Introduction

This book is devoted to environmental geomechanics, addressing the natural risks to the conservation of built cultural heritage, and the risks of soil pollution and waste respectively. Environmental geomechanics is a rapidly expanding field dealing mostly with the following surface structures such as: earth dams; embankments; the built environment; underground structures for storage and other civil engineering applications; with natural sites such as slopes and cliffs; and more generally with the geosphere involving reservoir engineering, mining, quarries and man-made deposits.

The chapters contained in this book address many of these problems. The book is certainly not exhaustive but the problems dealt with are characterized from a geomechanics point of view by the fact that coupling effects in the multiphase deforming geomaterials are taken into account; couplings due to heat, mass and pollutant transfer and to climatic variations and human action. The geomaterials taken into consideration are soil and rock, which may also be used as building materials. The fluids in the pores of these geomaterials are mainly water in a liquid or gaseous form, dry air but also hydrocarbons such as oil and natural gas. The solid phase may also undergo chemical transformation as in the case of the degradation of natural building stones. Phase changes are important and are linked to precipitation, condensation, evaporation, radiation, pollution, etc.

The natural risks mentioned in the first part of the book are linked with gravity effects on inclined masses, and include the instability of snow masses, soils, rocks and material transported in rivers. Surface subsidence and collapse of horizontal soil masses linked to human activity such as withdrawal of liquid or gaseous hydrocarbons from underground reservoirs or accidental infiltrations are then considered. The chapters devoted to the conservation of cultural heritage deal with the degradation of building stones and earthen plaster due to climate and pollution. This problem also involves several interactions with phase change including fluid

transfer and important chemical effects. The solution of these complex problems requires extensive use of numerical methods and a great diversity of experimental techniques. Two case studies show how the combination of the presented tools enables the preservation of European and African churches.

The second half of the book discusses environmental problems such as polluted soils and waste, the importance of which has grown increasingly over recent years in industrialized countries and are now becoming just as important in developing countries.

The problems posed by polluted soils have been recognized for more than two decades due to the popularity of redevelopment of sites and industrial land, often in semi-urban zones in developing towns. We have thus realized how little attention was paid in the industrial period to the protection of soils, a feeling probably reinforced by the invisible factor of soil pollution. In fact, soil pollution receives less attention from society (media, associations, etc.) than that given to air and water pollution. We are however observing that the significant mobilization of interest in recent years has recently been transcribed by a complete set of detailed and accessible methodological guides being put into practice, from the methodology of recognizing polluted sites to their eventual pollution control in the case of established risk.

Furthermore, waste management was for a long time carried out without considering on the one hand how to store the waste in perennial conditions and thus assuring the long-term protection of the environment, and on the other hand how to limit the production of waste through incentive measures at the source and by waste sorting.

For these two problems the phenomena of retention and transport of various pollutants (soluble, metallic and hydrocarbon) in geomaterials (natural soils or compacted confinement barriers in storage centers) rest on the various physical chemical laws that are described by the equations. A good knowledge of the phenomena of the retention and transfer of pollutants is essential for the understanding of past movements of pollutants or those still to come, as well as for the optimization of their pollution control. Numerical modeling of these transfers is now quite well known and we will see in this book how it is treated for each of the pollutants considered. These models are probably most characterized by the many thermo-hydro-chemical-mechanical couplings which are largely non-linear, which recent progress in numerical modeling has enabled us to solve in a satisfactory way.