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TI: Data Assimilation of InSAR Surface Deformation Measurements for the Estimation of Reservoir Geomechanical Parameters in the Upper Adriatic Sedimentary Basin, Italy *(Invited)*
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AB: In the last decades, extensive work has been conducted to estimate land subsidence due the development of deep gas reservoirs situated in the Upper Adriatic sedimentary basin, Italy. These modeling efforts have stemmed from the development finite-element (FE) coupled reservoir-geomechanical models that can simulate the deformation due to the change in pore pressure induced by hydrocarbon production from the geological formations. However, the application of these numerical models has often been limited by the uncertainty in the hydrogeological and poro-mechanical input parameters that are necessary to simulate the impact on ground surface levels of past and/or future gas-field development scenarios. Resolving these uncertainties is of paramount importance, particularly the Northern Adriatic region, given the low elevation above the mean sea level observed along most of the coastline and in the areas surrounding the Venice Lagoon. In this work, we present a state-of-the-art data assimilation (DA) framework to incorporate measurements of displacement of the land surface obtained using Satellite Interferometric Synthetic Aperture Radar (InSAR) techniques into the response of geomechanical simulation models. In Northern Italy, InSAR measurement campaigns have been carried out over a depleted gas reservoir, referred to as “Lombardia”, located at a depth of about 1200 m in the sedimentary basin of the Po River plain. In the last years, this reservoir has been used for underground gas storage and recovery (GSR). Because of the pore pressure periodical alternation produced by GSR, reservoir formations have undergone loading/unloading cycles, experiencing effective stress changes that have induced periodical variation of ground surface levels. Over the Lombardia reservoir, the pattern, magnitude and timing of time-laps land displacements both in the vertical and in the East-West directions have been acquired from 2003 until 2008. The availability of these data opens new pathways towards the improvement of current land subsidence modeling efforts. The DA framework presented here allows for merging, within an automated process, InSAR data into coupled reservoir-geomechanical model results. The framework relies upon Bayesian-based ensemble smoothing algorithms and has the potential to significantly reduce the uncertainty associated with compressibility vs. effective stress constitutive laws, as well as key geomechanical parameters characterizing the orthotropic behavior of the reservoir porous media and their spatial distribution. The DA framework is here applied

using InSAR data collected over the “Lombardia” reservoir. The flexibility of smoothing algorithms is such that spatially distributed and possibly correlated measurement errors are accounted for in a relatively straightforward fashion, so that surface deformation data that are considered more reliable can be assigned a larger weight within the model calibration. A series of numerical simulation results are presented in order to assess the capabilities of the DA framework, its effectiveness, advantages and limitations.
DE: [1243] GEODESY AND GRAVITY / Space geodetic surveys
DE: [1822] HYDROLOGY / Geomechanics
DE: [1910] INFORMATICS / Data assimilation, integration and fusion
DE: [4314] NATURAL HAZARDS / Mathematical and computer modeling
SC: Natural Hazards (NH)
MN: 2012 Fall Meeting