Preface

This special issue of the Academy Proceedings contains 16 papers selected from amongst those presented at the 'International Conference on Seismic Hazard' with particular reference to the Bhuj earthquake of 26 January 2001, held at New Delhi during October 3–5, 2001. This earthquake of $M_w = 7.6$ was the third in 8 years to occur in the interior of the Indian continent, and was one of the most devastating in India's history. It killed over 20,000 people and rendered a much larger number homeless, followed by prolonged disruption of socio-economic activities.

The importance of the earthquake is that it was sufficiently large to be recorded throughout the world, and is the first $M > 7$ earthquake to have occurred in the mid-continent since the deployment of seismic networks in India. Its potential contribution to seismic hazard analysis in India is that potentially it provides the quantification between felt intensity and magnitude needed to calibrate the numerous historic earthquakes in India that occurred before the availability of instrumental records. Its potential contribution to studies of the world's continents is that it is sufficiently large to have disturbed the lower crust, and thereby to provide a measure of the viscous properties of the mid-continent.

One of the difficulties with seismic hazard studies in India is that they have hitherto been based on empirical patterns of earthquake occurrence. Each succeeding earthquake has alerted seismologists to the potential in that region for shaking from future earthquakes. While this has resulted in regions of high seismic risk being assigned to the region bordering the Himalaya and also to the region of Kachchh, both regions with a long history of damaging earthquakes, it has also resulted in isolated patches of seismic risk being manifest as "bulls-eyes" surrounding earthquakes in southern and central India. The basis for these isolated patches of seismic hazard is of course the tangible occurrence of recent earthquake damage. But it might also be possible to conclude that stresses in these isolated regions have recently been reduced, and that therefore they are now the regions least likely to experience a damaging future earthquake. In the presence of two orthogonal conclusions, it is best to err on the side of caution, as has been done. However, the low productivity of mid-plate earthquakes, and the long interval of time that presumably separates their recurrence, means that no simple patterns for the distribution of earthquakes will be manifest for possibly thousands of years.

An alternative approach to seismic hazard studies in India is to improve our understanding of the stresses and modes of failure of this mid-plate region. These stresses result from the forces of collision between India and southern Asia, from potential gradients caused by surface topography and erosion, from the loading of India by sediments deposited in the Arabian Sea and in the Bay of Bengal, and from the flexural effects of India's descent beneath the Tibetan plateau. The physics of these processes are fundamental to stressing the Indian plate, and since they are unique to India, presumably explain why India exhibits anomalously high mid-plate seismicity compared to neighbouring plates.

The difficulty with physical models is that they do not predict regions of future failure, merely distributed regions of enhanced stress. Clearly, a hybrid combination of physical insight and careful observation remains the only viable option to improved knowledge of future seismic risk, and the opportunity to discuss findings from the Bhuj earthquake provides an important step in this direction. The October 2001 conference brought together for the first time the numerous scientists, both Indian and foreign, who had conducted measurements in the days following the Bhuj earthquake.

The first paper of this volume discusses the effects of flexure in imposing a stress system throughout India that is presumably fundamental to the earthquake process. The second paper discusses strain changes that occurred in the 200 km region surrounding the Bhuj epicenter. The next 3

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papers attempt to identify the geographical distribution of ground shaking intensity based on eyewitness, media and ground truth accounts of the Bhuj earthquake, whilst 5 others that follow deal with various aspects of aftershock activity that shed light on their space-time patterns and focal mechanisms.

Two subsequent papers of this volume describe the response of elevated water tanks and other masonry structures to intense ground shaking of the area, calling attention to the viability or otherwise of various structural features and construction practices in the region, which should prove instructive to future building activity in earthquake prone areas.

The last 4 papers deal with various important aspects of specific site responses generally. The first of these presents the site response characteristics of different areas in and around Delhi, whilst the other three that follow, demonstrate computer simulated effects arising from basin-edge effects, earthquake induced undrained pore pressure changes and liquefaction of granular materials.

We hope that these articles will be of use to students and researchers engaged in the task of developing insightful knowledge that would contribute to mitigation of the adverse impacts of earthquakes. Their appearance in this volume has been made possible by the initiatives taken by the Department of Science and Technology, Govt. of India, and the India Meteorological Department who jointly organized the meeting. The International Program of the National Science Foundation, USA made possible the participation of US scientists in this meeting.

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Guest Editors