Third Generation Paleoseismology: Clustering, Segmentation, Supercycles and Paleo Slip Models

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Third generation paleoseismology is moving beyond event identification and dating, and to some extent beyond simply establishing long recurrence statistics. Long and detailed paleoseismic records afford uncommon opportunities to examine recurrence models, clustering, segmentation, interaction with other faults, long term strain history and paleo slip characteristics. A 10,000 year onshore-offshore record in Cascadia and a 16,000 year marine record at the Hikurangi margin have identified periods of clustering and quiescence in the record. In Cascadia, clusters of 4-5 events, with gaps of 700-1200 years between clusters are unlikely to be randomly generated. In Cascadia, a pattern of decreasing recurrence time in at least four segments southward, from ~ 500-530 years in the north, to ~ 240 years or less in the south, consistent with geologic structural barriers. Long turbidite records for Cascadia and the Northern San Andreas Fault suggest that these two faults have virtually the same average recurrence interval through the Holocene, and may have a stress transfer relationship across the triple junction. Paleoseismology is beginning to reveal information about magnitudes and has potential to reveal slip patterns of paleoearthquakes. Finally, energy in plate boundary fault zones may have long term cycling involving many seismic cycles. Several lines of evidence, both direct and indirect suggest that the connection between interevent time and earthquake magnitude, and models predicated on this relationship, may be relatively weak. In Sumatra, precisely dated coral evidence has illuminated long term energy cycling of the central Sumatran margin. In Cascadia, similar cycling is apparent based on balancing consistent records of turbidite mass (energy release) against plate convergence (energy gain). Long-term cycling may explain mismatches between deformation models based on interevent times in the last 4600 years and coastal paleoseismic data.