Subsurface structure at the InSight landing site estimated from compliance analysis of Martian convective vortices

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The internal structure of Mars gives us an important piece of information to reveal how the planet formed and evolved until today. For example, the global physical structure and/or bulk composition is a key to constraining the thermal environment at the initial stage of the formation, and the subsurface structure allows us to infer how the subsequent geological evolution proceeded.

To push forward our knowledge of the Martian interior, NASA's InSight (Interior Exploration using Seismic Investigation, Geodesy and Heat Transport) has been conducting seismic observations on Mars since 2018 in the western portion of Elysium Planitia. In this study, we focus on the subsurface structure (several tens of meters) at the InSight landing site. From the remote sensing data, it is known that the site is located near the North-South structural dichotomy, and several geological units co-exist, which indicates that the region went through several geological activities such as volcanism, erosion, metamorphism, fluvial sedimentation, and so on (e.g., Golombek et al., 2017; Golombek et al., 2020; Pan et al., 2020). Understanding the subsurface structure besides surface features would give us further constraints on the past geological activities.

For the investigation of the subsurface structure, we pay attention to the ground deformation induced by local pressure variations (e.g., convective vortices, dust devils). Measuring the ratio of the ground response against pressure load can tell us how rigid the ground is. So, the compliance analysis brings us the estimation of elastic structure (such as Young's modulus, seismic velocity). The initial analyses using the InSight seismic and pressure data constrained the elastic structure down to 10-20 m (e.g., Lognonné et al., 2020; Kenda et al., 2020). We attempt to construct a new subsurface structure model which covers the deeper range (~ 75 m) and has a higher depth resolution, by improving the existing compliance approach (e.g., extending frequency range, considering the wind speeds in the analysis).

In the presentation, following a general overview of the subsurface structure deduced from the InSight data, we will present a new subsurface structure model at the landing site derived through the compliance analysis, and discuss the possible contribution to the understanding of the past geological processes.

References

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