Geodynamic inversion with uncertain initial geometries

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Advanced numerical methods and increasing computational power have enabled us to incorporate numerical forward models into geodynamic inverse frameworks. We now have several strategies to constrain the rheological properties of the crust and lithosphere. Yet, the initial geometry of geological formations (e.g., salt bodies, magma bodies, subducting slabs) and associated uncertainties are, in most cases, excluded from the inverse problem and assumed to be part of the a priori knowledge. Usually, geometrical properties remain constant, or we employ simplified bodies like planes, spheres or ellipsoids for their parameterization.

Here, we present a simple method to parameterize complex three-dimensional bodies and incorporate them into geodynamic inverse problems. Our approach enables us to automatically create an entire ensemble of initial geometries within the uncertainty limits of geophysical imaging data. This not only allows us to account for geometric uncertainties, but also enables us to investigate the sensitivity of geophysical data to the geometrical properties of the geological structures.

We present 3 areas of application for our method, covering salt diapirs, magmatic systems and subduction zones, using both synthetic and real data.