Centre Sismologique Euro-Méditerranéen
European-Mediterranean Seismological Centre

Newsletter

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EDITORIAL

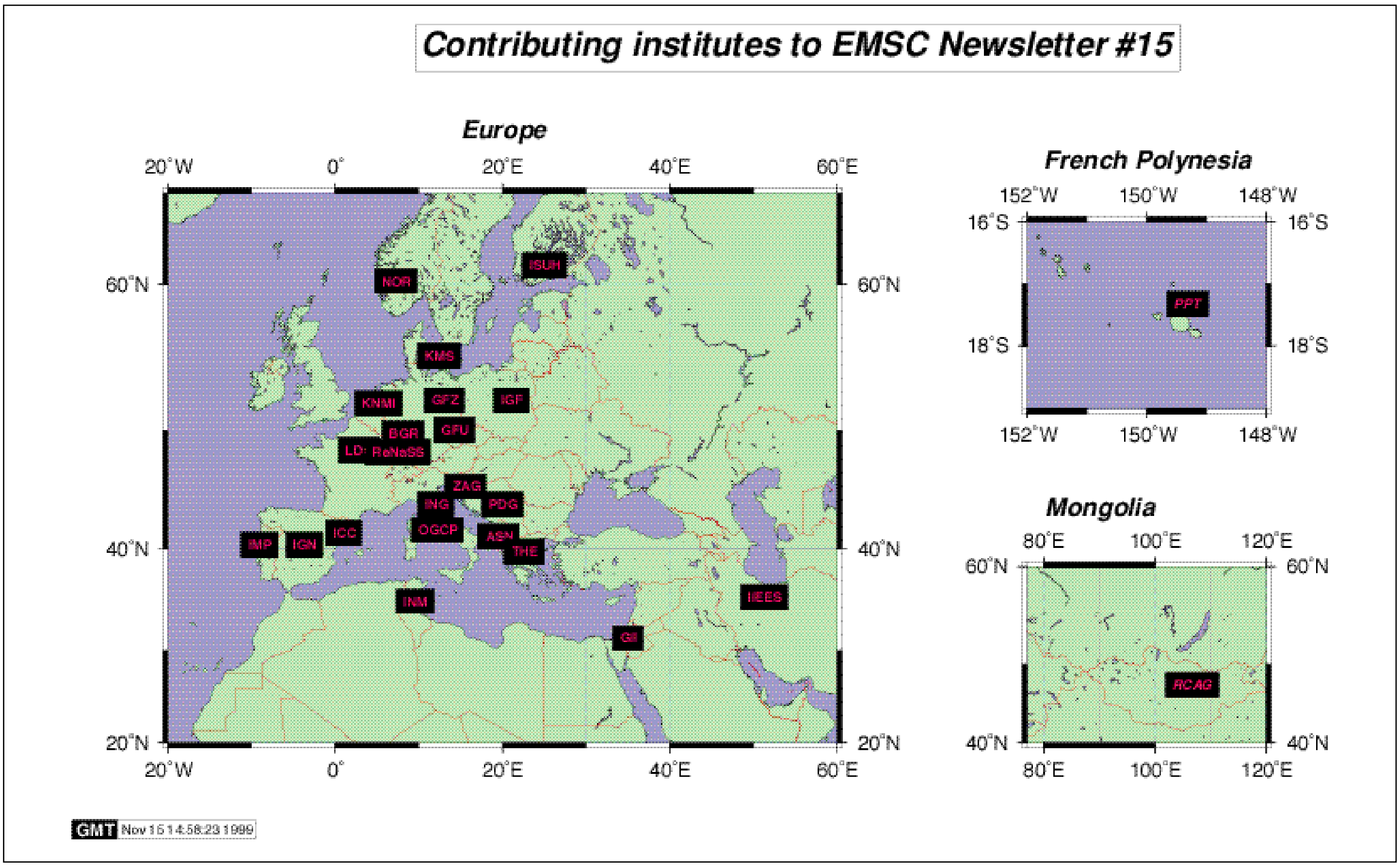
During our Birmingham Assembly in July, our Secretary General brought the disturbing news that the EMSC financial position was not sustainable and that we have only one full year of solvency in which to rectify the situation. Much of our operational costs are underwritten by LDG with contributions in-kind by our key nodal members, and we expect this support to continue. However, our principal cash sponsor, the Council of Europe, has reduced its contribution over a number of years and we need to seek new funding avenues.

One possibility is to raise the annual membership subscription as it has been held at 5,500 FFr for over 8 years. This is not a preferred option because we seek an increasing membership and geographical coverage to better meet our goals and to provide the service throughout our region. I will be writing to members whom I think might be able to afford a revaluation of the fee to ask if they would increase it to two, or more units. My own institution, the British Geological Survey, will increase its contribution from the two membership fees it pays at present,to four in 2000. I hope that others will do the same or, alternatively, will sponsor a partner institution in another country so that they can join the EMSC community. I also propose to seek sponsorship from commercial companies. Other than these initiatives, I am seeking your ideas for other funding opportunities. Please help.

On a positive note, we have won a project from the European Commission to lead a research programme (EPSI) which includes the definition of a unified magnitude scale and propagation model to produce the EMSC bulletin.The new money pays for the new work so does not help financially, but it enables us to pursue the vigorous developments of recent years thereby improving the service to members. The result of our last EC project was the reduction of our alert-triggering threshold to magnitude 5.0 and a significant increase in participating networks.

This issue of the Newsletter demonstrates another aspect of the energy and interest of our community with 24 reports on the procedures for magnitude calculations which are used from Mongolia through Albania to Norway.

Chris Browitt
President



Albanian Seismological Network (ASN), Tirana , Albania

Betim Muco (betim@sizmo.tirana.al)
Seismological Institute, Tirana,Albania

Since the setting up of the seismological station of Tirana in 1968 and afterwards, with the other stations of Albanian Seismological Network (ASN), the formula used for magnitude estimation was:

$$ML = \log Y - \log Ao - \log [V/Vw (T)]$$

where **Y** - maximum amplitude in mm,
Ao - correction for Wood-Anderson instrument,
V - magnification of our instrument,
Vw - magnification of Wood-Anderson instrument,
T - period in sec.

As one can see, this is a local Richter magnitude converted from a Wood-Anderson instrument to ours (Muco, 1978). After 1990, the Ao correction was determined for Albania (Muco and Minga, 1992), and some new formulas were derived and used in the practice for ASN. The formula for the Tirana station is:

$$ML = \log(A/T) + 1.663 \log D + 0.001 D - 3.43$$

where **A** - amplitude in nm,
T - period in sec and
D - distance in km.

Another formula for signal duration is given by:

$$Md = 2.32 \log t + 0.001 D - 1.84$$

where **t** - signal duration in sec,
D - distance in km.

For the different stations of ASN, other coefficients were derived, but keeping Tirana as master station (Muco and Minga, 1991). The magnitude scale of our Institute is a Richter local magnitude or duration magnitude. Phases used for measurement are Lg ones. Amplitude is measured peak-to-peak and divided by two. No velocity or acceleration recordings. An attenuation coefficient was derived for each Albanian station and applied as a correction in the new formulas. The measurements for the local magnitude are obtained from DDJ-1, short-period (1 sec) instruments or Kinemetrics short-period (1 sec). Our formulas are applied for distances up to 700 km. For teleseismic events, we use a medium-period instrument and the well-known Ms formula of Karnik. Some scaling relationships used are (Muco, 1998):

$$ML (TIR) = 0.5 Mb (ISC) +1.75$$
$$Ml (TIR) = 0.57 Ms (ISC) + 1.96$$

References

- Muco, B., 1978. On the determination of magnitude of near earthquakes from signal duration. Permbledhje studimesh, No.3-4, 137-141.
- Muco, B. and Minga, P.,1992. Anelastic-attenuation coefficient and the correction of Ao values of Richter magnitude formula for Albania.Geofizika, Zagreb, Vol.9, 123-132.
- Muco, B. and Minga,P., 1991. Magnitude determination of near earthquakes for the Albanian Network. Boll.Geof. Teor. Appl., XXXIII, 129, 17-24.
- Muco, B., 1998. Catalogue of ML>3.0 earthquakes in Albania from 1976 to 1995 and distribution of seismic energy released. Tectonophysics, 292, 311-319.

