

# Modelling of self-potential signals associated with groundwater flows

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Landslides triggered by rainfall are one of the most dangerous natural disasters which give the loss of lives and properties. Although the importance of the short-term forecast of landslides is widely accepted, it is not achieved. In this research, we pay attention to electro-magnetic approach for monitoring ground water condition under the slope. That is, we understand the processes of the landslide and develop the system for forecast to detect precursory signal through the electromagnetic changes. In this study, we apply the self-potential approach, which is related on electro-kinetic effects or streaming potential. We have conducted several flume tests and sandbox experiments and the results showed the repeatability of the phenomena or correlation between self-potential and ground water condition. Therefore, we will report the model and numerical computation for the sandbox experiment on injection in this presentation.

SP signals measured in the sandbox during pumping experiment are considered to be due to the electro-kinetic effects. The total current density  $j$  is  $j = sE - I dh/dx_i$ , where  $s$  (in  $S m^{-1}$ ) is the electrical conductivity,  $E$  (in  $V m^{-1}$ ) is the electric field,  $I$  (in  $A Pa^{-1} m^{-1}$ ) is the current coupling coefficient, and  $h$  (in m) is the hydraulic head. The variation of SP signals of the sandbox gives quasi-instantaneous information on changes of the hydraulic head. Therefore we consider this problem with quasi-static limit condition i.e.  $div j = 0$ . It leads  $div(s grad phi) = -div(I grad h)$ . Where  $phi$  (in V) is electric potential. In addition, we assume that  $s$  and  $I$  are uniform through the sandbox because we assume saturated condition. Finally, the solved equation is  $s d^2 phi/dx_i^2 = -I d^2 h/dx_i^2$ . We simulated distribution of hydraulic head during pumping test using finite element method. Then, we modeled the SP generation.

Consequently, the variation of SP modeled and observed are generally consistent with each other. Therefore, we found that groundwater flows control the occurrence of SP in the sandbox experiment. However, in the detail of time variation, modeled SP differ from those of observed partly. We consider that heterogeneity of soil or necessary of 3D modeling could cause these discordances. Details will be shown in our presentation.

Keywords: self-potential, ground water flow, modelling