Centre Sismologique Euro-Méditerranéen
European-Mediterranean Seismological Centre

Newsletter

N° 5 July 1994

Special Issue on Rapid Determination of Epicentres

EDITORIAL

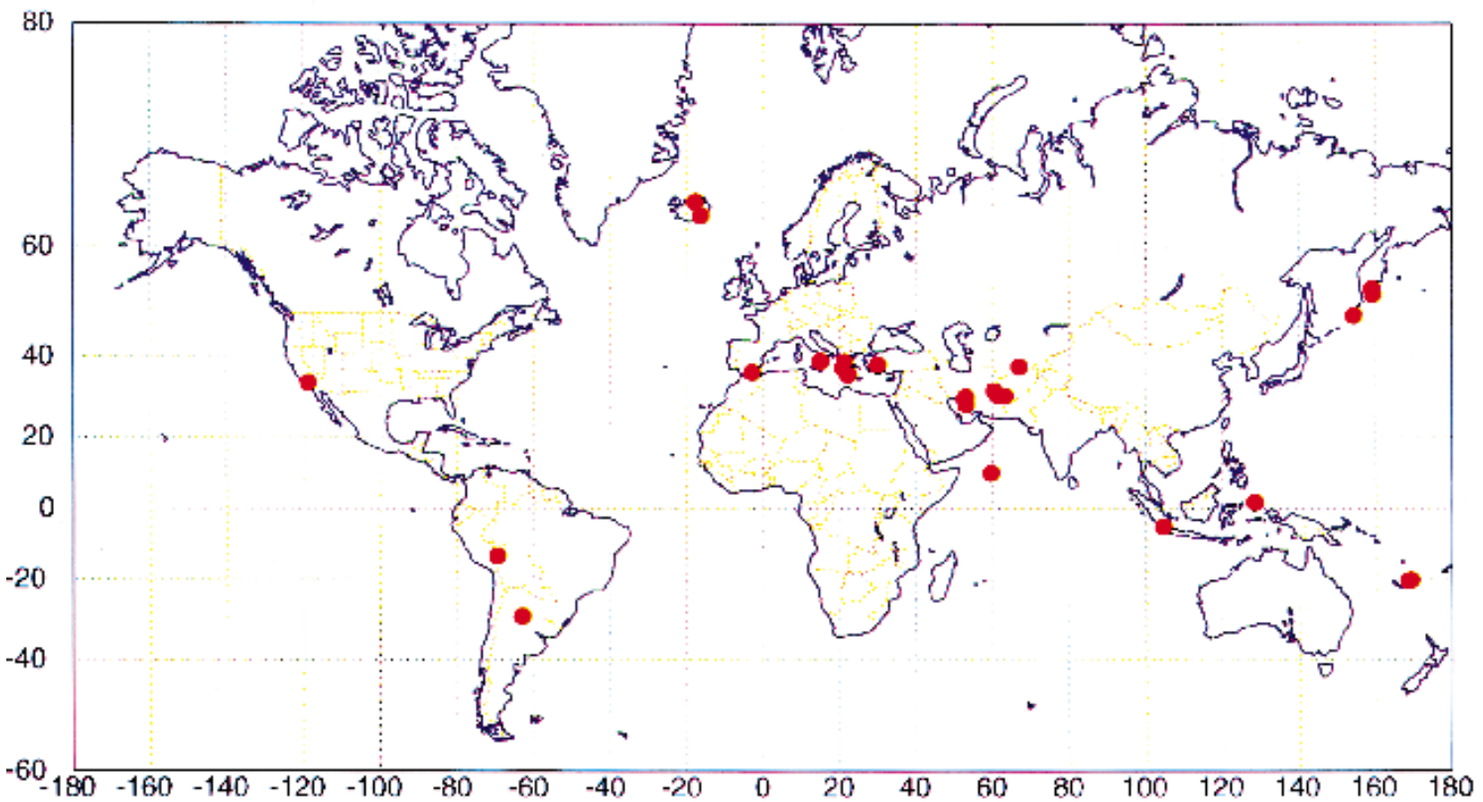
It is working. The new EMSC procedures for rapid determinations of larger earthquakes (M>5.5) have been in place for some 6 months in the hands of the 3 key nodal members: IGN (Madrid), ING (Rome) and LDG (Paris). This issue of the Newsletter focuses on the facilities available, the operating procedures used and the performance of the overall system.

By automatically transferring the data received from the contributors, the data sets of all 3 key nodal members are continuously updated. This new structure is of great benefit to the whole EMSC community. For example, if computers at one centre are down for a period, another element of the network can stand-in to maintain the service. This built-in redundancy of the network approach results in a highly robust operation with minimal chance of no coverage for rapid determinations. In order to ensure a continuing high level of performance, to avoid misunderstandings and maintain harmony, the key nodal members meet regularly in pursuit of the collective goal. In order to improve further both responsiveness and accuracy, the Secretary General of EMSC is positively encouraging the inclusion of more participants in the network of automatic data providers to the three key nodal members who maintain the rapid determination service.