Department of Geophysics, University of Zagreb (ZAG), Croatia

Ines Ivancic (iivancic@rudjer.irb.hr)
Faculty of Science, University of Zagreb – Horvatovac b.b – 1000 Zagreb, Croatia

The magnitude formula applied is :

$$MLH = \log A + 1.449 \log (\Delta) + 2.554$$

where **A** - is the maximum amplitude of ground displacement in micrometers,
Δ - is epicentral distance in degrees (Herak 1996).

The magnitudes ML are calculated on the basis of maximum amplitudes of Sg (or Lg) phases, using the peak-to-peak amplitude measurements of the velocity recordings.

The maximum distance to the station used for magnitude computation is approximately 2000 km. Measurements are made on long-period Sprengnether seismographs (series S-5100 H and V) with analogue recorders.

The magnitude formula is derived to match local magnitudes from Central European stations.

References

- Herak and Markusic, 1996,Terra Nova, 8,86-96.

Geophysical Institute (GFU), Prague, Czech Republic

Jan Zedník (jzd@ig.cas.cz) and Karel Klíma (kk@ig.cas.cz)
Geophysical Institute, Academy of Sciences of the Czech Rep.Bocni II/1401, 141 31 Prague 4, Czech Republic

The Geophysical Institute (GFU) of the Academy of Sciences of the Czech Republic has been using Kárník's formula (Kárník, 1962, 1968) for local magnitude estimation at the stations of the Czech seismic network:

$$M = \log A/T + \sigma(D),$$

where **A** - is the maximum amplitude of Sg (Lg) short-period wave (μm),
T - is the period (s),
D - is the epicentral distance in the range 1° - 6°,
σ(D) - is the amplitude-distance curve of the Sg(Lg) wave (the table is given in Kárník and Christoskov,1977).

This magnitude scale was carefully linked to the standard surface wave scale for strong events which were recorded at regional distances. Peak-to-peak amplitude measurements are applied on both analog and digital records. For historical reasons, only short-period vertical channels are used.

There were numerous attempts to revise the Kárník formula, e.g. Plomerová et al., 1979, Procházková et al., 1985, Tobyá and Procházková, 1986. Kárník and Zedník (1986) derived the formula:

$$M = \log A/T + 2.18 \log(D) + 2.88$$

from the largest events of the earthquake swarm in West Bohemia in 1985/1986. None of the suggested calibrating curves were applied routinely in the seismological practice.

Local seismic network WEBNET (West Bohemian Network) uses the following formula for the estimation of local magnitudes:

$$M_L = \log A - p \log T + s \log D + c - (1-p) \log (2\pi)$$

where **A** - is the total vector of S wave (μm),
T - is period (s),
D - is epicentral distance in km,
p - equals to 0, for velocity recordings and equals to 1 for records of displacement recordings,
s - is parameter representing the spreading of the wave front and its value is 2.1,
c - is the station correction. Its value -1.7 was determined by using strong regional events.

References

- Horálek J., Fischer T., and Bou?ková A. (1999): Magnitude determination in West Bohemian local seismic network. (Personal communication).
- Kárník, V. (1962): Amplitude-distance curves of surface waves at short epicentral distances (Δ<2000 km). Studia geoph et geod., 6,340-346.
- Kárník, V. (1968): Magnitude calibrating curves for near earthquakes. Studia geoph et geod., 12, 220-223.
- Kárník V., and Christoskov, L. (1977): Magnitude determination at short epicentral distances in Europe. Publ. Inst. Geopys. Pol.Acad.Sc.,A-5 (116), 51
- Kárník, V., and Zedník J.(1986): Amplitudes of Sg (Lg) waves from the largest events of the swarm in the west Bohemia and calibrating curves for near shocks. Proceed. of Workshop on Earthquake swarm 1985/86 in Western Bohemia, Geophys. Inst., Czech Acad. Sc., 255-260.
- Plomerová, J., Ruprechtová, L., Tittel B., Weyrauch J., and Wylegalla K. (1979): New calibrating functions for short-period body waves of Friuli earthquakes. Studia geoph et geod., 23, 189.
- Procházková D., Tobyá? V., and Knaislová D. (1985): Magnitude relations for short epicentral distances at seismic stations PRU and KHC. Travaux Inst. Geophys. Acad Tchecosl. Sci. No 602,Academia Praha.
- Tobyá? V., and Procházková D.(1986): Comparison of some calibrating functions for magnitude determination at short epicentral distances. Proceed. of Workshop on Earthquake swarm 1985/86 in Western Bohemia, Geophys. Inst.,Czech Acad.Sc.,247-253.

National Survey and Cadastre (KMS), Copenhagen, Denmark

Soren Gregersen (srg@kms.dk)

Kort og Matrikelstyrelsen, Rentemestervej 8, DK-2400 Copenhagen NV, Denmark

Two different magnitude formulae are used depending on the region (Denmark or Greenland).

Denmark Formula:

$$mL = \log(a) + \log(V(T)) + 1.61 \log(\Delta) - 2.76$$

where ***a*** - vertical ground amplitude in μ

V(T) - magnification of Wood-Anderson seismograph at the relevant period

Δ - epicentrale distance in km

Type of magnitude: only mL
Type of phase: Lg
Type of amplitude measurement: zero-to-peak of maximum phase on the vertical seismogram
Type of recording: velocity recordings
Type of corrections: none
Limits of application: distances above 1° and up to approximately 20°
Instrument specifications: short-period seismographs (WWSSN and GS-13)
Scaling relationship with other magnitudes: the scale has been tested to fit the local magnitude scale used for Sweden (Wahlström, 1978)

Greenland Formula:

$$mL = 2.50 + 2.5 \log(D) + \log(A/T) + \text{path correction}$$

where ***A*** - vertical ground amplitude in μ

T - period of largest phase

D - epicentrale distance in degrees

Type of magnitude: only mL
Type of phase: Lg (largest phase on the record)
Type of amplitude measurement: zero-to-peak of the largest phase on the vertical seismogram
Type of recording: velocity recordings
Type of corrections: selected path corrections found by experience, caused by special Lg wave attenuation
Limits of application: distances from 2° to 25°
Instrument specifications: short-period seismographs (WWSSN)
Scaling relationship with other magnitudes: the form of formula chosen to be that of the Canadian seismograph network, adjusted to fit about 10 mb (ISC) magnitudes available in Greenland

Reference

- Wahlström, 1978. Report no.3-78,Seismol. Inst. Uppsala

Institute of Seismology University of Helsinki (ISUH), Finland

Marja Uski (uski@seismo.Helsinki.FI)

Institute of Seismology, P.O. Box 26, FIN-00014 University of Helsinki, Finland

The local magnitude scale applied by the Institute of Seismology of the University of Helsinki is based on Richter's original ML concept (1958) and reads (Uski and Tuppurainen,1996):

$$ML(Lg) = 0.86 \log(a) + 1.42 \log R + 0.00017 R - 2.19 + S$$

where ***a*** - (nm) is the zero-to-peak ground motion amplitude calculated from the Lg-wave maxima on the short-period vertical seismogram,

R - is hypocentral distance (R < 1900 km),

S - the station correction term varies between 0.06 and -0.10.

The Lg wave attenuation function (-logA0 in Richter's definition) appropriate to the Finnish seismic network was derived from maximum trace amplitudes as obtained from synthesized Wood-Anderson seismograms. The absolute level of the function was adjusted so that at 60 km the curve equals the revised -logA0 for southern California (Hutton and Boore, 1987). In addition, the above equation includes a distance-dependent correction to compensate the use of vertical component amplitudes (Z) instead of the mean value of the two horizontal component amplitudes (H) used by Richter: log(H/Z) = 0.00009 R.

Due to the fact that the Lg wave quickly dies out even by short oceanic travel paths, the ML(Lg) formula is strictly valid only for continental earthquakes. For offshore events the local magnitude is usually estimated from maximum Pn or Sn wave amplitudes using the equations (Uski, 1997):

$$ML(Pn) = 0.86 \log(a) + 1.93 \log R - 2.34 + S$$
$$ML(Sn) = 0.86 \log(a) + 1.73 \log R - 2.34 + S$$

where the station-dependent normalizing constant S lies within the range -0.16 to -0.45 for Pn, and -0.08 to -0.20 for Sn.

The attenuation functions for Pn and Sn were derived from the decay of synthesized Wood-Anderson amplitudes versus distance. A station-dependent calibration term S was determined by normalizing the Pn and Sn magnitudes to the ML (Lg). A set of strictly continental earthquakes was used for normalization.

