Scale effect of the spatial correlation factor used in Markov random fields: A case study in Taipei Basin

Presenter: Le Hoai Han
Advisor: Prof. Jia-Jyun Dong
Co-Advisor: Dr. Yu-Chen Lu
Date: 2023/03/03

Abstract

The geological model is the basis for the analysis, simulation, and evaluation of the geotechnical systems (e.g., geological hazards, foundations, tunnels, slopes, etc.). However, due to the limitation of borehole data, the stratigraphic and geological properties are difficult to obtain and highly uncertain. Thus, a spatial correlation factor is a key parameter to interpret the areas where borehole locations are sparsely distributed.

The Taipei Basin is a typical region that has some areas with insufficient boreholes to create a geological model. Hence, this study aims at translating the geological knowledge into the spatial correlation factor of a statistical model and quantifies the geological model uncertainty with scale effect. In this work, we take advantage of stochastic Markov random field (MRF) modeling to construct the geological model based on borehole information and soil parameters from the Central Geological Survey Engineering Geological Investigation Databank in the Taipei Basin. The method concentrates on 4 main tasks: (1) data analysis of the borehole data to create a more accurate cross-section; (2) use of MRF simulation to get the 2-D stratigraphic models; (3) the information entropy is quantified and expressed by the uncertainty of the stratigraphic models; (4) using maximum likelihood estimation (MLE) to get the spatial correlation factor. From the preliminary results of this study in the N-S direction, the influence of the scale effect was shown: the spatial correlation is strong relative to the scale, roughly decreasing with increasing scale. In the future, this study will choose another section in the E-W direction to simulate the stratigraphic models with a scale base. Then, apply the 3-D simulation by considering the spatial orientation distribution and comparing it with the 2-D simulation results.

Keywords: Markov random field, stratigraphic model uncertainty, information entropy, maximum likelihood estimation.