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Seismic reflection images of the Great Sumatra-Andaman earthquake rupture: from source to surface

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The Great Andaman-Sumatra earthquake rupture initiated at about 30 km below seafloor along a megathrust at the interface of the downgoing Indian plate and overriding Sunda plate. The rupture propagated to the seafloor and produced a slip on the scale of 15-20 m, which produced the disastrous tsunami that took over 280,000 lives and unaccountable loss of properties around the Indian Ocean. However, two years on, we neither know the nature of the source region nor how the rupture arrives to the surface that caused the tsunami. In July 2006, we carried out a deep seismic reflection survey on board the WesternGeco seismic vessel Geco Searcher towing two long Q-Marine streamers and a very large source. One streamer was 12 km long at 15 m water depth and the second streamer was 5.5 km at 7.5 m depth. A large array of 48 tuned air guns of 10,170 cubic inch was used as a source, which provided 330 bar-m output. Two deep seismic reflection lines were shot. The first line is 255 km long and runs close to the epicenter of the 26th December event, traversing the subduction front, a narrow accretionary wedge, the Simeulue plateau and the Simeulue forearc basin. The second line is 455 km long and located 255 km farther west: it traverses the whole margin, from the oceanic basin on the Indian plate up to the Andaman Sea, running across the the deformation front, the accretionary wedge, the West-Andaman Fault, the Aceh forearc basin, the submarine Sumatran fault and volcanic arc. Onboard processing of these data shows reflectors down to 18 s two-way travel time (TWTT), i.e. down to about 50-60 km depth. The subducting oceanic crust, including the oceanic Moho, could be seen down to 13 s TWTT near the epicenter of the 26th December earthquake, i.e. the megathrust that produced the earthquake could be followed from the source region at about 30 km depth to the surface near the subduction front. We also observe a discontinuity in the subducting plate beneath the West Andaman Fault. On the western line, a backthrust seems to emerge near the western side of the Aceh basin and originate at about 20 km in the crust. A more detailed processing is under way and should provide unprecedented reflection images of this megathrust and hence insight about nature of the tsunamigenic Great Andaman-Sumatra earthquake.