During these first months of operation with the new structure of EMSC, we received very positive feedback from the scientific community, especially concerning the task of Rapid Determination of Epicentres. This is only the first step. In the near future, new projects will become operational such as the determination of earthquake source parameters and the access to the strong motion database. We are confident this will provide EMSC members with an even better service.

On behalf of the EMSC Executive and all of its members, I thank and pay tribute to the efforts and successes of IGN, ING and LDG who have achieved so much in such a short time from a standing start. Before and during this period, the principal officers of EMSC, Chris Weber (President), Rami Hofstetter (retiring Secretary General) and Bruno Feignier (Secretary General designate) have played critical roles leading to the success of the endeavour. We extend our thanks to them.

C. Browitt
Vice-President



EMSC Rapid Determination of Epicentres
Map of alert locations between 01/01/1994 and 06/05/1994

INTRODUCTION

The Rapid Determination of Epicentres (RDE) was selected as one of the most important tasks of EMSC by its members and the scientific community. It consists of disseminating rapidly (ideally within an hour) some basic information about strong earthquake occurences. To accomplish this task, the three centres exchange the data they receive from various contributors in order to keep their databases similar. Therefore, any of the three centres can be requested to take over the Rapid Determination of Epicentres at all times, although only one key nodal member is on duty. When an alert is triggered, a new location, taking into account all available arrival times, is computed. This location is then disseminated to EMSC members, data providers and the Council of Europe, along with the magnitude estimates given by the various seismological centres. This information is currently sent to over 130 addresses worldwide and is transmitted via e-mail (64%), fax (26%) and telex (10%).

KEY NODAL MEMBERS

The Instituto Geográfico Nacional (IGN), Madrid

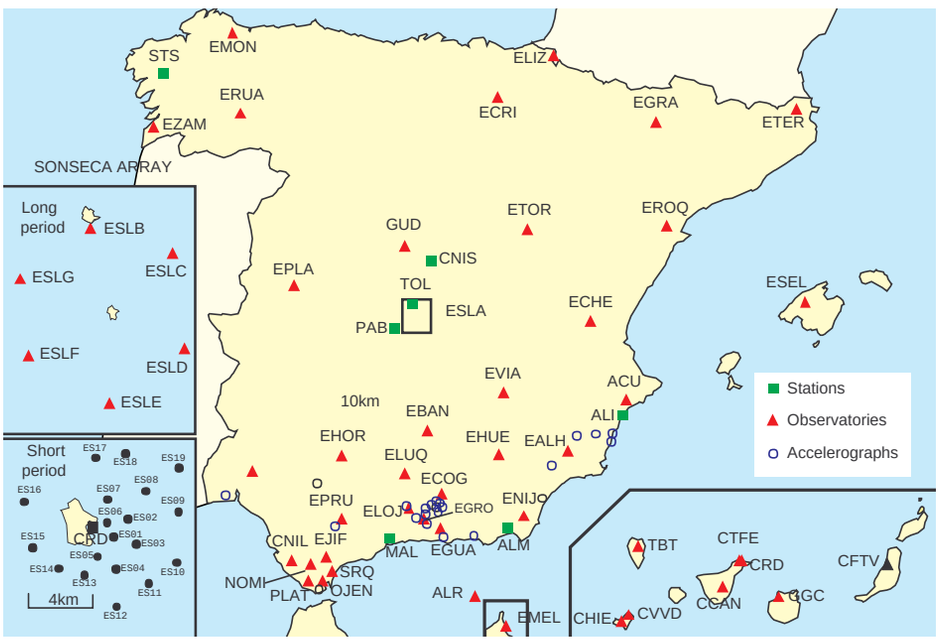
The Spanish National Seismic Network is composed of 30 telemetred short-period stations set up across mainland Spain, as well as in the Balearic and Canary Islands. At present, FM transmission takes place over leased telephone lines to the National Seismic Information Center (CNIS) in Madrid, where the data reception is carried out. Apart from the main network, a further seismic array - also recording in real time - is connected via a 9600 baud line to the CNIS in Madrid; it is formed of one broad band and 19 short-period vertical stations in boreholes, in addition to 6 long-period stations, distributed over an area of 25 km radius near Sonseca (Toledo) . In order to supplement these instruments, two IRIS stations, 3 broad band 16-bit resolution stations and a network of more than 35 strong motion digital instruments are distributed all over the most active areas of Spain.

The real time information is visualized on paper to check the signals. Digitized data from the short-period stations are fed into two different data acquisition systems. The first one is a DATASEIS system manufactured by Kinemetrics, which performs STA/LTA on different channels and records the events on tape. The second system, currently used, is based on the algorithm used by the United States Geological Survey (USGS) and the Istituto Nazionale di Geofisica (ING) whereby signal recognition is done in the frequency domain prior to the identification of seismic phases for automatic earthquake location. As soon as the location process is complete, the waveform data - as well as all additional information on arrival times, amplitudes and periods - are stored in a database for later studies.

