EGU21-14053
https://doi.org/10.5194/egusphere-egu21-14053
EGU General Assembly 2021

Short-wavelength Bouguer anomaly and active faults in the northeastern Japan arc from the viewpoint of differential geometry

Mitsuhiro Hirano[1], Hiroyuki Nagahama[2], and Jun Muto[3]
[1]Department of Earth Sciences, Tohoku University, Sendai, Japan (mitsuhiro.hirano.s8@dc.tohoku.ac.jp)
[2]Department of Earth Sciences, Tohoku University, Sendai, Japan (hiroyuki.nagahama.c7@tohoku.ac.jp)
[3]Department of Earth Sciences, Tohoku University, Sendai, Japan (jun.muto.a3@tohoku.ac.jp)

In the northeastern Japan arc with the active compressive stress field since ~3 Ma, it is reported that active faults have a characteristic distribution on the short-wavelength (< 160 km) Bouguer anomalies: Active faults tend to be located in negative regions. It suggests that they do not simply correspond to geologic distributions, and also reflect active crustal deformation in the northeastern Japan arc. Although previous studies proposed that cracks and volumetric strain caused by faulting contribute to negative gravity anomalies, the quantitative effect of active faults on the short-wavelength Bouguer anomalies in the northeastern Japan arc has been unclear in previous studies because of the low resolution of the gravity map. So, we evaluated the quantitative effect of active faults in the northeastern Japan arc using the latest digital datasets for gravity measurements. First, we created a new short-wavelength (< 160 km) Bouguer anomaly map with high spatial resolution and redrew the geologic map to the mass-density distribution map. On our map, active faults are accompanied by negative regions or grooves. The negative regions or grooves with active faults cannot be only explained by the existence of a low mass-density layer (e.g., sedimentary layer) based on the mass distribution map and cylinder's model with a mass-density depending on the depth. We then showed that gravity anomalies due to accumulated cracks and volumetric strain caused by faulting over the past three million years, which is estimated at around -10 mGal, should also be taken into account. Our result indicates accumulated crustal deformation can generate negative gravity anomaly zones along the strain concentration zones, impacting the pattern of short-wavelength Bouguer anomalies throughout in the entire northeastern Japan arc. Moreover, the earthquakes occur near the crustal bending regions in Niigata-Kobe Tectonic zone, which is a strain concentration field. Since active crustal deformation with large dislocation is associated with the curvature of crustal bending, gravity anomalies can be related to the crustal geometry including the curvature. Finally, we would reveal that the relationship between gravity anomaly and crustal deformation originates from the correspondence among differential geometric objects in space-time and material space, and the short-wavelength Bouguer anomalies are the result of its projection.