Identification of necessary conditions for supershear wave rupture speeds: Application to Californian and Asian Fault

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The Mw 7.8 2001 Kunlun, Tibet earthquake, with a 400 km long rupture, taught us that the portions of strike-slip faults most likely to propagate at supershear speed are long and straight. This is only a necessary (but not sufficient) condition, that is, of course all straight portions of faults will not reach super-shear speeds. 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. Laboratory experiments (Rosakis et al. *Science* 1999) show that such speeds can be attained in nature.

For the Tibet earthquake, the 100 km region of highest rupture speed not only exceeded the shear-wave speed, but actually approached the compressional wave speed of nearly 6 km/s (Robinson et al., JGR, 2006). This result has recently been confirmed in an independent study, using a very different technique (Vallée et al. JGR submitted 2008). Robinson et al. showed that this region of highest rupture speed also had the highest slip rate, the highest slip and the highest stress drop. Off-fault cracks, interpreted as due to the passage of the Mach front, exists 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). Re-examination of earlier reports of super-shear rupture speeds on the North Anatolian fault show that such speeds did occur on very straight sections of the fault. Of course all straight portions of faults will not reach super-shear speeds.

So what can the Tibet earthquake teach us about other strike-slip faults worldwide? For the San Andreas fault, both the 1906 and the 1857 earthquakes have long, straight portions, the former having been identified by Song et al. (EOS 2005) as having attained a supershear speed 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 (Das, *Science* 2007). Similar considerations will be discussed for Asian faults.