



Numerical simulation of land subsidence above an off-shore Adriatic hydrocarbon reservoir, Italy, by Data Assimilation techniques

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Abstract. The numerical prediction of land subsidence above producing reservoirs can be affected by a number of uncertainties, related for instance to the deep rock constitutive behavior, geomechanical properties, boundary and forcing conditions, etc. The quality and the amount of the available observations can help reduce such uncertainties by constraining the numerical model outcome and providing more reliable estimates of the unknown governing parameters. In this work, we address the numerical simulation of land subsidence above a producing hydrocarbon field in the Northern Adriatic, Italy, by integrating the available monitoring data in the computational model with the aid of Data Assimilation strategies. A preliminary model diagnostic analysis, i.e. the χ^2 -test, allows for identifying the most appropriate forecast ensemble. Then, a Bayesian approach, i.e. the Red Flag technique, and a smoother formulation, i.e. the Ensemble Smoother, provide a significant reduction of the prior uncertainties. The experiment developed on a real-world gas field confirms that the integration of monitoring observations with classical geomechanical models is a valuable approach to improve the reliability of land subsidence predictions and to exploit in a systematic way the increasing amount of available measurement records.

1 Introduction

The numerical prediction of land subsidence above producing reservoirs can be affected by a number of uncertainties, related for instance to the definition of the constitutive law that describes the behavior of the porous medium, geomechanical properties, boundary and forcing conditions, etc. These uncertainties involve in the lack of quality and reliability of the land subsidence prediction. The accuracy and the amount of the available monitoring data, such as surface displacements recorded by GPS stations, can greatly help reduce such uncertainties, by constraining the computational model, solving approximately the inverse problem and providing more reliable estimates of the uncertain governing parameters.

A novel efficient workflow that combines Data Assimilation (DA) techniques and geomechanical model has been proposed in a recent work by Gazzola et al. (2019) and improved in Gazzola et al. (2020) with an application to a synthetic test case. The methodology starts from the generation of a set of ensembles of Monte Carlo realizations in order to consider uncertainties associated, for example, to the choice of the constitutive law that describes the porous medium behavior and the values of the geomechanical parameters. Then, the procedure includes a three-steps workflow: (i) a first diagnostic of the ensemble, i.e. the χ^2 -test, based on the mismatch between the available measurements and the model outcomes, which allows for identifying the most appropriate constitutive law and focusing on one ensemble only; (ii) a Bayesian approach, i.e. the Red Flag (RF) technique, which provides the probability of occurrence of

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Geological Disasters in Deep Engineering Mechanism, Warning and Risk mitigation

Guang-Liang Feng, Fengqiang Gong, Chi Zhang, Shibing Huang, 2023-06-15 With the increasing demand for infrastructure construction as the global economy progresses the need for exploration and utilization of deep underground space becomes more crucial Various deep underground projects are planned are under construction and have been built to encounter great construction challenges due to the complex geo environment such as strong tectonic movement fragile geo environment and complex thermo hydro mechanical chemical conditions These deep engineering projects could be endangered by different kinds of geological disasters such as intense rockburst large deformation strong water inrush and large scale collapse which might result in massive loss of life and economic damage during the construction of deep underground projects It is necessary to take proactive measures to ensure that the development of deep engineering projects is risk informed and sustainable Efforts are being called for strengthening science and technology innovation and cooperation in geological disaster mitigation and sustainable development during the construction of deep engineering projects It is paramount to use new technologies and international cooperation to jointly tackle the geological disasters risks and achieve sustainable development To mitigate the risk of geological disaster in deep engineering under the complicate geo environment the mechanism of the formation and evolution of geological disasters in deep engineering needs to be understood The testing monitoring simulation risk assessment and early warning methods for geological disaster in deep engineering are also needed urgently New theories methods and techniques related to the mechanism warning and risk mitigation of geological disasters in deep engineering will be extremely helpful for the construction safety of deep engineering
Recent Advances in Geo-Environmental Engineering, Geomechanics and Geotechnics, and Geohazards Amjad Kallel, Zeynal Abiddin Erguler, Zhen-Dong Cui, Ali Karrech, Murat Karakus, Pinnaduwa Kulatilake, Sanjay Kumar Shukla, 2018-12-31 This edited volume contains the best papers in the geo engineering field accepted for presentation at the 1st Springer Conference of the Arabian Journal of Geosciences Tunisia 2018 In addition it includes 3 keynotes by international experts on the following topics 1 A new three dimensional rock mass strength criterion 2 New tools and techniques of remote sensing for geologic hazard assessment 3 Land subsidence induced by the engineering environmental effects in Shanghai China The book is useful for readers who would like to get a broad coverage in geo engineering It

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