

Long-Range Science Plan for Seismology

Structural Control of Subduction Zone Megathrust Earthquakes

Teh-Ru Alex Song

Department of Terrestrial Magnetism, Carnegie Institution of Washington,
5241 Broad Branch Road, NW, Washington, DC 20015, USA

Recent silent earthquakes, or episodic slow slip events and non-volcanic tremor have been observed in a few shallow subduction zones such as Cascadia, Southwest Japan and southern Mexico. In general, the majority of the slow slip and tremor activities take place at the transition zone down-dip of the strong coupling section where great thrust earthquakes occur. In southern Mexico, Song et al. (2008) modeled local and teleseismic waveform simultaneously and found a strong correlation between an ultra-slow velocity layer (USL) at the top of the subducting slab. The majority of reported slow slip patches coincide with the presence of the USL while tremor activities primarily concentrate further down-dip where the USL ends sharply. The persistence of the USL before, during and after the slow slip events suggests its longevity, whereas the spatial extent of the USL delineates the zone of transitional frictional behaviour. Moreover, megathrust earthquakes, intra-slab events and SSEs likely temporally and spatially linked.

Subduction zone megathrust earthquakes are one of the major nature disasters associated with human activities and structure. Although earthquake prediction is not currently feasible, it is critical to evaluate the mid-to-long term seismic potential through understanding how strain is accommodated by the release of seismic energy within minutes, episodic slow slip in months, and how they interact with each other spatially and temporally. The detection of the USL could potentially be useful in delineating the regime in which episodic slow slip events occur. In addition, it could provide a basis for modeling stress feedback between megathrust interface and transition zone and estimating mid-to-long term seismic potential.

There are several important questions remained to be answered:

- 1. What's the spatial extent of the USL in other subduction zones?*
- 2. How is the USL spatially and temporally related to the episodic slow slip events and non-volcanic tremor?*
- 3. Does temporal variation in the coupling of subduction zone interface dictate the occurrences of slow-slip events in the transition zone?*
- 4. How are megathrust earthquakes, intra-slab events and SSEs linked?*

To address these questions, it benefits from systematic waveform modeling of available local and teleseismic data that reveal complicated waveform interaction and interferences associated with slab structure.

Reference: Song, Teh-Ru Alex, Don. V. Helmberger, Michael R. Brudzinski, Rob W. Clayton, Paul Davis, Xyoli. Pérez-Campos, Shri, K. Singh, (2008), Subducting slab ultra-slow velocity layer coincident with silent earthquakes in southern Mexico (submitted).