NORSAR

NORWEGIAN SEISMIC ARRAY

Seismology and Disarmament

To achieve a nuclear Comprehensive Test Ban Treaty (CTBT) has been a major aim of international disarmament negotiations for more than two decades. The Limited Test Ban Treaty of 1963 prohibited nuclear explosions in the atmosphere, in outer space and under water. The treaty did not comprise underground nuclear tests since the verification possibilities were not seen as adequate at that time.

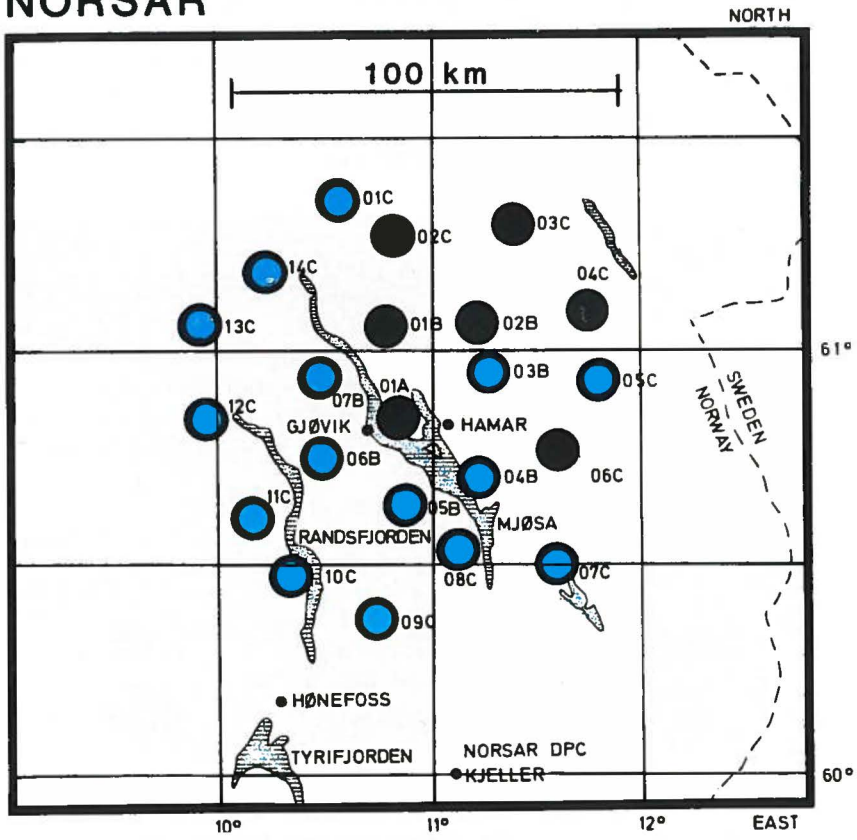
Underground nuclear explosions can, at a distance, only be detected through observation of the strong pressure waves that are generated, and that propagate through the interior of the earth in a way similar to waves generated by earthquakes. This is the reason why seismology, which is the science that deals with earthquake signals, has achieved a central position in the further work toward establishing adequate verification procedures for a potential CTBT.

The Norwegian Seismic Array (NORSAR)

In 1967, the United States government proposed to Norway the construction of a large seismic observatory on Norwegian soil. The observatory was to be a so-called array station, comprising more than 100 seismometers deployed in a spatial pattern over an area of about 100 km in diameter. Such a seismic array would act as a huge antenna, being able to focus on signals from seismic events in various regions of the earth, and thus locating these events as well as suppressing «noise» disturbances originating from other sources (e.g., wind and sea waves).

In May 1968, the Norwegian Government accepted the United States proposal, and the Norwegian Seismic Array (NORSAR) was constructed during the years 1968—70. NORSAR has since been in continuous operation, and the observatory has so far recorded more than 50.000 earthquakes worldwide besides reporting more than 400 presumed underground nuclear explosions, conducted by the US, USSR, UK, China, France and India. NORSAR produces a monthly summary of recorded seismic events, which is distributed to seismological agencies in more than 25 countries.

NORSAR



The Norwegian Seismic Array (NORSAR) is located in southeastern Norway as shown in the figure. The array comprises 22 subarrays, 7 of which are currently in operation (filled circles). Data from the subarrays, which each consists of 9 seismometers, are transmitted to the data center at Kjeller for subsequent analysis.

The NORSAR observatory is administered by the Royal Norwegian Council for Scientific and Industrial Research (NTNF). The operation costs are covered by the United States, while the research activity is funded jointly by the United States (through the Defense Advanced Research Projects Agency) and Norway (through NTNF and the Norwegian Ministry of Foreign Affairs). NORSAR is today one of the world's largest and most advanced seismological observatories. The array is situated in a favorable

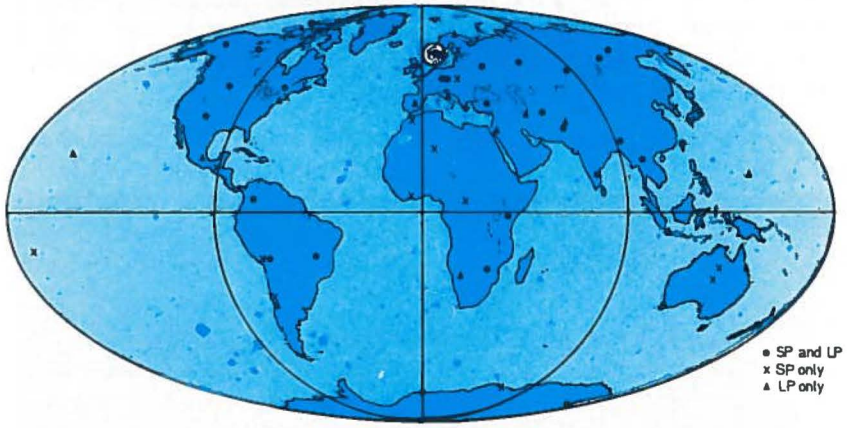
geological area, well removed from major earthquake zones, and its event detection capabilities are excellent for most of the northern hemisphere. For many regions of the world, the NORSAR detection performance is unsurpassed today. Research work at NORSAR is continually being conducted toward even further improving system capabilities.

