

Verification of the tunnel geological structure based on the helicopter-borne magnetometry data analysis

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1. Introduction

More detailed geological information of tunnel ground is very important for its construction. Especially, geological complicated area, such as accretionary complex, is needed more accurate information for process control and avoidance of risk during construction of tunnels. The authors carried out helicopter-borne magnetic survey to verify its applicability for geotechnical evaluation of a mountainous planned road tunnel in east Hokkaido, Japan. We describe corresponds with the results of the geological profiles estimated from the outcomes of tunnel construction records and its analysis results of magnetic anomalies which was obtained by helicopter-borne magnetometry data.

2. Outline

The geology of the study area is mainly consists of greenstone, pyroclastic sedimentary rock and hyaloclastite, and is mixed with pillow lava, chert and limestone. Many faults are formed in the area around the survey site due to tectonic movements at the time of formation of the accretionary complex and after that. Surveyed tunnel is planed to 910 m long and maximum overburden is 150 m. The magnetic intensity was measured from a helicopter at low altitude using a cesium magnetometer, and a magnetic intensity map was compiled based on the scalar volume of the magnetic force after reduction to pole magnetism. The probable geological model of the tunnel profile was analyzed using the magnetic anomaly pattern. The forward modeling process for the magnetic data was conducted using Mag2dc software (Cooper, 2003) based on the Talwani algorithm for calculation anomalies. The forward modeling was carried out according to the type of magnetic anomaly over blocks/steps, dependence of anomaly on width, depth, susceptibility contrast and dip angle. The tunnel geological models that estimated using the magnetic anomaly pattern were verified by the geological properties from tunnel construction records.

3. Results of survey

Results of this survey, executed in a mountainous area where accretionary complexes are distributed, are summarized as follows:

1) Helicopter-borne magnetic survey was carried out for a tunnel in northeastern Hokkaido and magnetic intensity map was figured. By the correlation to the other results such as the geological survey or the observation of rock type and fracture shear and conditions in advanced core, high magnetic intensity zone corresponded to the sedimentary rock and the fracture and shear zone of hyaloclastite and massive basalt.

2) Two geological models were made by combining helicopter-borne magnetic survey results with geological survey results and magnetic intensity model. The models were correlated to the detailed data obtained by advanced boring core observation, and these distributions are roughly confirmed by advanced boring core observation.

3) In this case study, helicopter-borne magnetic survey provided useful information for effective interpretation. To analyze geological structure by helicopter-borne magnetic survey is very effective to evaluate potential geotechnical issues when excavating a tunnel.

Keywords: helicopter-borne magnetic survey, magnetic anomalies, accretionary complex, road tunnel