Stratigraphic Traps as Exploration Targets: Examples from Petrotrin's Soldado Acreage, Gulf of Paria, Trinidad*

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Abstract

To date, most of the exploration and development drilling in Petrotrin's Soldado fields have targeted accumulations associated with anticlines and updip fault closures, usually with good success (Figure 1). After fifty-nine years of exploitation and exploration, all of the simple structural targets have been identified and tested. The data set includes 3D and 2D seismic of different vintages and seven producing fields in which approximately 969 wells have been drilled.

Formations penetrated in this study area range from the Lower Cruse to the Morne L'Enfer. The Cruse represents a progradational sequence of deepwater turbidites to shallow-water (deltaic) sediments. The top of this sequence is marked by an unconformity that is overlain by the Forest Formation, which represents another progradational sequence of prodelta to shallow-water deltaic sediments. The Morne L'Enfer unconformably overlies the Forest. The major structural features within the area are the Erin Syncline which is bounded to the North by the Main Field Anticline and to South by the Southern Anticline

To replace and grow reserves in accordance with Petrotrin's five year strategic business plan, a different approach is required. As part of a re-evaluation of exploration leads that commenced in 2002, the 3D seismic data was re-interpreted and four major stratigraphic surfaces mapped: the Top Forest Formation, the Top Cruse Formation, the Top Lower Cruse Member, and the 10.5 Ma unconformity. Interval RMS amplitude maps for the Forest interval reveal meanders, channels, point bars never before interpreted in the area (Figure 2) . The unconformity at the base of the Morne L'Enfer was also observed in areas to erode deeply into the underlying Forest, truncating the reflectors and associated stratigraphy. This unconformity and its overlying claystone dominated sediments have created a stratigraphic trap on the southern flank of the Erin Syncline. The occurrence of a flat spot within the Forest Formation strongly suggests a fluid contact within the (Forest) interval.

Traditionally the Lower Cruse interval has been mapped as being dominated by basin-floor fans; however, a re-examination of the paleobathymetriy, log motifs, and seismic attributes suggest a slope setting. Regionally the Lower Cruse interval is dominated by claystones and occasionally by thick sands. The interval has been interpreted to have been deposited as a multiple-sourced sand/mud-rich deepwater turbidite system on the slope. Spectral Decomposition was used to further understand the stratigraphic setting of the Lower Cruse. Various

tuning cubes were generated for the interval, and it was observed that each frequency was tuned at a different thickness. At a low frequency of 10 Hz and a time window of 100 ms illustrate a channelized system with a sand trend from SW to NE and source direction from the SW (Figures 3, 4A, and 4B). Spectral Decomposition was also used to calculate the thickness of the sand within the system and found to be 513 feet. A SW-NE-trending progradational feature mapped on seismic internally exhibits bidirectional downlap that creates potential closure in an updip direction. The top and base of this feature is correlated to an oil-bearing zone in another exploration well 7000 feet away.

A second feature 500 ft deeper was also identified and mapped. An interval thickness map was generated that indicates a maximum thickness of 600 feet within the axis of the WSW-ENE-trending system. A horizon interval RMS extraction was generated between the top and base of the feature. The WSW–ENE-trending high amplitudes parallel the interval thickness map. It was thus inferred that the amplitude variation could reflect a change from claystone to sand.

A stacked amalgamated channelized complex within the Upper and "*Middle*" Cruse Formation was identified as an exploration lead. Palaeontological data indicates bathymetry are shallow, inner neritic environment (less than 100 feet water depth). The tops and bases of three of the channels were mapped. Interval isopach (thickness) and RMS amplitude maps were also generated. On seismic lines, it was observed that in one of the channels there was a change in orientation of the beds from flat to lateral accretion surfaces; this could imply channels-cutting across point bars. The main axis of the channel complex is north-south, with an incision that suggest transport direction from the south. The lithology within this system is unknown, as no nearby well has penetrated a similar feature.

Within this study area no structural traps were identified; we have, however, demonstrated that stratigraphic traps exist within all of the formations mapped .Two explorations wells, one to 9500 feet and the other to 12,500 feet, have been proposed to be drilled to test the validity of these stratigraphic concepts.

