An efficient and low-cost measurement system for IP monitoring of deep structures by long survey line

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The present study developed a low-cost and lightweight potential receiver system using ethernet cables and small switch boxes, to perform a time-domain IP measurement on a long survey line for the purpose of monitoring the IP property structure at depths. Various measurement systems have been developed to monitor resistivity structures in a shallow subsurface, in order to understand temporal changes in groundwater flow and passive remediation of contaminants. In particular, multi-core cables and scanners have made it possible to efficiently acquire data with a very large number of channels, and been used for ERT monitoring and other applications. However, in the case of IP measurement at deeper depths, using a single multi-core cable both for current injection and potential measurement may result in poor data quality due to EM coupling. In addition, multi-core cables tend to be thick and heavy, and the total weight of a long measurement line exceeding several hundred meters becomes very large and costly. Furthermore, wiring multi-core cables is a difficult task when measuring in mountainous areas where the terrain is rugged. In this study, the cable system for current injection and the system for potential measurement were separated, to avoid EM coupling by current injection. Therefore, the multi-channel measurement system using ethernet cables less susceptible to crosstalk was developed to improve data quality, increase work efficiency, and reduce costs.

In this system, equally spaced potential electrodes are connected to the switch boxes, and each switch box is connected by the ethernet cables. The ethernet cable, consisting of 8 cores, enables simultaneous acquisition of up to n=7 data with a single current injection using Dipole-dipole array. A time-domain IP measurement was tested at a mine in Japan using this system. The survey line has a length of 700 m with 50 m electrode spacing. It is known that this mine is a black ore-type deposit, containing sulphide veins and disseminated sulphides composed of pyrite, chalcopyrite, and sphalerite at depths below about 50 m below sea level. In this experiment, IP anomalies corresponding to these locations were successfully detected. In addition, the ethernet cable system is lightweight, weighing only about 2 kg even with a length of 50 m, so it was possible to significantly reduce the burden of wiring work in spite of the heavily rugged topography of the investigated area with an obliquity of about 30°. This system would be suitable for repeated time-domain IP measurements for deep structures.