HOW DO LONG PALEOSEISMIC RECORDS ADVANCE SUBDUCTION ZONE UNDERSTANDING?

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The recent 2011 Mw=9.0 Tohoku Japan, and the 2004 Mw=9.15 Sumatra-Andaman superquakes have humbled many in earthquake research. Neither region was thought capable of earthquakes exceeding Mw~8.4. These events have pointed out clearly that we no longer have a fundamental model for discrimination of M9 producing regions. At a minimum, the Tohoku earthquake implies that other comparable subduction zones, and perhaps others (McCaffrey et al., 2008) may be capable of similar behavior. A significant number of subduction zones have relatively old oceanic plates being subducted that were previously discounted as M9 producers. These include much of South America north of the 1960 event (possibly represented by the 1868 Arica Chile earthquake; (Dorbath et al., 1990), the remainder of the Japan trench, the Kuriles, the western Aleutians, the Philippine, Manila and Sulu trenches, Java, the Makran and Hikurangi, Antilles and others. Any or all of these subduction systems may be capable of generating earthquakes much larger than known or expected today. Our perspective on this issue is clearly hampered by short historical and even shorter instrumental records. Paleoseismology offers an avenue, though labor intensive, to address the hazard question directly and mostly without reference to model assumptions about the underlying mechanics of subduction zones. With a long-term record, hazard estimates can move forward, while the interesting patterns observed may be investigated. For example, in Sumatra, Sieh et al. (2008) observed long term cycling of the subduction zone. Similarly, Cascadia also appears to follow a pattern of energy cycling where some events release less energy while others release more energy than available from plate convergence (slip deficit) and may have borrowed stored energy from previous cycles. This suggests that energy release in the earthquakes is not closely tied to recurrence intervals, but also that it is not likely to be a Poisson process. The highest energy states may result in either a very large earthquake, or a series of smaller earthquakes to relieve stress. Long records at other subduction zones such as Sumatra, Hikurangi and elsewhere are beginning to reveal the actual long-term behavior of these areas.