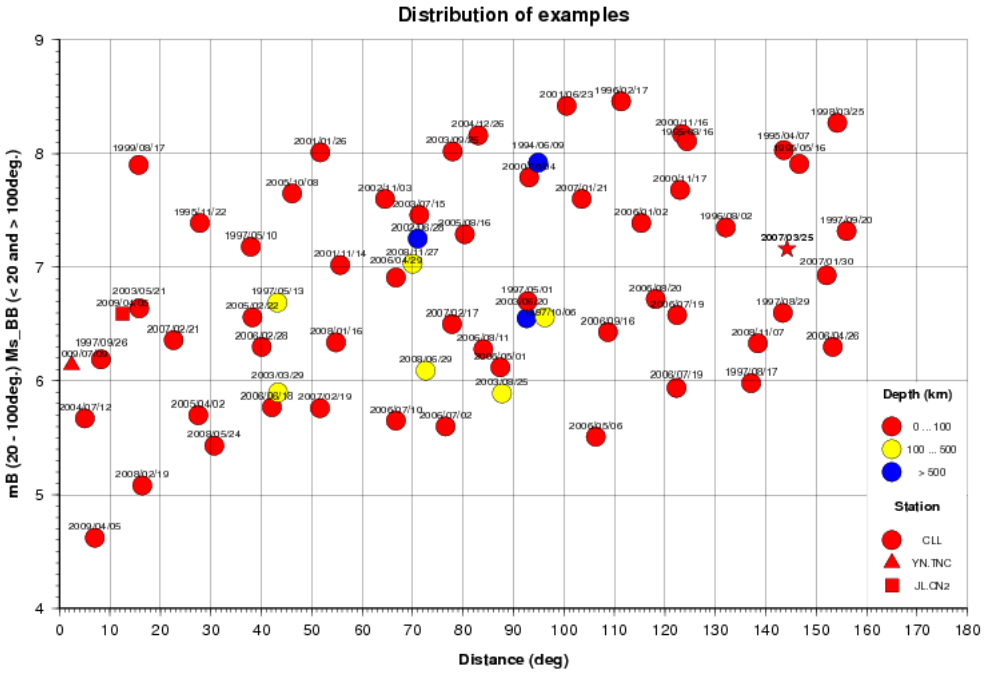

Figure 1 Distribution of mB_BB-Ms_BB magnitudes over the epicentral distance of event records in the IASPEI reference data set.

To carry out the amplitude, period and time measurement according to IASPEI standards you should use the **analysis program SEISAN**. It has implemented the exact standard filters required both for local ML magnitudes (Wood-Anderson response according to Uhrhammer and Collins, 1990), for mb and mb_Lg (WWSSN-SP response), and Ms_20 (WWSSN_LP response). For the poles and zeros of the respective simulation filters see Table 1 in **IS 3.3**.

Note that no pre-processing filters are applied to the velocity broadband records for measuring the maximum velocity amplitude and related period for mB_BB and Ms_BB.

Standard amplitude measurements for the different standard magnitudes have in future to be reported to the international data centres (ISC, NEIC and others) by using the recommended nomenclature for the so-called “amplitude-phase” names. They are:

IAML, IAmb, IAmb_Lg, IAMs_20, IVmB_BB, and IVMs_BB, respectively.

I stands for “international” or “IASPEI standard”, **A** for displacement amplitude in units of nm, **V** for velocity amplitude in nm/s, followed by the respective standard magnitude name.

3. How to measure in SEISAN the IASPEI standard amplitudes, periods, measurement time, how to calculate the related magnitudes and present these parameters in the annexed event list?

The SEISAN analysis program (Havskov and Ottemöller, 1999) is widely used on a global scale. Its latest update (Ottemöller, Voss and Havskov, 2011) can be downloaded, together

with the SEISAN manual, an introduction to exercises and to data from either the ftp site of the Institute of Geosciences of the University of Bergen, Norway (http://www.uib.no/rg/geodyn/artikler/2010/02/software) or directly via hyperlink **seisan** from the summary list of *Download Programs & Files* (see **Overview** of contents on the NMSOP-2 front page). Additional information can also be found in Havskov and Ottemöller (2010), and Havskov et al. (2011).

Different from the IASPEI Standard Format (ISF), all magnitude names in SEISAN - and in most other analysis software - still comprise only two letters. Yet, with the exception of Mw and duration/coda magnitude Mc, SEISAN calculates only IASPEI standard magnitudes. Yet, the calculation of mb_Lg is not yet implemented although related amplitude measurements can be made. SEISAN mb is identical with the mb standard, provided that you measure the maximum amplitude in the whole P-wave group; the same applies to mB, which stands for standard mB_BB. Further, SEISAN Ms means Ms_20 and MS means Ms_BB.

The measured amplitudes will be stored in the SEISAN event analysis files according to the unique IASPEI standard amplitude-phase names (see above and Table 1 below).

For measuring amplitudes and periods proceed as follow:

1.) SEISAN needs subdirectories for all years and months for which reference events are available. These subdirectories are stored in directories REA (S files) and WAV (waveform data), which are in turn stored in the basic directory (in general TEST_). Type in the WOR (work) directory the command **makerea** and answer the questions. Answer GO AHEAD with Y (yes). New subdirectories are then created without changing already existing subdirectories.

2.) Load the magnitude reference event files into SEISAN with the commands **mulplt,** and **Regis**. Then you will be asked whether the event was local, regional or distant. You answer accordingly with either L, R or D and give your Operator Code (up to 4 letters).
The required vertical component broadband waveform files (and additional horizontal component waveform file for ML determination; to be specified in the later update of IS 3.4) can be downloaded via hyperlink from the folder **reference_events** in the list of *Download Programs & Files* (see **Overview** on the NMSOP-2 front page). Therein you find the following tar-subfolders:

ref_evt_00_05.tar.gz contains the waveform data files for the years 2000-2005;
ref_evt_06_09.tar.gz those for 2006-2009 and
ref_evt_94_99.tar.gz those for 1994-1999.

The reference events were recorded at station CLL in Germany. Note that two different digitizers were used, with the change occurring on 2 February 2007. The required response data files for SEISAN you find also in the folder **reference_events**:

CLL_BH_Z.1993-04-13-000_SEI and
CLL_BH_Z.2007-02-07-000_SEI, respectively.

These files have to be loaded into the CAL directory.

3.) After this is done, load a specific event record file with **eev** yyyymmddhh. SEISAN then creates a line with running number, day, month, year, beginning of the time

window of the event record file and a question mark. After **?** you may write the following **commands**:

- **po** for plot the seismogram (without further questions);
- **e** for read/edit the s file;
- **update** for saving the s file;
- **q** for finishing the eev.

