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Delineation of a Productive Zone in "Abjnr" Oil Field, Southwestern Niger Delta

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ABSTRACT
*3-D seismic data have been used to delineate a productive zone in "**Abjnr**" oil field, Southwestern Niger Delta. The research involved importing digital seismic data into the Seismic Micro-Technology (**SMT**) software to generate seismic sections on which faults where mapped. A Horizon was selected prior to loop tying and timing and posting. Structural maps generated, contoured in time and depth reveals regions with structural highs. The reservoir area extent was determined using the planimetering software method. The structural maps produced revealed fault dependent closures at the central portion of the field, which served as possible trapping mechanism for the reservoir.*

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I. PREAMBLE

Seismic structural maps when carefully evaluated hold information such as structural highs, faults orientation, structural closures, rollovers anticlines among others that define the geometry of productive zones.The application of seismic reflection technology to the detection of oil and gas fields has been very useful in the oil industry and profession of exploration geophysics. It can sometimes directly detect boundaries of acoustic impedance between different fluid layers in a reservoir rock, but an indirect approach is normally employed, and it involves searching for the traps, such as anticlinal closures within which the oil or gas may be present. Seismic reflection technology has been applied in exploration geophysics to search for these traps, within which oil or gas may be present (Kearey and Brooks, 1991).Structural interpretation is an important aspect of the developmental programme of a field. It has diverse application in many areas of 3-D seismic interpretation among which include: helping to effectively analyze controlling influences on reservoir geometry, position and hydrocarbon migration pathways.Sometimes the estimate of reserves may even be dependent on structural interpretation when fluid contacts located on depth structure maps are needed as inputs in volumetric analysis (Rotimi*et al.*, 2009).The 3-D seismic data used for this research work was gotten from Chevron Nigeria Limited. The data include co-ordinates with which the base map was generated. These said data provides a geologist with useful information about the surface geology with which inferences can be drawn when the need arises for drilling of exploratory, appraisal or development wells in an area of interest.Adeoye and Enikanselu (2009), confirms that the area extent of the reservoir that is derivable from the structural map is very important inestimating the hydrocarbon in place.

II. LOCATION AND BRIEF GEOLOGY OFTHE STUDY AREA

The study area is within latitude 4.1^0 and 5.4^0N and longitude 5.0^0 and 5.5^0E. The basic lithostratigraphic units are the Benin, Agbada, and Akata formations (Riejers*et al.*, 1997).Most known traps in Niger Delta fields are structural, although, stratigraphic traps are not uncommon. The structural traps developed during synsedimentary deformation of the Agbada parallic sequence (Evamy *et al.*, 1978, Stacher, 1995). Structural complexity increases from the north (earlier formed depobelts) to the south (later formed depobelts) in response to increasing instability of the under-compacted, overpressured shale. Doust and Omatsola, (1990) describe a variety of structural trapping elements, including those associated with simple rollover structures; clay filled channels, structures with multiple growth faults, structures with antithetic faults, and collapsed crest structures. On the flanks of the delta, stratigraphic traps are likely as important as structural traps (Beka and Oti, 1995).

III. MATERIALS AND METHODS

The basic materials that were made available for this research included 3-D seismic data, base map (Figure 1) of the site of study and kingdom suite software (**Seismic Micro Technology)** 8.2 version. The base map consists of equally spaced lines (inline and cross line), each representing a seismic section. On the sections, faults were picked and a horizon was also mapped. Loop tying with timing and posting were also carried out.

