نشریه ژئومکانیک و ژئوانرژی (ژئومکانیک نفت)
GEOMECHANICS and GEOENERGY JOURNAL (GGJ)

Extended Abstract

Evaluation of the quality of Gachsaran Formation cap rock using petrophysical, geomechanical and rock mechanics parameters in a field in southwest Iran

Hassan Sadr[1], Ali Misaghi[2*], Mohammad Reza Asef[3], Ahmad Reza Lakzaei[4]

1-3 Department of Applied Geology, Faculty of Earth Sciences, Kharazmi University, Tehran, Iran
4 National Iranian South Oilfields Company, Ahvaz, Iran

Received: 2025/07/05 Accepted:2025/12/20

DOI: 10.22107/ggj.2026.589715.1266

Keywords

Cap rock, Integrity, Geomechanics, Rock mechanics, Petrophysics, Gachsaran

Abstract

The cap rock of an oil reservoir plays a fundamental role in preserving hydrocarbons over geological time, against the stresses imposed. An integrated effective cap rock must be thick and have sufficient lateral continuity at the field scale, so that there are no leakage windows. Otherwise, the entire hydrocarbon reserve will be lost. For this reason, it is of great importance to study the cap rock to assess its integrity, type of geomechanical behavior, degree of permeability, its relationship to subsurface faults and drilling hazards. In this research, using 3D seismic data and inversion, as well as well logs, various information layers related to petrophysical, rock mechanics, and geomechanical parameters of the caprock of the Gachsaran Formation in one of the fields in southwestern Iran were generated and examined as a three-dimensional model for the field volume and mapped across the geographical area. These parameters were analyzed both individually and in combination, and the strengths and weaknesses of the caprock were reported. These layers include acoustic impedance, seismic wave velocity, density, porosity, effective Young's modulus, shear modulus, bulk modulus, Poisson's ratio, brittleness, and closure stress ratio. Finally, the investigation revealed that most areas of the caprock exhibit suitable ductility and resistance to stress due to minimal variations in these parameters. However, certain areas with higher strength and competence can be identified for drilling and field development programs.

1. Introduction

The cap rock is placed over the hydrocarbon reservoir and is actually a type of rock/formation that can prevent the leakage and escape of hydrocarbons. Studying the cap rock integrity is important because if the cap rock is unable to retain these hydrocarbons, it will lead to the loss of these reservoirs. Studying the cap rock is of great importance in order to evaluate the integrity of the type of geomechanical behavior, the degree of permeability, its relationship with subsurface faults, and drilling hazards (Shartali, 2009).

Gachsaran Formation, consisting of lime, marl, anhydrite and salt members, is the cap rock of the studied reservoir in southwest Iran. This formation may often cause problems such as mud loss, drill jamming and wall collapse (Mehrgini et al, 2016).

In this study, 3D seismic and well log data were used to create Geomechanical, Petrophysical, and Rock mechanics maps of this cap rock. Studied Geomechanical parameters include Effective Young Modulus, Sharing Modulus (G), Bulk Modulus (K) and Poisson's ratio (PR). Petrophysics parameters include Seismic Wave Velocities (V_P, V_S), Density and Porosity. Rock mechanical parameter evaluated is the Closing

* *Corresponding Author: ali.Misaghi@khu.ac.ir*

Stress Ratio (CSR). These data were created using the seismic inversion method. Basically, areas of the cap rock that have low Effective Young's Modulus, Bulk Modulus, and Shear Modulus, and simultaneously have high Closing Stress Ratio, are known as weak areas that may lose their integrity under stress more quickly than other areas.

2. Methodology

In this research 3D seismic as input data were worked out to derive petrophysical geomechanical and rock mechanical parameters using post-stacking random inversion method. Accordingly, unlike deterministic inversion methods, in which the goal is to minimize a function between artificial and real seismic models, in random methods (based on geostatistical principles such as Sequential Gaussian Simulation, SGS), the goal was to create various realizations of resistance. In order to limit the generated models to the desired model, control points such as well Impedance were used (Alvez et al., 2014). The interpolation method in this type of inversion is based on the kriging method, which also uses the variogram to correct the distribution of values. Finally, it provides the best outputs by comparing the values of the synthetic seismic trace with the real seismic trace (Aminzadeh et al., 2013). Finally, 3D models and geographic maps of acoustic impedance, seismic velocity, density, porosity, effective Young's modulus, shear modulus, bulk modulus, Poisson's ratio, and closing stress ratio were generated as shown in Figure (1)

3. Summary

Based on the evaluation of petrophysical, geomechanical, and rock mechanics parameters, it was observed that changes in most of these indicators are minimal, however, higher strength can be considered for some areas of the cap rock. This research revealed that the northern, east, southeast, and southwest areas of the cap rock have the highest competency and more appropriate for future developments and drilling. However, appropriate locations for drilling should satisfy other criteria such as trap mechanism, ground conditions, surface topography etc.

4. Acknowledgment

The data required for this research was provided by the National Southern Oilfields Company, for which we would like to express our gratitude

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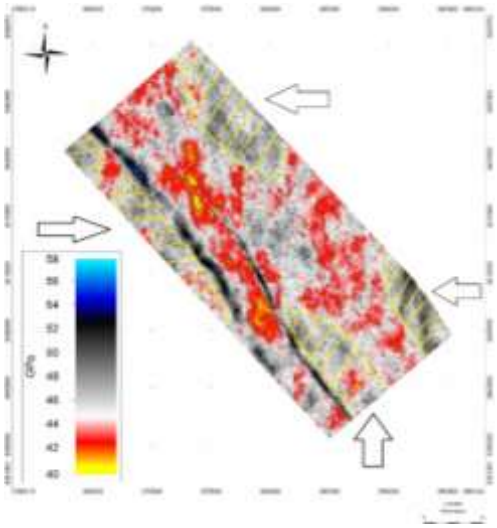

Fig. 1. Location of qualified areas on the P-wave acoustic impedance distribution map