In earlier versions SEISAN writes after the **po** command "aux station code not empty, use a station code ?". Answer with any letter, but not with blank. In the new SEISAN version you can type ENTER. Then the requested complete seismogram will appear. Click on Menu and then - on the appearing command line - the "boxes" (buttons) for either WA (for Wood Anderson), mb, mB, Ms, or MS for which you wish to measure the amplitudes, periods and the amplitude-phase times. For ML, mb or Ms determination the respectively filtered record will then appear. For mB or MS you work on the instrument corrected unfiltered velocity broadband record.

4.) First choose the time resolution of the record so that the whole event record is present on the screen, including both the earlier body waves and the later surface waves with their usually (in the case of crustal earthquakes) much larger amplitudes and the longer and dispersive periods.

5.) For measuring mb or mB, increase the time resolutions by setting markers to cut the whole P-wave group out of the record. P usually has its largest amplitude between the first onsets of P and PP within the first minute (maybe including depth phases pP and/or sP). However, in the case of very great earthquakes (Mw > 8) the rupture duration may last even for several (up to about 10) minutes and you may find the P-wave maximum only more than one min. after the first P-wave onset. In the case of ML and mb_Lg measurement (which will be added in a later version of this exercise) increase the time resolution by cutting out the Sg-Lg group.

6.) Mark with the cursor the highest peak and deepest adjacent trough position and press at each marker position the letter **a**. Then the program will automatically measure the respective displacement or velocity amplitude, as well as the period and measurement time and write these parameter values into the **s**(single)-**file**. As measurement time the program takes the position of a vertical marker line which appears at the picked deepest trough position. This differs in time by about ± a quarter of a period from the amplitude-phase arrival-times according to the IASPEI standard, which is measured as the time of the zero-crossing between the peak and adjacent-trough from which the amplitudes are measured. But this is close enough.

7.) This interactive measurement procedure is preferred for our exercise and reference event task. It will train both your own assessment of the different record appearance as well as of the specifics of the SEISAN program in relation to the recommended IASPEI standards for magnitude measurements. However, SEISAN allows also to measure automatically Amax (or Vmax) and T within the whole time window visible on the screen when you set the cursor somewhere near to the maximum of the whole local event train or of the teleseismic P-wave time train and press the capital letter **A**. This works fine, however, only in the case of good signal-to-noise ratio.

8.) For Ms (Ms_20) and MS (Ms_BB) proceed in the same way after selecting the Rayleigh (LR) surface-wave part of the record and then, with a higher time resolution, the time window around the LR maximum.

In Table 1 we show an example of the S file (with the original name 14-0926-00D.S200111) into which SEISAN has written the results of the amplitude (A) and period (T) measurements for the event 2001 1114 926 0.0D. Note that SEISAN stores the measured amplitudes with the correct IASPEI standard amplitude nomenclature in accordance with the IASPEI Standard Format (ISF), which is used at the international seismological data centers such as the ISC and NEIC. This amplitude nomenclature allows to associate the measured amplitudes unambiguously with the respective standard magnitudes. Therefore, standard amplitude measurements have in future to be reported to the international data centers in this format.

Table 2 will be added later, giving a similar data example for IAML, IAmb_Lg, and IVMs_BB (measured down to epicentral distance of 2°).

Table 1 Plot of the amplitude-period data measured with SEISAN for 4 different telesesimic IASPEI standard magnitudes from one reference event record.

```
2001 1114  926  0.0 D                          TES                              1
ACTION:UP  11-10-20 20:49 OP:sw   STATUS:            ID:20011114092600    I
011114_0926.bhz                                                               6
STAT  SP IPHASW   D HRMM  SECON CODA AMPLIT PERI AZIMU VELO AIN AR TRES W DIS CAZ7
CLL   BZ IP         935 46.37
CLL   BZ IVmB_BB    936  5.04      9581.4 4.69
CLL   BZ IAmb       937 24.18       736.8 1.42
CLL   BZ IVMs_BB   10 1 40.06      25.2e4 18.1
CLL   BZ IAMs_20   10 1 45.48      70.7e4 18.6
```

9.) Insert for the analyzed events the measured displacement amplitudes (and periods, were required) as well as the values in **Annex 1** for QP and QL into the following formulas:

$$mb = \log_{10}(A/T) + QP - 3.0, \text{ respectively}$$

$$Ms\_20 = \log_{10}(A/T) + QL - 3.0,$$

and the related measured velocity amplitudes into the formulas:

$$mB\_BB = \log_{10}(V_{max}/2\pi) + QP - 3.0 \text{ , respectively}$$

$$Ms\_BB = \log_{10}(V_{max}/2\pi) + QL - 3.0$$

and calculate the respective magnitudes with a spread sheet or pocket calculator. The -3.0 is required, since SEISAN and most other currently used analysis programs measure amplitudes in nm, whereas the classical calibration values and formulas for body and surface-waves were based on amplitude measurements in μm.

10.) Finally, insert the measured amplitudes, periods, measurement times and the calculated magnitudes into the respective empty (hyphen-less) column-lines of the reference event list (**Annex 1**). **txt, xls** and **doc** file versions of the tables can be

downloaded via the folder **reference_events** from the listing of *Dowload Programs & Files* (see **Overview** on the NMSOP-2 front page)

For clarification: When you pick the onset times on records of several seismic stations, either local, regional or globally distributed ones, and locate first the seismic event yourself with SEISAN then the respective source parameters and epicentral distances are automatically calculated and stored in the respective SEISAN event file, thus enabling direct calculation of the magnitudes from the measured amplitudes and periods..

In our case, however, we have provided you only with one single component record. From this SEISAN can not calculate the source parameters and required Q values, unless you type yourself the event coordinates and station distance into the respective SEISAN event file. This, however, might be a potential source for typos and thus wrong results. Therefore, we request you to calculate for this comparative exercise the magnitudes yourself.

This detour, however, you will not encounter in the routine use of SEISAN for event location and magnitude determination using local, regional or global network records.

4. How to measure and report your institutional magnitudes?

If you use at your station/network either an interactive or an automatic program for seismogram analysis and parameter determination please let us know the name and version (year) of the program.

If you determine at your station/network centre magnitudes with an interactive analysis program then please load the reference event files into your program, and the 4 required response parameters for the events files. Then proceed by measuring the amplitude and period as you usually do, calculate the related body-wave and/or surface-wave magnitude according to your respective formulas and report it/them to us in the last but one column of the list in **Annex 3**.