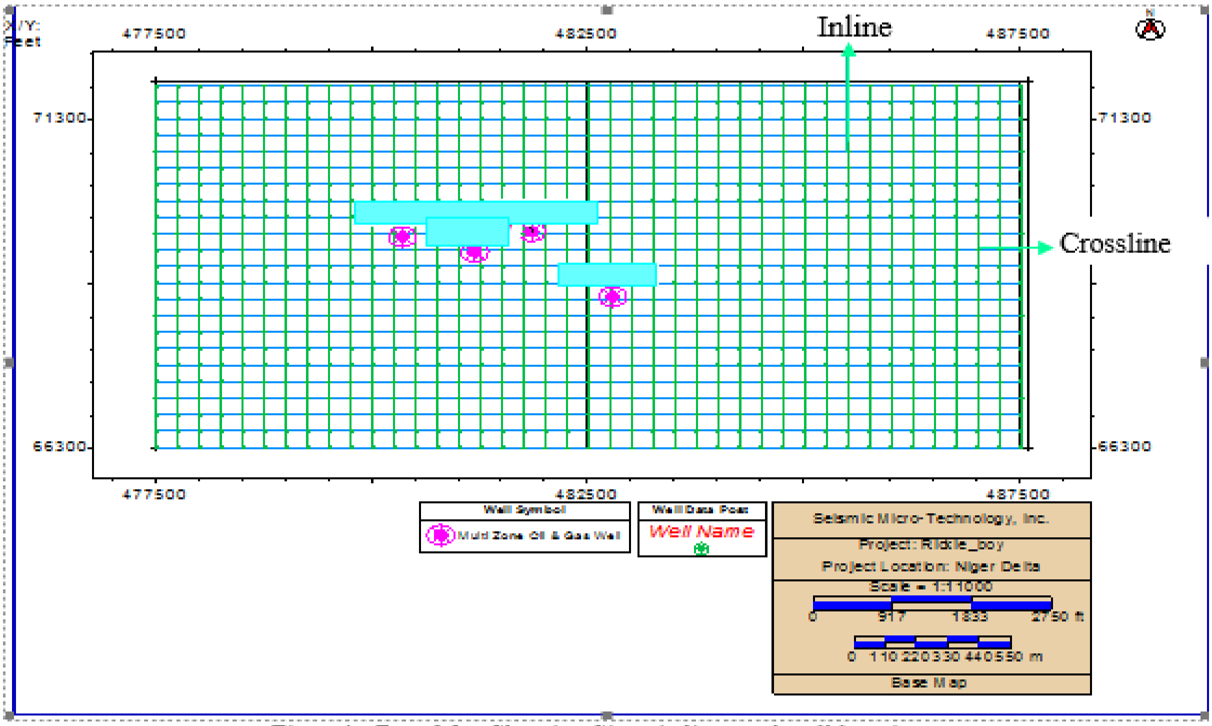

Figure1: Base Map Showing Siesmic lines and well locations.

Fault Picking

Picking of faults is an integral aspect of this research work. It was done after attributes like lines quality, depth, reliable imaging and structural complexities where carefully examined and understood.Consequent upon these points mentioned above, while picking faults on the seismic sections attributes such as abrupt endings of reflections, upthrown with relative downthrown, abrupt changes in dip directions, misclosures in tying reflections, distortion / displacement of reflections and disappearance of reflection below suspected faults lines were carefully looked out for:

Mapping of Horizon

A horizon was selected. It reflected on both inlines and crosslines. The horizon is tracking between 2.309 and 3.101seconds amplitude time and it occurring between depths of9600 ft (3072m) and 12580 ft (4112m).

Loop Tying

This involves transferring whatever features shown on the inlines to the crosslines and vice-versa. The concept of tying of loop helped in projecting the horizons being mapped into areas where well control may not exist and establishing a relationship between the trace of surfaces seen on seismic lines.

Timing and Posting

Timing was done by reading reflection time on the horizon picked at intervals. The values for time obtained were therefore posted at appropriate points on the seismic situation map. The top and bottom of horizon picked were timed at every change in about 0.005 milliseconds. This represents the arrival time of the reflection from the sea level. Faults were also posted to their corresponding location on the base map. All the marked locations were then linked with thick smooth lines.

