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# Introduction

# Seismogenic and Tsunamigenic Processes in Shallow Subduction Zones

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Earthquakes in shallow subduction zones account for the greatest part of seismic energy release in the Earth and often cause significant damage; in some cases they are accompanied by devastating tsunamis. Understanding the physics of seismogenic and tsunamigenic processes in such zones continues to be a challenge as well as a focus of ongoing research. In particular, questions that are being addressed include:

What are the mechanisms underlying higher slip in some areas (asperity distributions)? Are these mechanisms stable in space and time? Is the slip distribution in consecutive large/great earthquakes similar or different to the previous ones in the same place?

How much of the coseismic slip in large earthquakes occurs on the plate interface and how much on faults within the overriding plate?

What is the role of roughness in the subducting oceanic plate and/or the amount of subducting sediments for the earthquake dynamics? What is the importance of structural features in the downgoing slab? What is the role of fluids trapped in the seismogenic zone?

Are there any systematic differences between earthquakes which occur close to the trench and the deeper, interplate events? What are the characteristics of tsunamigenic earthquake sources? Could we predict in advance, only from the tectonic features of a subduction segment, if it is capable of generating a tsunamigenic earthquake?

What are the stress interactions between adjacent subduction earthquakes? How do these large/great subduction events modulate the seismicity in the upper plate and outer-rise area following the main event?

What controls the type and location of post-seismic slip? How prevalent is afterslip along the down-dip extension of the coseismic rupture plane versus post-seismic viscous relaxation of the asthenosphere?

What can we learn from current GPS measurements regarding the strength and distribution of coupling along the main interplate interface? Could it be used to predict slip distribution in future earthquakes along that subduction segment?

Some of these questions are addressed in this topical issue.

Systematic, depth-dependent variations in earthquake source properties across a shallow subduction zone are investigated by Ruff, Bilek and Lay, Zobin, and Satake and Tanioka. The last two authors concentrate on tsunami generation of subduction earthquakes and systematic differences between tsunamigenic (interplate or intraplate) and tsunami earthquakes, in which most of the moment release occurs in a narrow region near the trench.

The influence of nonhomogeneities in earthquake slip on local tsunamis is discussed by Geist and Dmowska. Bourgeois *et al.* investigate and model the local tsunami caused by the Chimbote, northern Peru earthquake of 21 February, 1996.

Tsunami inversion leading to slip distribution of the 1952 great Kamchatka earthquake is presented by Johnson and Satake, followed by the analysis of the 20th century seismicity in that area which aims to determine the relationship between the asperities of the 1952 event and the large earthquakes of the Kamchatka subduction zone.

The difficulties in applying solely tsunami data to infer source parameters of an earthquake are illustrated by Piatanesi *et al.* in the example of the October 4, 1994 Shikotan earthquake.

Von Huene *et al.* use high resolution bathymetry and detailed seismic profiles to evaluate the influence of subducted topographic features and the amount of subducted sediment on the slip distribution in the great Alaska 1964 earthquake.

Moderate seismicity in the region of Prince William Sound for over thirty years following the 1964 great Alaska earthquake is analyzed by Doser *et al.* in relation to the slip distribution of this event. Another study of historical as well as modern seismicity follows, for the northwestern part of Irian Jaya, Indonesia, in which Okal presents relocations of over 220 earthquakes in the context of the great 1979 Yapen and 1996 Biak earthquakes.

A new seismic study of the rupture process of the $M_w = 8.1$ 1995 Antofagasta (northern Chile) earthquake is presented by Carlo *et al.* and compared with previous inversions. The 1995 event is significant both as the first great thrust event observed in the region and for its possible interactions with other portions of the interplate contact zone.

Results of the GPS study of the same but broader area, performed in 1993, 1994 and 1995, and presented by Klotz *et al.*, follow. The analysis considers three different deformation processes: interseismic accumulation of elastic strain due to subduction coupling, coseismic strain release during the Antofagasta earthquake and crustal shortening in the Sub-Andes. The study illustrates that the interseismic accumulation of elastic deformation requires full locking of the subduction interface. Geodetically derived slip distribution of the Antofagasta earthquake is in good agreement with previous seismic inversions.

The last two papers, by Swenson and Beck, and Spence *et al*., discuss the central Peru subduction zone and, in particular, seismic subduction of the Nazca Ridge, as evidenced by the 12 November 1996 $M_w = 7.7$ Peru earthquake. The papers offer detailed inversions of the 1996 event as well as a complimentary view of seismotectonics of the area.

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