Relationship between resistivity distribution and shallow subsurface structure on granitic hollows

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The location of shallow landslide is controlled by subsurface structure such as soil thickness and bedrock depth. An efficient method is required for estimating subsurface structure in order to reduce disasters caused by shallow landslides. Although electrical resistivity survey (ER survey), which is one of geophysical methods, has been applied for estimating deep-seated geological and hydrological condition, its applicability for an uppermost zone of slopes has not been fully discussed. This study applies ER survey to granitic hollows in Ibaraki (sites A and B) and Hiroshima (site C) prefectures, Japan to verify the estimability of shallow subsurface structure in hillslopes. The ER surveys were conducted under conditions without rainfall, and the electrode spacing was 0.5 m or 2.0 m in each survey. According to observation of soil pits near each site, slopes in the sites A and B were composed of a fine-grained topsoil layer ($N_c \leqq 3$, where N_c is a value of cone penetration resistance), a coarse-grained saprolite layer ($3 < N_c < 30$) and bedrock layer ($N_c \geqq 30$). At the site C, a gravel layer was found below a topsoil layer instead of a saprolite layer, and the bottom of the topsoil layer corresponded to the zone of $N_c = 5$. For the case of the horizontal stratum structure, the ER distribution well reflected the subsurface structure estimated from the cone penetration test. On the other hand, the reproducibility decreased where the subsurface structure varies three-dimensionally or where the spatial distribution of the physical properties changes gradually. The resistivity increased with depth from the surface to the bottom of the topsoil layer. Discontinuity of physical properties between topsoil and saprolite/gravel layer probably appeared as increasing zone of resistivity. Consequently, the bottom of the topsoil layer was detected in the ER survey. The resistivity in most of bedrock area gradually decreased with depth. However, the depth of bedrock surface could not be detected from the spatial change in resistivity. The resistivity at bedrock surface tended to decrease with increasing the depth of the bedrock surface. Assuming that the physical properties of bedrock surface are spatially uniform, the resistivity at the bedrock surface is mainly influenced by distribution of subsurface water. The ER survey is applicable for an alternative of conventional methods to estimating shallow subsurface structure on granitic hillslopes.

Keywords: shallow landslide, granite, electrical resistivity, cone penetration test, shallow subsurface structure, subsurface water