Time – Depth Conversion

This involved the conversion of the acoustic wave travel time to actual depth, based on the acoustic velocity of subsurface medium. This conversion permits to produce depth and thickness maps of subsurface layers interpreted on seismic reflection data. These maps are crucial in hydrocarbon exploration because they permit the volumetric evaluation of oil or gas in place.In converting the time to depth, T-D conversion (check shot survey) was used. First and foremost, the time structural map was generated and then using the check short survey a new gridded horizon was formed. It is on this new horizon that depth structural map was generated by contouring in depth.

IV. RESULTS AND DISCUSSION

Faults and Their Orientations

Faults are good migration paths for hydrocarbon into reservoir rocks. They are important aspect of many reservoirs particularly in the way they control the movement of hydrocarbon. There are threemajor growth faults, X and Y shown in figure 2, then Z shown in figure 3. These growth faults are trending east-west but dipping southerly. These major growth faults are synthetic.Faults a, b and c areminor but also synthetic faults which tend to ebb after some distance across the field. Faults U and V are antithetically closing up with others to form closures and indications of rollovers and collapsed crest. Rollover anticlines are good traps for hydrocarbon. Therefore the trapping mechanism will be depending on the faults and the anticlinal structures which collectively form the structural closures as shown on the structural maps.

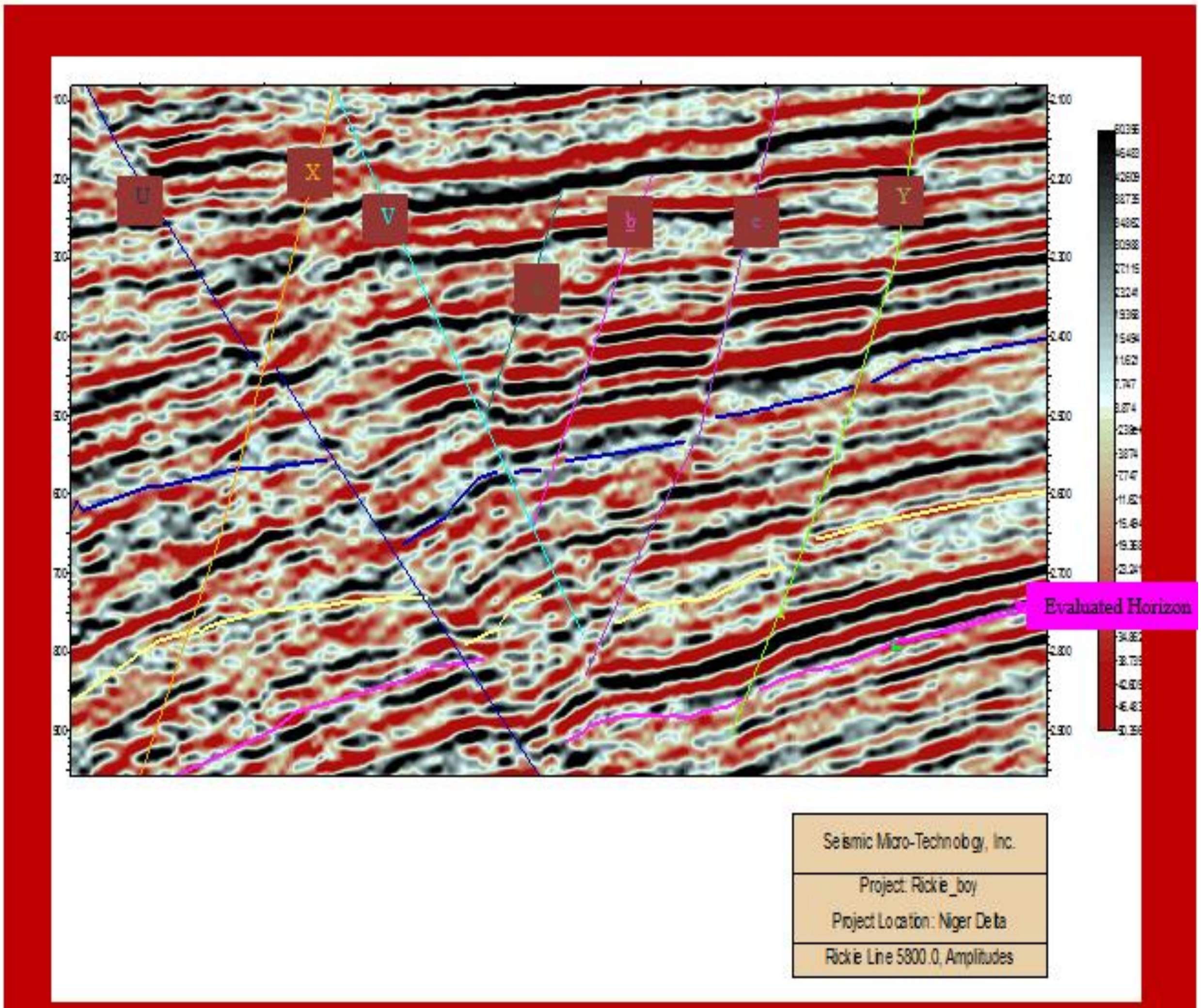

Figure 2: Inline 5800 showing Structure with Multiple Growth Faults and Collapsed Crest.

