ENCLOSURE 6

Draft minutes from Karlsruhe meeting

TOWARDS A FEDERATION OF BROAD BAND SEISMIC NETWORKS

by

A. Dziewonski and B. Romanowicz

Introduction

Seismologists from many parts of the world are now convinced that the time is appropriate to undertake a major initiative in instrumenting the surface of the Earth with a network of high quality modern seismographs. It is the realization of the compatibility of the efforts that begun nearly simultaneously in several countries that led to the meeting in Karlsruhe in April of this year. It was proposed at that meeting to form an organization that would aid in the coordination of national programs through establishing common instrumentation standards and a mechanism for the timely exchange of data.

Seismologists have always relied on free and open exchange of seismic data and international cooperation. Little of what we know today about the structure of the Earth's interior or the global pattern of stress release would exist if the mechanisms for sharing the data or observations were not instituted as early as the turn of this century. Nearly instantaneous analysis of global seismic data is now a social need considering the population growth in seismic and coastal areas. With the development of world-wide communication technology rapid access to seismic data from arrays of modern, broad-band digital seismograph systems, regardless of institutional and national boundaries, is now possible. With this concept national, social and scientific needs can be better met, with great benefit to all.

From a scientific point of view, a world-wide system of national, regional and global seismic stations tied by communication links to data centers and research institutions will make it possible to progress toward an understanding of our planet at an unprecedented rate. The global nature of seismology and the difficulty and expense of the endeavor require that seismologists and governments of the world cooperate to achieve these scientific and social goals.

Background

Contribution of seismology to our understanding of the structure and dynamics of the earth's interior has, at all times, been of prime importance. Seismic waves travelling through the Earth carry a wealth of information on the earthquake that generated them as well as on the internal structure. It has long been a dream of seismologists to be able to record with great precision the entire generated wavefield and efficiently exploit it for more accurate mapping of earthquake sources and fine structure of the mantle and core.

In the past few years, the advances in mapping the Earth's interior in three dimensions and spacio-temporal properties of seismic sources revealed how much more could be learned about our planet with properly deployed arrays of digital stations. At the same time, the technological developments made such plans entirely feasible.

There are now broad-band seismographs that allow registration in a single data stream the seismic signals from 10 Hz to tidal frequencies. These sensors are able to resolve ground noise at a quiet site and to record on scale, at distances beyond 30°, signals from the largest earthquakes: this corresponds to a dynamic range of 140 db. Modern analog-to-digital 24-bit encoders can convert this range of signals

without distortion introduced by gain ranging. Micro-computer technology allows us to develop station processors capable of performing many complex functions. Storage technology allows to record, archive and merge unprecedented quantities of data. Progress in telecommunications makes it practical to transmit large volumes of data in real time or nearly real time. Expansion of computer facilities, including super-computers, opens new possibilities with respect to the dimension of the data sets used and the complexity of the analysis.

Several nations have recognized the potential of these scientific and technological advances and are developing or planning to develop in the near future networks of such broad-band systems on a global, regional or national scale.

While all these networks will use similar instrumentation, each of them was conceived to address a different problem or to cover a different area. None of them, however, will ever be able to deploy enough instruments to fully resolve planetary scale problems, be it the details of the mantle or core's structure beneath the array, or the reconstruction of the source process of an important earthquake. A strong need has therefore developed to coordinate the individual efforts in order to make instrumentation fully compatible and data exchange as efficient as possible, for the benefit of all scientific projects involved.

Just as astronomers cooperate on an international scale to build a telescope of unsurpassed capabilities unaffordable by any one nation, or marine geophysicists use joint facilities to survey the ocean bottom, the idea naturally emerged to coordinate national efforts in an international federation of broad-band seismic networks. It was also felt that the time to do it was appropriate, since not all operational

decisions have yet been made: the ongoing projects can still modify their recording specifications and adjust station locations, while the networks in the planning stages can be designed to reflect the need for compatibiity within the global system of seismic networks of the new generation.

A first informal meeting was therefore called to establish the feasibility of forming such a federation and whether such a federation could benefit the individual national projects and the seismological community at large. It took place in Karlsruhe, FRG, on April 10-11, 1986 in the framework of the mid-term Symposium of the International Lithosphere Program (ILP), convened during the annual German Geophysical Society meeting. The Reporters on Global Seismic Networks of Working Group 6 -- B. Romanowicz (France) and A. Dziewonski (USA) -- were asked to organize this meeting. An invitation was extended to representatives to all countries that are deploying or are planning to deploy a broad-band digital network. The meeting was intended as a forum to exchange views on how to coordinate the various existing and planned efforts. It was chaired by M. Berry (Canada); the list of participants is attached at the end of this report.

The first session on April 10th was dedicated to a review of current plans for broad-band station or network deployment, followed by a discussion on the objectives and nature of the proposed federation. Issues addressed were whether specific standards should be defined for instrumentation and data rates, in what form and by what means the data should be exchanged and whether ILP was the appropriate organization to serve as an 'umbrella' for the Federation.