All the above formulae include a relation derived between ground motion amplitudes a (in nm) measured from the original seismograms and trace amplitudes A (mm) measured from the synthesized Wood-Anderson amplitudes:

$$\log A = 0.86 \log(a) - 2.34.$$

A maximum-likelihood fit to the mb(USGS) versus the Finnish ML gives:

$$mb = 1.01(+ 0.13)ML + 0.04(+0.59)$$

for 66 observations.

References

- Hutton, L. K. and Boore, D. M., 1987. The ML scale in southern California. Bull. seism. Soc. Am., 77, 2074-2094.
- Richter, C. F.,1958. Elementary Seismology. Freeman, San Francisco, 758 pp.
- Uski, M. and Tuppurainen, A., 1996. A new local magnitude scale for the Finnish seismic network. Tectonophysics, 261,23-37.
- Uski,M.,1997. Local magnitude relations for earthquakes recorded in Finland. Phil. Lic. thesis in geophysics, Dept. of Geophysics, University of Helsinki.

French National Seismic Network (RéNaSS), France

Michel Granet (Michel.Granet@eost.u-strasbg.fr,) and Hugues Dufumier (Hugues.Dufumier@eost.u-strasbg.fr)
EOST-IPGS, 5 rue Descartes, F-67084 Strasbourg cedex, France

The French National Network of Seismic Survey (so-called RéNaSS) funded mainly by INSU (CNRS) provides different kinds of magnitudes depending on the data processing (automatic and rapid determination, routine determination).

Automatic and rapid determination
About 40 short-period stations are linked to Strasbourg in real or quasi real-time using different transmission links (radio-telemetry, switched or dedicated phone lines, Internet, satellite). Continuously, seismograms are analyzed and phase picking is performed automatically. When a number of phase pickings are available, an automatic location procedure will locate the event using an algorithm depending on the "probable" nature of the earthquake (local, regional, teleseismic). This automatic location is then distributed via E-mail (subject = LOCATION OF ReNaSS : AAAAMMJJHHmm (N), where N is the number of messages for this event), including if estimated, a M_L or m_B magnitude.

A. For local and regional earthquakes, a M_L magnitude is computed using the following formula :

$$M_L = \log_{10}(Amax) + f(\Delta) \quad (1)$$

where

Amax - is the maximal amplitude (in millimeters) of the seismogram measured peak-to-peak after it was restituted in order to simulate a Wood-Anderson seismometer,

Δ - is the epicentral distance (in km) and f(Δ) is given by: $f(\Delta) = 0.82211327\ \Delta^{0.280637.}$

This formula is used only for the regional networks which are regularly calibrated and for distances shorter than 800 km.

B. For teleseismic earthquakes, a m_B magnitude is roughly estimated. The calculation of m_B is based on the observed amplitudes of P-waves. For each station, a magnitude is deduced using as a calibration factor, the value of m_B given by NEIC. Finally, the average for all observations is calculated and provided as m_B.

C. Once the seismologist on duty, at the headquarter, has checked the alarm and refined the location, a Msz magnitude is deduced from the maximal peak-to-peak vertical component of the surface wave recorded with a broad-band Geotech sensor located in Strasbourg. This Msz magnitude is distributed in an E-mail message with a header as the following "RENASS LOCALISATION PRELIMINAIRE" (or RENASS PRELIMINARY LOCATION) and sent by E-mail or/and Fax within 60 to 120 minutes after the occurrence of the earthquake (note that for local or regional earthquakes, a M_L magnitude is reported in the message, see (1)). The formula for this Msz is directly derived from the original IASPEI formula. In practice, Msz is given in our case by :

$$Msz = \log_{10}(A_{pp}/1.822) + 1.66 \log_{10}(D) + 3.3 \quad (2)$$

where

A_{pp} - is the peak-to-peak amplitude measured directly on the seismogram (in millimeters),

D - is the epicentral distance in degrees.

In order to determine rapidly this Msz magnitude, the seismologist on duty uses pre-calculated tables. The detail of this formula is given below.

Routine determination
In the monthly RéNaSS bulletin, magnitudes M_L (local and regional earthquakes), mB and Msz (teleseismic events) are provided. The way of how these magnitudes are obtained is the same as for the "rapid determination" procedure.

In a near future, RéNaSS will provide a Msz magnitude based on data from the French broadband observatories. The computation of this Msz refers to the original formula based on the maximal amplitude of the surface wave, valid both at regional and teleseismic distances, provided that the surface wave can be observed (Distance > 500 km).The formula is given by :

$$Msz = \log_{10}(V/(2\pi)) + 1.66 \log_{10}(D) + 3.3 \quad (3)$$

where *V* - is the maximal half-amplitude (V in microns/s, deconvolved from the instrument) of the vertical velocity component, filtered between 10 and 40 s, and between 2.5 and 4.5 km/s in group velocity,

D - is the epicentral distance in degrees.

Informations concerning the specifications on instruments can be found on our WWW site : http://renass.u-strasbg.fr.

Laboratoire de Détection et de Géophysique (LDG), France

Jean-Louis Plantet (plantet@ldg.bruyeres.cea.fr) and Bruno Feignier (feigner@ldg.bruyeres.cea.fr)
LDG, BP 12, 91680 Bruyères-le-Châtel, France

The LDG computes two types of magnitudes from the seismograms recorded by its national seismic network for regional events (D ≤ 20°) :a local magnitude ML and a duration magnitude MD.

ML :

- It is used for regional events when the station-hypocenter distance is greater than 100 km (this is related to the fact below 100 km attenuation corrections are too dependent on the local geological context).
- The applied formula is :

$$ML = \log_{10}(A/G) + Q_0(\Delta) + CS$$

where *A* - is the peak-to-peak amplitude of S waves (preferably Sg or Lg) measured on a vertical short-period seismograph filtered in the frequency band 0.3 – 7 Hz;

G - is the total gain of the acquisition system at 1 Hz;

$Q_0(\Delta)$ - is the attenuation of S and Lg waves obtained from experimental measurements made on data recorded by the French seismic network. Attenuation values are computed every 50 km between 100 and 1500 km.

C_s - is a station correction factor.

- This magnitude was calibrated against the ISC Mb magnitude and the following relationship was obtained:

$$ML_{LDG} = Mb_{ISC} \text{ +/- } 0.3.$$

MD :

- It is used for regional events.
- For events with MD < 4.0, the applied formula is :

$$MD = A_1 + A_2 \log_{10}(\tau) + A_3 \Delta$$

- For events with MD > 4.0, the applied formula is :

$$MD = B_1 + B_2 \log_{10}(\tau) + B_3 \tau^2 + B_4 \Delta$$

where τ - is the total duration of the signal;

Δ - is the epicentral distance in km;

$A_1, A_2, A_3, B_1, B_2, B_3$ and B_4 - are station-dependent correction coefficients.

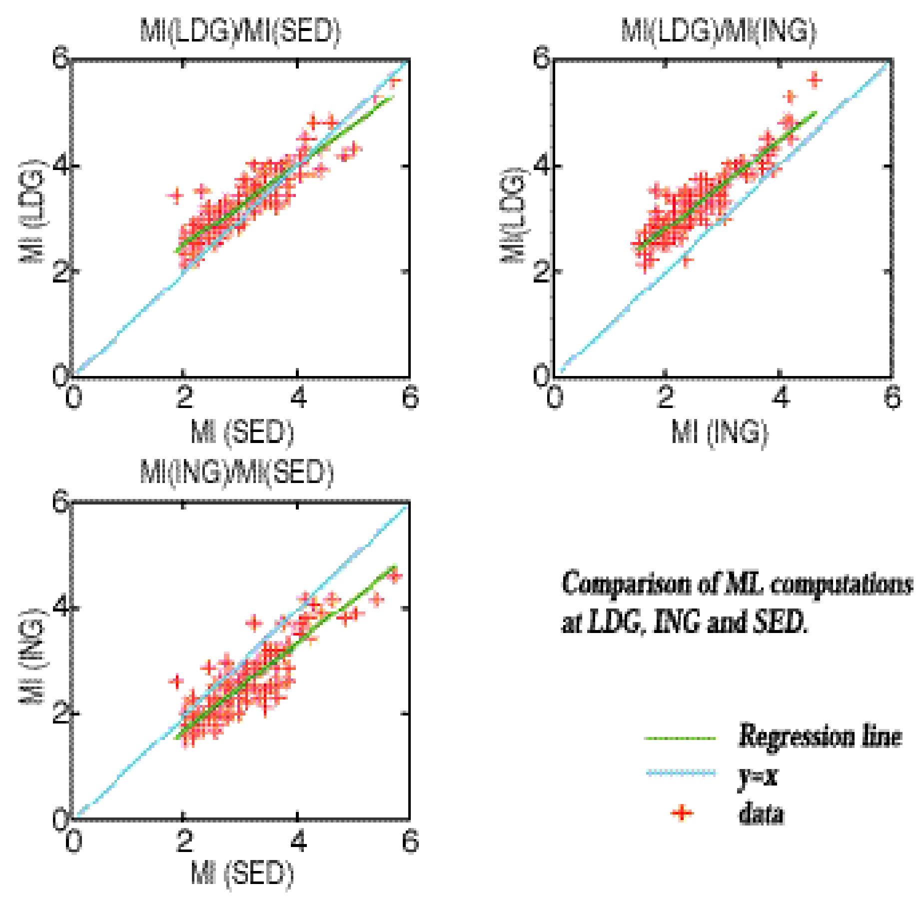
Both ML and MD have been calibrated against the Mb magnitude published by either the NEIC or the ISC for 548 events located at regional distances from the LDG network. The following results were obtained:

$$ML = (-0.06 + Mb) \text{ +/- } 0.37$$
$$MD = (-0.13 + Mb) \text{ +/- } 0.30$$

A recent study was conducted (Lebreton, 1997) to compare the ML computed at LDG with magnitudes obtained at neighbouring institutes (SED in Switzerland and ING in Italy). A total of 140 events, which had been detected and located by all three institutes during 1995 and 1996, was studied. These events have been used to derive least-squares relationships between the various ML computations. The results are shown in the figure and the following formulas were obtained:

$$ML_{LDG} = (0.75 +/- 0.03)\ ML_{SED} + (0.99 +/- 0.09)$$
$$ML_{LDG} = (0.82 +/- 0.03)\ ML_{ING} + (1.16 +/- 0.08)$$

These results show a greater scatter in magnitude estimates than the ones observed in previous studies (Ménéchal and Santoire, 1988). Additional work is required on this topic and will be carried out in the framework of an EC project coordinated by the EMSC.



Comparison of ML computations at LDG, ING and SED.

References:

- Lebreton, S., 1997. Comparaison des magnitudes locales diffusées par différents instituts européens, Diplôme Ingénieur EOST Strasbourg, 132 pp.
- Ménéchal, Y. and Santoire, JP, 1988. Magnitudes locales du LDG: Bilan – Comparaison à diverses références internationales, LDG Internal Report.

LDG, Papeete, French Polynesia

Dominique Reymond (reymond.d@labogeo.pf) and Olivier Hyvernaud (hyvernaud@labogeo.pf)

LDG, BP 640 Papeete, French Polynesia

Local events

For the computation of local events magnitude, our laboratory uses the classical Ml formula :

$$Ml = \log10(A) + 2.5 \log(\Delta) - 2.10$$

where A - is the peak to peak amplitude in micrometer for Pn and Sn wave

Δ - is the epicentral distance in km (in the [50-1000km] range)

For the events that we are interested in, that is oceanic intraplate events, the focal depth is only in [0-35km] .

This relation has been chosen to fit to mB magnitude for distances between 70 and 400 km.

Instrumentation : recording is made in velocity.

Teleseismic events

Introduced in 1987 by Okal, Talandier and Reymond, the Mantle magnitude Mm is used by our laboratory for the quantification of earthquake. The formula is given in the frequency domain for both Rayleigh and Love waves:

$$Mm = \log_{10}[X(T)] + C_D + C_S + C_0$$

where

$X(T)$ - is the spectral amplitude at the period T in micrometer.s

C_D - is the distance correction including a geometric and an anelastic attenuation :

$$C_D = 0.5 \log_{10} \sin\Delta + (\log_{10} e)\ \pi\Delta/QUT$$

Δ - is the epicentral distance in degree, Q, the Q factor at the considered period, and U the group velocity at the same period.

C_S - is the source correction, computed by an average of excitation functions of surface wave over 3240 focal geometries for a given range of depths. The result is formulated by a cubic spline best fitting, function of the period T ; for instance for Rayleigh waves in the [0-70km] range,

$$Cs = 1.6163\ \theta^3 - 0.83322\ \theta^2 + 0.42861\ \theta + 3.7411$$
and $\theta = \log_{10}(T - 1.8209)$.

C_0 - is a constant depending on depth (C_0= 0.90 for [0-70km]).

The formulation of the Mm magnitude has a theoretical basis and justification. The main advantages of Mm are :

- the lack of saturation effect even for large earthquakes (like Chile May 22, 1960);
- the application to any distance range (tested from 1 to 140°, including multiple path R2, until R5, ..etc);
- the application to any focal depth;
- the application at very long periods (from 50 to 300 s);

The simple relationship with the scalar seismic moment Mo :

$Log\ Mo = Mm + 13.0$ where Mo is in N.m

Instrumentation : Broad-band long-period seismometers. An instrumental correction must be applied if the response is not flat for periods lower than 300 s.

Relationship with other magnitudes: M_w is an extension of M_s magnitude correlated to ***Mo*** with a slope of 2/3 ($Mw = 2/3\ Log\ Mo - 6.06$) ; consequently M_m and M_w (and M_s for moderate earthquakes) could not have the same value except for one point :

$$M_m = M_s = M_w = 7.8$$

Federal Institute for Geosciences and Natural Resources (BGR), Hannover, Germany

Joerg Schlittenhardt (schlittenhardt@sdac.hannover.bgr.de)
Federal Institute for Geosciences and Natural Resources, Stilleweg 2,30655 Hannover, Germany

The magnitude formula and magnitude scale used by BGR for routine seismogram analysis of regional seismic events is based on the following formula of Richter:

$$ML = \log a - \log a0$$

as described by Wilmore (1979).

The Wood-Anderson system used for amplitude measurement is simulated from the original broad-band seismogram using a two-step simulation filter (Seidl,1980).This Wood-Anderson torsion seismometer has a natural period T0=0.8s, a damping constant h=0.8 and a magnification V0=2800.

The maximum trace amplitude of the seismogram is measured irrespective of the arrival time and, hence, seismic phase. The arithmetic mean of the measurements on two horizontal components is used for the magnitude determination.
The magnitude scale that is used is limited to regional events with a maximum distance of 1000 kilometers from the recording station.

Future work will incorporate the determination of scaling relations between different magnitude scales.

References

- Wilmore, P.L.(Editor), 1979: Manual of seismological observatory practice, Edinburgh, Scotland. Published by World Data Center A.
- Seidl, D., 1980: The simulation problem for broad-band seismograms. J. Geophys., 48, 84-93.

GeoForschungsZentrum (GFZ), Potsdam, Germany

Günter Bock (bock@gfz-potsdam.de)
GeoForschungsZentrum, Telegrafenberg, Haus E, 14473 Potsdam, Germany

At GFZ, we use waveform data of broad-band seismograph stations to derive the moment tensor for a double couple by fitting observed P- and S-wave amplitudes with theoretical amplitudes calculated for the IASP91 model and assuming the Q structure of PREM. The procedure has been described by Bock et al. (1994) and is usually carried out in the frequency range 0.05 to 0.02 Hz. The moment magnitude Mw is derived from the scalar seismic moment Mo using the relation (Kanamori, 1977):

$$Mw = 2/3 \log (Mo) - 10.7$$

where ***Mo*** - is in dynes*cm.

No special station corrections are applied. The formula is valid for earthquake sources whose low-frequency parts of the amplitude spectra are within the frequency band used in the inversion.

These magnitude estimates agree within an acceptable scatter with those derived by the Harvard Group in their CMT determinations.

There is no systematic shift of our estimates (i.e. systematically too low or too high) relative to Harvard.

References:

- Bock, G., Hanka, W. and Kind, R., 1994. EMSC rapid source parameter determination. CSEM/EMSC Newsletter, No. 6, December 1994.
- Kanamori,H.,1977.The energy release in great earthquakes. J. Geophys. Res., 82, 2981-2987.