If you avail only of a fully automatic program for magnitude determination then you should check whether you can load the reference event files, together with the response parameters and pre-determined epicentral distance and source depth data into the program and get it run off-line for determining the magnitude value(s) according to the program´s procedure. Report to us then these values with your common magnitude symbols in the last but one column (second from the right).

If your center operates a hybrid automatic program which also allows working in an interactive mode for a more detailed expert-controlled final data analysis (like e.g. SeisComP) then load the reference event waveforms and the 4 required response parameters for the events files into the program and use the interactive program mode for measuring amplitudes and periods and determine the magnitudes according to your common station/agency procedure of data analysis. Report these results in the last but one column.

If your agency had determined for any of the reference events already earlier magnitudes - interactively or automatically - using your own station or network data and procedures, then please report these values and the magnitude type to us in the last column. Indicate which parameter data were determined interactively (int) or automatically (aut). Data provided in the last column will permit us to assess how the magnitudes based on your own data relate to

both the NEIC magnitudes and the single station standard reference magnitudes determined by Dr. S. Wendt for CLL station.

5. To whom you may address related questions and submit your station/agency analysis results and questionnaire answers?

In the case of any questions related to the SEISAN analysis software, the use of the reference data set, results or encountered problems you may address them to

Dr. Siegfried Wendt at the Observatory Collm, University of Leipzig
E-mail: obssw@hpwork30.collm.uni-leipzig.de or wendt@rz.uni-leipzig.de.

Your analysis results (filled-in list in **Annex 1**) and answers to the requested documentation of your station/agency magnitude procedures (**Annex 2**) should be sent to both Dr. Wendt and Prof. Dr. Peter Bormann, E-mail: pb65@gmx.net.

We will analyze your response, feedback with you and pass the final outcome for further consideration to the IASPEI WG on Magnitude measurement, to the ISC and the NEIC. Good feedback and interesting results may justify to envisage a joint journal publication. Thanks in advance for your valuable co-operation.

Acknowlegment

We thank Dr. James W. Dewey, USGS, and Prof. Lars Ottemöller, University of Bergen, for reviewing this contribution and their valuable hints, which will also be considered in future upgrading of the IS.

Annex 1: Reference event list

Annex 2: Documentation of station/agency magnitude procedures

References

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Havskov, J., L. Ottemöller and P. Voss (2011). Introduction to SEISAN and computer exercises in processing earthquake data. Printed material by the University of Bergen, Norway.

IASPEI (2011) Summary of Magnitude Working Group recommendations on standard procedures for determining earthquake magnitudes from digital data. http://www.iaspei.org/commissions/CSOI/Summary_WG-Recommendations_20110909.pdf

Ottemöller L, P. Voss and J. Havskov (2011). SEISAN earthquake analysis software, User's manual. Printed material by the University of Bergen, Norway.

Annex 1

Reference event list

Below find a reference event list for the analysis of IASPEI standard magnitudes mb, mB_BB, Ms_20 and Ms_BB in comparison with your station/agency procedures and types of magnitude. Note that no measurements and data entries are required in column-lines with – . The hyphon indicates that at the given event distance and/or source depth the respective magnitude is not defined. No calibration values QP or QL are given in this case. If, however, your station/center has determined a magnitude for this event, because your station/network recorded this event at a suitable distance for magnitude determination, then please give the respective value and type of magnitude in the last column.

The reference list has been printed below as a table in a compressed form with rather small letters. Magnify it for reading, plotting, filling in your answers and sending them back to the authors. Alternatively you may use the respective ASCII files: **ref_evt_1.text** and **ref_evt_2.txt** or the Exel file **ref_evt.xls** in the directory **reference_events** (see in **Overview** on the NMSOP-2 front page for listing of *Download programs and files*).

