Long-Term Paleoseismic Records Along the Cascadia Subduction Zone and Northern San Andreas Fault Based on Turbidite Stratigraphy

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We have been investigating the recurrence pattern of Great Earthquakes along the Cascadia and Northern San Andreas margins using the record of abyssal plain turbidites. In Cascadia, we have previously suggested that virtually all turbidites record great earthquakes, based on identical numbers of events in widely separated cores, and relative dating techniques that demonstrate synchroneity of the triggering mechanism. The correlation used thus far has relied upon the presence of the Mazama ash in most cores. We have additionally tested this correlation with radiocarbon ages and physical properties of the core sediments. Despite a systematic spatial and temporal variation in 14C reservoir ages, we find that the repeat pattern of events supports regional correlation. We find also that a good stratigraphic correlation can be made between three key core sites at Juan de Fuca, Cascadia, and Rogue Channels using Gamma density and high-resolution magnetic susceptibility records of these cores. This correlation is independent of other correlation methods including the Mazama ash datum, event number comparisons, the 'confluence test' of synchronous triggering, and radiocarbon ages, but is consistent with them. That we are able to correlate physical property 'wiggle' plots between turbidite channels that are not connected, implies that something of the earthquake shaking signal may be contained in these records.

With strengthened correlations, and improved estimates of the reservoir correction, we infer that the pattern of Cascadia Great Earthquakes appears to include a repeating pattern consisting of a long interval ending in an earthquake, followed by a moderately long interval, then 1 or 2 shorter intervals. Over the last ~9000 years, the pattern appears to have repeated four times.

We are similarly investigating the turbidite record on the abyssal plain adjacent to the Northern San Andreas Margin. Unlike Cascadia, no regional stratigraphic datum has yet been found in our cores, however correlation of individual turbidites both along individual channels and across non-connecting channels is robust, providing numerous stratigraphic ties between these systems. We are using Gamma density, p-wave velocity, high-resolution magnetics, x-ray, mineralogic, and color reflectance data to build a comprehensive regional correlation along the length of the northern San Andreas. As in Cascadia, correlation of events along the margin for large distances suggests an earthquake origin for these turbidites, since other potential triggering mechanisms (except perhaps very large storms) operate in only single channels. We also observe mixing of separate mineralogic provenances at confluences, below which we see either doublets, with no intervening time (hemipelagic sediment) between them, or bimodal coarse fractions in single turbidites, each density and magnetic peak representing a separate provenance. The mixing of flows from distinct provenances into single turbid flows below confluences also demonstrates synchronous triggering of separate channel systems. Like Cascadia, we suggest that the information contained in these physical property wiggles may be the energy signature of the earthquake itself, in effect a paleo-seismogram.

Thus far we are able to correlate 35 events above younger than ~ 6200 years for the entire region. Of these, 10 events can be correlated along the length of the study region, from the northern limit of the SAF to south of San Francisco. Twelve events correlate along a northern 'segment' and nine events correlate along a southern 'segment.' We find no events that occur clearly in only one channel, and only four events that are found in two and three channels only. These events are in close proximity to the seismically active Mendocino Triple Junction, and probably are related to local earthquakes there. The 'segment boundary' along the SAF, if such exists, lies between Point Reyes and Point Arena.