Geophysical Laboratory of Thessaloniki University (THE), Greece

Emmanuel Scordilis (manolis@geo.auth.gr)
Geophysical Laboratory, Thessaloniki University, PO. BOX 352-1, GR-54006,Thessaloniki, Greece

Relations estimating M_L magnitude in Greece

The magnitude scale used by the Geophysical Laboratory of Thessaloniki University is the local magnitude $M_L(THE)$. Following are the formulae used for M_L estimation. In all relations c_i represent the station corrections.

$$M_L(THE) = 2.14 LogD + 0.0038\Delta + c_1 \quad (1)$$
for $\Delta \leq 100$ km

$$M_L(THE) = 1.97 LogD + 0.0012\Delta + c_2 \quad (2)$$
for $\Delta \leq 100$ km

where ***D*** - is the signal duration from the first P-wave onset up to the point that the maximum peak to peak trace amplitude becomes 2 mm,
Δ - is the epicentral distance in km.

$$M_L(THE) = 2.31 LogD + 0.0012\Delta + c_3 \quad (2)$$
for $\Delta > 100$ km, $3.0 \leq M_L(THE) \leq 6.0$

where ***D*** - is the signal duration from the first P-wave onset up to noise level.

$$M_L(THE) = Log(a) + 1.20 Log\Delta + 1.27 + c_4 \quad (1)$$
for 10 km $< \Delta \leq 100$ km, $1.4 \leq M_L(THE) \leq 2.8$

$$M_L(THE) = Log(a) + 2.736 + c_4 \quad (1)$$
for $\Delta \leq 10$ km

$$M_L(THE) = Log(a) + 1.20 Log\Delta + 1.27 + 0.35 + c_4 \quad (1)$$
for $\Delta \leq 100$ km, $M_L(THE) > 2.8$

$$M_L(THE) = Log(a) + 2.32 Log\Delta - 1.07 + c_5 \quad (3)$$
for $\Delta > 100$ km, $3.0 \leq M_L(THE) \leq 6.0$

where ***a*** - is the ground amplitude in μm that corresponds to the maximum peak to peak trace amplitude.

$$M_L(THE) = 1.01 M_L(ATH) - 0.13 \quad (6)$$
for $1.7 \leq M_L(THE) \leq 6.1$

which means that practically:

$$M_L(GR) = M_L(THE) \approx M_L(ATH)$$

where M_L(ATH) is the local magnitude estimated by National Observatory of Athens using maximum amplitude of Wood Anderson recordings and/or signal duration of other stations recordings.

Relationships with other M_L magnitudes

$$M_L(ISK) = 0.64 M_L(GR) + 1.42 \quad (6)$$
for $2.2 \leq M_L(GR) \leq 5.8$

$$M_L(TIR) = 0.83 M_L(GR) + 0.48 \quad (6)$$
for $2.0 \leq M_L(GR) \leq 5.5$

$$M_L(TTG) = 0.88 M_L(GR) + 0.51 \quad (6)$$
for $2.0 \leq M_L(GR) \leq 6.1$

$$M_L(SKO) = 1.25 M_L(GR) - 0.94 \quad (6)$$
for $1.6 \leq M_L(GR) \leq 5.4$

where $M_L(ISK)$, $M_L(TIR)$, $M_L(TTG)$, $M_L(SKO)$ are local magnitudes reported from the respective seismological centers.

Relations connecting M_L (GR) magnitude with m_b and M_W magnitudes from ISC and NEIC

$$m_b(ISC,NEIC) = 0.76 M_L(GR) + 1.33 \quad (4)$$

$$M_w = M_L(GR) + 0.43 \quad (5)$$
for $M_L(GR) \geq 3.6$

References

[1] Scordilis, E.M. Microseismic study of the Servomacedonian zone and the surrounding area. "Ph.D. Thesis, Universiry of Thessaloniki", 1-250, 1985.

[2] Kiratzi, A.A. and Papazachos, B.C. Local Richter magnitude and total signal duration in Greece. "Annales Geophysicae", 3, 531-538,1985.

[3] Kiratzi, A.A. and Papazachos, B.C. Magnitude determination from ground amplitudes recorded by short period seismographs from Greece. "Annales Geophysicae", 4, 71-78, 1986.

[4] Papazachos, B.C.,Kiratzi,A.A. and Karakostas, B.G. Towards a homogeneous moment-magnitude determination for earthquakes in Greece and the surrounding area. "Bull.Seism. Soc. Am.",87,474-483,1997.

[5] Margaris, B.N. and Papazachos, C.B. Moment magnitude relations based on strong-motion records in Greece. "Bull. Seism. Soc. Am.", 89, (in press), 1999.

[6] Baba, A.B., Papadimitriou, E.E., Papazachos, B.C., Papaioannou, Ch.A. and Karakostas, B.G. Unified local magnitude scale for earthquakes of south Balkan area. "Pure and Appl.Geoph.", (in press), 1999.

International Institute of Earthquake Engineering and Seismology (IIEES) Islamic Republic of Iran

Amir Mansour Farahbod (farahbod@dena.iiees.ac.ir)
IIEES, P.O. Box 19395/3913, Tehran, Islamic Republic of Iran

At IIEES, magnitude of local earthquakes is determined from the maximum amplitude (peak-to-peak) of the vertical components of ground velocity. In order to obtain the local magnitude, thes amplitude values and the corresponding period are converted to what they would be is the signal had been recorded by a standard Wood-Anderson seismograph (Bakun and Joyner, 1984).
In eastern Iran,by using F-P (total duration of oscillation), the relation

$$M= -0.38 + 2.2 \log(F\text{-}P) + 0.0002\Delta$$

with $\Delta < 200$ km (Farahbod at al., 1997) is used.

Surface wave magnitude is computed by using the relation:

$$Ms = \log (A/T) + 1.15\log\Delta + 4.17$$

where T = 26 s. (Thomas at al., 1978)
and IASPEI formula:

$$Ms = \log (A/T) + 1.66\log\Delta + 3.3$$

where $18 \leq T \leq 22$ s., and $20° \leq \Delta \leq 160°$.

Now, at IIEES, there are two types of instruments:

1- Recorder: SSR-1 Kinematrics, Sensor SS-1 (SP)

2- Recorder: Ismes Prax10-Field unit, Sensor:Guralp CMG-3T

Before the determination of earthquake magnitudes, the proper corrections for the instrument type are applied.
Scaling relationship between ***mb*** determined by IDC and NEIS and M_L measured by IIEES are as follows:

$$mb(IDC) = 0.61\ ML(IIEES) + 0.72$$

$$ML(IIEES)= 1.39\ mb(NEIS) + 0.71$$

References

- Bakun, W.H. and Joyner W.B., 1984. The ML scale in central California. Bull. Seismol. Soc. Am., 74: 1827-1843.
- Farahbod, A.M., Yamini Fard, F. and Hessami Azar, K.T., 1997. A review of Ardekul earthquake and its aftershocks (in Persian). IIEES publication No: 77-98-4.
- Thomas, J.H., Marshall, P.D. and Douglas,A.,1978.Rayleigh wave amplitudes from earthquakes in the range 0º-150º. Geophys. J., 53:191-200.

Geophysical Institute of Israel (GII), Israel

Avi Shapira (avi@iprg.energy.gov.il)
HaBaal Shem-Tov 6, Industrial Zone North, P.O.Box 182, Lod 71100, Israel

A local magnitude ML is computed for events with $ML \leq 5.0$ and $R \leq 1000$ km :

$$ML = -0.6 + 0.0015R + 2 \log T$$

where ***R*** - is the epicentral distance (km) ;
T - is the time interval between the arrival of the S wave and until the ground motion falls and stays below 0.5 micron/sec.

Originally correlated with a sample of ML values based on amplitude measurements from SP seismograms deconvolved to Wood-Anderson instrument.
Correlation with the Seismic Moment (dyne*cm) :

$\log Mo = (17.0\pm0.3) + (1.3\pm0.1)\ ML$ for $3.0 < ML < 6.7$

A body wave magnitude mb is computed for events with $\sim6 \geq mb \geq 4.0$ and $1500 \text{ km} \geq R \geq 100$ km :

$$mb= 0.6 + 0.0012R + 1.54 \log T$$

where ***R*** and ***T*** are defined as above.
The ***mb*** formula was derived by correlating T and R with ***mb*** values given by EMSC and NEIC

Other correlations :

$$mb= 0.39 \log E - 2.67 \quad (\sigma \pm 0.19)$$
(E being the seismic energy)

Observatory of Geophysics and Cosmic Physics (OGCP), University of Bari, Italy

Gildo Calcagnile (g.calcag@geo.uniba.it)
University Campus, Via E. Orabona, 4 - I-70125 Bari, Italy

The "Osservatorio di Geofisica e Fisica Cosmica" (Observatory of Geophysics and Cosmic Physics) of the University of Bari runs a regional seismic network of 6 short-period, vertical component stations (Newsletter 14); these stations, set to work as velocity-meters, employ Teledyne-Geotech S13 seismometers and Helicorder analogical recorders.

