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Geologic Setting, Field Survey and Modeling of the Chimbote, Northern Peru, Tsunami of 21 February 1996

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Abstract—Whereas the coast of Peru south of 10°S is historically accustomed to tsunamigenic earthquakes, the subduction zone north of 10°S has been relatively quiet. On 21 February 1996 at 21:51 GMT (07:51 local time) a large, tsunamigenic earthquake (Harvard estimate $M_w = 7.5$) struck at 9.6°S, 79.6°W, approximately 130 km off the northern coast of Peru, north of the intersection of the Mendaña fracture zone with the Peru–Chile trench. The likely mechanism inferred from seismic data is a low-angle thrust consistent with subduction of the Nazca Plate beneath the South American plate, with relatively slow rupture characteristics. Approximately one hour after the main shock, a damaging tsunami reached the Peruvian coast, resulting in twelve deaths. We report survey measurements, from 7.7°S to 11°S, on maximum runup (2–5 m, between 8 and 10°S), maximum inundation distances, which exceeded 500 m, and tsunami sediment deposition patterns. Observations and numerical simulations show that the hydrodynamic characteristics of this event resemble those of the 1992 Nicaragua tsunami. Differences in climate, vegetation and population make these two tsunamis seem more different than they were.

This 1996 Chimbote event was the first large ($M_w > 7$) subduction-zone (interplate) earthquake between about 8 and 10°S, in Peru, since the 17th century, and bears resemblance to the 1960 (M_w 7.6) event at 6.8°S. Together these two events are apparently the only large subduction-zone earthquakes in northern Peru since 1619 (est. latitude 8°S, est. M_w 7.8); these two tsunamis also each produced more fatalities than any other tsunami in Peru since the 18th century. We concur with PELAYO and WIENS (1990, 1992) that this subduction zone, in northern Peru, resembles others where the subduction zone is only weakly coupled, and convergence is largely aseismic. Subduction-zone earthquakes, when they occur, are slow, commonly shallow, and originate far from shore (near the tip of the wedge). Thus they are weakly felt, and the ensuing tsunamis are unanticipated by local populations. Although perhaps a borderline case, the Chimbote tsunami clearly is another wake-up example of a "tsunami earthquake."

Key words: Tsunami, subduction zone, seismicity, Peru seismicity, tsunami earthquake, tsunami sediments, tsunami modeling, Peru geology.

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