BOOK REVIEW

ASSESSING EARTHQUAKE HAZARDS AND REDUCING RISK IN THE PACIFIC NORTHWEST: US Geological Survey Professional Paper No.1560, 1996, by Albert M. Rogers, Timothy J. Walsh, William J. Kockelman and George R. Priest, Eds., 306 Pages, 3 Plates.

Earthquakes are one of the worst natural hazards and can cause tremendous loss to human beings in way of death, destruction of property and related economic consequences. The January 18, 1995 Kobe Earthquake in Japan is now known to be the most expensive earthquake with an estimated economic loss being in excess of 100 billion US dollars, the human lives lost being around 5000. The USGS has initiated a research programme to improve the understanding of the geological risks in the Pacific Northwest. The rapid increase in population density in urban areas during 1980s has increased the seismic risk considerably. Consequently, funding of such studies was increased in 1987 to support a 5-year accelerated research programme under the sponsorship of the National Earthquake Hazard Assessment Programme. The present volume is an outcome of these studies. According to the Editors "The broadest goals of this professional paper are to promote the recognition, assessment, and reduction of earthquake hazards in the Pacific Northwest. Engineers, planners, decision makers and land and building owners should, in the long term, use this information to reduce the effects of expected future earthquakes in Washington, Oregon, northern California, USA and British Columbia, Canada."

The volume is very well organized with a detailed introduction by the Editors followed by palaeoseismicity, tectonics and geophysics related reports.

In the introduction the editors note that the potential for large earthquakes and losses in the Pacific Northwest (latitude 40° to 49°N and longitude 116° to 126°W approximately, comprising the States of Washington and Oregon, and parts of Idaho, Nevada and California in USA and British Columbia in Canada) is greater than previously recognized. The geological and geophysical evidences suggest that earthquakes with magnitudes upto 8 to 9.5 have occurred in the preceding 7000 years on the Cascadia Thrust Fault. They point out that the time between great earthquakes may range from a few centuries to more than 1000 years. As of now, a reliable forecast of the time of the next great earthquake is not possible. Table I includes large damaging earthquakes in the Pacific Northwest region since 1833. There are a total of 22 entries, the latest one being the September 21, 1993 Klamath Falls earthquake in Oregon with a surface wave magnitude of 5.7 to 5.9.

Timothy Walsh has given an introduction to earthquake sources of the Pacific Northwest. He observes that the earthquake catalogues of the Pacific Northwest are short and require significant editing for pre-instrumental entries. The relative paucity of historical information requires that earthquake hazard assessment in Pacific Northwest must rely more heavily on geological mapping, tectonic and geophysical modelling.

Brian Atwater has examined coastal evidence for great earthquakes in western Washington. He opines that there are evidences in buried marsh and forests, that earthquakes of magnitude 8 or larger have occurred in the Cascadia Subduction Zone. Intervals of hundreds of years are inferred between great earthquakes on investigation of sequences of buried soils.

Nelson and Personius in their overview of great earthquake potential in Oregon and Washington, based on coastal geological studies, note that geological work for the last few years has produced convincing evidence of coseismic subsidence along the Washington and Oregon coasts. On the basis of regional subsidence recorded by estuarine deposits, it is inferred that plate-interface earthquakes of magnitude 8 or more, which cause more than hundred km long ruptures, occurred during the late Holocene in northwestern Oregon and southern Washington.

Peterson and Darienzo have written a very interesting article on discrimination of climatic, oceanic and tectonic mechanisms of cyclic marsh burial in Alsea Bay, Oregon. They find an average recurrence interval of about 500 radiocarbon years estimated from 8 repeat intervals of coseismic subsidence between 4510 and 480 Radiocarbon Years Before Present (RCYBP). They also underline a high correspondence between marsh subsidence and sand deposition in Alsea Bay.

John Adams writes about the great earthquakes recorded by turbidites off the Oregon-Washington coast. In the Cascadia Seachannel and three other places along the Oregon-Washington continental slope, Adams describes 13 turbidites that occurred after Mount Mazama eruption. The thin layers of pelagic deposits associated with each successive turbidite suggest that in each place 13 turbidity currents occurred at intervals of 590 ± 170 years on an average. This is a very interesting paper where Adams has proposed that triggering of turbidity currents by great earthquakes may be a much more common phenomena than hitherto realized. Similar observations may reveal great earthquakes on the continental margins of Alaska, Japan, New Zealand, Chile and other places where great thrust earthquakes, with a long term return period, are combined with a moderate supply of sediment to the edge of the continental shelf.