x

ref_evt_2.txt

			Time	Per.	Ampl.	Magn.	Magn. (your	Magn. (own netw.
			hh:mm:ss.s	(s)	(nm,nm/s)	IASPEI	method)	or stat.)
2009/07/09 11:19:16.8	D= 2.4	mb	-	-	-	-		
25.636N 101.081E 10		mB_BB	-	-	-	-		
mb=5.5( ) Ms= ( ) Mw(GCM)=5.7 Me=		Ms_20	-	-	-	-		
YUNNAN, CHINA	QL=3.93	Ms_BB						
GSE2-File: 200907091119142.YN.TNC.GSE								
2004/07/12 13:04:07.2	D= 5.0	mb	-	-	-	-		
46.296N 13.641E 8		mB_BB	-	-	-	-		
mb=5.0(82) Ms=4.9(36) Mw(HRV)=5.2 Me=		Ms_20	-	-	-	-		
AUSTRIA	QL=4.46	Ms_BB						
GSE2-File: 040712_1304.bhz								
2009/04/05 20:20:53.0	D= 7.1	mb	-	-	-	-		
44.236N 11.999E 28		mB_BB	-	-	-	-		
mb=4.6(36) Ms= ( ) Mw(GCM)= Me=		Ms_20	-	-	-	-		
NORTHERN ITALY	QL=4.71	Ms_BB						
GSE2-File: 090405_2020.bhz								
1997/09/26 09:40:26.3	D= 8.2	mb	-	-	-	-		
43.084N 12.812E 10		mB_BB	-	-	-	-		
mb=5.7(57) Ms=6.0(50) Mw(HRV)=6.0 Me=6.1		Ms_20	-	-	-	-		
CENTRAL ITALY	QL=4.82	Ms_BB						
GSE2-File: 970926_0940.bhz								
			Time	Per.	Ampl.	Magn.	Magn. (your	Magn. (own netw.
			hh:mm:ss.s	(s)	(nm,nm/s)	IASPEI	method)	or stat.)
2009/04/05 09:36:26.2	D= 12.4	mb	-	-	-	-		
32.007N 131.417E 26		mB_BB	-	-	-	-		
mb=5.8(172) Ms=5.4(117) Mw(GCM)=5.8 Me=5.3		Ms_20	-	-	-	-		
KYUSHU, JAPAN	QL=5.12	Ms_BB						
GSE2-File: 200904050936204.JL.CN2								
1999/08/17 00:01:39.1	D= 15.7	mb	-	-	-	-		

```
40.748N  29.864E  17                    |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=6.3(148) Ms=7.8( 61) Mw(HRV)=7.6 Me=7.7|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
TURKEY                                  |QL=5.29|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 990817_0001.bhz              |       |     |          |      |         |      |       |
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2003/05/21 18:44:20.1                   |D= 15.8|mb   |   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
36.964N   3.634E  12                    |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=6.5( 96) Ms=6.9( 48) Mw(HRV)=6.8 Me=6.8|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
ALGERIA                                 |QL=5.29|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 030521_1844.bhz              |       |     |          |      |         |      |       |
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2008/02/19 23:15:40.0                   |D= 16.4|mb   |   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
36.190N  21.770E  22                    |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=4.9(121) Ms=4.7(  2) Mw(GCM)=5.3 Me=   |       |Ms_20|   -      |  -   |    -    |   -  |       |
                                        |       |.....|..........|......|.........|......|.......|
SOUTHERN GREECE                         |QL=5.32|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 080219_2315.bhz              |       |     |          |      |         |      |       |
========================================|=======|=====|==========|======|=========|======|=======|
                                        |       |     |          |      |         |      | Magn. |  Magn.
                                        |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                        |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2007/02/21 11:05:28.6                   |D= 22.6|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
38.318N  39.275E   6                    |QP=6.26|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=5.6(162) Ms=5.5(164) Mw(GCM)=5.7 Me=5.6|       |Ms_20|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
TURKEY                                  |QL=5.55|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 070221_1105.bhz              |       |     |          |      |         |      |       |
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2005/04/02 12:52:36.6                   |D= 27.5|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
78.607N   6.098E  10                    |QP=6.51|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=5.5(202) Ms=5.8(130) Mw(HRV)=6.1 Me=6.4|       |Ms_20|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
SVALBARD REGION                         |QL=5.69|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 050402_1252.bhz              |       |     |          |      |         |      |       |
----------------------------------------|-------|-----|----------|------|---------|------|-------|
1995/11/22 04:15:11.9                   |D= 27.8|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
28.826N  34.799E  10                    |QP=6.54|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=6.2(137) Ms=7.3( 49) Mw(HRV)=7.2 Me=7.3|       |Ms_20|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
EGYPT                                   |QL=5.70|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 951122_0415.bhz              |       |     |          |      |         |      |       |
========================================|=======|=====|==========|======|=========|======|=======|
                                        |       |     |          |      |         |      | Magn. |  Magn.
                                        |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                        |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2008/05/24 04:58:18.9                   |D= 30.7|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
42.386N  30.515W  10                    |QP=6.64|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=5.4(288) Ms=4.8(181) Mw(GCM)=5.5 Me=   |       |Ms_20|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
AZORES ISLANDS REGION                   |QL=5.77|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 080524_0458.bhz              |       |     |          |      |         |      |       |
----------------------------------------|-------|-----|----------|------|---------|------|-------|
1997/05/10 07:57:29.7                   |D= 37.9|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
33.825N  59.809E  10                    |QP=6.54|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=6.4(107) Ms=7.3( 62) Mw(HRV)=7.2 Me=7.7|       |Ms_20|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
IRAN                                    |QL=5.92|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 970510_0757.bhz              |       |     |          |      |         |      |       |
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2005/02/22 02:25:22.9                   |D= 38.2|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
30.754N  56.816E  14                    |QP=6.54|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
mb=6.0(220) Ms=6.5(123) Mw(HRV)=6.4 Me=6.2|       |Ms_20|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
IRAN                                    |QL=5.93|Ms_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
GSE2-File: 050222_0225.bhz              |       |     |          |      |         |      |       |
========================================|=======|=====|==========|======|=========|======|=======|
                                        |       |     |          |      |         |      | Magn. |  Magn.
                                        |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                        |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
----------------------------------------|-------|-----|----------|------|---------|------|-------|
2006/02/28 07:31: 2.7                   |D= 40.1|mb   |          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
28.120N  56.865E  18                    |QP=6.47|mB_BB|          |      |         |      |       |
                                        |       |.....|..........|......|.........|......|.......|
```