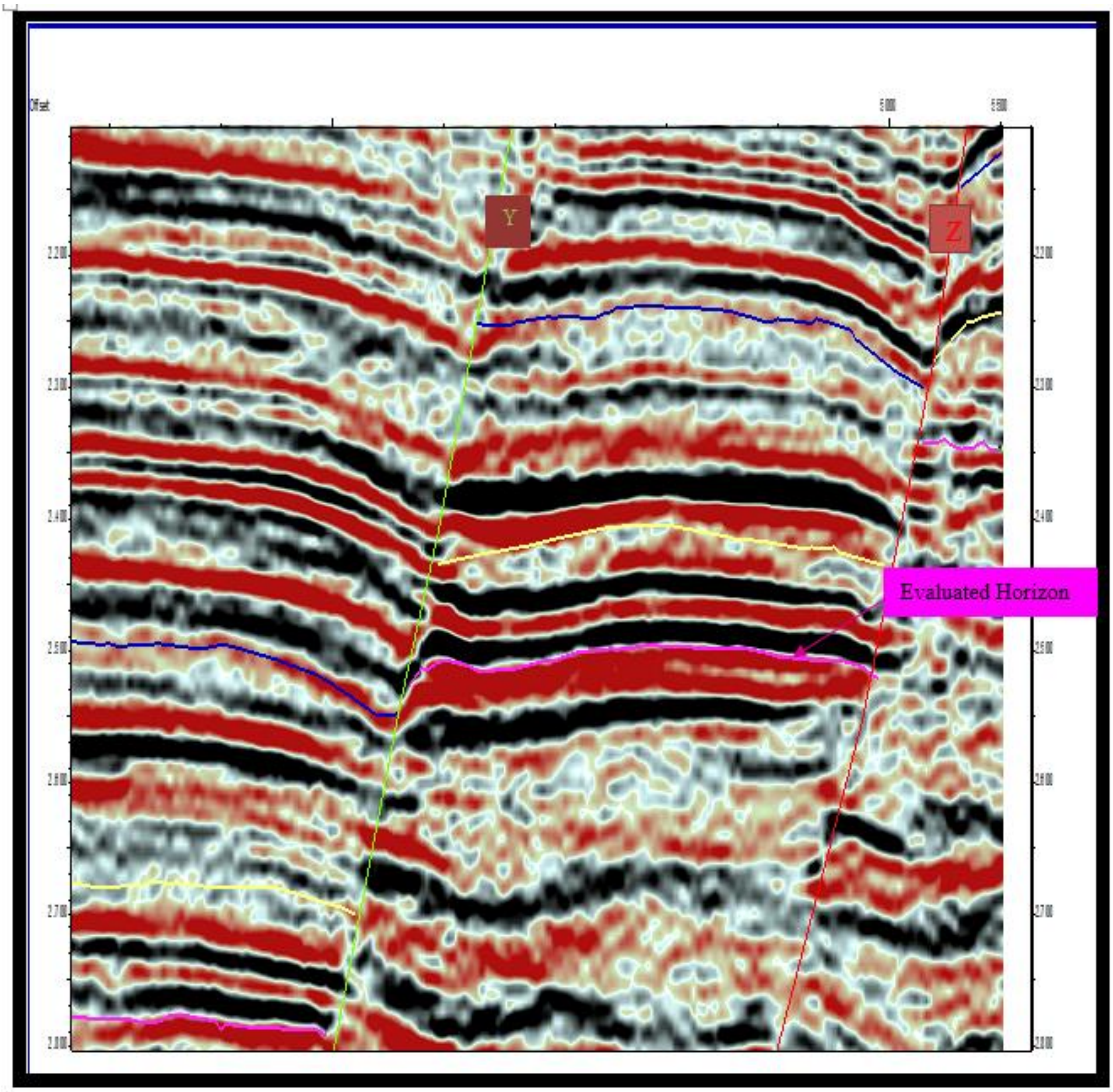

Figure 3: Seismic Section showing Synthetic Faults with Evaluated Horizon.

Structural Maps

The evaluated horizon is tracking between 2.309 and 3.101seconds amplitude time and it occurring between depths of 9600 ft. (3072m) and 12580 ft (4112m). The delineated reservoir is timed below 2.76 seconds (Figure 4) and a depth of about 11125 ft (3560m). The generated structural maps (Time and depth) have fault polygons imposed on them before they were contoured. They show the two-way travel time of the horizon and also the geometry of the reflector. These maps reflect geological information such as anticline with their respective syncline and the geometry of the faults as they relate to migration and accumulation of hydrocarbon. There are indications of rollover anticlines. The area shaded red on the central portion of the depth map (Figure 5) is the delineated pay zone of the reservoir. It is observed that time and depth contour values increases towards the south-western direction, but decreases towards the north-eastern direction. Therefore, the study area has more sediment deposited in the south-western part of the map, compared to the north eastern direction.It should be noted that the potency and accumulation of the hydrocarbon depends in some ways on the trap and cap rock.