Under a broad topic on tectonics and geophysics, Snavely and Wells investigate the Cenozoic evolution sea level of the continental margin of Oregon and Washington. One of the significant points they make is the absence of historical record for a large scale earthquake along the subduction zone off Oregon and Washington, from which they infer 900 km long seismic gap. However, they point out that inspite of a low present day seismic activity, the potential of a major subduction type of earthquake in this gap cannot be discounted.

Yeats et al. report on the tectonics of the Willamette Valley, Oregon. Low slip rates, probably less than 0.5 mm/yr, are inferred from very limited evidences. They observed that extent of individual faults are relatively short. However, brittle crust may extend to depths of 30 km indicating a capability of generating moderate size earthquake with long recurrence intervals.

Goldfinger et al. present results of detailed geophysical work involving seismic reflection, sidescan sonar, data from ALVIN submersible dives and SeaBeam bathymetry to investigate active strike-slip faulting and folding of the Cascadia Subduction Zone plate boundary and forearc in central and northern Oregon. There are three west northwest trending left lateral strike-slip faults on the abyssal plain of central Oregon. They infer that these shear zones developed in the upper plate above the subducted strike-slip faults. An alternative explanation is that strike-slip faulting in the upper plate has propagated seaward into the subducting plate.

Li Ma et al. investigate the focal mechanism of the western Washington earthquakes and their relationship to regional tectonic stress. They have inferred tectonic stress in western Washington by inverting earthquake focal mechanism. Washington, a part of the north American plate is found to be in a state of well-known regional north-south compressive tectonic stress which does not directly reflect the active subduction along the Cascadia Subduction Zone.

The last paper of this volume is by Weaver and Shedlock who estimate seismic source regions from earthquake distribution and regional tectonics in the Pacific northwest. The best understood earthquake source zone is within the subducting Juan de Fuca and Gorda plates where most of the historical damaging earthquakes occurred. The source zones for crustal earthquakes are very poorly known.

It is important to highlight some of the conclusions given by editors in their summary of this volume. They point out that large shallow earthquakes are likely to occur in the Pacific northwest. However, little is known about the recurrence of these events or their potential locations. Great earthquakes are possible on some segments of Cascadia thrust fault with magnitudes at least as much as 8. Unfavourable ground conditions in the Puget Sound -Willamette Valley lowland are likely to increase the earthquake hazard substantially. The shaking in principal urban areas will largely depend on the extent of downdip rupture in subduction earthquakes in the Cascadia thrust fault. In future large Benioff-zone earthquakes are likely to occur. They note that although much remains to be done for further understanding of earthquake hazard in Pacific northwest, significant progress has been made in several areas.

The work reported in this volume shows how geological record can be used to learn about the past earthquakes and make assessments of the future earthquake hazard. This is a very well written and documented volume and is a must for geologists and geophysicists involved in studying earthquake hazards.

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"EROSIONAL AND DEFORMATIONAL STRUCTURES IN SINGLE SEDIMENTARY BEDS: A GENETIC COMMENTARY" by S. Dzulynski. The paper forms a part of one - semester lecture course delivered at the Hebrew University, Jerusalem, in the year 1989. Annales Societatis Geologorum Poloniae, v.66, No.2, p.101.

While the material offered in the paper is not entirely new, but is a useful compilation of various scattered publications of the writer and his co-workers, many of which may not be available to Indian geologists. Secondly, the paper offers the present state of the art on the subject, and here lies its strength. Hence, the present updated compilation will, it is felt, help the Indian students of earth sciences immensely.

Most of the structures discussed here "are either produced on interfaces between one bed and the bed immediately below or above, and on interfaces within single beds". The structures discussed have paleocurrent implications and inferentially, give an insight into the paleogeography of ancient sedimentary basins. Genetic interpretations of structures are backed up by simple qualitative experiments, and has displayed photographs of natural specimens face-to-face with their experimental analogues. These simple experiments, in the words of the author, help geologists "to test and investigate certain concepts suggested by field observations and to stimulate the imagination of investigators".

The structures discussed here have been divided into two groups: (i) erosional markings produced by scouring action of the current or by impact of transported objects (tools) upon a cohesive substratum, and (ii) deformational structures resulting from interaction between the flowing and depositing current and the bottom, or from mutual interpenetration of soft-sediments differing in density and kinematic viscosity. The theoretical and experimental backup in generating deformational structures have been deftly handled.

The experiments conducted in generating various erosional and deformational structures are