The automatic location result is distributed by electronic mail and overprinted onto a digitized map of the area where the shock occurred; it is then disseminated by fax to the different users. To fulfill all the duties carried out by the center, a 24-hour year-round service is ensured by a staff of operators under the supervision of a geophysicist.

One of the most important tasks of the EMSC is the rapid determination of epicenters. The IGN (Madrid) currently receives seismic alerts and data from different national and international agencies besides the ones from France and Italy. When an EMSC alert is declared by a particular institution, the staff at IGN uses all available data concerning the event in order to confirm the alert. In such cases, the IGN is ready to disseminate the processed information throughout Europe if such a decision is made by the Coordination Bureau of EMSC.

All this information can be accessed by any user, by means of an X-25 or Internet connection, through the AUTODRM installed at the CNIS.



Map of the IGN seismic network.

Recording room at IGN.

The Istituto Nazionale di Geofisica (ING), Rome

The territory of Italy is one of the most seismically active area of the Mediterranean basin. As a result of the 1980 Irpinia earthquake, which killed several hundred people, the Istituto Nazionale di Geofisica (ING) was commissioned by the Italian Civil Defense Department to monitor the Italian seismicity and inform the Department as soon as possible about earthquake location and likely levels of damage.

To this purpose, the ING has established a monitoring room, offering a 24-hour service, which is equipped with a continuous seismic signal acquisition system developped at the ING in collaboration with the United States Geological Survey (USGS).

The ING has built up the size of its seismic network over the last fifteen years, nearly reaching the planned final number of eighty stations in 1993 (see figure). Meanwhile, the ING is also developping and installing local networks, equipped with high-technology digital broad-band stations, as well as setting up seismic stations in the neighbouring countries and over the whole Mediterranean area.

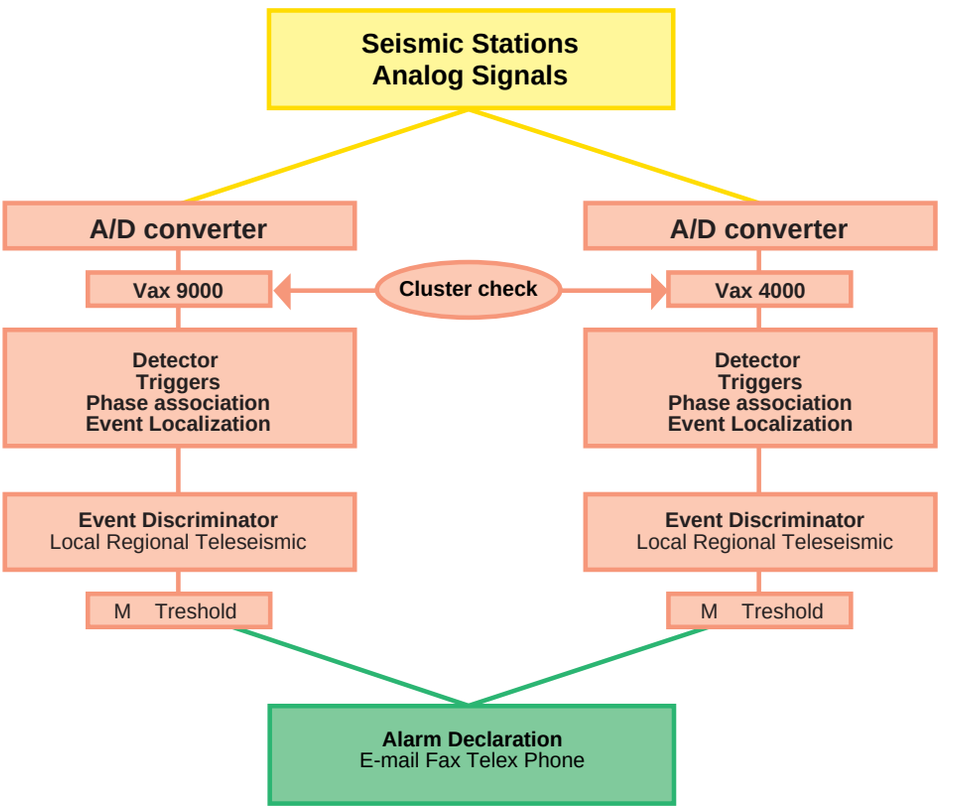
In its current operation, all the signals of the Italian Seismic Network are continuously transmitted along dedicated telephone lines to the ING centre, where the data is digitized, analyzed and stored in two different and independent acquisition systems (see figure).

Computer facilities at the ING include a Vax 9000, three VAX 6000 and some MicroVAX and HP Unix machines. This system is connected via DecNet, InterNet, BitNet, X25 and numerous modems to the majority of the scientific institutions worldwide.

These connections enable the mainframe computer (or the other acquisition system) to rapidly send out messages to all scientific institutions and organizations interested in source locations and arrival times of the most significant Mediterranean and teleseismic events.

At the beginning of 1993, the ING made a proposal to EMSC to carry out the Rapid Determination of Epicentres in collaboration with the IGN in Spain and the LDG in France. This offer was accepted in the framework of the new structure of EMSC adopted at the thirteenth EMSC assembly held in Rome on December 13, 1993. Consequently, the ING, IGN and LDG were jointly placed in charge of this task.