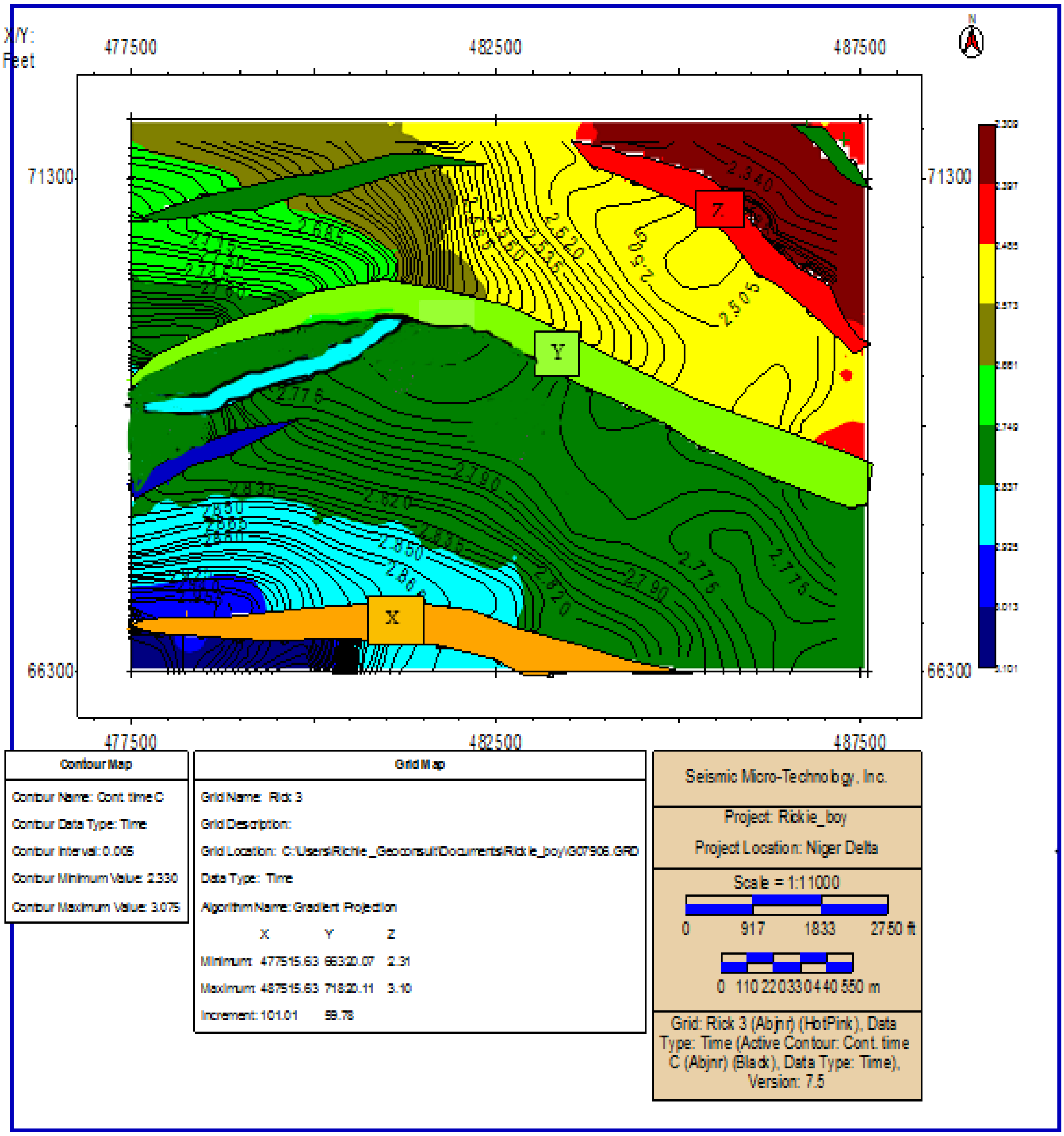

Figure 4: Time structural map of the evaluated horizon, timing between 2.309 and 3.101 seconds.

The thickening of sediments towards the area wherethe reservoir is delineated could specify that the resource is overlain by a thick cap rock that is protecting it till abstraction. The orientations of the faults are further expressedon the structural maps, just as explained on the seismic sections earlier on. The antithetic faults (U and V) juxtapose the synthetic fault (Y) within the field to form closures at the central portion of the mapped area. There are rollover anticlines that could form trap for the hydrocarbon.

