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Use of deformation monitoring results in solving geomechanical problems—case studies

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Abstract

Deformation analysis of any type of a deformable body includes geometrical analysis and physical interpretation. The ultimate goal of the geometrical analysis is to determine in the whole deformable object the displacement and strain fields in the space and time domains. Physical interpretation is to establish the relationship between the causative factors (loads) and the deformations. The latter may be obtained by deterministic modelling of deformations using, for example, finite element method (FEM). By comparing the geometrical and deterministic model of deformations, one can verify the designed behaviour of the deformable object. In addition, with properly designed monitoring surveys, one may also determine the actual deformation mechanism and explain causes of deformation in a case of unexpected behaviour of the investigated object. Thus, the role of deformation monitoring surveys becomes much broader than just the conventional determination of the geometrical status of the deformable object.

In this presentation two examples are given on the use of geodetic monitoring surveys in the

(a) determination of effects of hydrological changes on ground subsidence in a potash mine in Canada and
(b) verification of geomechanical parameters of a large earth dam in California during the filling up of the water reservoir.

Keywords: Monitoring; Finite element analysis; Mining; Earth dams; Geomechanical parameters

1. Introduction

Analysis of deformations of any type of a deformable body includes geometrical analysis and physical interpretation. Geometrical analysis describes the change in shape and dimensions of the monitored object, as well as its rigid body

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movements (translations and rotations). The ultimate goal of the geometrical analysis is to determine in the whole deformable object the displacement and strain fields in the space and time domains (Chrzanowski et al., 1983, 1986).

Physical interpretation is to establish the relationship between the causative factors (loads) and the deformations (Chen and Chrzanowski, 1986). This can be determined either by statistical method, which analyses the correlation between the observed deformations and loads, or deterministic method, which utilizes information on the loads, properties of the material, and physical laws governing the stress–strain relationship.

The deterministic modelling requires solving differential equations for which closed form solutions may be difficult or impossible to obtain. Therefore, numerical methods, such as the Finite Element Method (FEM), are used. In case of rock and soil materials, the in-situ geomechanical properties may significantly differ from the laboratory values (Bieniawski, 1984) mainly due to scale factor (Jing, 2003). This must be taken under consideration when performing deterministic modelling of deformation.

By comparing the geometrical model of deformations, derived from the observed deformation quantities, with the designed deformations obtained from FEM, one can verify the designed geomechanical parameters (e.g., Szostak-Chrzanowski et al., 2000). In addition, with properly designed monitoring surveys one may also determine the actual deformation mechanism (Chrzanowski and Szostak-Chrzanowski, 1993, 1995) and explain the causes of deformation in case of an abnormal behaviour of the investigated object. Thus, the role of deformation monitoring surveys becomes much broader than just the conventional determination of the geometrical status of the deformable object. The role of combined analysis of deformation monitoring surveys and physical interpretation has impact on: redesign of the operation of the investigated

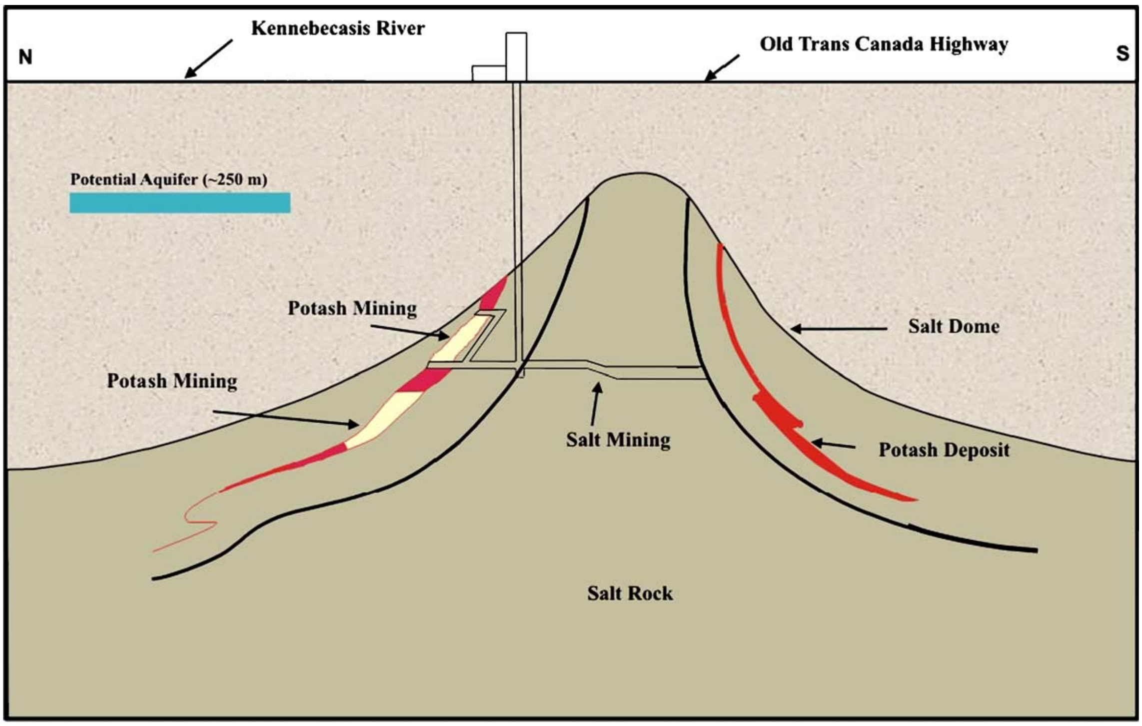

Fig. 1. Cross-section of the PCS potash and salt mine in New Brunswick.