Preface

The great Wenchuan *Ms* 8.0 earthquake of 14:28 May 12, 2008 (called the Wenchuan earthquake hereafter) has shocked the world. It is the largest earthquake in the mainland of China in the past 60 years, causing the most serious damages, the largest stricken areas and the greatest difficulty for disaster relief. As determined by the China Earthquake Network Center, the focal depth of the Wenchuan earthquake is 19 km, and the earthquake occurred on the middle segment of the Longmenshan thrust belt along the southeast margin of the Qinghai-Tibetan Plateau. The event completely destroyed Yingxiu Town, Wenchuan County, Qushan Town, Beichuan County and Qingchuan County in Sichuan Province, while the stricken areas involved 48,810 villages and 4,667 towns for 417 counties (cities or districts) in 10 provinces (municipalities or autonomous regions) including Sichuan, Gansu, Shanxi and Chongqing, with a total area of about 500,000 km^2 and 46.25 million sufferers. According to the official report up to September 28, 2008, it is known that 69,227 people were killed, 374,643 injured and 17,823 missing during the earthquake, while about 15.1 million people needed to be urgently moved away and settled down. The earthquake has caused enormous damages of buildings and basic facilities, heavy losses of industrial and agricultural productions, and direct economic losses of 845.1 billions Yuan (RMB). Moreover, the subsidiary hazards induced by the earthquake, such as collapse, landslide, debris flows and earthquake lakes are of unprecedented all over the world.

The Sichuan-Yunnan faulted-block in southwestern China, where the Wenchuan earthquake occurred, is a part of the southeastward extrusive active tectonic system in the eastern and southeastern Qinghai-Tibetan plateau. A lot of strong earthquakes occurred historically in this region especially on the eastern boundary of this faulted block, and thus a few of major national and international projects were/are carried out to study the geological setting, fault systems and earthquake dynamics. For example, one of the author of this book, Xiwen Xu, has led the research activities on active fault system in this region supported by a few of national projects including the National Key Basic Research Projects (No.2004CB418401 & G1998040701) since 1999, which further led to an international collaboration commenced in 2006 between the two authors and their groups to investigate the fault system dynamics and its associated earthquakes in this region using the finite element code developed by Xing et al. at The University of Queensland. The Wenchuan earthquake occurred

as a surprise, but more surprisingly to us is that it was located in a high risk zone of our preliminary simulation result done in May 2007, just 1 year before the Wenchuan earthquake occurred. This drives us to look deeply into the related issues.

Soon after the Wenchuan earthquake, under the organization of the China Earthquake Administration (CEA), the researchers from the Institute of Geology, China Earthquake Administration (IGCEA), went right to the epicentral areas to carry out emergency rescue and scientific investigation, and a large amount of data on the earthquake surface ruptures have been obtained at the first time. Moreover, after the accomplishment of the emergency rescue and urgent scientific investigation work, under the guidance of the State Wenchuan Earthquake Expert Committee, the researchers from IGCEA and the other related scientific institutions went again to the epicentral areas to carry out systematic scientific investigation, including the precise observation, measurement and record of the surface ruptures and earthquake hazards. Field observations show that the Wenchuan earthquake ruptured the two NW-trending imbricated reverse faults, the Beichuan-Yingxiu fault and the Guanxian-Jiangyou fault of the Longmenshan thrust belt. Among them, the earthquake intensity at Yingxiu, Longmenshan, Yuejiashan, Gaochuan, Chaping, Qushan and Nanba towns (villages) along the Beichuan-Yingxiu fault reaches up to XI, while the surface rupture zone is about 240 km long, dominated mainly by reverse faulting with right-slip component. The maximum vertical offset at the site to the north of Beichuan is 6.5±0.5 m, and the maximum right-lateral displacement is 4.9 m. The surface rupture zone to the south of Beichuan is dominated mainly by thrusting, where the maximum vertical offset is 6.2±0.5 m. The earthquake intensity at Bailu, Jinhua and Hanwang towns (villages) along the Guanxian-Jiangyou fault reaches X. The surface rupture zone is 72 km long and appears as a pure reverse faulting rupture with a maximum vertical offset of 3.5 m. In addition, a NW-trending surface rupture zone dominated by left-lateral strike slip faulting with vertical thrusting component is developed to the west of the aforementioned two surface rupture zones, having a length of about 7 km. The surface rupture pattern produced by the Wenchuan earthquake is the most complicated of recent great earthquakes and is the longest among the coseismic surface rupture zones for reverse faulting events ever reported in the intraplate settings. Inversions of seismic data have further indicated that the Wenchuan earthquake can further be resolved into two seismic faulting subevents with 6∼9 m coseismic offset that propagated to the northeast on a 300 km long, moderately-dipping (∼33°) fault along the Longmenshan thrust fault zone. The sub-event nearby Yingxiu Town underwent oblique right-lateral thrusting slip, while the northeast sub-event nearby Beichuan (Qushan Town) exhibited primarily right-lateral displacement. The average offset on the focal fault plane reaches 5 m. The oblique-slip reverse fault type surface rupture associated with the Wenchuan earthquake indicates that the horizontal motion of the block in the middle and eastern part of the Qinghai-Tibetan Plateau has been transformed into crustal shortening and uplift along the Longmenshan thrust belt in between the South China and Bayan Har blocks.

This book is a production of our relevant research and field investigation as above. It includes 5 chapters describing the tectonic setting, historical earthquakes,

the Wenchuan earthquake and aftershocks, numerical investigation of earthquake nucleation and occurrence, earthquake induced surface ruptures, disasters and damage features. The field observations of earthquake induced surface fractures and building damage, form a major and special part of this book and include a large number of digital photos with accompanying brief explanations. This collection of such photos in this book reflects authentically the characteristics of surface deformation and hazards produced by the Wenchuan earthquake. It may provide not only the objective historic record of this exceptionally great earthquake, but also basic data for earthquake research and engineering seismic design. We hope this book helpful for both earthquake scientists and the public in summing up of experience and lesson given by this earthquake for the countermeasure and disaster mitigation of large earthquake in the future, and further provide some new insights into the earthquake forecasting, distribution features of earthquake hazards occurred on steeply dipping oblique-slip thrust belt, as well as the tectonic movement and the uplift of the Qinghai-Tibetan plateau.

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Brisbane, Australia — Huilin Xing
Beijing, People's Republic of China — Xiwei Xu
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Xing, H.; Xu, X.

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