

Numerical simulation of accretionary wedge formation with lithification

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Most of great and giant interplate earthquakes occur in the subduction zones with accretionary prism (ex. Kanamori, 1986). It has been also noticed that seismogenic zone and tsunamigenic (or aseismic) zone correspond to lower slope angle inner wedge (undeformed forearc basin) and higher slope angle outer wedge, respectively. To explain this correspondence, several hypotheses are proposed (ex. Moore and Saffer, 2001; Song and Simons, 2003; Fuller et al., 2006; Wang and Hu, 2006; Kimura, 2007) but there is no physical model that can treat both wedge formation and earthquake generation processes.

Based on a hypothesis that lithification controls both geometry of accretionary wedge and up-dip limit of seismogenic zone (Kimura, 2007), we simulate formation of accretionary wedge using 2D discrete element method (DEM) with lithification model. Particles are supplied at constant rate on a subducting plate with constant velocity. Lithification is modeled as an increase in strength and number of bonds between contacted two particles depending on local stress and contacting time. Geometry of accretionary wedge varies in km scale and seismic slip is in m scale. In order to treat both processes in one DEM model, millions of particles are necessary. We have developed a highly efficient algorithm and demonstrate DEM simulation with such a huge number of particles.

One of the results of formation in accretionary wedge is that thicker sediment supply enhances seaward development of accretionary wedge with lower taper angle. Global data also show such a trend (Clift and Vannucchi, 2004). Although this trend is reproduced without lithification process, wedge slope change between outer and inner wedge can be seen only when lithification process is included. In such a case, outer wedge is highly deformed but deformation is localized into some faults in the inner wedge. These results are still preliminary ones because particle numbers used in these simulations are from several thousand to hundreds of thousand. We will investigate deformation and fracture pattern not only in the wedge but near the plate boundary with million particles.