Selected References

Reading, H.G. and M. Richards, 1994, Turbidite systems in deep-water basin classified by grain size and feeder system: AAPG Bulletin, v.78, p. 792-822.

Moody, J.D., D.R. Pyles, J. Clark,. and R. Bouroullec, 2012, Quantitative outcrop characterization of an analog to weakly confined submarine channel systems: Morillo 1 Member, Anisa Basin, Spain: AAPG Bulletin, v. 96, p. 1813-1841.

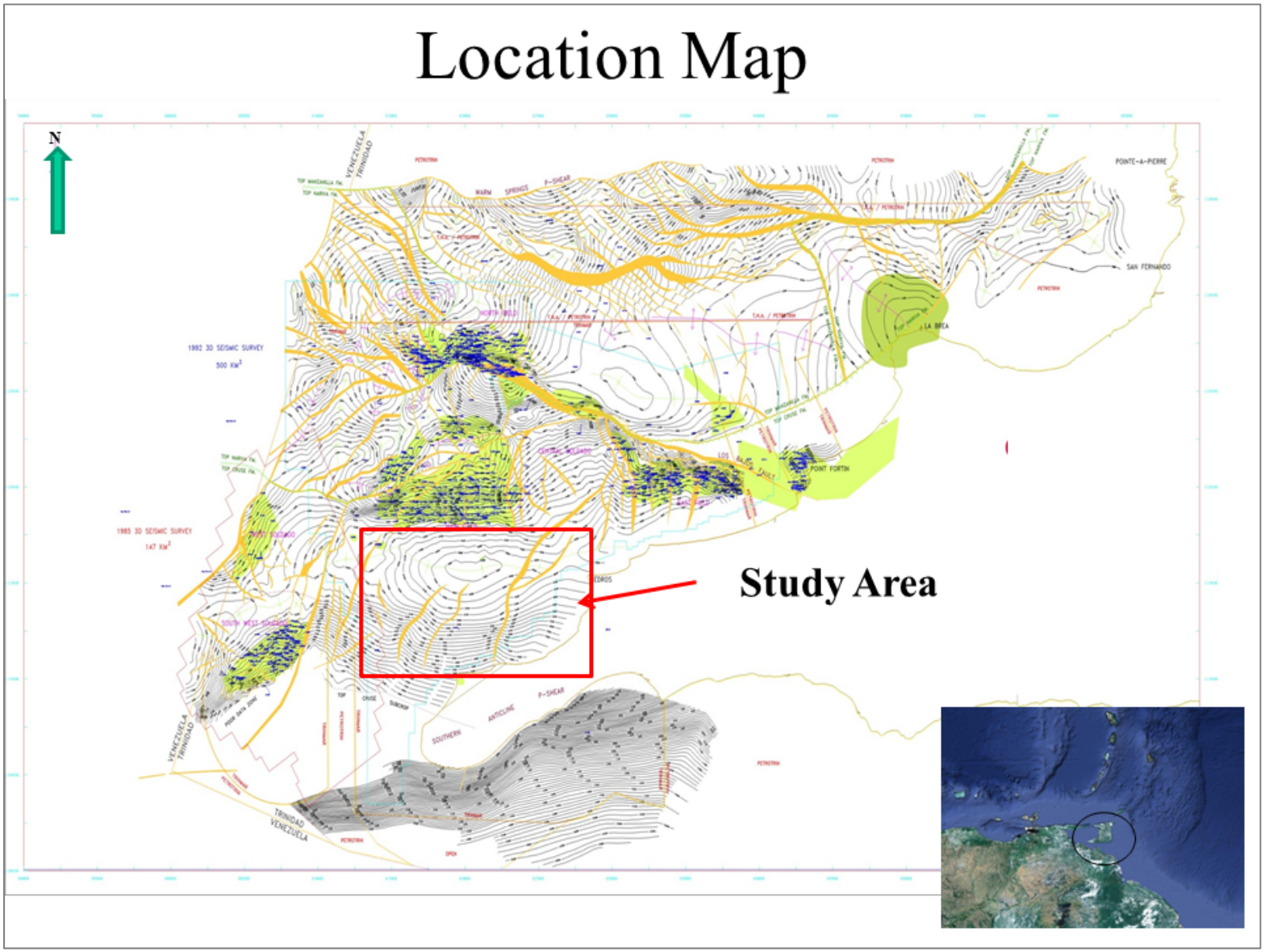

Figure 1. Generalized structure map of region containing study area.

