Potential civil and scientific applications

Tristan da Cunha: An example of using CTBT data

The International Monitoring System (IMS) uses seismic, hydroacoustic, infrasound and radionuclide monitoring technologies capable of detecting evidence of nuclear explosions underground, underwater and in the atmosphere in order to monitor compliance with the Comprehensive Nuclear-Test-Ban Treaty (CTBT). These verification technologies, together with the data, technologies and products of the International Data Centre (IDC), have potential civil and scientific applications which can provide significant benefits to States and the international scientific community.

On the night of 29/30 July 2004, the 300 inhabitants of the remote island of Tristan da Cunha were disturbed by a sequence of earthquakes, evoking terrible memories in the older residents of the 1961 eruption and the subsequent evacuation.

As reported in the last issue of *CTBTO Spectrum*, a Provisional Technical Secretariat (PTS) team installed three International Monitoring System (IMS) stations – infrasound, radionuclide and hydroacoustic – on the island in late March. Shortly after installation, the data were used in what is possibly the first application of CTBT data for disaster mitigation, thus serving as an example of civil and scientific applications of CTBT verification data.

Tristan da Cunha is an active volcano, 13 kilometres in diameter and rising two kilometres above sea level. The first report of possible new activity came from the station operator. Then PTS staff examined the data from the hydroacoustic station HA09 which, being a T-phase station, is perfectly suited to record seismic signals from nearby earthquakes (see Figure 1.) They established quickly that the recorded signals were typical of an earthquake swarm associated with a volcano. The peak in the earthquake activity, however, had already passed and activity was slowly dying down.

It was possible to determine that the earthquakes were located somewhere to the south and east of Edinburgh, the island's only settlement, and between 30 and 40 kilometres away. Since Edinburgh is on the north-west shore of the island, the earthquakes could have occurred deep beneath the volcano. They could also have occurred at a shallower depth, offshore to the south-east, an interpretation supported by reports of volcanic rocks (pumice) floating in the water near the island.

The British Geological Survey (BGS) sent a scientist to the island to investigate the reports and examine the pumice. She determined that the pumice was fresh and was typical of an underwater eruption. This, together with the IMS data, indicates that there had been an eruption from an unknown underwater volcano, somewhere to the south-east of Tristan da Cunha.

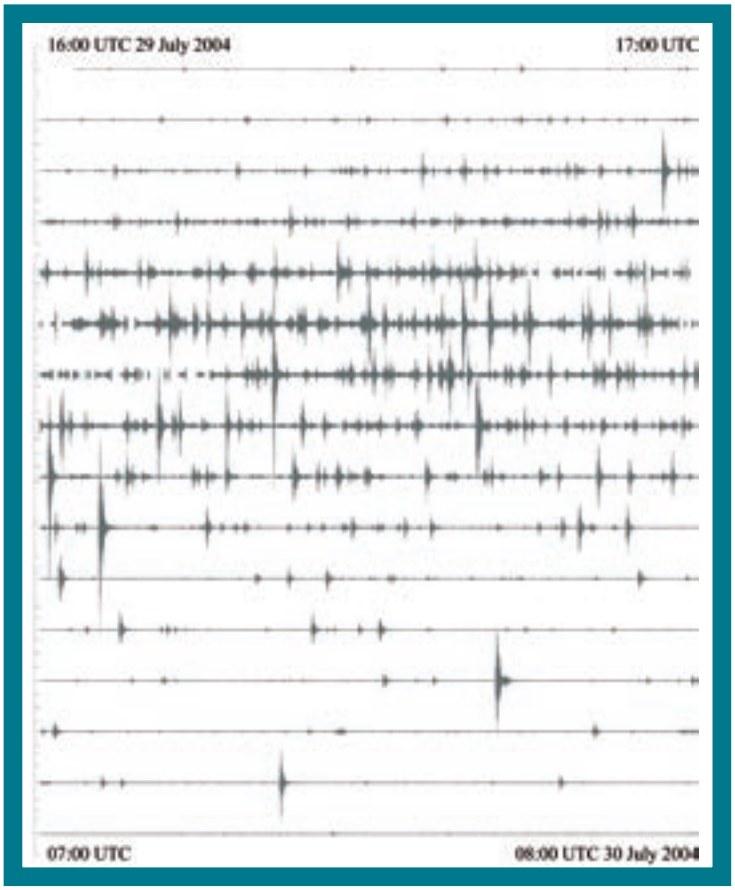

FIGURE 1: SEISMIC PLOT SHOWING THE SEISMIC ACTIVITY RECORDED BETWEEN 16:00 UTC ON 29 JULY 2004 AND 08:00 THE NEXT DAY. THE DATA SHOWN ARE FROM THE VERTICAL COMPONENT OF H09W1. EACH LINE REPRESENTS DATA COLLECTED OVER ONE HOUR; 16 CONSECUTIVE HOURS OF DATA ARE SHOWN; DATA ARE PLOTTED AT THE SAME AMPLIFICATION.

