Keynote Speech

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Chair: J. Bruce H. Shyu

Geology of Earthquakes Against Extreme Hazards

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A lot of people around the world have suffered from a number of extreme hazards from earthquakes and tsunamis in past a few decades. 2004 Indian Ocean tsunamis and 2010 Heiti earthquake caused the extreme number of fatalities. Extremely high tsunamis ever occurred in Japan account for the severe damage from 2011 Tohoku Earthquake and tsunamis. As well, extremely intense ground shaking during 1995 Kobe and 2016 Kumamoto earthquakes raised the number of fatalities and casualties drastically. One of the important tasks of earthquake geology is to know the nature of such extreme hazards and to help the society prepare for them. In order to better perform the tasks, it is necessary to examine what we knew and did not know, and what we learned from unexpected extreme events.

Before 2004 Indian Ocean earthquake, there was no record of M 9 earthquake, which generate very extensive tsunami hazards that are not comparable with previously known M 7 to M 8 earthquakes. 2011 M 9 Tohoku earthquake and tsunamis occurred after we learned a lot from 2004 Indian Ocean earthquake. Before 2011 also, earthquake geology had revealed 1700 Cascadia earthquake and tsunamis, 17 century southern Kuril (eastern Hokkaido) tsunamis, and 869 Jogan tsunamis in Tohoku area. The 2011 Tohoku disasters might have been mitigated with lessons from these findings and experience in 2004. If the information of 869 tsunamis based on tsunami deposits were applied for tsunami awareness and preparedness in Sendai-Ishinomaki areas, thousands of lives could have been saved.

The extremely intense ground shaking of Japan Meteorology Agency intensity 7 was first observed and established during 1995 Kobe earthquake. ~1000 gal PGA and 100 to 170 cm/s PGV that killed 6600 people was due to the blind reverse faulting under Kobe city. The partial rupture of known surface active faults and geologic structure of active sedimentary basin rim caused this shaking and damage. After 1995 Kobe earthquake, five JMA I=7 earthquakes occurred. Four of them including 2018 Hokkaido earthquake were from blind faults with minor surface ruptures. The April 16 2017 is the only I = 7 event with clear surface ruptures. We have learned a lot about faulting and ground shaking in past 30 years, but more efforts are necessary to forecast and mitigate damage from strong ground motion from active faults.

In order to reduce future damage from extreme earthquake and tsunami, it is important to locate such hazards and help the society to prepare for them.