The magnitude of the regional events is routinely evaluated with the following formula:

$$Md = a + b \ln D + c \ln2 D + d \Delta$$

where ***D*** - is the total duration (in seconds) of the events recorded from the "central" station (BAI));
Δ - is the epicentral distance (in degrees);
a, b, c, d - are coefficients; the coefficient "a" include the station correction.

This relation was calibrated using data from seismic bulletins of ING referring to events of epicentral distance up to about 400 km. The values of the coefficients, obtained through a multiple regression, are:

a = 0.88843, b = 0.50144,
c = 0.34558, d = 0.12383.

Occasionally, the magnitude of earthquakes located in specific areas are estimated adopting specific coefficients calculated for those areas.

Istituto Nazionale di Geofisica (ING), Italy

Rita Di Giovambattista (digiovam@marte.ingrm.it)
Via di Vigna Murata 605, 00143 Rome, Italy

ING Bullettin

The ING seismic data are collected by the Italian Telemetered Seismic Network, composed of about 100 seismic stations equipped with Teledyne Geotech S-13 seismometers characterized by a free period of 1s and a critical dumping of 70%. The signals are transmitted over telephone lines and subsequently demodulated and acquired by an automatic acquisition system developed in 1984 in co-operation with the United States Geological Survey (USGS). The automatic picking of the seismic phases is checked daily and if necessary corrected by seismic analysts who also recognize other phases well identifiable on the seismograms.

Procedures for MD and Ml estimation

Md estimation

Md estimation has been introduced in the ING procedures since the first '80 and is routinely reported in the ING Bulletin. Console et al., 1988, observing that the application of the original formula introduced by Lee et al. 1972 produced higher values of the magnitude for distances larger than a few hundred kilometers proposed a new relation:

$$Md= -0.87 +2.00\log (\tau +0.082\pm0.147)\Delta$$

In this formula, coefficients a (-0.87) and b (2.00) are those proposed by Lee for California.

The total duration of the signal is automatically determined by the acquisition system starting from the first arrival of the P wave till the time in which the envelope of the signal assumes a value equal to 1.5 times the mean value of the background noise preceding the seismogram onset.

The duration automatically determined is checked by analysts by means of interactive procedures operating on the digital waveforms. For signals lasting more than the maximum time interval allowed for the memorization, duration is measured on the analogue recordings and is introduced in the bulletins by editing the database.

In the analogue recordings the duration of the signal is taken from the starting time of the first P arrival till the time in which the signal has the same amplitude of the background noise. For each event a mean magnitude is then estimated,using all the magnitudes estimated for each station, excluding those values exceeding 2 s. The previous formula is applied to all stations having a distance lower than 600 km from the estimated epicenter.

Ml based on short period recordings

An automatic procedure to estimate Ml has been implemented since the automatic acquisition system was operating. The automatic procedure estimates the maximum amplitude (from zero to peak) of the recorded signal . The time interval between the corresponding maximum and the minimum is estimated to calculate the period of the maximum amplitude wave. At the estimated period the ratio between the amplification expected for a Wood-Anderson seismometer and the one of the seismometer used to record the signal is then calculated. This ratio is then multiplied by the observed amplitude to obtain an approximate value of the maximum amplitude that would be recorded by the Wood-Anderson instrument. The magnitude is then estimated using the same correlation table for the distance used by Richter.

The following considerations must be taken into account for the evaluation of the estimated Ml:

the ING seismic network is mainly of vertical- component seismometers

the maximum amplitude is estimated on short period instruments having a transfer function that differs from that of a Wood-Anderson instrument. The assumption made by the procedure is that the recording instrument and the Wood-Anderson should record the maximum amplitude for the same wave.

The attenuation with distance for California is assumed true also for Italian region

Systematic corrections for single stations should be taken into account.

Ml based on MedNet Network

For larger events Ml is estimated on digital waveforms recorded by VBB instruments, simulating synthetic Wood-Anderson recordings. The original relation proposed by Richter is used to estimate the Ml. These estimated magnitude are introduced in the ING Bulletin by editing procedures.

References

- Console R., De Simone B., Di Sanza A., 1988. Riesame della relazione Magnitudo-Durata. VII GNGTS meeting, Rome
- S. Barba, R. Di Giovambattista and G. Smriglio, 1995. The ING seismic Network Databank (ISND): a friendly parameters and waveform database Annali di geofisica, V. 38, N.2, pp.213-219

Research Centre of Astronomy & Geophysics, Mongolian Academy of Sciences, Mongolia

Dugarmaa Tundev (dugarmaa@csg.mn)
Ulaanbaatar-51, P.O.Box-152, Mongolia

Magnitude calculation is provided for the Russian seismic station of the Mongolian network only. Energy class ***K*** is determined from the magnitudes.

Formula: Energy class K is determined based on the Rautian nomogram.

Type of magnitudes: The scales, K=1-18 levels;

Type of phases: Pn, Pg, Sn, Sg in the local events, and P, PP, PKP, S, SS and L using a different nomogram for teleseisms;

Type of amplitude measurement: zero-to-peak;

Type of recording: displacement;

Type of corrections: none;

Limit of application: 1000-1500km, not large earthquakes;

Instrument specifications: SKM-3, SK-GK with 3 components, photopaper recording system (Russian);

Scaling relationship: We are calculating a magnitude using following formulas:

$$K=4+1.8M \quad K\leq 14$$
$$K=8+1.1M \quad K>14$$

References

- The methods of detail study of seismicity. I.B.Ruznichenko (editor).Trudi IFZ.AN.SSSR.n9,1960.
- T.G.Rautin. About a determination of seismic energy in the distance to 3000kms. Trudi IFZ.AN.SSSR.n32,1964.

Royal Netherlands Meteorological Institute (KNMI), Netherlands

Reinoud Sleeman (sleeman@knmi.nl)
Seismological Division, P.O. box 201, 3730 AE De Bilt, Netherlands

The Royal Netherlands Meteorological Institute (KNMI) calculates and reports magnitudes for earthquakes using broad-band station HGN, the Netherlands. The station is equipped with 3 STS-1 sensors, and each channel (Z,N,E) has a flat response for velocity between 360 s and 10 Hz. Data are sampled with 40 samples per second. Local magnitudes are calculated for earthquakes within a distance of 600 km. For earthquakes at distances larger than 10 degrees we report surface wave magnitudes. The table shows the formula's and their references.

MAGNITUDE FORMULAE

$M_L = \log (A_{wa}) - \log (A_0)$ (1)

$M_L = \log (A_{:m}) + 1.90 \log (R) - 0.35$ (2)

$M_S = \log (A/T)_{max} + 1.66 \log (\Delta) + 3.3$ (3)

M_L - local magnitude.
A_{wa} - maximum amplitude in mm on a Wood-Anderson seismometer; peak-to-peak/2 of the largest horizontal component.
A0 - attenuation function, depends on distance; distance is calculated using the time difference between the P- and S-phases and the Jeffreys-Bullen velocity model.
$A_{:m}$ - maximum S-wave true ground displacement in 10-6 m;peak-to-peak/2 of the largest horizontal component.
R - hypocentral distance in km.
M_S - surface wave magnitude
(A/T)max - maximum true ground displacement amplitude (peak-to-peak/2) for the 20 s period surface waves (vertical component)
Δ - epicentral distance in degrees

The mean of the M_L values, determined by the application of the formula of Richter and Ahorner, is reported as local magnitude.

The selection of earthquakes for which we report M_S is mainly based on the near-real time earthquake bulletin provided by the U.S. Geological Survey.

References:

- Richter, C. F., 1958. Elementary Seismology. San Francisco: W. H. Freeman and Company, 768 pp. Pages 340-342.
- Ahorner, L., 1983. Historical seismicity and present-day microearthquake activity of the Rhenish Massif, Central Europe. In: K. Fuchs, K. von Gehlen et al.(eds): Plateau Uplift - Springer-Verlag, Berlin: 198-221.
- Vanek, J., A. Zápotek, V. Kárnik, N.V. Kondorskaya, Yu. V. Rizmichenko, E.F. Savarensky, S.L. Solov'yov and N.V. Shebalin, 1962. Standardization of magnitude scales. Izvestiya Akad. Nauk S.S.S.R., Ser. Geofiz.2:153-158.

NORSAR, Kjeller, Norway

Jan Fyen (jan@norsar.no), Johannes Schweitzer (johannes@norsar.no)
NORSAR, P.O. Box 51, N-2027 Kjeller, Norway

Formula: Baath, M., O. Kulhanek, T. van Eck, and R. Wahlstroem (1976): Engeneering analysis of ground motion in Sweden. Report No. 5-76, Seismological Institute, Uppsala.