HA09 data is now being forwarded to the BGS so it can monitor the volcano. At the time of writing, several months after the eruption, small earthquakes continue to be recorded at a declining rate.

This example merits close examination by anyone interested in the civil use of the CTBTO verification technologies. If IMS data are to be used to monitor a nearby volcano, the data need to be available in real-time at the responsible technical institute. Furthermore, the procedures for monitoring and interpreting the data need to be established in advance, so that authorities will be able to react rapidly to a developing situation. Natural disasters, unfortunately, do not normally give enough warning for this to be done ahead of time. ■

CTBT contribution to global seismology ...

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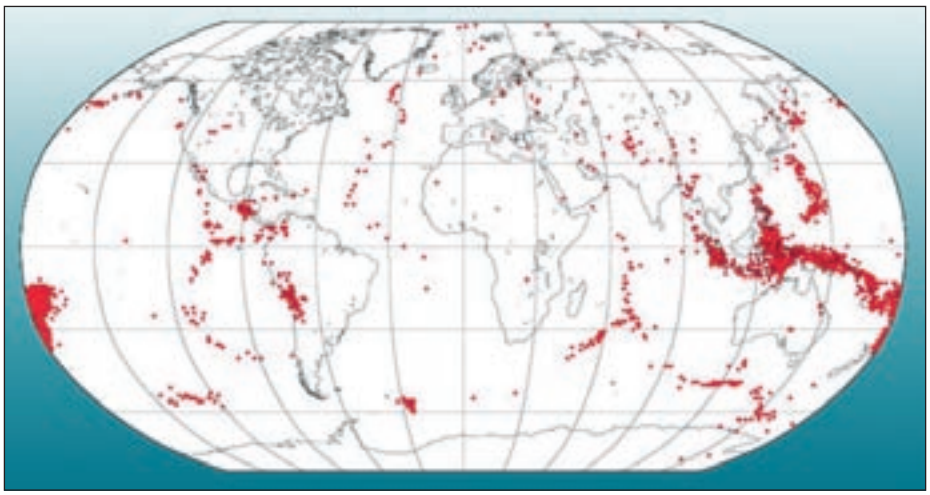

FIGURE 2: LOCATIONS OF EVENTS WHICH OCCURRED IN 2001 AND WERE ONLY REPORTED TO THE ISC THROUGH THE IDC REVIEWED EVENT BULLETINS

globe. The Centre's main task is to re-determine earthquake locations and magnitudes, and to search for previously unidentified earthquakes. More about the ISC and its products can be found on its web site: www.isc.ac.uk.

In recent years, the most significant new contributions to global seismology have been the installation of the global IMS seismic network and the release of the parametric data by the IDC, which are systematically included in the ISC Bulletin. In many cases, the IDC locations serve as first approximations to the ISC location procedures and the IDC phase readings help improve the accuracy of locations in the ISC Bulletin, thus providing the seismological community with increasing numbers of observations and accurate data which are used in seismological research.

Despite the relatively small number of IMS stations, about 10% of the phase readings in the ISC Bulletin come from the IDC and help in event location. Furthermore, thanks to the IDC's careful analysis procedures, the ISC Bulletin is enriched with many events that are not reported by any other seismological agency. The map in Figure 2 shows the locations of events reported in the 2001 ISC Bulletins that were only reported by the IDC. Therefore, it is evident that the CTBTO network and operations help to close the gaps in monitoring areas where no national or regional networks exist, particularly in the oceans.

The ISC purposely waits until all possible data has been collected from all operating seismic stations before editing its bulletin. Following this practice the ISC is likely to prepare the most complete and accurate earthquake catalogue, which, in turn, is used by the IDC to evaluate its own performance in terms of completeness and location accuracy.

There is no doubt that the close interaction between the ISC and the Preparatory Commission contributes significantly to improving the performance of both organizations. This cooperation is an example of the direct civil and scientific applications of CTBT verification data and technologies. These data facilitate a wide spectrum of seismological studies, such as the exploration of the three-dimensional structure of the earth; earthquake hazard and risk assessments; earthquake forecasting and engineering; earthquake source processes; and tectonics. Therefore, it is important that the States Signatories and the scientific community continue to work towards further progress in the field of CTBT data accessibility. ■

Biographical note

Avi Shapira is based in Thatcham, United Kingdom, where he heads the International Seismological Centre (ISC).

Originally from Israel, he holds a Doctor of Science degree from the Uppsala University in Sweden. Dr Shapira has held several research positions related to seismology, including Director-General of the Geophysical Institute of Israel and advisor to the Government of Israel on earthquake preparedness. He is the author of approximately 45 peer reviewed papers, over 50 invited reviews and publications in proceedings of conferences, and over 150 reports and abstracts on seismological research. ■