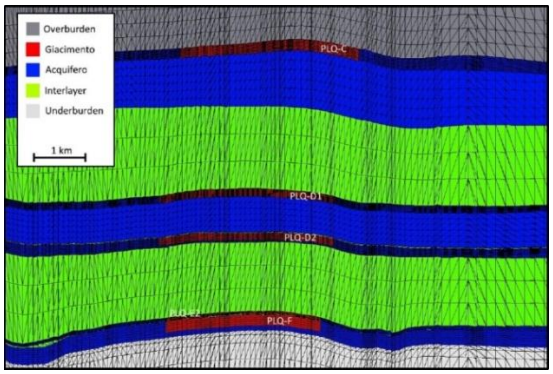
Geomechanical modelling of anthropogenic land subsidence above an offshore gas field

Project summary



Client:	ENI S.p.A.
Year:	2014
Service:	Computer Modelling
Sector:	Geomechanical Engineering
Site:	Off-shore, 45 km far from the coastline
Geological setting:	Sedimentary basin
Constitutive law:	Isotropic hypo-plasticity with mechanical hysteresis
Project in numbers:	1446624 degrees of freedom

Abstract

The object of this study is the development of a numerical model to predict the geomechanical effects induced by hydrocarbon extraction from an off-shore gas field.

The geomechanical analysis is performed with the aid of a state-of-the-art 3D finite-element numerical model developed by the M3E team with the main objective of predicting the sea bottom displacements over the field.

Project description

The gas field of interest is located off-shore, about 45 km far from the coastline. The reservoir is located in a normally consolidated sedimentary basin at a depth between 3011 and 3093 m and has a multi-pay structure consisting of a sequence of independent layers, connected to a bottom and/or lateral aquifer.

The overall domain covers a 40 km x 40 km area, bounded above by the sea bottom bathymetry and below by a rigid bedrock located at 5 km depth. The domain's extension was selected so as to locate the reservoir in a barycentric position, placing the model boundaries far enough from the volume that is depleted.

In the field area, the characteristic size of the grid elements is 100 m, consistent with the dynamic reservoir model. The unstructured three-dimensional grid was obtained by using the mesh generator specifically developed by the M3E team for geological

applications. The overall 3D mesh totals 482'208 nodes and 2'833'297 elements.

The computational grid, equipped with appropriate constitutive laws at the elemental level, has been used to simulate the geomechanical behaviour of the reservoir and predict the displacements at the sea bottom surface.

The hydrocarbon extraction from the reservoir produces a variation of the effective stress which propagates also in the aquifers hydraulically connected with the gas layers. Such a variation is the forcing function which causes a local deformation of the reservoir and propagates up to the sea bottom.

The development of an accurate geomechanical model allows for the reliable prediction of deformations at both a local and a regional scale which are of interest for both the oil company managing the reservoir and the administration responsible of the authorization process.

Project outcome

The result of the project was a 3D geomechanical finite-element model able to predict the deformation induced by the hydrocarbon exploitation from an offshore gas field. The model can be used for the effective management of the reservoir production program.