By the end of the session a consensus clearly developed that a platform was desirable to debate common interests, exchange and

coordinate plans for station deployment and that the main objective was the efficient and timely exchange of data from the different networks making the data available to the seismological community. It was proposed that a draft document reflecting the points of agreement of this session of the meeting be prepared, its terms to be debated and finalized the next day.

We shall first give a review of the current projects, as presented at Karlsruhe, followed by the statement of purpose for the formation of the Federation, agreed upon April 11th. Finally we shall give the proposed agenda for the next meeting and describe the actions which shall be taken in the meantime.

Review of current efforts

B. Romanowicz described the current status of the French digital global network GEOSCOPE: 11 operating stations, 3 in the process of installation, with the ultimate goal of 20-30 stations distributed worldwide, equipped with with 3 component STS seismometers (Wielandt and Streckeisen, 1982) and a microprocessor-based recording system. The current recording specifications are: continuous recording with 0.1 sps for the very long period (VLP) channel, triggered recording at 5 sps for the broad-band channel (BRB). The data are received at IPG in Paris by airmail and network tapes are made available for outside distribution with a format similar to the GDSN network tapes. In addition, two stations are equipped with quasi-real time telemetry using a packet switching communication system (France, Guyana) and this will be extended to about 10 stations. Future plans include modification of the stations to very-broad-band (VBB; Wielandt and Steim, 1986) and possible increase of data rates.

R. Masse presented the current plans of the United States Geological Survey (USGS). The USGS cooperates with China in establishing a network of 9 three-component broad-band stations equipped with STS seismometers. [The Chinese seismologists are interested in the concept of the Federation, have asked to be informed about the developments in Karlsruhe and have indicated that they might participate in future meetings.] The instruments are in place and the network should be operational soon. The data tapes will be sent to Beijing where data will be merged. Later, they will be included on the GDSN network day tapes and, in addition, time windows for events of magnitude 5.5 and greater will be added to the USGS event tapes.

The Global Telemetered Seismic Network (GTSN) will comprise 4 stations in Africa, 4 in South America and 1 in Antarctica, equipped with KS 5400 borehole seismometers with a VBB velocity response. The data will be transmitted by real time telemetry and received in Albuquerque and the program should be complete in 1989. Finally, there is a plan for a broad-band network across the U. S. of about 20 stations. Masse concluded by stressing that the event tape program of the current GDSN has proved successful: 25 countries are presently receiving the tapes.

The IRIS (Incorporated Research Institutions for Seismology) plans were presented by its president, S. Smith. IRIS is a consortium of 50 U. S. universities; in aspects related to global seismic network it has established close cooperation with the USGS. The initial IRIS plan was to deploy 100 3-component broad-band stations globally distributed as evenly as possible. Real time telemetry would be used at least in North America. The first step will be upgrading 5 DWWSSN sites in the fall of 1986 with STS seismometers. Within the next 5 years, 25 WWSSN/IDA and

11 SRO/ASRO stations will be upgraded and 12 new sites developed in addition to a denser than average deployment within the continental U. S. The data will be received at an IRIS/USGS Data Collection Center in Albuquerque and, in addition, an IRIS Data Management Center will be developed for rapid dissimination of data to the users.

E. Husebye described the plans of ORFEUS (Observatories and Research Facilities for European Seismology). This project was initiated in 1984. Its first goal is to establish a data center for merging data from all broad-band digital stations in Europe, and to distribute them in the form of event tapes. It should be operational in 1988 and will then collect data from about 50 stations. A Science Plan is now available for this project.

H. Berckhemer presented the plans of the Federal Republic of Germany (FRG). The Graefenberg array was the first broad-band network to be equipped with STS seismometers and has been operational for 10 years now. The plan for the next 3 years is to expand it into a national network of 20 broad-band stations with an aperature of 400 km. The stations will be autonomous, can be accessed directly and the data retrieved by anyone through a data switching network (DATEX). Continuous data are kept at a station for 2 weeks; they will also be sent to a central facility in Erlangen for archival on laser disks. The Graefenberg array is the contribution of the FRG to ORFEUS and the global digital network. In addition there are plans to install a few broad-band stations in southeast Asia and the USSR. One station equipped with STS seismometers already exists at Roorkee (India), as reported by S. Duba.

M. Berry presented the plans for Canada: an array of 4 three-component broad-band stations in Yellowknife and project CANDIS

-- a broad-band national network of about 12 stations, 4 of which have now been funded and will be installed within the next two years.

E. Boschi reported on one operational very broad-band station in l'Aquila, Italy. The station uses STS seismometers and the station processor is based on the Harvard design. It records continuously VBB data at 20 sps; in addition long period data (1 sps) and very long period data (0.1 sps) are derived through on-line digital filtration. The Istituto Nazionale di Geofisica may deploy several other stations of this type in the near future.

