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Accuracy improvement of tunnel geological features evaluation by helicopter-borne EM and magnetic survey

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1. Introduction

For long tunnels, however, surveys must cover a wide range of areas, placing a limit on the feasible improvement in accuracy, as adequately grasping the geological conditions of the entire tunnel ground as well as depth properties incur significant labor and costs. Geophysical explorations making use of helicopters are applied in civil engineering geological fields, such as long tunnels and of large scale landslides, have recently been on the increase. This method enables the simultaneous conduction of more than one exploration at a time with electromagnetic soundings and magnetic prospecting from the air. Capable of rapidly and broadly measuring the characteristic values of the underground, this method allows the gathering of three-dimensional geological information.

2. Outline and Method

The authors were carried out HEM (helicopter-borne electromagnetic method) and the HMS (helicopter-borne magnetic survey) on a planned mountain tunnel with a total length of 4.1 km and 0.9 km long tunnel in the accretionary complex areas of Hokkaido, Japan. Records and survey results of constructed tunnels were also examined. Moreover, the pilot boring core, which had been conducted at all lines of the tunnel, was analyzed, shedding light on lithofacies distributed throughout the aforementioned areas. In the area surrounding the survey site, the Nikoro Group of the Tokoro belt is distributed. The Nikoro Group 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. The authors describe the feasibility and effectiveness of helicopter borne surveys tunnel construction to detect the distribution of geological property in the accretionary complex area by comparing them with other geological data and observation results.

3. Results

As the results, apparent electrical resistivity by HEM, it was found to reflect the lithofacies and the degree of weathering, deterioration and frequency of shear and fracture of the underground. According to data of seismic refraction, it was confirmed that the low velocity layer corresponded to a low apparent electrical resistivity part. Several low resistivity zones, mottled or relatively steep gradient parts of resistivity were recognized. These area or zones were correlated with actual lithofacies and actual geotechnical problems encountered by the tunnel excavation. As for the magnetic intensity by HMS, it was showed high value in basalt area, and low value in hyaloclastite area respectively. These tendencies correspond to the distribution of geological property observed by horizontal pilot boring core ahead of the tunnel excavation. Thus, the distribution of geological property will be indicated not only by the apparent electrical resistivity but also by the magnetic intensity. By these two combinations, the geotechnical condition is estimated briefly without decreasing its accuracy.

Keywords: helicopter-borne EM, helicopter-borne magnetic survey, tunnel