Palaeoseismology: Historical and Prehistorical Records of Earthquake Ground Effects for Seismic Hazard Assessment

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Palaeoseismology: Historical and Prehistorical Records of Earthquake Ground Effects for Seismic Hazard Assessment

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Foreword

Earthquakes are one of the greatest natural hazards humans face. During the twentieth century alone, over two million people died during strong ground shaking, attendant fires, tsunamis and landslides. Most recently, in May 2008, about 80 000 people died in an earthquake in Sichuan Province in China and, earlier, on 26 December 2004, more than 200 000 people lost their lives to the tsunami resulting from the great earthquake off the west coast of Sumatra in Indonesia. In December 2003, the ancient city of Bam in Iran was destroyed by an earthquake, with the loss of over 30 000 lives. The worst disaster in modern times occurred in China in July 1976, when an entire city was destroyed and over 240 000 people killed in less than six minutes. Earlier, in 1556, an earthquake in north-central China killed an estimated 800 000 people, one of the worst natural disasters in recorded history.

Given the tremendous toll in human lives and attendant economic losses, it is appropriate that scientists are working hard to better understand earthquakes, with the ultimate aim of forecasting and, ultimately, predicting them. Their research is broadly of three types. First are instrumental studies of earthquakes by seismologists. Most countries have seismic networks, and seismologists use these records to characterize earthquakes in time and space. Their research allows them to continually improve understanding of seismic risk. Second are geodetic studies of contemporary surface deformation. Modern, GPS-based measurements of changes in the position of fixed points on Earth's surface are providing important insights into crustal stress that can be linked to the instrumental earthquake record. Third are studies of active tectonics and of the geological evidence left by historic and prehistoric earthquakes. These studies provide valuable context for interpreting contemporary seismicity and crustal strain accumulation. They also are the only means of extending the instrumental earthquake record into prehistory, which is particularly important in areas such as western North America where written accounts of earthquakes are limited to the past 150 years.

The papers in this Special Publication fall into the third group mentioned above, a field of research termed 'palaeoseismology'. Palaeoearthquake research is a broad endeavour, with roots in geology, seismology, tectonics, structural geomorphology, geomorphology, stratigraphy and sedimentology. Its practitioners are interdisciplinary scientists who emphasize field research and typically have strong interests in risk, a topic that lies outside physical science.

This Special Publication is the 'brain child' of its three editors, Klaus Reicherter, Alessandro Michetti and Pablo Silva Barroso. It stems from presentations and lively discussions at two recent events sponsored by the INQUA Subcommission on Palaeoseismology: a session at the 2006 EGU in Vienna titled '3000 years of earthquake ground effects in Europe'; and an ICTP/IAEA workshop held in 2006 at Trieste on seismic hazard analyses for critical facilities. A key contribution of these meetings was to show how the systematic study of earthquake surface rupture, liquefaction, tsunami deposits, and other ground effects can be integrated with traditional seismological and tectonic information to provide a better understanding of seismic hazards and risk.

Some words about INQUA seem appropriate here, because this organization enabled the scientific meetings and discussions that led to this Special Publication. INQUA (the International Union for Quaternary Research) is a member union of the International Council of Science. Its primary objectives are to encourage the interdisciplinary study of all aspects of the Quaternary Period (the last two million years), and to facilitate and coordinate international cooperation for this study. The Quaternary is a unique period in Earth history – humans appeared at the beginning of the Quaternary, and their evolution was driven by frequent large changes in global climate with environmental conditions very different from those of today. These climatic fluctuations led to major global reorganization of terrestrial geography, ocean circulation and structure, and biotic communities. An important part of INQUA's remit is fostering research on hazardous Earth processes, including earthquakes, tsunamis, landslides, floods, and severe storms. The research is carried out under the aegis of INQUA's Commission on Terrestrial Deposits and Processes, of which the Subcommission on Palaeoseismology is part.

In the introduction the editors comment on each of the papers in the volume. Their summary makes it clear that the papers, although diverse in subject and scope, group around several themes. Many of the papers are concerned with the effects of earthquakes on the natural environment, and in particular with the application of the recently introduced 'INQUA ESI scale' to large historic earthquakes in different tectonic settings. The ESI scale is based on primary and secondary ground effects of earthquakes rather than traditional effects on

people and infrastructure, and was developed by the Subcommission on Palaeoseismology over the past five years. Another group of papers examines regional earthquake histories in relation to the tectonic environments in which they occur. A third group is concerned with earthquakes and archaeology.

By nature of its subject, this volume can provide only a sample of modern palaeoseismological research. It cannot possibly cover the entire breadth of palaeoseismology, for such a volume would be an encyclopedia not a single volume. Nevertheless, this 'sampler' will whet the appetite of readers interested in learning what palaeoearthquake research can bring to the table of earthquake research. To those readers, I say 'bon appetite'.

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