Type of magnitude: ML

Type of phase: Lg phase, observed on vertical seismograms (beams).

Type of amplitude measurement: peak-to-peak divided by 2.

Type of recording: velocity instruments

Type of corrections: filtered for the frequency range with best SNR, amplitudes measured in counts and transformed in ground motion with respect to the systems transfer function.

Limits of application: used for all regional distances.

Instrument specifications: ARCES and NORES: GS13; SPITS: CMG-3ESP

Scaling relationship with other magnitudes: see Baath et al.

Institute of Geophysics (IGF), Polish Academy of Sciences, Poland

Pawel Wiejacz (pwiejacz@igf.edu.pl)
ul. Ks. Janusza 64, 01-452 Warszawa, Poland

The magnitudes reported by Polish Seismic Network (PLSN) are usually magnitudes of local mining induced events from the territory of Poland. This is done namely by the stations at KSP, OJC and RAC. Magnitudes are also calculated from NIE, but they are reported only in the final bulletin which is sent to the ISC. Stations SUW, WAR and KWP do not participate in the magnitude calculations for Polish mining induced events. Effective since January, 1998, the moment magnitudes are calculated using formula :

$$M = 0.666 \log(M0) - 6.0$$

where *M0* - is seismic moment.
This, in turn, is calculated from long period spectral level using :

$$M0 = (4 \pi d v^3 R W0)/(FC RC)$$

where *d* - is density at source (assumed 3 g/cm3),
v - is velocity at source;
R - is distance to station;
W0 - is the spectral level;
FC - is radiation pattern coefficient assumed 0.4;
RC - is 0.52 for P wave and 0.63 for S wave.

This magnitude is denoted Mm, moment magnitude. This method of calculation is used on Pg, Pn,Sg, and Sn phases, but what goes into the bulletin is the Sg or Sn result, depending on which wave gives the largest amplitudes.

Since the calculation is made in the spectral domain, the question regarding type of amplitude measurements is irrelevant. The recordings used are velocity. The spectra are corrected. Damping is selected at a level so the spectra fit best to the theoretical model of Brune. The method is used up to 300 km distance, which is the approximate distance from Lubin to the stations NIE.
The instruments are short-period devices. Observatories at OJC and KSP use GS-13 seismometers. RAC and NIE use SM-3 seismometers.

The scaling relationship between these magnitudes and other magnitudes has not been studied. It is however known, that magnitudes determined by international organizations are generally higher by 0.3-0.4 unit of magnitude in case of Lubin events and 0.1-0.2 in case of Upper Silesia. PLSN does not perform routine magnitude determination for teleseismic events and regional events outside Poland. In those few cases that this is done, the following formula is used (peak-peak):

$$Ms = log(A/T) + 1.66log(d) + 3.3$$

or the magnitude is calculated by means of 'Seismic Handler' computer program developed by Klaus Stammler of Seismological Center Grafenberg. It may be interesting to note that for the few largest Lubin events that were observed at stations SUW (and lately at the new station KWP) at a distance about 500 km, the calculation of magnitude by the 'Seismic Handler' gave a result consistent with that of outside organizations and not with the moment magnitude.

Instituto de Meteorologia (IMP), Lisboa, Portugal

Fernando Carrilho (fernando.carrilho@meteo.pt)
Instituto de Meteorologia, Divisao de Sismologia, Rua C ao Aeroporto, 1700 Lisboa, Portugal

In the Instituto de Meteorologia, we monitor two main seismic areas, where we use different magnitude formulas: Portugal mainland\Atlantic Adjacent area and Azores islands area.
We compute local magnitudes as :

$$ML = log10(A) + a\ log10(D) + b\ D + c + S$$

where *A* - is the amplitude (in nm),
D - is the hypocentral distance (km),
a,b and c - are coefficients given below,
S - is a station correction.

We also compute coda magnitudes as:

$$MD = c1 + c2\ log10(C) + c3\ D + S$$

where *C* - is the duration (in seconds) of the record,
D - is the hypocentral distance (km),
S - represents station corrections,
c1,c2,c3 - are coefficients given below.

Amplitudes are measured on displacement traces, obtained from short-period velocity traces, high-pass filtered at 0.8Hz in order to resemble Wood-Anderson records, as the one-half the peak-to-peak distance on the largest single swing of the S or Lg wave, on all the available components. The amplitudes measured on the vertical components are empirically converted to horizontal multiplying them by 1.41. Some additional corrections, empirically obtained, are applied to individual stations in order to correct site effects. For each station, the magnitude is the mean value obtained over all the components, and the event local magnitude is taken as the mean magnitude computed over all stations.

Durations are measured on vertical short-period velocity records, from the first P-wave arrival until where the signal decays to the level of ground noise.

In the Portugal Mainland and Atlantic adjacent, the coefficients used in computation of local magnitudes are a=1.47, b=0.00022 and c=-2.52. The coefficients used for coda magnitude are c1=-0.78, c2=1.77 and c3=0.0011, obtained from the correlation with the PDE mb magnitudes. Both magnitudes are computed within distances up to 1000 km.

In the Azores area, we are not computing local magnitudes yet, since digital records are relatively recent and there are not enough data to compute appropriate attenuation coefficients. Coda magnitude is computed with coefficients c1=-0.87, c2=2.0 and c3=0.0035, for epicentral distances up to 500 km.

Institut Cartografic de Catalunya (ICC), Spain

Antoni Rocca (roca@icc.es)
Institut Cartografic de Catalunya, Parc de Montjuic, E-08038 Barcelona, Spain

The Catalan network (ICC) locates earthquakes in an area between 40º - 43ºN and 0ºW - 4ºE, corresponding to the North-East of the Iberian Peninsula and the half eastern part of the Pyrenees.

Before 1997, magnitudes were computed using the signal duration scaled to the magnitude computed by LDG (France) or by taken magnitudes proposed by the Observatoire Midi Pyrenees in Toulouse.

Since 1997 the computed magnitude is a local magnitude as defined by Richter (1935):

$$ML = 3DlogA - logA0$$

where *A* - is the maximum trace amplitude (displacement) recorded on a Wood-Anderson seismometer and,
logA0 - is a standard value as a function of distance where distance is < 600 km.
Available digital records correspond to ground motion velocity, recorded on short-period and vertical components.
Records are processed by a numerical Wood-Anderson simulation in order to obtain A. The maximum amplitude (zero to peak) of the largest phase is taken into account rather than the amplitude of a given phase. The final ML is computed by averaging the magnitudes computed for each station.
The method is applied for regional events with a distance D < 250 km), and ML < 5.
For larger magnitudes, short-period records are saturated,thus broad-band records and accelerograms are used for these particular cases. Currently, the network is being upgraded with broad-band, 3-component sensors with a continuous recording system. These records will be progressively introduced in the daily routine.
The ML values obtained are lower than the values obtained by LDG agency, especially for the lowest magnitudes. Comparison of values obtained between 1992 and 1997 give the following relationship:

$$ML(LDG) = 0.75\ ML(ICC) \pm 1.2.$$

Instituto Geografico Nacional (IGN), Madrid, Spain

IGN, General Ibanez de Ibero, 3 - E-28003, Madrid, Spain

The IGN is routinely using a Mb (S) formula to compute magnitude for regional events. It was obtained by fitting the mb(Lg) constants in order to obtain NEIC magnitudes. As a result we obtained two different formulaes:
$mb = 3.90 + 1.05\ log(D) + log(A/T)$ for D < 3º
$mb = 3.30 + 1.66\ log(D) + log(A/T)$ for D > 3º

where *D* - is the epicentral distance in degrees,
A - is the maximum amplitude of the Lg or Sn phase in microns,
T - is the corresponding period in seconds.
In cases where Lg propagation is blocked (due to an oceanic path greater than 2 or more degrees) as well as for teleseismic distances, the following mb (P) magnitude formula is applied:

$$mb = log(A/T) + correction\ (depth,\ distance)$$

where *A* - is the maximum amplitude of a P type phase (Pn or P) in nm;
T - is the corresponding period in seconds;correction(depth,distance) is the P attenuation factors according to Veith-Clawson (1972) filled with B factors beyond 100º.