Map of the ING seismic network.



Schematic diagram of the acquisition system at ING.

The Laboratoire de Détection et Géophysique (LDG), Paris

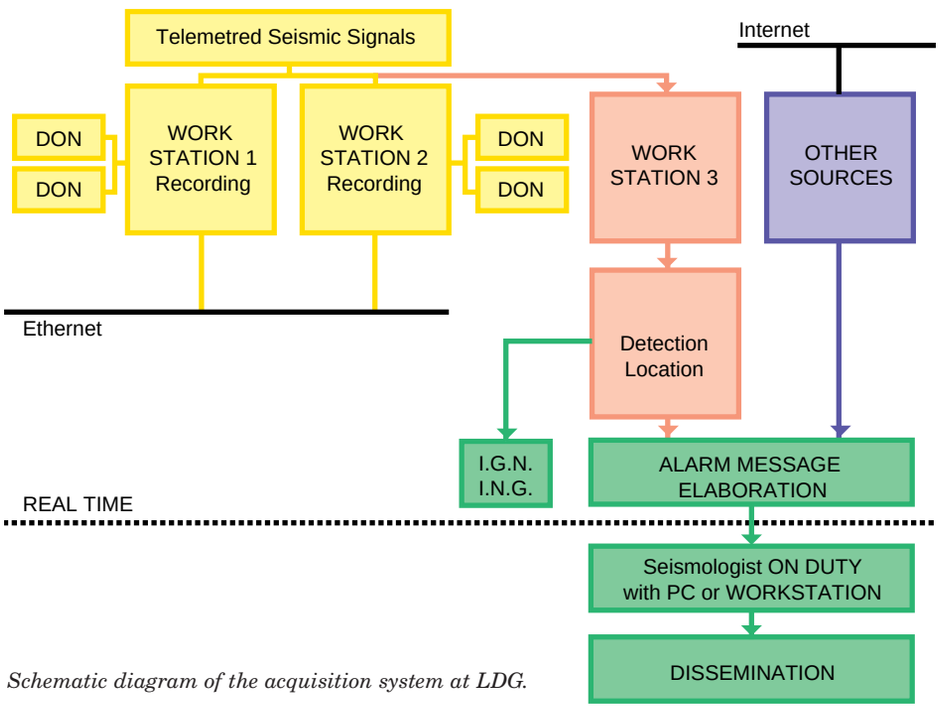
The Laboratoire de Détection et Géophysique (LDG) has been maintaining a seismic network since the early sixties. This network consists presently of 29 short-period vertical stations, one three-component station and some low-sensitivity channels, so that over 40 short-period channels are transmitted, using a sampling frequency of 50 Hz. Additionally, 5 three-component long-period stations, recorded at two or three different gains (around 40 channels), with a 1 Hz sampling frequency, are collected. All the data are telemetred to the LDG near Paris via herzian links through redundant ways.

After selection, the signals are recorded on paper and on opto-magnetic disks using Real Time Interfaces and two HP9400 work stations, each of which is equipped with two opto magnetic drives working in flip-flop mode. The two workstations are continuously supervising each other in order to achieve maximum recording security.

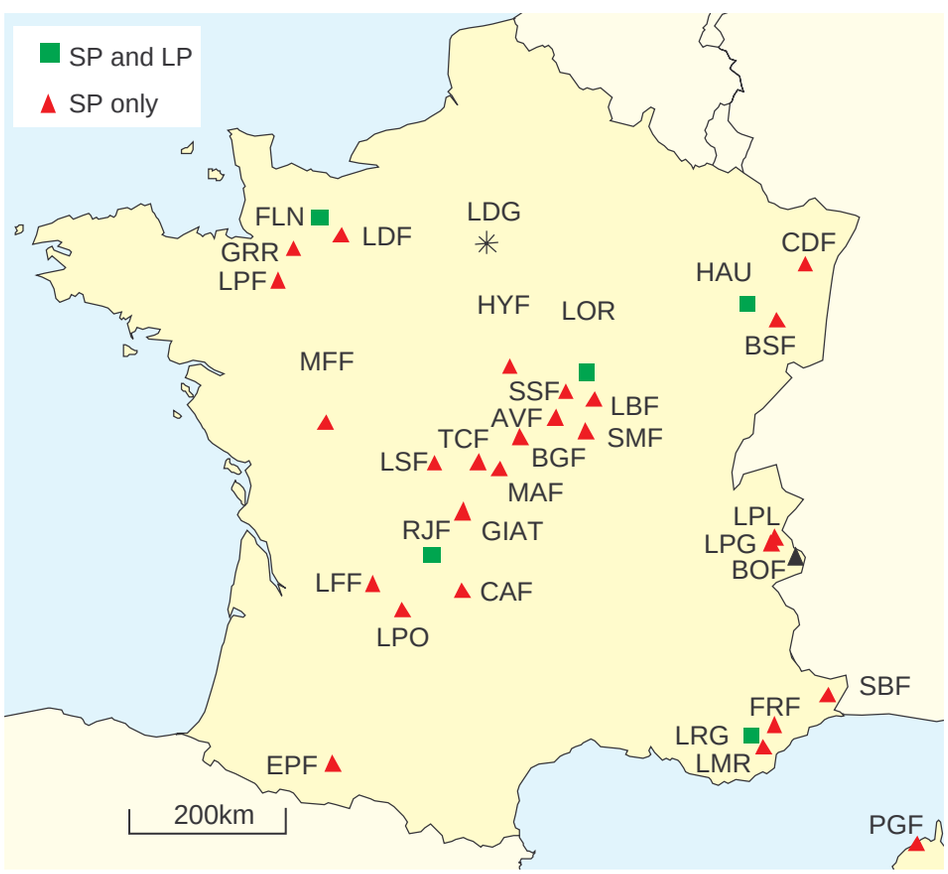
Since one of the duties of the LDG is to inform the national authorities of the occurence of large earthquakes, a third station is specially devoted to the automatic detection and location of such events.

