Geology

Can turbidites be used to reconstruct a paleoearthquake record for the central Sumatran margin?: REPLY

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Notes

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Can turbidites be used to reconstruct a paleoearthquake record for the central Sumatran margin?

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We thank Goldfinger et al. (2014) for their Comment on our paper (Sumner et al., 2013) concerning turbidite paleoseismology on the Sumatran margin.

Turbidite paleoseismology requires that *every* large earthquake produces a widespread turbidite: it is this wide aerial extent that enables the turbidite to be recognized as being earthquake-triggered. Testing whether every large earthquake produces a widespread deposit requires *independent evidence* of the timing of earthquakes; it cannot be tested using approaches that rely upon turbidite mapping; e.g., confluence testing or synchronous triggering. Few studies have been conducted on margins where the known history of major earthquakes can be compared with the recent stratigraphic record, but such studies are needed to test where it is more or less appropriate to apply turbidite paleoseismology.

(1) The confluence test presumes that the occurrence of equal numbers of turbidites upstream and downstream of a confluence indicates widespread triggering. However, turbidite numbers vary with height above the thalweg, because flows have variable thicknesses. Goldfinger et al. state that they cored in the thalweg; however, the thalweg can be a poor location to analyze turbidite recurrence due to bypass, erosion, and amalgamation (McHargue et al., 2011). (2) Goldfinger et al. list a series of points used to infer synchronous triggering, but fail to say *how* they are used; Atwater et al. (2014) discuss problems with these points, particularly that event counts are not equal above and below all confluences on the Cascadian margin. (3) We agree that constraining turbidite volume is difficult, as stated in our paper.

Goldfinger et al. express concerns regarding our sampling density, but we demonstrated that it is comparable to that in other studies (our table DR1 in GSA Data Repository 2013212). Further, Patton et al. (2013) do not present data for the 109 cores in their supplemental figure, but for just 15 of them. Publication of the full dataset collected on the R/V *Revelle* in 2007 would indeed be a valuable contribution.

Coherent landslides are rare on the Sumatran margin (Henstock et al., 2006) and probably not controlled by earthquake magnitude (Brune et al., 2010): the youngest mapped landslide in the 2004 rupture area does not correlate in age with a major earthquake (Tappin et al., 2007). Despite this, Goldfinger et al. suggest that an earthquake record can be extracted from small-scale slides, which we consider doubtful. Based on what is known about landslide distribution on the Sumatran margin, the earthquake record encapsulated within small landslides is likely to be both *complicated* (by other triggers) and *incomplete*.

Goldfinger et al. state that our cores are not within the 2004 rupture zone. However, we investigated deposits related to the 2004 and 2005 earthquakes (both exceptionally large) and historical earthquakes. Our cores encompass the 2005 rupture area and the southern end of the 2004 rupture. Specific sites were chosen where turbidite deposition would be reasonably expected to have occurred; e.g., the flatter points in basins, and downstream of canyon mouths. It is unclear how basin floors in Casacadia were "proven" ineffective for turbidite paleoseismology: were the anticipated number of turbidites simply not recovered? Runout distances in different basin plains are variable.

Patton et al. (2013) did not find a "soupy" turbidite at the top of 15 out of 17 cores, but they found a potential 2004 event in three cores: 96, 104, and 105. Furthermore, their density logs do not support the presence of soupy turbidites in most core tops. Goldfinger et al. question whether the youngest turbidite in core 2MC relates to the 2004 earthquake, and whether there are additional turbidites in 4MC. We do not discount that the youngest turbidite in 2MC could relate to the 2004 and 2005 earthquakes, nor that other surficial trench turbidites could do so. Core 4MC has a bioturbated turbidite at 3.5 cm and an oxidation band at 11 cm, as shown on the graphic log (so-called sketch), which is a standard technique for representing sediment cores, as is the use of a hand lens and grain-size comparator for measuring grain size. Similar grain-size measurements by the first author have been calibrated to those made with a laser particle analyzer (Sumner et al., 2012). The ^{210}Pb count data that Goldfinger et al. request were included in our table DR4 (in Data Repository 2013212).

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