Parametric study on ground surface deformation forming pull-apart basin

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Understanding the forming process of pull-apart basin due to faulting is an important topic in the field of geomorphology and several types of studies on pull-apart structure have been widely conducted: field works (e.g., Aydin and Nur, 1982), theoretical studies (e.g., Du and Aydin, 1995), and numerical studies (e.g., Liu and Konietzky, 2018). As an example in Japan, the Suwa Basin along the Itoigawa-Shizuoka Tectonic Line is considered to be a pull-apart basin produced by two left-lateral strike-slip faults (e.g., Fujimori, 1991).

Since most of the previous studies were limited to individual case studies or a few simulation cases, a systematic parametric study is needed to methodically understand ground deformation patterns resulting in pull-apart basins. Here, I performed a series of three-dimensional finite element analyses to understand the deformation patterns of the ground surface by changing the parameters that control both the fault configuration and the stress field around the faults. In this study, all procedures for the finite element simulations were implemented in a multi-purpose finite element package (COMSOL Multiphysics).

On the basis of 715 simulations, the followings are obtained:

(1) When the step-over width equals to 3.0 km and the overlap equals to 2.0 km, strong basin subsidence is observed irrespective of the directions for principal stresses.

(2) An extremely large overlap cannot produce strong basin subsidence irrespective of the magnitudes of step-over widths.

(3) The direction of principal stress affects the magnitude of the basin subsidence, but it does not affect the displacement pattern of the ground surface.

(4) The sensitivity of overlap to the basin subsidence is larger than that of the step-over width to the basin subsidence.

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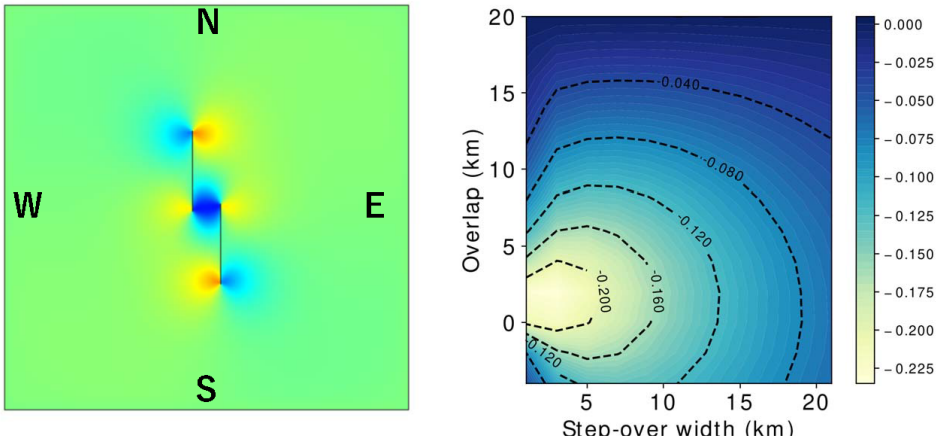

(a) The up-down component of displacement (red: up, blue: down) with 7 km step-over and 2 km overlap.

(b) Relationship among step-over, overlap, and the basin subsidence at the center of the simulation model.

Figure 1: A part of parametric study in which step-over, overlap, and principal stress direction are selected as the parameters.

