Differences in ground motion and fault rupture model between surface and subsurface rupture earthquakes

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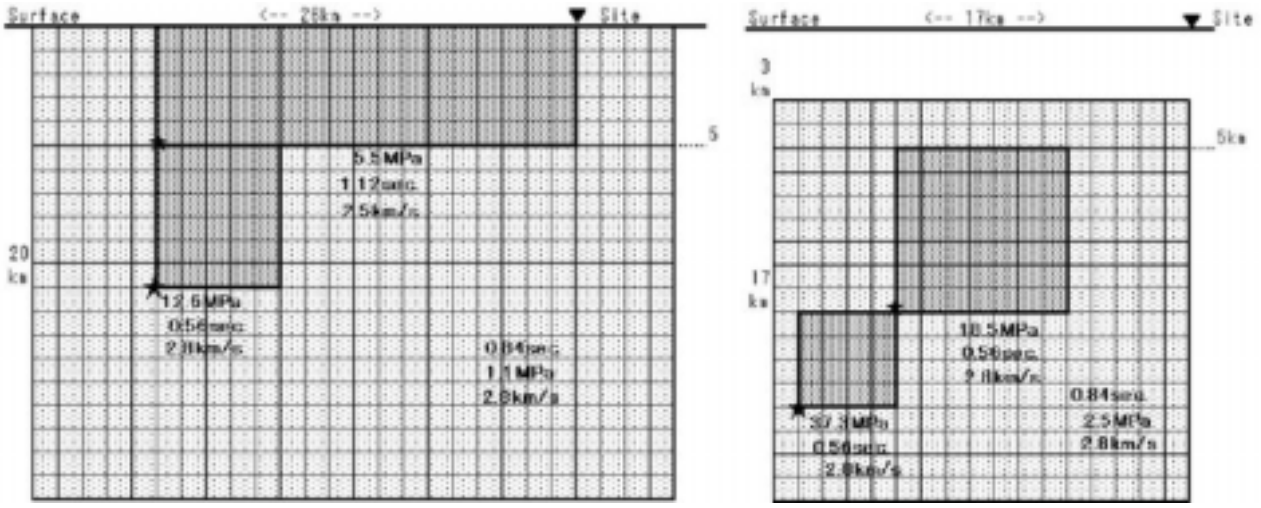
We have studied differences in ground motion and fault rupture characteristics between surface rupture earthquakes and subsurface rupture earthquakes. We found the ground motion caused by subsurface rupture in the period range around one second is larger than the average for all earthquakes, e.g. as represented by the empirical ground motion model of Abrahamson and Silva (1997). On the other hand, ground motion from earthquakes that rupture the surface is smaller in the same period range.

We divided the crustal earthquakes used by Somerville et al. (1999) into two types, and found that the rupture area of subsurface rupture earthquakes is clearly smaller than that of surface rupture earthquakes having the same seismic moment [Kagawa et al.(2001)]. We also found that the large slips of surface rupture earthquakes are concentrated into the depth shallower than several km, i.e. their asperities are shallow. Meanwhile, slips of subsurface rupture earthquakes are spread over the depth deeper than 5 km, i.e. asperities are deep. Furthermore, slip velocities of shallow asperities are almost half that of deep asperities.

To test whether these differences in source characteristics can explain the observed differences in ground motions between the two types of earthquake, we assumed standard fault rupture models for surface and subsurface earthquakes. We calculated strong ground motion by a stochastic method [based on Kamae and Irikura (1992)] in the near fault region. The simulated ground motions in the period range around one second have the same characteristics as those of the observed ground motions. We consider that the difference in ground motion between two types of earthquakes is caused by the difference of magnitude-area scaling, depth of asperities and their slip velocities.


Surface
<-- 28ka -->
Site
5
20
ka
5.5MPa
1.12sec.
2.5km/s
12.6MPa
0.56sec.
2.8km/s
0.84sec.
1.1MPa
2.8km/s
Surface
<-- 17ka -->
Site
3
ka
5ka
17
ka
10.5MPa
0.59sec.
2.8km/s
0.84sec.
2.5MPa
2.8km/s
0.56sec.
2.8km/s