World Academy of Science, Engineering and Technology
International Journal of Geological and Environmental Engineering
Vol:17, No:11, 2023

3D Seismic Acquisition Challenges in the NW Ghadames Basin Libya, an Integrated Geophysical Sedimentological and Subsurface Studies Approach as a Solution

Authors : S. Sharma, Gaballa Aqeelah, Tawfig Alghbaili, Ali Elmessmari

Abstract : There were abrupt discontinuities in the Brute Stack in the northernmost locations during the acquisition of 2D (2007) and 3D (2021) seismic data in the northwest region of the Ghadames Basin, Libya. In both campaigns, complete fluid circulation loss was seen in these regions during up-hole drilling. Geophysics, sedimentology and shallow subsurface geology were all integrated to look into what was causing the seismic signal to disappear at shallow depths. The Upper Cretaceous Nalut Formation is the near-surface or surface formation in the studied area. It is distinguished by abnormally high resistivity in all the neighboring wells. The Nalut Formation in all the nearby wells from the present study and previous outcrop study suggests lithology of dolomite and chert/flint in nodular or layered forms. There are also reports of karstic caverns, vugs, and thick cracks, which all work together to produce the high resistivity. Four up-hole samples that were analyzed for microfacies revealed a near-coastal to tidal environment. Algal (Chara) infested deposits up to 30 feet thick and monotonous, very porous, are seen in two up-hole sediments; these deposits are interpreted to be scattered, continental algal travertine mounds. Chert/flint, dolomite, and calcite in varying amounts are confirmed by XRD analysis. Regional tracking of the high resistivity of the Nalut Formation, which is thought to be connected to the sea level drop that created the paleokarst layer, is possible. It is abruptly overlain by a blanket marine transgressive deposit caused by rapid sea level rise, which is a regional, relatively high radioactive layer of argillaceous limestone. The examined area's close proximity to the mountainous, E-W trending ridges of northern Libya made it easier for recent freshwater circulation, which later enhanced cavern development and mineralization in the paleokarst layer. Seismic signal loss at shallow depth is caused by extremely heterogeneous mineralogy of pore- filling or lack thereof. Scattering effect of shallow karstic layer on seismic signal has been well documented. Higher velocity inflection points at shallower depths in the northern part and deeper intervals in the southern part, in both cases at Nalut level, demonstrate the layer's influence on the seismic signal. During the Permian-Carboniferous, the Ghadames Basin underwent uplift and extensive erosion, which resulted in this karstic layer of the Nalut Formation uplifted to a shallow depth in the northern part of the studied area weakening the acoustic signal, whereas in the southern part of the 3D acquisition area the Nalut Formation remained at the deeper interval without affecting the seismic signal. Results from actions taken during seismic processing to deal with this signal loss are visible and have improved. This study recommends using denser spacing or dynamite to circumvent the karst layer in a comparable geographic area in order to prevent signal loss at lesser depths.

Keywords : well logging, seismic data acquisition, sesimic data processing, up-holes
Conference Title : ICGG 2023 : International Conference on Geology and Geophysics
Conference Location : London, United Kingdom
Conference Dates : November 27-28, 2023