Detection is based on a standard algorithm using the STA/LTA ratios of signals filtered in different bandwidths (one in the case of local earthquakes, the other in case of teleseismic events). An event is triggered when given thresholds are exceeded for a given duration by a given number of channels.

As soon as an earthquake is detected, a routine is applied for the picking of arrival times before running the automatic epicentre location program. If the magnitude of an event is greater than a threshold defined for the region, an automatic mail with automatically picked arrival times and location, is sent to the other key nodal members of EMSC. The seismologist on duty, equipped with a portable computer, PC or workstation, is automatically alerted. He must check the validity of the location and disseminate the relevant information to the French and European authorities as well as other EMSC members.



Schematic diagram of the acquisition system at LDG.

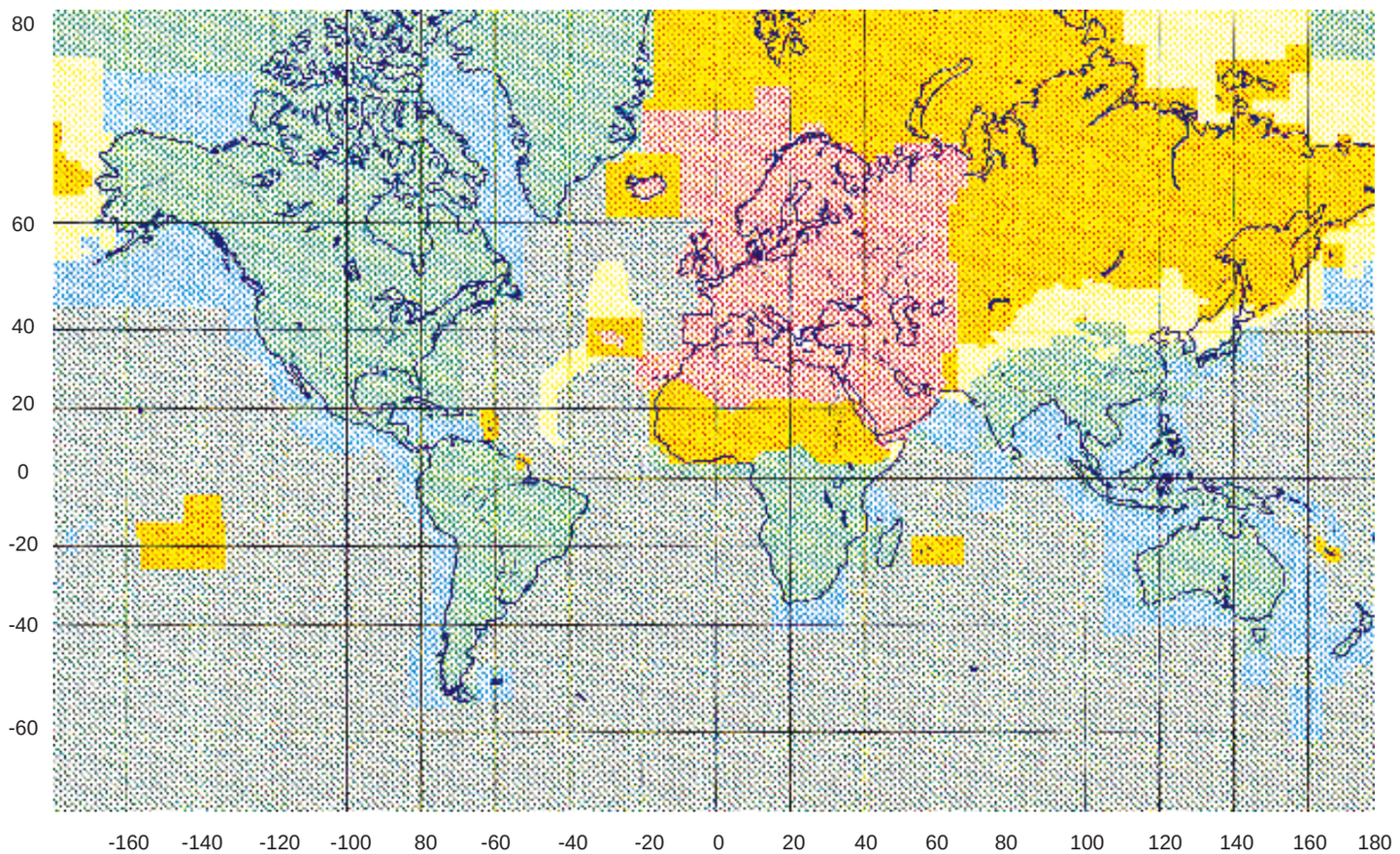


Map of the LDG seismic network.

RAPID DETERMINATION OF EPICENTRES: FIRST RESULTS

Alert triggering thresholds

As shown in the figure below, the thresholds to trigger the alarm vary with the geographical location of the earthquake. The magnitude has to be greater than 5.5 in the EMSC zone which covers from the mid-Atlantic ridge to the Urals in longitude and from the Arctic ocean to the southern part of the Mediterranean Sea in latitude. Then, the magnitude has to be greater than 6 for the countries taking part in the Open Partial Agreement (which covers most of the former Soviet Union). For the remaining continents, the threshold is generally set to 7. This set up allows to focus on the Euro-Mediterranean seismicity and also provide information about major earthquakes worldwide.



Magnitude thresholds for triggering an alarm :

White 5.3 ; Red 5.5 ; Amber 6 ; Yellow 6.5 ; Green 7 ; Blue 7.5 ; Grey 7.7

Rapid Determination of Epicentres (RDE) Data Contributors

With Thessaloniki joining a few weeks ago, twelve centres are currently contributing to the RDE by providing data in pseudo-real time through electronic mail. Only the messages received from these centres are automatically processed and can actually trigger the alert procedure, although other data, sent by fax or telex, can be added to the messages if they arrive in a time delay compatible with the RDE procedure. New data contributors are expected in the coming months and, in particular, tests are ongoing with the Obninsk Data Centre in Russia, thanks to the efforts of LDG (Paris) and CGDS (Moscow). The following table lists the data contributors and their associated codes used in the RDE messages.

Code	Institute	Country
FEIS	Fast Earthquake Information Service, Bochum	GERMANY
GERT	GERESS	GERMANY
INGL	Istituto Nazionale di Geofisica, Rome	ITALY
IPRG	Institute for Petroleum Research and Geophysics	ISRAEL
KAN	Kandilli Observatory	TURKEY
LDG or LDGM	Laboratoire de Détection Géophysique, Paris	FRANCE
MAD	Instituto Geografico Nacional, Madrid	SPAIN
NEIA or NEIR or NEIM	National Earthquake Information Service, Boulder	USA
NOR	NORSAR	NORWAY
SED	ETH Zurich	SWITZERLAND
THE	Thessaloniki Observatory	GREECE
YKA	Geological Survey of Canada, Ottawa	CANADA

