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# Application of helicopter borne geophysics to the civil engineering geology, a case study of road slope investigation

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1. Introduction:
A lot of case studies with the investigation by the HEM (helicopter-borne electromagnetic method) and the HMG (helicopter-borne magnetic method) are reported in recent years. Both methods are suitable methods to acquire the three-dimensional information to evaluate geological features properties of the underground in promptly and over the wide area. The authors describe the applicability on the civil engineering geology fields of both methods through the confirming results of the correspondence another geological investigation results to evaluate the geological structures in the underground of road slopes situated along the coast in the east part of Hokkaido.

2. Outline
The investigated sites were road slopes where surface collapses were caused in the past time. The geological features of the investigated site were clarified as the Neocene mudstone, fine-grained sandstone, tuffs, conglomerates and terrace deposit by the results of the geological survey. The height of the road slopes are above the sea 60m or more, and a smooth terrace spreads out their backwards. The authors carried out HEM, frequency domain, and the HMG. In addition, vertical electric soundings and the electric conductance such as the stream water of neighborhood were measured for the calibration of the resistivity by HEM and confirmation of the resistivity distribution of sallow part of the site ground.

3. Results
As the results of HEM, the apparent resistivity distribution is high in a shallow part, and low in the depth overall. The change in resistivity distribution was thought to be caused corresponding to the difference of the rock type on this site. In general, the specimen resistivity is the order of conglomerate, sandstone, mudstone for sedimentary rocks of this site. The change in resistivity distribution was also thought to be corresponding to the moisture states balance. The resistivity is high in the unsaturated zone of shallow part, and low in the saturation zone of the deep part. As for this, the resistivity such as the gush water around the investigated site in the result of 30ohm-m. Moreover, in the results of vertical electric soundings, the resistivity of the site ground from surface to about 10m was 200 ohm-m, and when it is deeper than 10m, the resistivity of the ground was about 60ohm-m or less. These results were similar to the result of HEM. Thus, the vicinity of the boundary with the terrace deposit on the base that showed a low resistivity was thought to have caused the collapse on a slope surface because underground water flowed. As a result of HMG, the distribution of the magnetic anomaly confirmed the change in this site. The change in the magnetic anomaly distribution was thought to be caused corresponding to the rock distributed on this site. In general, magnetism strength is the order of conglomerate, sandstone, mudstone for sedimentary rocks. Magnetic anomaly distribution on this site corresponds to the existing geologic map, and distribution of rock type in outcrop along river. Therefore, the distribution of the magnetic anomaly and geological features were corresponding on this site.

## 4. Conclusions

HEM and HMG were applied to the investigation of the road slope, and information three-dimensional that presumed the distribution of geological features were obtained in this site. Moreover, both methods were obtained as similar information compared with existing geological features investigated results. As for these two exploration methods, application to the geological investigation was very possible according to the condition and accuracy.

Keywords: helicopter-borne electromagnetic method, helicopter-borne magnetic method, civil engineering geology, road slope