J. Ind. Geophys. Union, 26(1) (2022), 1-6

Seismic Attribute Analysis of 3D seismic data: A case study from Taranaki basin, New Zealand

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ABSTRACT

Seismic attributes are the elements of seismic data that are extracted from the seismic reflection data to create seismic characteristics that emphasize certain physical, geological, or reservoir property aspects. Seismic characteristics derived from reflection data are based on a variety of physical processes. Wave properties, including amplitude, frequency, phase, and velocity, vary significantly when seismic waves propagate through earth's strata. Because of their restricted horizontal and vertical distribution, traditional seismic interpretation cannot always anticipate the geometry and spatial distribution of structural and stratigraphical features. The quantitative interpretation through seismic attributes enables a unique use of seismic characteristics to understand better fault systems, paleochannels, and spatial reservoir distribution. Seismic attributes, such as coherence, local structural dip, curvature, sweetness, RMS attribute, and envelope, are effective tools to understand the detailed geometry and variation in structural and stratigraphical features. Comparative seismic attribute analysis is undertaken to understand better the geometries of structural and stratigraphic features using 3D marine seismic data from Parihaka (Taranaki basin, New Zealand). The results can significantly improve the structural and stratigraphical interpretation and exploration objectives.

Keywords: Seismic attributes, Paleochannels, Faults, Coherence, Curvature, Sweetness, Quantitative interpretation.

INTRODUCTION

Hydrocarbon exploration aims to find and map structural and stratigraphic characteristics related to hydrocarbon production, deposition, movement, and entrapment (Omoja and Obiekezie, 2019). These structural and stratigraphic traps might be quite subtle, making accurate mapping challenging. However, advances in the 3D seismic reflection technique have made it feasible to map such structural and stratigraphic configurations with great precision and dependability, lowering the risk factor associated with hydrocarbon exploration. Seismic characteristics have been increasingly being employed in hydrocarbon exploration and reservoir characterisation studies for many years, and seismic interpretation procedures frequently include them (Marfurt and Kirlin, 2001). Geoscientists study and analyse the subsurface features like buried paleochannels, faults, and reservoir zones revealed by subsurface geophysical data using three-dimensional seismic datasets (Hossain, 2020).The study of seismic attributes is an essential element of seismic interpretation, and they have been used to identify the spatial distribution of reservoir's, structural and stratigraphical features (Fomel, 2007). In this study, different seismic attributes are extracted and analysed to understand the spatial distribution of structural, stratigraphical and hydrocarbon potential zones.

DATA

3D marine seismic data set is used for this study. New Zealand Crown Minerals provided the data set from Parihaka, Taranaki Bain, New Zealand. Kirchhoff time migrated, full angle, prestack is used for this study. Figure 1 shows the Parihaka 3D grid, about 324.79 sq km in area, is centered approximately 28 km to the northwest of New Plymouth, in the Taranaki Basin. It is a large sedimentary basin in the North Island, New Zealand. The Taranaki Basin covers an area of about 100,000 square kilometres, with the majority of the basin lying offshore at depths between 50 and 250 metres (Mattos et al., 2019). The Taranaki Basin is a central hydrocarbon-producing region in New Zealand that has a 150-year history of oil and gas exploration. The study area encompasses the southwestern end of the North Taranaki Graben, which is a prominent geological feature. The North Taranaki Graben is an under-explored, yet good location for oil and gas development, according to New Zealand Petroleum and Minerals (Shalaby et al., 2020).

SEISMIC ATTRIBUTE ANALYSIS

The seismic attribute is a quantity retrieved or produced from seismic data that may be studied to improve more subtle information in a typical seismic image, leading to improved geological or geophysical interpretation of the data (Li and Zhao, 2014a). Geometry, kinematics, dynamics, and statistical properties of seismic waves are extracted or generated from prestack and poststack seismic data via mathematical transformations (Li and Zhao, 2014a). Reservoir features and advanced 3D seismic interpretation are based on seismic attribute analysis, which allows us to extract information about lithology and reservoir heterogeneity from the seismic data (Li and Zhao, 2014b). Seismic characteristics are increasingly being employed in oil and gas exploration and production, and they have been incorporated into the seismic interpretation process. Seismic characteristics have evolved into several different forms, including structural and stratigraphic features (Chopra and Marfurt, 2005). Although amplitude data is the most basic form of seismic data, seismic attributes can disclose features that are not readily apparent in amplitude data (Hossain, 2020).