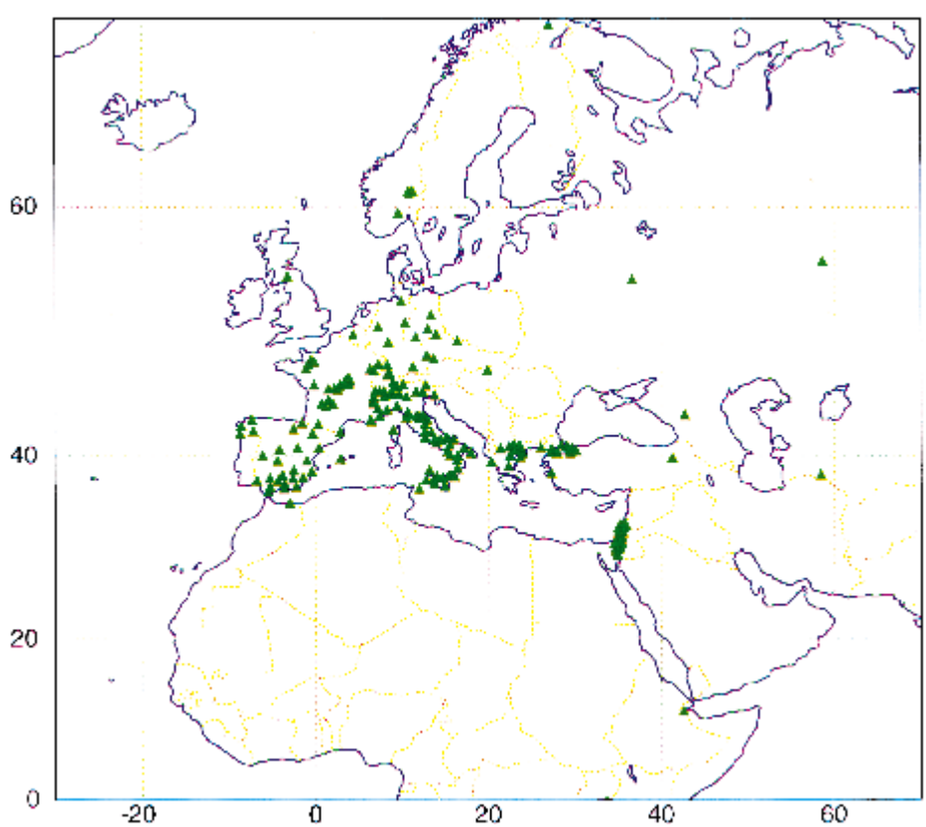
Alerts from 01/01/1994 to 06/05/1994

The figure displayed on the cover page of this issue presents the epicentre locations of the 27 alerts recorded during the first 4 months of operation. When EMSC alert locations are compared with the source locations computed by NEIS (in the Quick Epicentre Location Bulletin released approximately one week after the event), the location difference is less than 100 km for over 65% of the data. This result demonstrates that, even using fully automated phase picks, one can obtain accurate epicentre location, provided that a large number of data is available.