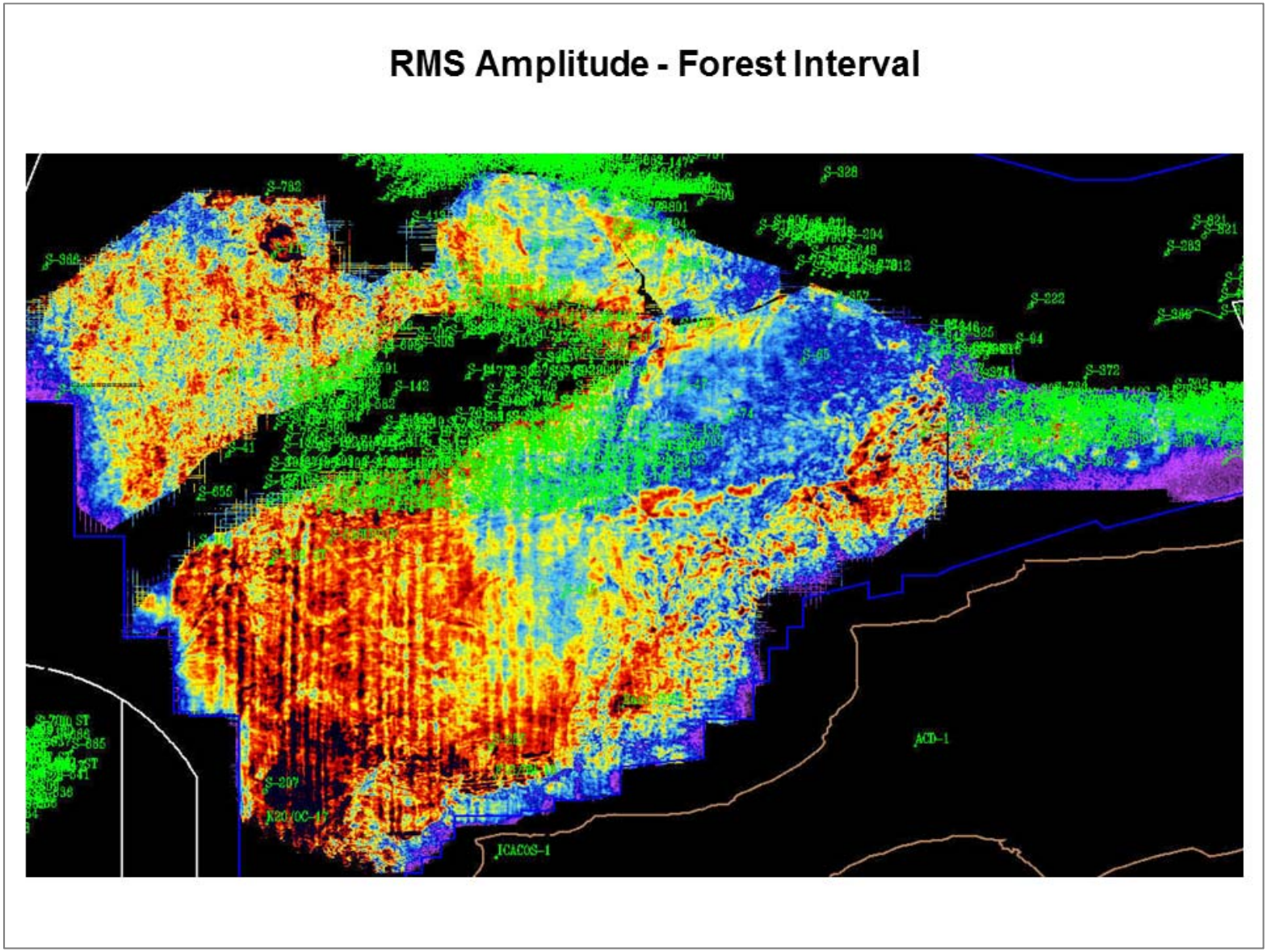

Figure 2. RMS amplitude extraction for Forest interval, illustrating potential stratigraphic features.

