Nonvolcanic tremor along the Oaxaca segment of the Middle America subduction zone

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[1] The Oaxaca subduction zone is an ideal area for detailed studies of plate boundary deformation as rapid convergent rates, shallow subduction, and short trench-to-coast distances bring the thermally defined seismogenic and transition zones of the plate interface over 100 km inland. Previous analysis of slow slip events in southern Mexico suggests that they may represent motion in the transition zone, defining the downdip edge of future megathrust earthquakes. A new deployment consisting of broadband seismometers distributed inland along the Oaxaca segment provide the means to examine whether nonvolcanic tremor (NVT) signals can also be used to characterize the boundary between the seismogenic and transition zones. In this study, we established that NVT exists in the Oaxaca region based on waxing and waning of seismic energy on filtered day-long seismograms that were correlated across neighboring stations and were further supported by appropriate relative time moveouts in record sections and spectrograms with narrow frequency bands. Eighteen prominent NVT episodes that lasted upwards of a week were identified during the 15 months analyzed (June 2006 to September 2007), recurring as frequently as every 2–3 months in a given region. We analyze NVT envelope waveforms with a semiautomated process for identifying prominent energy bursts, and analyst-refined relative arrival times are inverted for source locations. NVT burst epicenters primarily occur between the 40–50 km contours for depth of the plate interface, except in eastern Oaxaca where they shift toward the 30 km contour as the slab steepens. NVT hypocenters correlate well with a high conductivity zone that is interpreted to be due to slab fluids. NVT is more frequent, shorter in duration, and located further inland than GPS-detected slow slip, while the latter is associated with a zone of ultra-slow velocity interpreted to represent high pore fluid pressure. This zone of slow slip corresponds to approximately 350°C–450°C, with megathrust earthquakes, microseismicity, and strong long-term coupling occurring immediately updip from it. This leaves NVT primarily in a region further inland from the thermally defined transition zone, suggesting that transition from locking to free slip may occur in more than one phase.

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1. Introduction

[2] Subduction zones are where oceanic lithosphere is recycled into Earth's interior [*Stern*, 2002], and where the largest, devastating megathrust earthquakes rupture when plate motion accumulates tectonic stresses on the locked, seismogenic zone of the plate interface. Moving downdip along the plate interface, from this cold and brittle zone, the increasing pressures, temperatures, and slab dehydration/metamorphic reactions generate a transition in frictional behavior from stick slip to stable sliding [e.g., *Hyndman and Wang*, 1993; *Scholz*, 1990]. Recent observations have now revealed slow slip episodes (SSE) that occur regularly in this

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