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Rock Damage Structure of the South Longmen-Shan Fault in the 2008 *M*8 Wenchuan Earthquake Viewed by Fault-Zone Trapped Waves and Scientific Drilling

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Observations and 3-D finite-difference simulations of fault-zone trapped waves (FZTWs) recorded at the south Longmen-Shan fault (LSF), which ruptured in the 2008 M8 Wenchuan earthquake in Sichuan, China show a distinct low-velocity zone (LVZ) composed by severely damaged rocks at seismogenic depths. The LVZ is several hundred meters wide along the rupture zone, within which seismic velocities are reduced by ~30-60% from wall-rock velocities with the maximum velocity reduction in the 200-m-wide fault core zone at shallow depth, consistent with the results from petrological and structural analyses of cores and well log (electric resistivity, fracture density, gamma radiation and P-wave velocity measurements) of scientific drilling. After the Wenchuan earthquake, Two boreholes WFSD1 and WFSD2 were drilled ~300-m and ~1-km west of the main rupture and met the principal slip along the Yinxiu-Beichuan fault (YBF) at depths of 589-m and 1230-m, respectively, accompanied by fractured rocks in a range of a couple of hundred meters. Near the drilling site, the nearly-vertical fault scarp of ~4-m and 190-m-wide highly fracture zone (consisting of cataclasite, fault breccia and fault gouge) restricted to the hanging wall were mapped at the ground surface after the Wenchuan earthquake, where a dense cross-fault seismic array was deployed to record FZTWs generated by aftershocks. We interpret the remarkable LVZ composed by severely cracked rocks as being a break-down zone accumulating damages caused by dynamic rupture in major historical earthquakes, mainly damaged in the 2008 M8 earthquake. By examining the FZTWS recorded for similar earthquakes before and after the 2008 event, we estimate that seismic velocities within ruptur zone was reduced by ~10% or more due to the co-seismic damage of fault rocks during the M8 mainshock. Scientific drilling and locations of aftershocks generating prominent FZTWs also show rupture bifurcation along the thrusting YBF and the Anxian-Guangxian fault (AGF), which dip westward at varying angles and connect at seismogenic depth. A combination of seismic, petrologic and geologic study at the LSF of Wenchuan earthquake allow us to further understand the faulting mechanics, physical properties and rock damage structure at active faults.

Key words: Wenchuan earthquake, fault rock co-seismic damage, fault-zone trapped waves, fault scientific drilling.

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