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mb=5.8(148) Ms=6.2(143) Mw(HRV)=6.0 Me=6.0|       |Ms_20|          |      |         |      |       |
                                          .....................................................
SOUTHERN IRAN                             |QL=5.96|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 060228_0731.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2006/06/18 18:28: 2.1                     |D= 42.1|mb   |          |      |         |      |       |
                                          .....................................................
33.028N  39.702W   9                      |QP=6.50|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.5(229) Ms=5.8(129) Mw(HRV)=6.0 Me=5.7|       |Ms_20|          |      |         |      |       |
                                          .....................................................
NORTH ATLANTIC RIDGE                      |QL=6.00|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 060618_1828.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
1997/05/13 14:13:45.7                     |D= 43.2|mb   |          |      |         |      |       |
                                          .....................................................
36.411N  70.945E 196                      |QP=6.31|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.1(184) Ms=         Mw(HRV)=6.4 Me=6.3|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                          .....................................................
HINDU KUSH REGION                         |       |Ms_BB|   -      |  -   |    -    |   -  |       |
                                          .....................................................
GSE2-File: 970513_1413.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2003/03/29 11:46:48.9                     |D= 43.3|mb   |          |      |         |      |       |
                                          .....................................................
35.976N  70.585E 114                      |QP=6.54|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.9(168) Ms=         Mw(HRV)=5.8 Me=5.3|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                          .....................................................
HINDU KUSH REGION, AFGHANISTAN            |       |Ms_BB|   -      |  -   |    -    |   -  |       |
                                          .....................................................
GSE2-File: 030329_1146.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2005/10/08 03:50:40.8                     |D= 46.1|mb   |          |      |         |      |       |
                                          .....................................................
34.539N  73.588E  26                      |QP=6.81|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.9(225) Ms=7.7(124) Mw(HRV)=7.6 Me=7.4|       |Ms_20|          |      |         |      |       |
                                          .....................................................
PAKISTAN                                  |QL=6.06|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 051008_0350.bhz                |       |     |          |      |         |      |       |
=================================================================================================
                                          |       |     |          |      |         |      | Magn. |  Magn.
                                          |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                          |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
-------------------------------------------------------------------------------------------------
2007/02/19 02:33:43.0                     |D= 51.6|mb   |          |      |         |      |       |
                                          .....................................................
 1.750N  30.758E  19                      |QP=6.70|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.6(142) Ms=5.4(173) Mw(GCM)=5.6 Me=5.6|       |Ms_20|          |      |         |      |       |
                                          .....................................................
UGANDA                                    |QL=6.14|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 070219_0233.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2001/01/26 03:16:40.5                     |D= 51.7|mb   |          |      |         |      |       |
                                          .....................................................
23.419N  70.232E  16                      |QP=6.70|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.9(152) Ms=8.0( 94) Mw(HRV)=7.7 Me=7.6|       |Ms_20|          |      |         |      |       |
                                          .....................................................
INDIA                                     |QL=6.14|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 010126_0316.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2008/01/16 11:54:44.1                     |D= 54.8|mb   |          |      |         |      |       |
                                          .....................................................
32.331N  85.158E   9                      |QP=6.80|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.0(215) Ms=5.8(199) Mw(GCM)=5.9 Me=5.8|       |Ms_20|          |      |         |      |       |
                                          .....................................................
XIZANG                                    |QL=6.19|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 080116_1154.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2001/11/14 09:26:10.0                     |D= 55.6|mb   |          |      |         |      |       |
                                          .....................................................
35.946N  90.541E  10                      |QP=6.80|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.1(176) Ms=8.0(101) Mw(HRV)=7.8 Me=8.1|       |Ms_20|          |      |         |      |       |
                                          .....................................................
TSINGHAI PROVINCE, CHINA                  |QL=6.20|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 011114_0926.bhz                |       |     |          |      |         |      |       |
=================================================================================================
                                          |       |     |          |      |         |      | Magn. |  Magn.
                                          |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                          |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
-------------------------------------------------------------------------------------------------
2002/11/03 22:12:41.0                     |D= 64.5|mb   |          |      |         |      |       |
                                          .....................................................
63.517N 147.444W   5                      |QP=6.98|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=7.0(161) Ms=8.5( 65) Mw(HRV)=7.9 Me=8.1|       |Ms_20|          |      |         |      |       |
                                          .....................................................
CENTRAL ALASKA                            |QL=6.30|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 021103_2212.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
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2006/04/29 16:58: 6.3                    |D= 66.7|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
60.491N 167.516E  11                     |QP=6.96|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=6.4(242) Ms=6.6( 14) Mw(HRV)=6.6 Me=6.5|       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
EASTERN SIBERIA                          |QL=6.33|Ms_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
GSE2-File: 060429_1658.bhz               |       |     |          |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2006/07/10 07:21:37.9                    |D= 66.7|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
11.627S  13.432W  10                     |QP=6.96|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=5.3(103) Ms=5.3(146) Mw(HRV)=5.5 Me=  |       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
ASCENSION ISLAND REGION                  |QL=6.33|Ms_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
GSE2-File: 060710_0721.bhz  P-SNR only 1.8|       |     |          |      |         |      |       |
=====================================================================================================
                                         |       |     |          |      |         |      | Magn. |  Magn.
                                         |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                         |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
-----------------------------------------------------------------------------------------------------
2008/11/24 09:02:58.8                    |D= 70.0|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
54.203N 154.322E 492                     |QP=6.39|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=6.5(267) Ms=         Mw(GCM)=7.3 Me=7.0|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                         |       |     |          |      |         |      |       |
SEA OF OKHOTSK                           |       |Ms_BB|   -      |  -   |    -    |   -  |       |
