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Spatial Distribution of Stress Orientation by Inversion of Focal Mechanism Solutions Using MSATSI: A Case Study Across Japan Trench

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Abstract

Estimation of stress field orientations is a necessary aspect for recognition of crustal mechanics as well as the physics behind occurrence of earthquakes. A case study employing the new MATLAB software package SATSI (Spatial and Temporal Stress Inversion) for stress inversion utilizing the focal mechanism data is presented here to produce stress orientation models in North East (NE) Japan. In this work, the study region is divided into 49 small sub-regions so that the stress tensors and focal mechanisms can independently fit in each sub-region. Determination of any stress variation is strongly needed by the data while eliminating the artifacts due to overfitting of noisy or nonuniquely fitting data. To resolve it, a damped inversion procedure was applied which inverted the stresses in all sub-regions, while at the same time reducing the difference in stress between adjacent sub-regions. Earthquake focal mechanisms have been used to determine the stress patterns at depths capable of generating earthquakes in NE Japan since 1960-2021. In this work, 0D, 1D and 2D stress inversion using the MSATSI (MATLAB package for Spatial and Temporal Stress Inversion) routine was performed and examined the spatial variation of stress orientations over NE Japan along the Japan Trench and put forward recent knowledge about the stress pattern. From the obtained 2D inversion results, a spatially varying stress regime is observed in the crust which demonstrates normal faulting on the subducting Pacific plate which changes to reverse faulting on the Okhotsk Plate through an intermediate state of oblique faulting.

Keywords: MSATSI, Stress inversion, Focal mechanism solution