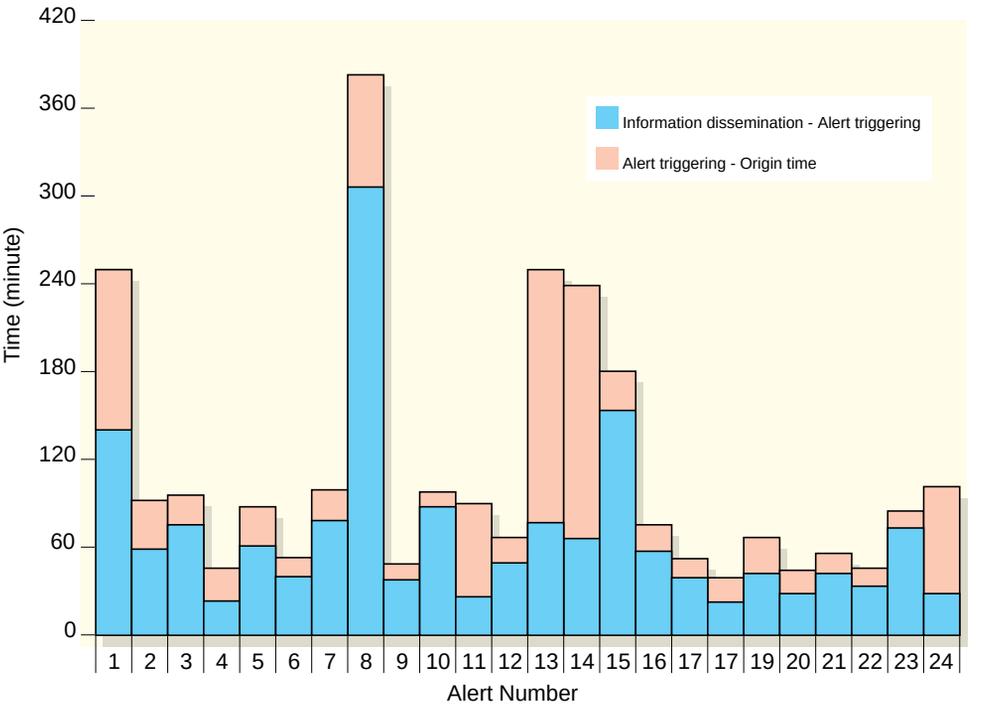
The figure on the right displays the seismic stations used for the RDE in the EMSC area, during the same time period. This map shows that, if Western Europe offers an excellent coverage, monitoring could still be improved by including stations from Eastern Europe and Northern Africa. In that regard, tests are being carried out with Russian seismo logical institutes to include their data in the RDE procedure.

EMSC - Rapid Determination of Epicentres

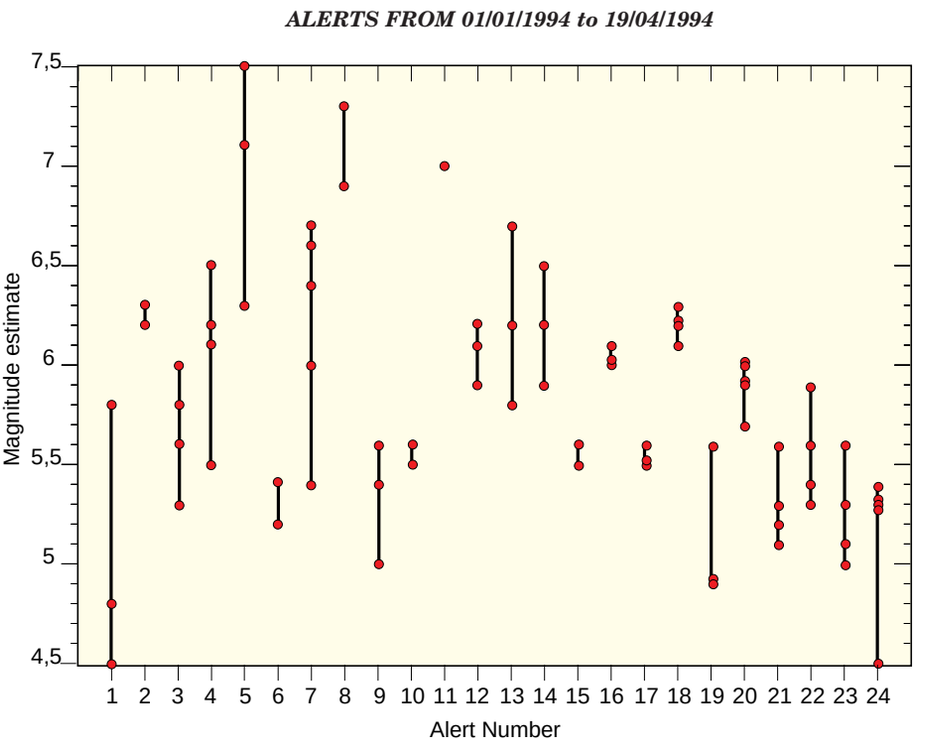
Map of seismic stations used from 01/01/1994 to 06/05/1994