                                         |       |     |          |      |         |      |       |
GSE2-File: 081124_0902.bhz               |       |     |          |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2002/06/28 17:19:30.3                    |D= 71.0|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
43.752N 130.666E 566                     |QP=6.37|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=6.7(205) Ms=         Mw(HRV)=7.3 Me=7.1|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                         |       |     |          |      |         |      |       |
E. RUSSIA-N.E. CHINA BORDER REG.         |       |Ms_BB|   -      |  -   |    -    |   -  |       |
                                         |       |     |          |      |         |      |       |
GSE2-File: 020628_1719.bhz               |       |     |          |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2003/07/15 20:27:50.5                    |D= 71.3|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
 2.598S  68.382E  10                     |QP=6.89|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=6.1(141) Ms=7.6( 69) Mw(HRV)=7.6 Me=7.6|       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
CARLSBERG RIDGE                          |QL=6.38|Ms_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
GSE2-Files: 030715_2027.bhz + lhz and  030715_2038.bhz  |          |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2008/06/29 20:53:04.9                    |D= 72.6|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
45.156N 137.446E 326                     |QP=6.50|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=5.6(293) Ms=         Mw(GCM)=6.0 Me=6.0|       |Ms_20|   -      |  -   |    -    |   -  |       |
                                         |       |     |          |      |         |      |       |
NEAR SOUTHEAST COAST OF RUSSIA           |       |Ms_BB|   -      |  -   |    -    |   -  |       |
                                         |       |     |          |      |         |      |       |
GSE2-File: 080629_2053.bhz               |       |     |          |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2006/07/02 03:53:56.5                    |D= 76.5|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
51.713N 176.930E   9                     |QP=6.87|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=5.5(218) Ms=5.3(151) Mw(HRV)=5.7 Me=  |       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
RAT ISLANDS, ALEUTIAN ISLANDS            |QL=6.43|Ms_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
GSE2-Files: 060702_0353.bhz + lhz and  060702_0405.bhz  |P-SNR = 2.3      |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2007/02/17 00:02:56.8                    |D= 77.8|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
41.794N 143.553E  31                     |QP=6.90|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=5.9(209) Ms=5.9(179) Mw(GCM)=6.0 Me=5.8|       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
HOKKAIDO, JAPAN REGION                   |QL=6.44|Ms_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
GSE2-Files: 070217_0002.bhz + lhz and  070217_0014.bhz  |          |      |         |      |       |
-----------------------------------------------------------------------------------------------------
2003/09/25 19:50: 6.4                    |D= 77.9|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
41.815N 143.910E  27                     |QP=6.80|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=6.9(220) Ms=8.1(114) Mw(HRV)=8.3 Me=8.0|       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
HOKKAIDO, JAPAN REGION                   |QL=6.44|Ms_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
GSE2-Files: 030925_1950.bhz + lhz and  030925_2001.bhz  |          |      |         |      |       |
=====================================================================================================
                                         |       |     |          |      |         |      | Magn. |  Magn.
                                         |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                         |       |     |hh:mm:ss.s| (s)  |(nm.nm/s)|IASPEI|method)| or stat.)
-----------------------------------------------------------------------------------------------------
2005/08/16 02:46:28.4                    |D= 80.3|mb   |          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
38.276N 142.039E  36                     |QP=6.76|mB_BB|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
mb=6.5(220) Ms=6.8(136) Mw(HRV)=7.2 Me=6.7|       |Ms_20|          |      |         |      |       |
                                         |       |     |          |      |         |      |       |
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NEAR EAST COAST OF HONSHU, JAPAN          |QL=6.46|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-Files: 050816_0246.bhz + lhz and  050816_0257.bhz  |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2004/12/26 00:58:53.2                     |D= 83.0|mb   |          |      |         |      |       |
                                          .....................................................
 3.295N  95.982E  30                      |QP=6.88|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=7.0(134) Ms=8.8(122) Mw(HRV)=9.0 Me=8.5|       |Ms_20|          |      |         |      |       |
                                          .....................................................
OFF W. COAST OF NORTHERN SUMATERA         |QL=6.49|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-Files: 041226_0058.bhz + lhz and  041226_0110.bhz  |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2006/08/11 20:54:14.4                     |D= 84.0|mb   |          |      |         |      |       |
                                          .....................................................
 2.403N  96.348E  22                      |QP=7.00|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.8(111) Ms=6.2(167) Mw(HRV)=6.2 Me=5.9|       |Ms_20|          |      |         |      |       |
                                          .....................................................
NORTHERN SUMATERA                         |QL=6.49|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-Files: 060811_2054.bhz + lhz and  060811_2105.bhz  |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2006/05/01 07:47:59.9                     |D= 87.4|mb   |          |      |         |      |       |
                                          .....................................................
 8.165N  82.882W  13                      |QP=7.04|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.1(121) Ms=5.6(127) Mw(HRV)=5.9 Me=5.1|       |Ms_20|          |      |         |      |       |
                                          .....................................................
PANAMA-COSTA RICA BORDER REGION           |QL=6.52|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 060501_0747.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2003/08/25 06:28:35.2                     |D= 87.7|mb   |          |      |         |      |       |
                                          .....................................................
14.034N  91.069W 100                      |QP=6.80|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.4(169) Ms=         Mw(HRV)=6.0 Me=5.6|       |Ms_20|   -      |  -   |    -    |  -   |       |
                                          .....................................................
GUATEMALA                                 |       |Ms_BB|   -      |  -   |    -    |  -   |       |
                                          .....................................................
GSE2-File: 030825_0628.bhz                |       |     |          |      |         |      |       |
=================================================================================================
                                          |       |     |          |      |         | Magn. |  Magn.
                                          |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                          |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
-------------------------------------------------------------------------------------------------
2003/06/20 06:19:38.9                     |D= 92.6|mb   |          |      |         |      |       |
                                          .....................................................
 7.606S  71.722W 558                      |QP=6.85|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.4(204) Ms=         Mw(HRV)=7.1 Me=6.5|       |Ms_20|   -      |  -   |    -    |  -   |       |
                                          .....................................................
WESTERN BRAZIL                            |       |Ms_BB|   -      |  -   |    -    |  -   |       |
                                          .....................................................
GSE2-File: 030620_0619.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
1997/05/01 11:37:36.2                     |D= 92.8|mb   |          |      |         |      |       |
                                          .....................................................
18.993N 107.350W  33                      |QP=7.20|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.1(104) Ms=6.8( 48) Mw(HRV)=6.9 Me=7.3|       |Ms_20|          |      |         |      |       |
                                          .....................................................
