Development of Extraction Technology for Potential Slopes for Deep-seated Landslides, Focusing on Subsurface Resistivity Tomography Obtained by Airborne Electromagnetic Survey

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INTRODUCTION

In recent years, many deep-seated landslides occurred throughout Japan, including that caused by Typhoon Talas in 2011 in the Kii Mountains. To alleviate the damage caused by deep-seated landslides along with the control measures, it is essential to extract potential slopes for deep-seated landslides (hereafter referred to potential slopes). Although previous reports showed the methods to extract potential slopes with checking of the gravitational slope deformation and the use of the electrical conductivity (EC) of spring water from slopes, these methods may require a detailed field survey and a great deal of labour. Meanwhile, there has been growing attention paid to airborne electromagnetic surveys to gather underground data over a wide area. This study examines the method to extract potential slopes with the resistivity by airborne electromagnetic survey.

STUDY METHOD AND STUDY AREA

First, a slope which was inferred to be a potential slope was extracted with terrain interpretation, the distortion ratio and EC value of spring water. At this slope, a boring survey was also conducted to verify (i) the assumed weathering state of the bedrock and (ii) relevance of the assumed loosening zone, based on the resistivity. Second, the conditions of the loosening zone for potential slopes in a wide area were examined with the resistivity. We used 140000, 31000, 6900, 1500, 340 (Hz) on airborne electromagnetic surveys.

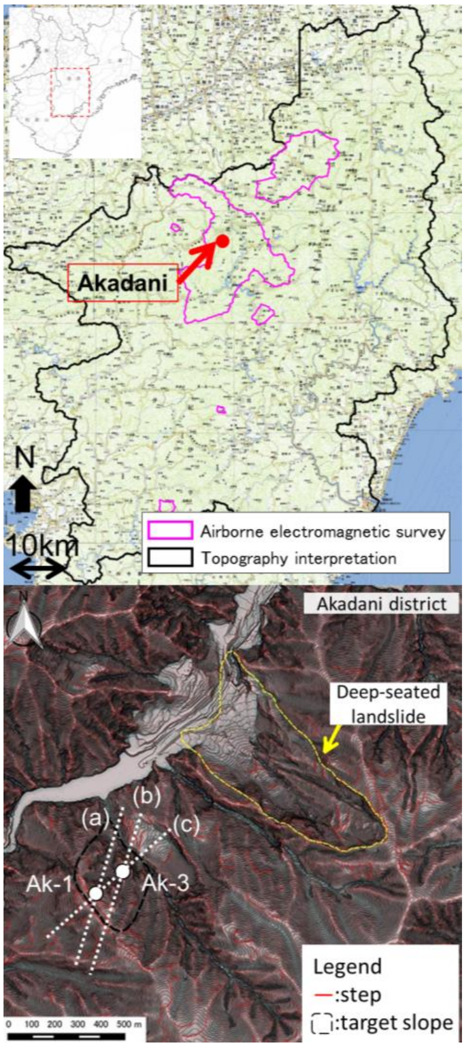

Fig. 1 Study area

Airborne electromagnetic survey allows us to estimate the characteristic of bedrock with electromagnetic induction.

The study area is shown by **Fig.1**. The slope for this study is located in the vicinity of Akadani river (**Fig.1**), where deep-seated landslide occurred by Typhoon Talas in 2011.

THE APPARENT RESISTIVITY AND BORING CORE SAMPLES

Relative changes of the apparent resistivity are believed to be affected by the moisture content, clay mineral content. On the basis of the apparent resistivity, the low resistivity zone sandwiched by high resistivity zones may indicate clay-rich layers and the distribution of mudstone and tuff layers. The center of the low resistivity zone is observed at a depth of around 52 m from the ground surface (**Fig.2**).

According to the boring core samples, pelitic rocks, which contain tuffaceous shale and are sandwiched by sandstone layers, are distributed at a depth of around 52 m (**Fig.3**). X-ray diffraction found a formation of smectite near the center of the low resistivity zone. The resistivity analysis and the boring survey indicate the low resistivity zone sandwiched by high resistivity zones may represent loosening zone.

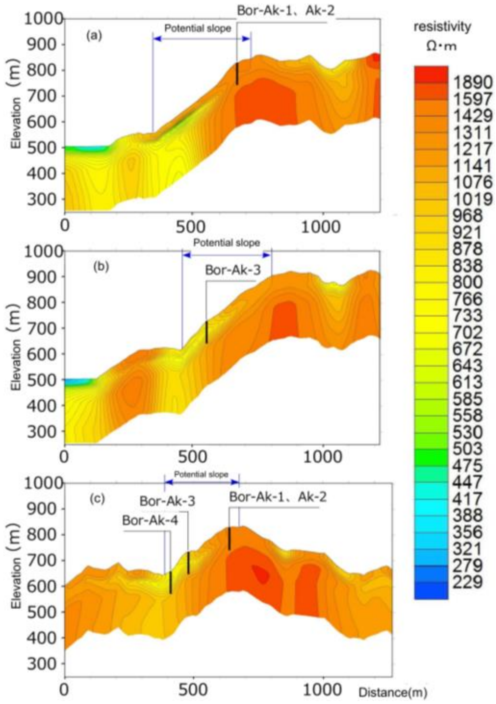

Fig. 2 Apparent resistivity

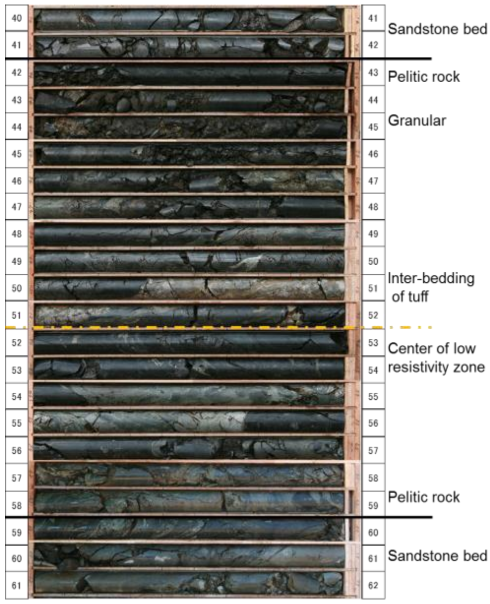

Fig. 3 Core boring result (Ak-3)

APPLICATION TO OTHER SLOPES IN THE KII MOUNTAINS

74 slopes were extracted as potential slopes based on the distortion ratio and topography interpretation in the study area. At 14 slopes, a low resistivity zone lies between two high resistivity zones. At 35 slopes, a low resistivity zone is widely distributed at every depth. There are also 25 slopes which have the characteristics of the distribution of apparent resistivity. These slopes have the same resistivity structure as slopes where deep-seated landslides occurred by Typhoon Talas in 2011.

CONCLUSIONS

The boring survey and resistivity analysis point out that an area where the resistivity significantly changes in the direction of the depth may represent a loosening zone of the ground. Moreover, there are some patterns for the distribution of the resistivity for potential slopes. The next step of the study is to examine an analytical method capable of more clearly representing a loosening zone and a more detailed extraction method for potential slopes.

Keywords: deep-seated landslide, airborne electromagnetic survey, resistivity, boring survey