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Identification of necessary conditions for supershear wave rupture speeds: the San Andreas fault.

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The Mw 7.8 2001 Kunlun, Tibet earthquake was the first one that showed that a necessary (but not sufficient) conditions for a strike-slip fault to reach supershear rupture speeds are that it has long, straight portions (Das, Science, 2007). That is, once a fault accelerates to the maximum permissible speed, it can continue at this speed provided it is straight and there are no obstacles along the way, and provided the fault friction is low. For the Tibet earthquake, the ∼100 km region which reached the highest rupture speed of nearly 6 km/s also had the highest slip rate, the highest slip and the highest stress drop (Robinson et al., JGR, 2006). Off-fault cracks

due to the passage of the Mach cone exist in only that portion of the fault identified as traveling at supershear speed and not in other places along the fault (Bhat et al., JGR, 2007), providing additional independent support for identification of the region of near-compressional wave rupture speed. Recently Vallée et al. (2007 Fall AGU abstract; JGR submitted) mapped the progression of the rupture front using a network in Nepal, a completely different method than used earlier, also supports our original results. Re-examination of earlier reports of super-shear rupture speeds on the North Anatolian fault and the Denali fault show that such speeds also occurred on the straightest section of these faults.

So what can the Tibet earthquake teach us about the San Andreas fault? Both the 1906 and the 1857 have long, straight portions, the former having been identified by Song et al. (EOS, 2005) as having reached supershear speeds to the north of San Francisco, the region of highest slip. If the repeat of the 1857 starts in the central valley, as it is

believed to have done in 1857, it has the potential to propagate at supershear speeds through the long, straight portion of the San Andreas fault in the Carrizo Plain, the region believed to have had the largest displacement in 1857 based on paleoseismic studies. The resulting shock waves would strike the highly populated regions of Santa Barbara and the Los Angeles Basin. A question that arises is whether a fault that is straight at the surface remains straight at depth. Very accurately located background seismicity in California (Schaff et al., JGR, 2002) shows that faults are often even narrower and straighter at depth than at the surface, so that it may be reasonable to assume that the fault segments at depth are at least as straight as seen at the surface.