OFF COAST OF JALISCO, MEXICO              |QL=6.57|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-File: 970501_1137.bhz + lhz and  970501_1150.bhz   |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
2000/06/04 16:28:26.2                     |D= 93.1|mb   |          |      |         |      |       |
                                          .....................................................
 4.721S 102.087E  33                      |QP=7.20|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=6.8( 95) Ms=8.0(106) Mw(HRV)=7.9 Me=8.3|       |Ms_20|          |      |         |      |       |
                                          .....................................................
SOUTHERN SUMATERA                         |QL=6.57|Ms_BB|          |      |         |      |       |
                                          .....................................................
GSE2-Files: 000604_1628.bhz + lhz and  000604_1640.bhz  |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
1994/06/09 00:33:16.2                     |D= 94.9|mb   |          |      |         |      |       |
                                          .....................................................
13.841S  67.553W 631                      |QP=6.95|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=7.0( 76) Ms=         Mw(HRV)=8.2 Me=   |       |Ms_20|   -      |  -   |    -    |    - |       |
                                          .....................................................
NORTHERN BOLIVIA                          |       |Ms_BB|   -      |  -   |    -    |    - |       |
                                          .....................................................
GSE2-File: 940609_0033.bhz                |       |     |          |      |         |      |       |
-------------------------------------------------------------------------------------------------
1997/10/06 12:30: 5.8                     |D= 96.2|mb   |          |      |         |      |       |
                                          .....................................................
 9.790N 125.779E 105                      |QP=7.29|mB_BB|          |      |         |      |       |
                                          .....................................................
mb=5.9(102) Ms=         Mw(HRV)=6.4 Me=5.8|       |Ms_20|   -      |  -   |    -    |    - |       |
                                          .....................................................
MINDANAO, PHILIPPINE ISLANDS              |       |Ms_BB|   -      |  -   |    -    |    - |       |
                                          .....................................................
GSE2-Files: 971006_1230.bhz + lhz and  971006_1242.bhz  |          |      |         |      |       |
=================================================================================================
                                          |       |     |          |      |         | Magn. |  Magn.
                                          |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                          |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
-------------------------------------------------------------------------------------------------
2001/06/23 20:33:14.1                     |D=100.5|mb   |   -      |  -   |    -    |   -  |       |
                                          .....................................................
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16.265S  73.641W  33                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=6.7(191) Ms=8.2(118) Mw(HRV)=8.4 Me=8.1|       |Ms_20|          |      |         |      |       |
                                          |.....................................................
NEAR COAST OF PERU                        |QL=6.62|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 010623_2033.bhz + lhz         |       |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2007/01/21 11:27:45.1                     |D=103.5|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
 1.065N 126.282E  22                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=6.7(134) Ms=7.3(172) Mw(GCM)=7.5 Me=7.5|       |Ms_20|          |      |         |      |       |
                                          |.....................................................
MOLUCCA PASSAGE                           |QL=6.64|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 070121_1127.bhz + lhz         |       |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2006/05/06 18:26:50.5                     |D=106.3|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
38.620S  78.570E  10                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=5.3( 31) Ms=5.3(  1) Mw(HRV)=5.9 Me=   |       |Ms_20|          |      |         |      |       |
                                          |.....................................................
MID-INDIAN RISE                           |QL=6.66|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 060506_1826.bhz + lhz   small SNR     |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2006/09/16 09:45:23.9                     |D=108.7|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
 3.080S 129.441E  17                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=5.9( 55) Ms=6.2(147) Mw(GCM)=6.3 Me=6.5|       |Ms_20|          |      |         |      |       |
                                          |.....................................................
CERAM                                     |QL=6.68|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 060916_0945.bhz + lhz         |       |     |          |      |         |      |       |
======================================================================================================
                                          |       |     |          |      |         |      | Magn. |  Magn.
                                          |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                          |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
------------------------------------------------------------------------------------------------------
1996/02/17 05:59:30.6                     |D=111.3|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
 0.891S 136.952E  33                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=6.5( 99) Ms=8.1( 66) Mw(HRV)=8.2 Me=7.7|       |Ms_20|          |      |         |      |       |
                                          |.....................................................
WEST IRIAN                                |QL=6.70|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 960217_0559.bhz + lhz         |       |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2006/01/02 06:10:49.8                     |D=115.3|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
60.957S  21.606W  13                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=6.4( 50) Ms=7.3(140) Mw(HRV)=7.4 Me=7.6|       |Ms_20|          |      |         |      |       |
                                          |.....................................................
SOUTHWESTERN ATLANTIC OCEAN               |QL=6.72|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 060102_0610.bhz + lhz         |       |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2006/08/20 03:41:48.0                     |D=118.2|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
61.029S  34.371W  13                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=6.4( 38) Ms=6.8(144) Mw(HRV)=7.0 Me=7.6|       |Ms_20|          |      |         |      |       |
                                          |.....................................................
SCOTIA SEA                                |QL=6.74|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 060820_0341.bhz + lhz         |       |     |          |      |         |      |       |
======================================================================================================
                                          |       |     |          |      |         |      | Magn. |  Magn.
                                          |       |     | Time     | Per. |  Ampl.  | Magn.|(your  |(own netw.
                                          |       |     |hh:mm:ss.s| (s)  |(nm,nm/s)|IASPEI|method)| or stat.)
------------------------------------------------------------------------------------------------------
2006/07/19 18:08:57.9                     |D=122.3|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
 5.328S 150.691E  10                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=5.7( 61) Ms=5.7(115) Mw(HRV)=5.9 Me=   |       |Ms_20|          |      |         |      |       |
                                          |.....................................................
NEW BRITAIN REGION                        |QL=6.76|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 060719_1808.bhz + lhz         |       |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2006/07/19 11:48:58.3                     |D=122.4|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
 5.474S 150.684E  28                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=5.6( 68) Ms=6.4(156) Mw(HRV)=6.4 Me=   |       |Ms_20|          |      |         |      |       |
                                          |.....................................................
NEW BRITAIN REGION                        |QL=6.77|Ms_BB|          |      |         |      |       |