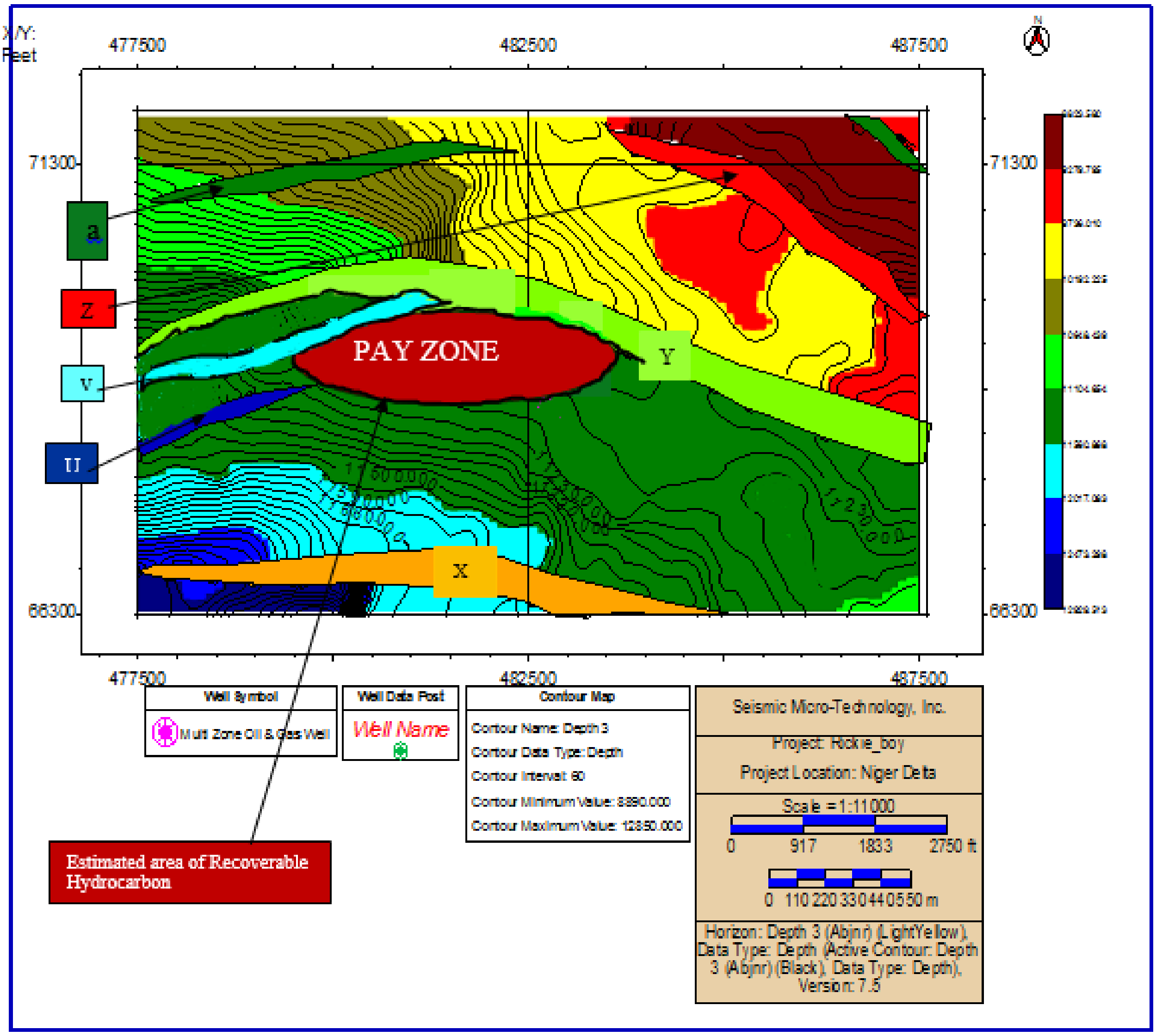

Figure 5: Depth Structural map, showing pay zone.

V. CONCLUSION

Delineation of a productive zone on a reservoir in "**Abjnr"** oil field in the Niger Delta has been carried out. The mapped area has structural high with well oriented faults and rollover anticline at the central portion. These features, with the gradient of that portion as shown by the contour lines on the depth structural map suggest a possible migration path and accumulation of hydrocarbon in that portion. It is therefore concluded that the central portion of the field has structural highs sandwiched between the growth faults which can be responsible for possible hydrocarbon accumulation. This is gainfully supported by the cited rollover anticline on the delineated portion.

VI. RECOMMENDATION

It is therefore recommended that information, such as hydrocarbon saturation **(S_h)** and reservoir thickness **(h)** should be derived using wire-line logs, to enable the estimation of the recoverable Oil-In-Place in the reservoir.

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BIOGRAPHY

Abraham-A. *M. Richardson* has Geology background with Post-Graduate Diploma Degree (PGD) and a Masters' Degree (M.Tech) in Applied Geophysics and Exploration Geophysics respectively, from the Federal University of Technology Akure (FUTA), Ondo State, Nigeria. He has successfully carried out some research works both individually and in group in the areas of Biostratigraphy, Groundwater Geophysics, Seismic and Petrophysics. His areas of interest also include; General Geology, Environmental Geophysics and Engineering Geophysics.