CTBTO PREPARATORY COMMISSION | preparatory commission for the comprehensive nuclear-test-ban treaty organization

CTBTO Spectrum

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Who we are

The Comprehensive Nuclear-Test-Ban Treaty bans all nuclear weapon test explosions. The Treaty is a cornerstone of the international nuclear non-proliferation regime. It opened for signature in New York on 24 September 1996, and today has achieved strong worldwide support.

The CTBTO Preparatory Commission is an international organization consisting of a plenary body composed of all States Signatories and the Provisional Technical Secretariat. It carries out the necessary preparations for the effective implementation of the Treaty, and prepares for the first session of the Conference of the States Parties to the Treaty after its entry into force.

Inside this issue

Using seismic data in air crash investigations

by Dr David McCormack

When an aircraft crashes, not many people think of turning to seismology. However, seismic data can sometimes play a key part in determining the nature of a crash. Analysis of seismographs can quickly produce a crash location, information that may be vital to directing search efforts in remote, wooded or snow-covered areas. In addition, more detailed study of the seismic signals recorded from an impact can give insight into whether an aircraft was intact when hitting the ground and an estimate of the speed at which the plane struck the surface. The strength of seismic signals from an impact depends on the energy contained in the falling object. This in turn is a function of the mass and velocity at the time of impact such that the heavier the object, or the faster it is travelling, the larger the resulting seismic signal. Adding up these factors can give clues about whether the craft exploded in air, rapidly descended intact to the surface, or was attempting to make a crash landing. Such information is particularly important where more traditional crash information from the so-called 'black boxes' is absent.

Perhaps the most widely known example in recent years of seismic waves generated by aircraft impact was from the Lockerbie crash in 1988. Following a mid-air explosion, a Pan Am Boeing 747 crashed on the small town of Lockerbie, located close to the International Monitoring System (IMS) seismic station at Eskdalemuir, Scotland. The impact was clearly recorded as a local event by the seismographs of the array (Figure 1). Comparison of the seismic signals with radar recordings of the descent of the wreckage permitted identification of distinct impacts from various major pieces of the wreckage, leading to a better understanding of the relationship between size and speed of impactors and the amplitude of the seismic signals recorded.

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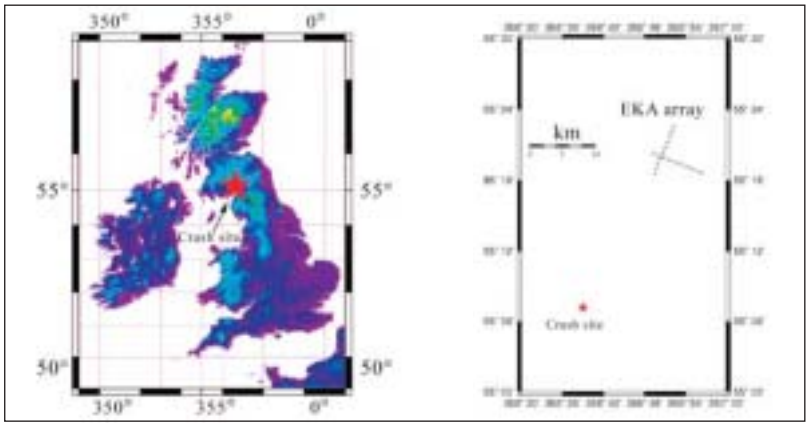

FIGURE 1. THE LOCATION OF THE LOCKERBIE CRASH, USING THE SEISMIC SIGNALS RECORDED BY A SEISMOMETER AT THE NEARBY ESKDALEMUIR IMS STATION (EKA ARRAY)

Potential civil and scientific applications

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

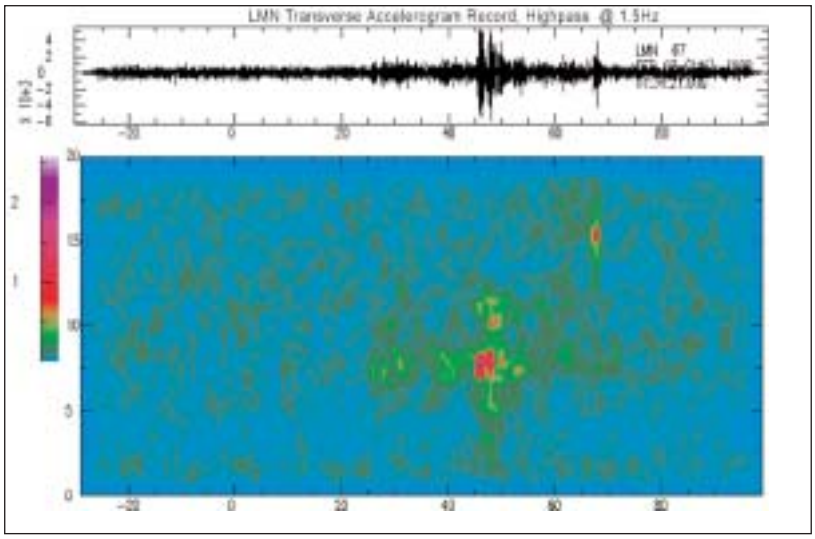

FIGURE 5. SIGNALS GENERATED BY THE SWISSAIR MD11 CRASH AND ASSOCIATED SPECTROGRAM FROM THE SEISMIC STATION OF THE CANADIAN NATIONAL NETWORK (LMN)

Using seismic data...

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Such understanding was critical to the analysis of seismic data from the impact of another large passenger aircraft in 1998. A Swiss Air MD11 crashed in shallow water at Peggy's Cove near Halifax, Canada, following an onboard fire (Figure 4). No onboard data were recovered for the last few minutes of the flight, and the crash occurred in an area of poor radar coverage. Although the location of the crash was quickly established from eyewitnesses and wreckage, seismic data provided the only accurate means of timing the crash. In addition, analysis of the signals from a nearby broadband seismic station (Figure 5) of the type used throughout the IMS rapidly suggested that the impact velocity was very high. This was confirmed many months later by engineering analysis of the aircraft engines.

FIGURE 4. PEGGY'S COVE SWISSAIR CRASH LOCATION

Seismic signals associated even with high-speed impacts of the heaviest aircraft types are small, typically equivalent to those from magnitude 2 earthquakes or even smaller, which means they are generally detectible only within a few hundred kilometers of the crash site even by the most sensitive equipment under optimal conditions. However, with the growing numbers of seismic stations around the world, both as part of the IMS and in other scientific networks which transmit data in real time, it is becoming increasingly possible to detect such seismic signals when these unfortunate events occur, and to provide the information to crash investigators in a timely fashion. ■

Biographical note

David McCormack is based in Ottawa where he currently heads the nuclear explosion monitoring programme of the Geological Survey of Canada. Originally from Northern Ireland, he has degrees in physics and seismology. Dr McCormack has held several research positions related to nuclear treaty monitoring in the United Kingdom and Canada. Since 1997, he has acted as a senior technical adviser to the Canadian delegation to the CTBTO Preparatory Commission. ■