                                          |.....................................................
GSE2-Files: 060719_1148.bhz + lhz         |       |     |          |      |         |      |       |
------------------------------------------------------------------------------------------------------
2000/11/17 21:01:56.5                     |D=123.0|mb   |   -      |  -   |    -    |   -  |       |
                                          |.....................................................
 5.496S 151.781E  33                      |       |mB_BB|   -      |  -   |    -    |   -  |       |
                                          |.....................................................
mb=6.2( 77) Ms=8.0(78) Mw(HRV)=7.8 Me=6.8 |       |Ms_20|          |      |         |      |       |
                                          |.....................................................
NEW BRITAIN REGION                        |QL=6.77|Ms_BB|          |      |         |      |       |
                                          |.....................................................
```

GSE2-Files: 001117_2101.bhz + lhz								
2000/11/16 07:42:16.9	D=123.4	mb	-	-	-	-		
5.233S 153.102E 30		mB_BB	-	-	-	-		
mb=6.2(40) Ms=7.8(83) Mw(HRV)=7.8 Me=7.2		Ms_20						
NEW IRELAND REGION	QL=6.77	Ms_BB						
GSE2-Files: 001116_0742.bhz + lhz								
1995/08/16 10:27:28.6	D=124.4	mb	-	-	-	-		
5.799S 154.178E 30		mB_BB	-	-	-	-		
mb=6.5(106) Ms=7.8(71) Mw(HRV)=7.7 Me=7.3		Ms_20						
SOLOMON ISLANDS	QL=6.78	Ms_BB						
GSE2-Files: 950816_1027.bhz + lhz								

			Time	Per.	Ampl.	Magn.	Magn. (your	Magn. (own netw.
			hh:mm:ss.s	(s)	(nm,nm/s)	IASPEI	method)	or stat.)
1996/08/02 12:55:29.3	D=132.1	mb	-	-	-	-		
10.769S 161.445E 33		mB_BB	-	-	-	-		
mb=6.2(68) Ms=7.1(49) Mw(HRV)=6.9 Me=6.8		Ms_20						
SOLOMON ISLANDS	QL=6.82	Ms_BB						
GSE2-Files: 960802_1255.bhz + lhz								
1997/08/17 20:11:10.8	D=137.1	mb	-	-	-	-		
13.592S 167.391E 26		mB_BB	-	-	-	-		
mb=5.4(47) Ms=6.1(57) Mw(HRV)=6.0 Me=		Ms_20						
VANUATU ISLANDS	QL=6.85	Ms_BB						
GSE2-Files: 970817_2011.bhz + lhz								
2008/11/07 07:19:35.7	D=138.4	mb	-	-	-	-		
14.829S 168.032E 13		mB_BB	-	-	-	-		
mb=6.0(192) Ms=6.3(184) Mw(GCM)=6.4 Me=6.3		Ms_20						
VANUATU	QL=6.85	Ms_BB						
GSE2-Files: 081107_0719.bhz + lhz								

			Time	Per.	Ampl.	Magn.	Magn. (your	Magn. (own netw.
			hh:mm:ss.s	(s)	(nm,nm/s)	IASPEI	method)	or stat.)
1997/08/29 06:54: 0.2	D=143.4	mb	-	-	-	-		
15.235S 175.576W 33		mB_BB	-	-	-	-		
mb=5.6(60) Ms=6.4(54) Mw(HRV)=6.4 Me=6.7		Ms_20						
TONGA ISLANDS	QL=6.88	Ms_BB						
GSE2-Files: 970829_0654.bhz + lhz								
1995/04/07 22:06:56.9	D=143.6	mb	-	-	-	-		
15.199S 173.529W 21		mB_BB	-	-	-	-		
mb=6.8(90) Ms=8.0(46) Mw(HRV)=7.4 Me=		Ms_20						
TONGA ISLANDS	QL=6.88	Ms_BB						
GSE2-File: 950407_2206.lhz								
2007/03/25 00:40: 1.6	D=144.2	mb	-	-	-	-		
20.617S 169.357E 34		mB_BB	-	-	-	-		
mb=6.5(77) Ms=7.0(151) Mw(GCM)=7.1 Me=6.8		Ms_20						
VANUATU ISLANDS	QL=6.88	Ms_BB						
GSE2-Files: 070325_0040.bhz + lhz superposed								
2007/03/25 01:08:19.1	D=144.3	mb	-	-	-	-		
20.754S 169.354E 35		mB_BB	-	-	-	-		
mb=5.9(50) Ms=7.1(6) Mw(GCM)=6.9 Me=		Ms_20						
VANUATU ISLANDS	QL=6.88	Ms_BB						
GSE2-Files: 070325_0040.bhz + lhz superposed								
1995/05/16 20:12:44.2	D=146.6	mb	-	-	-	-		
23.008S 169.900E 20		mB_BB	-	-	-	-		

mb=6.9(93) Ms=7.7(56) Mw(HRV)=7.7 Me=		Ms_20						
LOYALTY ISLANDS REGION	QL=6.90	Ms_BB						
GSE2-Files: 950516_2012.bhz + lhz								
			Time hh:mm:ss.s	Per. (s)	Ampl. (nm,nm/s)	Magn. IASPEI	Magn. (your method)	Magn. (own netw. or stat.)
2007/01/30 04:54:50.6	D=152.1	mb	-	-	-	-		
54.740S 146.298E 11		mB_BB	-	-	-	-		
mb=6.2(26) Ms=6.9(76) Mw(GCM)=6.9 Me=7.5		Ms_20						
WEST OF MACQUARIE ISLAND	QL=6.92	Ms_BB						
GSE2-Files: 070130_0454.bhz + lhz								
2006/04/26 01:46: 3.9	D=153.3	mb	-	-	-	-		
57.482S 147.568E 10		mB_BB	-	-	-	-		
mb=5.6(27) Ms=5.9(138) Mw(HRV)=6.1 Me=		Ms_20						
WEST OF MACQUARIE ISLAND	QL=6.93	Ms_BB						
GSE2-Files: 060426_0146.bhz + lhz small SNR								
1998/03/25 03:12:25.1	D=154.2	mb	-	-	-	-		
62.877S 149.527E 10		mB_BB	-	-	-	-		
mb=6.6(57) Ms=8.0(63) Mw(HRV)=8.1 Me=8.8		Ms_20						
BALLENY ISLANDS REGION	QL=6.93	Ms_BB						
GSE2-Files: 980325_0312.bhz + lhz								
1997/09/20 16:11:32.2	D=156.0	mb	-	-	-	-		
28.683S 177.624W 30		mB_BB	-	-	-	-		
mb=6.1(64) Ms=7.0(46) Mw(HRV)=7.0 Me=		Ms_20						
KERMADEC ISLANDS REGION	QL=6.94	Ms_BB						
GSE2-Files: 970920_1611.bhz + lhz								

Please fill-in your analysis results in the above listing and send them to both

Dr. Wendt, E-mail: obssw@hpwork30.collm.uni-leipzig.de or wendt@rz.uni-leipzig.de.

and Prof. Dr. Peter Bormann, E-mail: pb65@gmx.net.

Thanks for your important co-operation.

Annex 2

DOCUMENTATION OF STATION/AGENCY MAGNITUDE PROCEDURES

(Copied from the SUMMARY OF IASPEI MAGNITUDE WORKING GROUP RECOMMENDATIONS ON DETERMINING EARTHQUAKE MAGNITUDES FROM DIGITAL DATA, updated version 2011; see http://www.iaspei.org/commissions/CSOI/Summary_WG-Recommendations_20110909.pdf)

Documentation of procedures for amplitude/period based magnitudes by seismographic stations/analysis centers should generally address the following points:

1. Phase-type from which the amplitude measurement is made.

2. Units of the reported amplitude. Specify if amplitudes are reported in units of trace-amplitude motion instead of ground motion.

3. Time-window in which the amplitude measurement is made.

   a. For example, a flexible time-interval between the P onset and the PP onset or a fixed time window after the first P onset (e.g. 5 s, 10s or other).

   b. For example, the time-interval spanned by waves having group-velocities between 3.2 and 3.8 km/s.

4. Amplitude-response, filter characteristics, or transfer-function of the seismograph or simulated seismograph through which the amplitude measurement is made.

5. Orientation of seismograph (horizontal or vertical) from which the measurement is made.

6. Details of measuring amplitude

   a. For example, does the amplitude correspond to 0.5*(peak-to-trough amplitude), where “peak-to-trough amplitude” corresponds to difference between a maximum positive excursion and a maximum negative excursion of the trace, or is the amplitude instead measured as the maximum absolute excursion from the “zero” position of the seismograph trace?

   b. For example, if the amplitude corresponds to 0.5*(peak-to-trough amplitude), are the “peak” and “trough” respectively the absolute maximum and absolute minimum values of the entire wave-group, or are they the adjacent peak and trough corresponding to the maximum trace excursion that is associated with a single zero-crossing?

   c. For example, are displacement amplitude(A) and period(T) measured at the time of maximum A or at the time of the maximum of the quotient (A/T)?

   d. For example, any way in which station/agency procedure differs from the corresponding IASPEI standard procedure.

7. Details of measuring period, for example, is it the time between the neighboring peaks, respectively troughs or twice the time span measured between the largest peak and adjacent trough at which the double amplitude has been measured.

8. To what part of a phase the amplitude-measurement time refers. For example, is the amplitude-measurement time the time of the zero-crossing associated with a peak-to-adjacent trough measurement or is it the time of an absolute maximum or absolute minimum?

9. The equations that are used for calculating particular types of magnitudes

   a. Specify if distance is measured as epicentral distance or hypocentral distance.

   b Specify the distance range for which the equation is applied.

   c. Specify restrictions on hypocentral focal-depth, if any.

10. Other restrictions on the calculation of the magnitude

    a. For example, must signal-amplitude satisfy a signal-to-noise ratio criterion?

    b. For example, is the magnitude measured only for earthquakes of a certain size, as defined by an independent measure of earthquake size?

11. Any way in which the magnitude procedure departs from an IASPEI standard procedure if the procedure is intended to produce the IASPEI standard magnitude.

    a. For example, if measurements are made over a somewhat different distance or depth range than specified in the IASPEI procedure.

    b. For example, if non-standard filtering is applied in some situations in which the non-standard filtering **is not expected to affect the magnitude** (e.g., when measuring magnitudes for very small events for which standard-filtering would produce records of too small signal-to-noise ratio). Please specify.

12. How data are averaged for a network average.

    a. For example, is the network average a simple arithmetic mean, a trimmed mean, the median value, or some other average?

    b. If, as for example might be the case for ML, data from each of two horizontal components at a single station are used, are data from each component treated as a separate observation in the network average, or are the two components first averaged into a station magnitude, which is then treated as a single observation in the network average?

For some magnitude types (e.g., coda-based magnitudes) the procedures to be documented will have to be substantially altered from the preceding to better reflect the measurements that are critical to those magnitude-types, but the level of detail should be analogous to what is proposed above for amplitude/period based magnitudes.

Please insert your answers to the above questions in color for easier recognition and send them back to

Dr. Wendt (wendt@rz.uni-leipzig.de) and
Prof. Bormann (pb65@gmx.net).