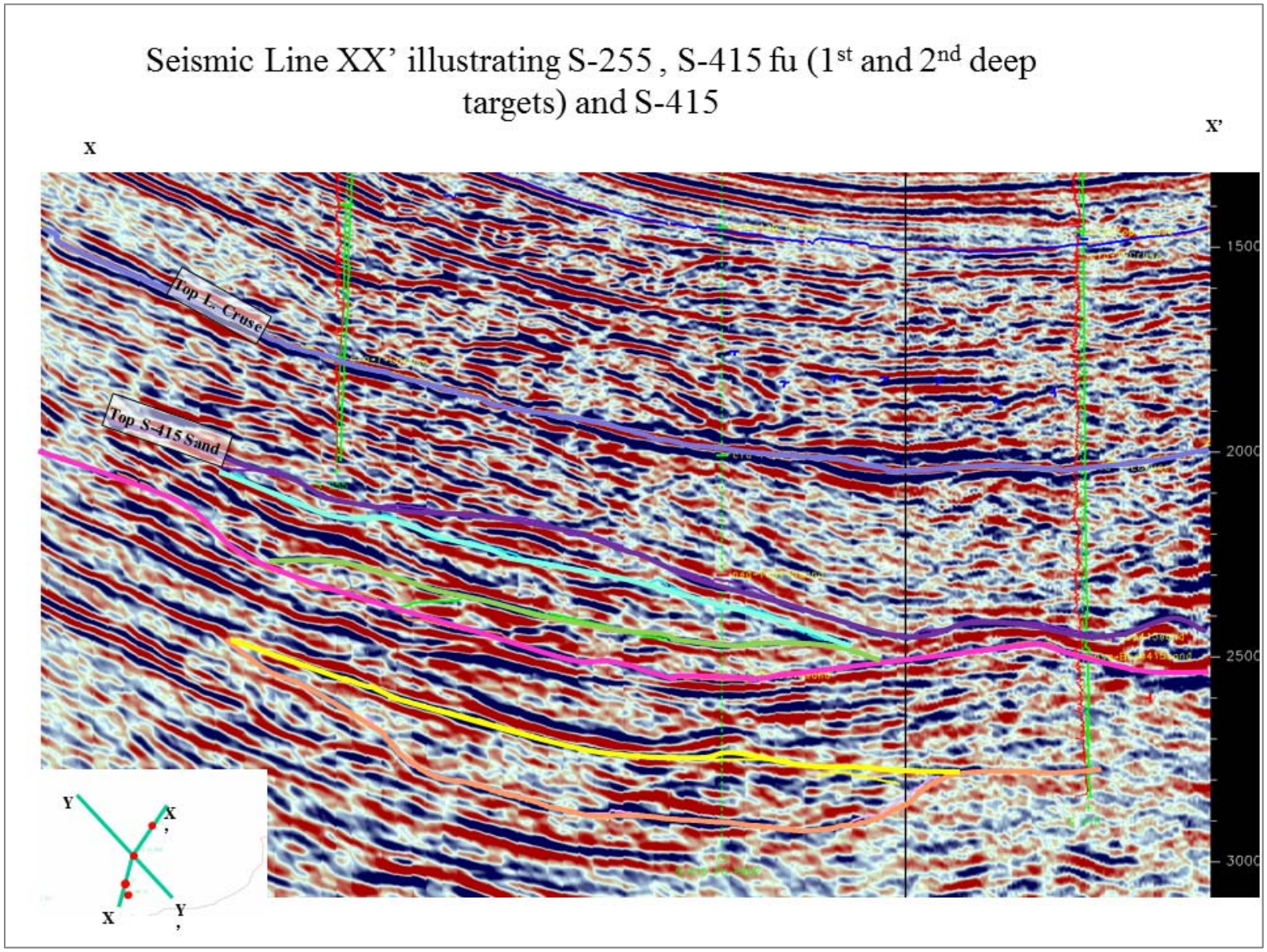

Figure 3. Line XX', showing some markers and locations of wells S-255, S-415 FU (1st and 2nd deep tests) and S-415.