Another goal of the RDE is to provide earthquake information in a short amount of time. The figure on the right displays the delays between the origin time of the event and the dissemination. For each alert, this delay has been split between the time needed by the algorithms to detect the event, locate it and trigger the alert procedure (shown in red in the histogram) and the time necessary to the seismologist to collect enough data to compute a reliable epicentre location (shown in blue in the histogram). It appears that, for 65% of the alerts, the whole process took less than 1.5 hour. For 35% of them, the one hour delay, which was set as the ultimate goal, was actually reached.



The figure on the right presents the different magnitude estimates that were received for each alert. In this figure only magnitude estimates of the same type (mb or M_S) have been plotted. In fact, mb have been used for all the alerts except for alerts 8 and 11 (respectively Halmahera and Vanuatu events) where M_S measurements were obtained. This figure shows a fairly important scatter for some events (over one order of magnitude). Consequently, IGN, ING and LDG laboratories set up a working group on magnitude estimates using the amplitude data from all three networks. It is hoped that other institutes will join this effort, allowing EMSC to provide a more reliable magnitude calculation.



PRELIMINARY CONCLUSIONS

Considering that this brand-new procedure has been in place for only a few months, these preliminary results are very encouraging. Not only has the alert system proven to be operational and reliable, but also RDE location results have shown to be accurate. By increasing the number of institutes automatically providing their data, we should be able to further improve the quality of the results and the rapidity of the dissemination.

Finally, further improvement of the overall system will come from the feedback that users give us. Therefore, we welcome suggestions and recommendations. Please address these, via e-mail, to csem@ldg.bruyeres.cea.fr.

FORUM

CALL FOR PAPERS

The EMSC Newsletter, in its new format, will be published 3 times a year. It intends to be an informative tribune open to the whole scientific community. The focus of the Newsletter will be mainly on topics such as data collection and exchange, real-time earthquake analysis, and seismological research related to the Euro-Mediterranean basin. Scientific papers dealing with such topics are welcome. Manuscripts must be in English, no more than 4-typewritten-page long and may include color figures. Publication will be free of charge, provided that the papers are camera-ready copies. Prior to publication, all papers will be reviewed by at least one reviewer.

CALL FOR DATA

The International Institute of Earthquake Engineering and Seismology (IIEES) in Tehran, Iran is interested in short and long period records of two events occuring on March 1, 1994 at 03:49 U.T. and April 3, 1994 at 06:52 U.T. located in Iran.

Contact person: Dr. Mehran Tiv, IIEES, PO Box 19395/3913, Tehran, Islamic Republic of Iran

Telephone: 21-275484, Fax: 21-4378732, Telex: 213419 DIFIR

DRM News

The Data Request Manager (DRM) of EMSC is on line and can be accessed freely. It contains all the data sent automatically by the data contributors via e-mail. To log on, use the following procedure:

telnet ldg.bruyeres.cea.fr

user: **emscdrm**

password: **emscguest**

NEXT ISSUE OF THE NEWSLETTER

The next issue of the EMSC Newsletter will be devoted to two other services offered by EMSC:

- The first part will focus on the task entitled «earthquake source parameters». This duty is taken over by the GeoForschungsZentrum (GFZ) in Potsdam, Germany. This service will be operational by the end of the year and will disseminate informations about the source mechanism of significant European earthquakes. The dissemination will be made through e-mail, a few hours after the Rapid Determination. The next issue will present some case studies of earthquakes that occured in early 1994.
- The second part will describe the Strong Motion Database. This service, operated by the Center for Geophysical Data Studies (CGDS) in Moscow, collects strong motion records from various sources and stores them in a database. Enquiries on the contents of the database and data requests should be addressed to A. Gvishiani, M. Zhizhin or A. Mikoyan at:

CGDS, PO Box 23, 109651 Moscow, RUSSIA

e-mails:gvi@cgds.msk.su, jjn@cgds.msk.su, mik@cgds.msk.su

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