The type of amplitude measurements is (A(peak-to-peak))/2. The type of recordings using for measurements is velocity digital records. No correction are being applied currently. Regional

magnitudes are computed from 0 to 15-20 degrees.
Measurements are made mainly on short-period vertical component analogue instruments (Kinemetrics SS-1, and MARK L-4). Broad-band data from one IRIS station (PAB, Streckeisen model STS-1), from two dial-up broad-band stations (Streckeisen STS-2, and Guralp GMC-3T, recording system MARS-88), and from the central broad-band station (Geotech KS54000) of the Sonseca Seismic Array located in Sonseca (Toledo) are also used. All the analogue signals are digitized before acquisition and analysis.
Location comparisons between IDC and IGN solutions, between 1 November 1995 and 29 February 1996, using 26 pairs of events located inland, have led to the following scaling relationship:

$$ML(REB) = 0.87\ Mb(IGN) + 0.7$$
with mean = +0.23 and standard deviation = 0.34.

For 13 events located outside the Iberian peninsula between 1 March 1996 and 30 June 1996, the comparison gave:

$$ML(REB) = 0.26\ Mb(IGN) + 3.21$$
with mean= +0.75 and standard deviation = 0.47

$$Mb(REB) = 0.64\ Mb(IGN) + 1.54$$
with mean = +0.35 and standard deviation = 0.30

In general, the differences between REB and IGN magnitudes are very small inside Spain and greater outside due to an understimation of the IGN formula for Lg amplitude.

For additional information, contact Emilio Carreño (emilio@ign.es).

Institut National de la Météorologie, Tunis, Tunisia

M'hamed Chadi
Service sismologique, B.P. 156, 2035 Tunis-Carthage, Tunisia

Magnitude formula applied: See below

Magnitude scale: Richter

Type of measurement: coda duration (F-P)

Type of amplitude measurement: no amplitude measurement.

Type of recording: velocity sensors;

Type of corrections: none;

Limit of application: up to 1000 km;

Instrument specifications: short-period seismometers;

Scaling relationships with other magnitudes: no scaling relationship established with other magnitudes.

For events recorded between 1975 and 1989, records from three stations were used. From 1975 to 1982, the magnitude was determined using the maximum amplitude of the trace (A in nm) and the S-P time using either the Richter magnitude scales (as modified by Eiby and Muir) or by applying the following formulas:

$$Ml = 0.67\ logA + 0.20\Delta + 3.80$$
(for $\Delta \leq 500$ km)

$$Ml = 0.60\ logA + 0.03\Delta + 5.00$$
(for $\Delta > 500$ km)

From 1982 to 1989, the calculation was done using the signal duration (D in sec.) and the epicentral distance (Δ in km). The magnitude was calibrated on the Mb provided by the NEIS by measuring signal from the onset time up to the time where the amplitude was twice the level of the natural background noise. The following relationships were derived by linear regressions for each of the stations:

For ml $\geq$ 3.4:

$Ml = 2.40\ logD + 0.04\Delta - 1.64$ (ZGN)

$Ml = 1.98\ logD + 0.11\Delta - 0.44$ (MBZ)

$Ml = 2.22\ logD + 0.12\Delta - 0.99$ (KCHT)

For ml <3.4:

$Ml = 1.80\ logD + 0.20\Delta - 1.31$ (ZGN)

$Ml = 0.64\ logD + 0.37\Delta + 0.54$ (MBZ)

$Ml = 2.10\ logD - 0.08\Delta - 1.54$ (KCHT)

Montenegro Seismological Observatory (PDG), Yugoslavia

Branislav Glavatovic (seismocg@cg.yu)
R. Burica 2 P.F. 196 – 8100 Podgorica, Montenegro, Yugoslavia

Two different magnitudes are computed by the Seismological Observatory.

Duration magnitude Md:

$$Md = Co + C1\ t + C2\ t^2 + C3\ D + C4\ log(AL)$$

where ***Ci*** - are the empirical coefficients calculated according to the large set of regional and local earthquake parameters: amplitudes measured on the short-period vertical seismometers in the Central station (PDG) and magnitude as an average of all regional stations ML magnitude. Co=2.003; C1=0.836; C2=0.3247; C3=0.000421; C4=1.0678;

AL - is the specific amplitude level expressed in micrometers (10-6 m) (for example 0.2*10-6 m) of the seismic signal on vertical short-period seismometer (S-13 teledyne Geotech 1 Hz sensor);

t - is the seismic signal duration time (in seconds) at the amplitude level of AL;

D - is the epicentral distance of the seismometer.

Local magnitude ML - by reduction to a Wood Anderson seismometer:

$$ML = log(Awa) + Mcor$$

where

Awa = A/qt

qt = Uo (Bo + B1 t + B2 t^2). qt is a function depending on the period t (expressed in seconds) of the maximum of seismic signal, calculated as a quotient of the S-13 short-period Teledyne Geotech vertical seismometer and Wood Anderson torsion seismometer response curves,

Uo - is the reference magnification level for the recorded seismic signal (usually 50000) at the frequency 2.5 Hz;

A - is the maximum amplitude level of the seismic signal;

Bo = 0.472;
B1 = -0.2254;
B2 = 0.0;

Mcor is the magnitude correction for the specific station, according to the empirical data.

The ORFEUS page

DEVELOPMENTS AT ORFEUS

Discussions on the ORFEUS operations have been vivid at the Birmingham IUGG99 meeting in July this year. During the ORFEUS workmeeting and meetings of three of its working groups; Station Siting, Technical Support and Software a number of issues came up. Below, please find a short selection of relevant issues:

Station code registration.

Apparently, a number of networks in our region operate stations with unregistered station codes. This can have unpleasant consequences for other stations with duplicated names. Therefore network operators are strongly urged to register their new station codes with NEIC to the attention of Bruce Presgrave (caracara@neic.cr.usgs.gov).

Broadband station overview.

An up-to-date overview over operational and planned broadband seismograph stations within Europe and the Mediterranean area can be found at the ORFEUS working group 1 web site. If you find a station incorrectly listed, please, contact WG 1 chairman Winfried Hanka (hanka@gfz-potsdam.de) or Torild van Eck (vaneck@knmi.nl).

PC-Shareware working group.

A new working group for seismological software for PC (DOS/WINDOWS) has been initiated. Its library is presently part of the ORFEUS Seismological Software Library and accessible at http://orfeus.knmi.nl. If you are interested to contribute, please, contact Mariano Garcia Fernandez (mgarcia@ija.csic.es) or Yih-Min Wu (ludan@ss2.cwb.gov.tw).

AutoDRM installations:

ORFEUS and the ETH/SED in Zürich started an initiative to install AutoDRM software at networks that have not yet the AutoDRM option available. The intention is to promote rapid (waveform) data exchange. Institutes willing to make their waveform data available and interested in receiving assistance in installing the AutoDRM software are requested to contact Reinoud Sleeman (sleeman@knmi.nl) or Urs Kradolfer (kradi@seismo.ifg.ethz.nl).

Near Real Time data exchange for archiving:

The Orfeus Data Centre (ODC) is automating and speeding up its archiving procedures. In co-operation with a number of networks we are testing schemes to format and transfer broadband waveform data to the ORFEUS Near Real Time (NRT) archives. If interested in participating in these procedures, please, contact Läslo Evers (evers@knmi.nl) or Bernard Dost (dost@knmi.nl).

GSE2SEED:

Version 1.0 of GSE2SEED, a program to reformat GSE2.0 format to full SEED is available from the ORFEUS software ftp site: orfeus.knmi.nl/pub/software/conversion/GSE2SEED. Still the conversion requires that all information (like response info) is available within the GSE format. If you have questions about this software, please, contact Reinoud Sleeman (sleeman@knmi.nl).

ORFEUS Electronic Newsletter vol1no3.

A new issue of the ORFEUS Electronic Newsletter is out. The first page is sent by email to those listed on our email list. The complete Newsletter is available on http://orfeus.knmi.nl/newsletter/. If you want to be included in this email list, please, contact Torild van Eck (vaneck@knmi.nl). The ORFEUS Electronic Newsletter aims at disseminating rapidly relevant information to the ORFEUS community within the European-Mediterranean area.

FORUM

EMSC information

Florence Rivière	Secretary General	+33-1-69267814	riviere@ldg.bruyeres.cea.fr
Sébastien Lacaze	Alert system / Data Exchange	+33-1-69267813	lacaze@ldg.bruyeres.cea.fr
Véronique Guerdet	Administration	+33-1-69267808	
Fax	Administrative matters	+33-1-69267000	
Fax	Seismological data	+33-1-64903218	
Alert messages			alert@ldg.bruyeres.cea.fr
Bulletins			csem@ldg.bruyeres.cea.fr
JSOP data and calibration data			jsop@ldg.bruyeres.cea.fr
Other matters			csem@ldg.bruyeres.cea.fr

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