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Application of 3-D migration in problem of subsurface sensing on an uneven ground surface

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At the present time due to technological progress and cost reduction are widely distributed GPR (Ground Penetration Radar) systems. These systems allow carrying out subsurface studies and successful results have been obtained for industrial applications such as searching for lost communication lines, control of pipes state of water and gas supply systems, landmine detection, groundwater investigations, exploration of mineral resources, and also for archaeological and historical applications, i.e. study of archaeological layers of the Earth, searching for different types of artifacts and etc. Methods of seismic data processing come to the help us. The main method of seismic data processing is migration.

As a result of diffraction of each point reflector located in a homogeneous medium is displayed in the form of a hyperbola. In this case the true position of the point scatterer corresponds to the apex of hyperbola. Process of migration moves reflections to their true positions and collapses diffractions, thus increasing spatial resolution and yielding image. In seismic data processing the most commonly used methods of migration are the method of diffraction summation in time-domain and Stolt method in f-k ?domain. We have compared these methods using simulation of reflection of point scatterers. Using both methods we can find the true position of a scatterer. The main limitation of Stolt migration consists in the fact that a velocity of wave propagation in a medium is constant and another limitation is the interpolation a dataset on a regular grid. Diffraction summation method is more universal method, but Stolt migration using the Fourier transform is faster more than 1000 times.

The experiments were carried out in different sites of Japan. For positioning of the antenna was used rotary laser positioning system. This system gives more accuracy spatial coordinates, than GPS. The datasets are processed using the following steps: time zero correction, gain application, background removal and 3D migration. Migration was processed using by diffraction summation algorithm and under the assumption of a flat surface. But, really, survey area is not flat, and we need take into account topographical properties of surface and make correction on height in the migration process. We developed algorithm based on diffraction summation method which takes into consideration irregularity of surface. Simulation tests of this algorithm were successful in 2D and 3D migration cases. Now we are trying to apply algorithm for real datasets.

The experiment result demonstrates the possibility of performing a full 3-D migration. We found some targets with small slope in depth direction due to topographical properties of surface. Further work will focus on implementing and testing these methods for reconstructing images takes into account topographical properties of surface.

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