M. Cara briefly presented plans for a mobile array of broad-band stations plus one fixed station in France, in addition to GEOSCOPE.

G. Nolet described the NARS portable array of the Netherlands, comprising ~~20~~ 14 broad-band stations forming a linear array across western Europe and operating now for 5 years. The recording is on an event basis and the data, starting in 1985, are included in the event tapes of the USGS. The network will be moved to Spain for one year in 1987.

N. Shimazaki, who represented the Japanese seismologists as an observer, described the current plans in Japan. There will be a GEOSCOPE station in the last quarter of 1986. A group of seismologists in Japan is currently forming an organizational structure appropriate for participation in the worldwide effort for broad-band station deployment.

Efforts of Belgium to install several broad-band stations in Africa were mentioned as well as possible plans in Australia; the Australians have indicated interest in participating in future meetings.

Statement of Purpose

The following text describing the objectives of the Federation was unanimously approved at the meeting on April 11, 1986.

FORMATION OF A 'FEDERATION OF DIGITAL BROAD-BAND SEISMOGRAPH NETWORKS'

The international seismological community recognizes new opportunities within its field for improved understanding of the internal structure and dynamical properties of the Earth provided by recent developments in seismograph network technology.

It also recognizes that rapid access to seismic data from arrays of modern broad-band digital instruments, wherever they might be, in now possible.

The developments include greatly improved broad-band seismographic systems that capture the entire seismic wave field with high fidelity, efficient and economical data communications and storage, and widely available, powerful computing facilities.

In view of the above, and to take advantage of existing developing global and regional networks, it is considered that the Federation be formed to provide a forum for:

-- developing common minimum standards in seismographs (e.g. bandwidth) and recording characteristics (e.g. resolution and dynamic range);
-- developing standards for quality control and procedures for archiving and exchange of data among component networks;
-- coordinating the siting of additional stations in locations that will provide optimum global coverage.

The Federation welcomes the participation of all institutions committed to the deployment of broad-band seismographs and willing to contribute to the establishment of an optimum global system with timely data exchange.

Plans for the founding meeting

It is expected that the Federation will be formally established at a meeting to be held in Kiel during the EGS-ESC Joint Assembly Meeting, August 21-30, 1986.

It was recognized in Karlsruhe that each of the three main objectives of the Federation, as stated in the text above, should be the subject of further consultation and discussion and that some preparation is needed before the next meeting. The Agenda proposed for this meeting is as follows:

1. General specifications of broad band systems (desirable and minimum) will be addressed and agreed to.
2. Specifications for data collection (e.g. event versus continuous recording) and standard procedures for for data exchange (formats, etc.) will be addressed and agreed to.
3. Review of siting plans for various networks; it is expected that involved national programs will attempt to reconcile possible duplications of effort.
4. Election of a chairman and an executive committee of the Federation.

In the meantime, E. Wielandt (Switzerland) will prepare a document on Item 1 above and gather comments from other experts. A group

comprising representatives of IRIS, ORFEUS, Graefenberg Array and GEOSCOPE will examine Item 2. Prospective members of the Federation are asked to come to the next meeting with a document describing the long term plans for their networks, in order to address Item 3.

Finally, it was agreed that, in its initial stage, the Federation could profit from being associated with an existing international organization recognized by ICSU. M. Berry will write to K. Fuchs, the President of ILP, asking him to investigate the practical aspects of how ILP could provide a 'home' for the Federation.

The Karlsruhe meeting ended on an enthusiastic note of willingness to cooperate and a feeling that the Federation existed in fact.

The founding meeting in Kiel will be chaired by H. P. Harjes, Institut fur Geophysik, Universitatstr. 150, D-4630 BOCHUM, FRG. He should be contacted for statement of intent of membership in the Federation and participation in the meeting. This report serves as both announcement and invitation to the founding meeting.

Barbara A. Romanowicz
Institut de Physique du Globe
4, Place Jussieu
75230 Paris CEDEX 05
FRANCE

Adam M. Dziewonski
Department of Earth and Planetary Sciences
Hoffman Laboratory
20 Oxford Street

Harvard University

Cambridge, MA 02138 USA

List of participants of the Karlsruhe meeting:

D. Anderson (USA)
P. Basham (Canada)
H. Berckhemer (GRF)
M. Berry (Canada, ISC)
E. Boschi (Italy)
M. Cara (France)
B. Dost (The Netherlands)
H. Durbaum (FRG)
A. Dziewonski (USA, IRIS)
K. Fuchs (FRG, ILP)
H. Harjes (GRF, IASPEI, ISC)
E. Huntig (GDR)
E. Husebye (Norway, ORFEUS)
R. Kind (FRG)
R. Masse (USA)
St. Mueller (Switzerland, IASPEI)
G. Nolet (The Netherlands, ORFEUS)
J. Oliver (USA, ILP)
B. Romanowicz (France)
N. Shimazaki (Japan)
S. Smith (USA)
E. Wielandt (Switzerland)
W. Zurn (FRG)