Development of a method for identifying surface faults using active and passive sensors in remote sensing data

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High-precision and reliable identification of surface rupture disturbances is a relevant issue due to construction planning, exploration of mineral deposits, and forecasting hazardous geological events (earthquakes) [1]. Fault detection is performed using methods of automatic supervised thematic analysis of multispectral and radar satellite images. The developed software solutions are based on open libraries of the Python programming language [2].

For the study, a section of the Altai Mountains was chosen due to the increased seismic activity in this region, as well as the high degree of geological and geophysical research. Subsequently, parameters of multispectral and radar satellite data for detecting regional faults were determined. During the processing of multispectral imagery from the "Landsat-8/9" satellite and a series of quality experiments, a raster algebra function [2] or "Deformation Index" was developed: $alt = (SWIR1)/(SWIR2)$,

where SWIR1 is the value of reflected radiation in the 1st short-wave infrared range (1.57-1.65 μm); SWIR2 - in the 2nd, respectively (2.11-2.29 μm). The range of numerical values of the index corresponding to the presence of a surface fault ranges from 1.5 to 2.5 inclusive. As a result of interpreting the values, it was found the areas of groundwater outlet and temperature anomalies correspond to this range, indirectly indicating the presence of breaks. Comparing the obtained data with the fault network of the Geological Institute of the Russian Academy of Sciences and the digital elevation model (valley asymmetry parameter) confirmed this assumption [3].

Furthermore sharp gradients of vertical movement velocities also indicate the presence of faults. High-precision (up to 1 mm) determination is implemented through differential radar interferometry. The initial data is a two-pass survey from the satellite "Sentinel-1b" (GSD 10 m/pixel). By analyzing the interferogram and unwrapping the phase of the reflected signal, maps of surface displacements were created, confirming the initial hypothesis and refining the information obtained from passive scanning systems.

The combination of data obtained through space imaging with active and passive sensors allows for the high-precision identification of regional surface faults.

Literature

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