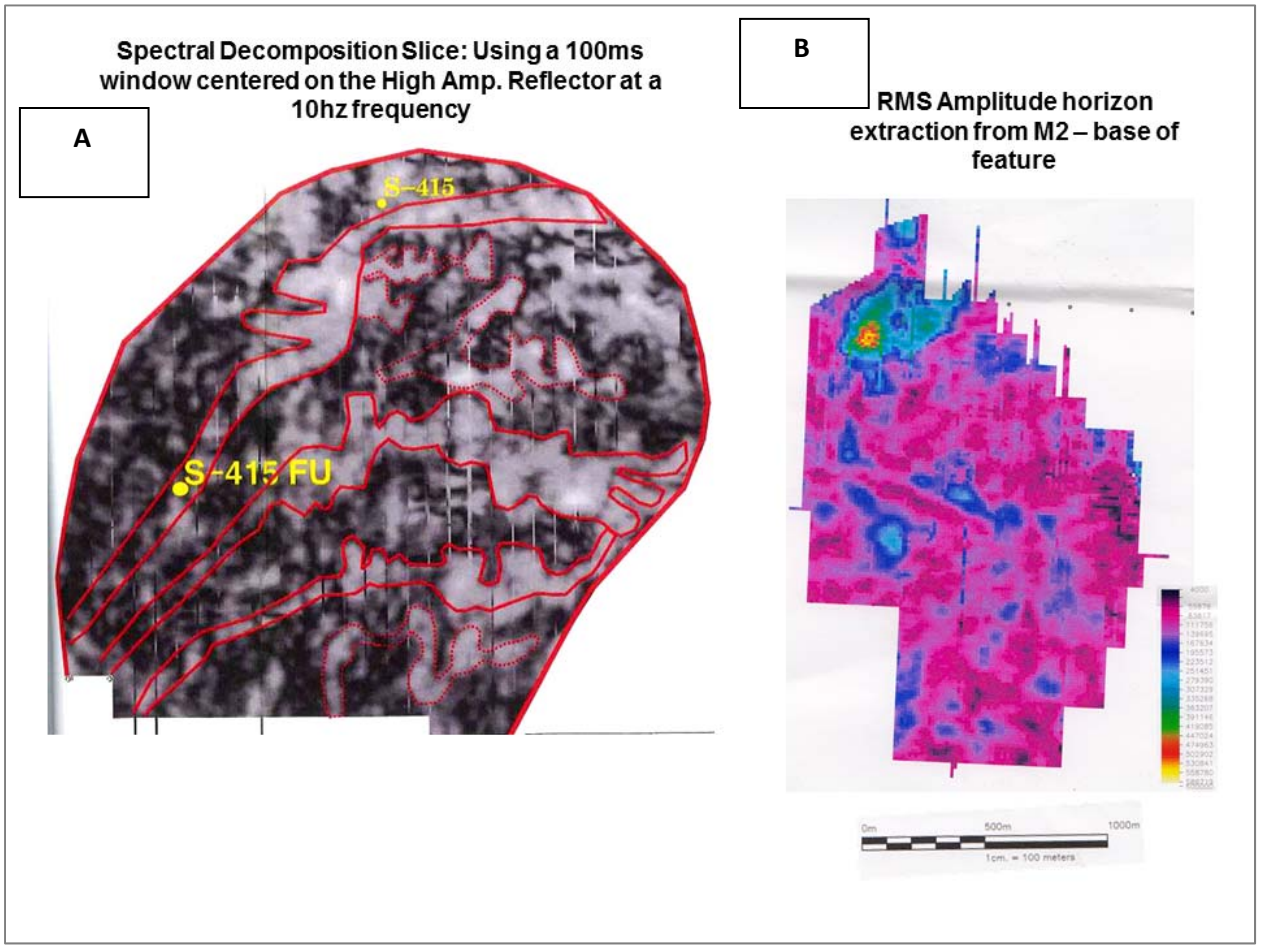

Figure 4. A. Spectral Decomposition Slice, using a 100ms window centered on the High Amplitude Reflector at a 10 Hz frequency. B. RMS Amplitude horizon extraction from M2to base of future.