At the NORSAR data processing center, the signals recorded by the array are analyzed using advanced computer equipment. From the panel shown on the figure, the analyst can view the recorded signals in real time, besides conducting necessary calibration functions in order to ensure high quality operation.

The Seismic Expert Group of the Committee on Disarmament

In 1976, the Conference of the Committee on Disarmament (the CCD) established an **Ad Hoc** Group of Government-appointed scientific experts to consider international co-operative measures to detect and identify seismic events, so as to assist in the verification of a potential CTBT. Norway has through the contributions by NORSAR scientists participated actively in the work of the **Ad Hoc** Group from the very beginning.

The **Ad Hoc** Group has recommended the establishment of a global network of more than 50 high quality seismic stations, in which NORSAR will play a key role. Under its current mandate by the Committee on Disarmament (the CD), the Group is now further pursuing its work by elaborating in detail how such a global system should be operated. A crucial question in this connection is how to obtain rapid, reliable international exchange of the large data volumes that would be accumulated. As a national contribution, Norway has undertaken to develop a suitable system for such exchange, and this work, which is based upon the technical experience with data transmission achieved at NORSAR, has given promising results.



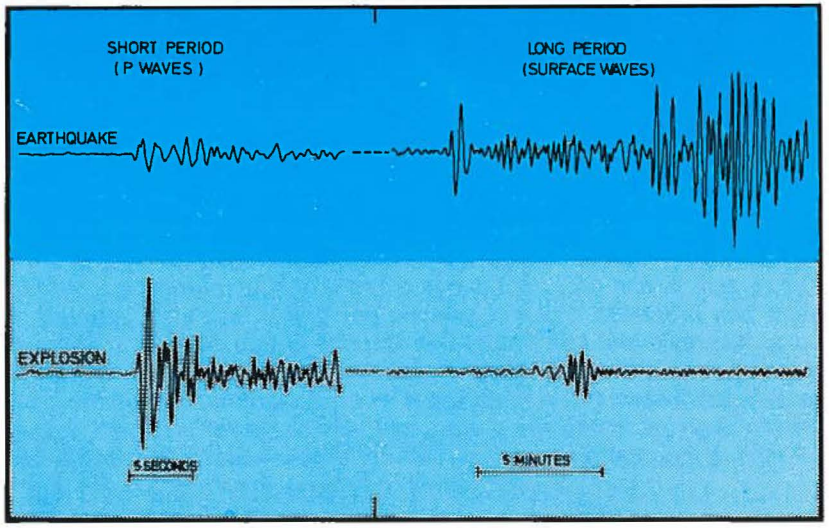
The seismic expert group established by the UN Committee on Disarmament has proposed a global seismic network to assist in verifying a comprehensive test ban treaty. The stations in this network are shown on the figure, and the NORSAR array is marked with a circle. The different symbols correspond to different types of stations, as indicated. SP means short period seismometers, suitable to record pressure waves, LP means long period seismometers suitable to record surface waves.

Research at NORSAR

The main purpose of NORSAR is research and experimentation toward achieving adequate verification of a CTBT. Toward this goal, Norway has aimed at developing the observatory into an international center for research in seismology, and visiting scientists from more than 20 countries (eastern, western as well

as non-aligned states) have conducted research work at NORSAR, over time periods ranging from one week to more than a year.

The results of these research efforts have been significant, and are manifested in more than 320 publications and technical reports originating at NORSAR over the past 10 years. Among these contributions have been improved techniques in detecting and locating low magnitude seismic events and improved methods to discriminate between low magnitude earthquakes and low-yield nuclear explosions. The emphasis on small seismic events is not incidental, in fact the major obstacle in verifying a CTBT today is the fact that low-yield nuclear explosions may remain undetected by seismological means, and even if detected, may be extremely difficult to positively be identified as explosions (and not earthquakes).



Seismic signals are recorded both from earthquakes and underground explosions. As shown on the figure, a typical earthquake signal (top) and an explosion signal (bottom) have different characteristic features, which may be used to discriminate between these two types of sources. In particular, the ratio between long period and short period signal energy for a detected seismic event is an effective discriminant.

The NORSAR research efforts have also comprised more general seismological problems, in particular the application of seismic techniques in exploration for oil, gas and ore resources. Research is also being conducted in assessing earthquake hazard for vital industrial installations, such as nuclear power plants, large dams and offshore oil platforms and pipelines.

Future Perspectives

During the United Nations First Special Session on Disarmament in 1978, Norway made a commitment to provide the NORSAR observatory as a station in a global network to verify a potential comprehensive nuclear test-ban agreement. NORSAR will in addition be able to act as an international data center within such a system, should this be desired. Based on the seismological expertise accumulated at NORSAR over the years, Norwegian scientists can furthermore contribute to the scientific assessment of the recorded data, in order to verify that a CTBT is adhered to. Thus Norway will, through NORSAR, be in a position to give a significant contribution toward achieving a comprehensive test ban, which is a task of utmost importance in the overall perspective of nuclear disarmament.

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