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PATTERN RECOGNITON SYSTEM TO LOCALIZE REFLECTORS IN SEISMIC IMAGES

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Introduction

Integral transforms and special functions are becoming a powerful mathematical tool in the automation task of locating structures and pattern recognition. Recently, a pattern recognition system named 2D multiresolution automated system for detecting Bottom-Simulating Reflectors (BSRs) on seismic reflection images was presented [1]. The wavelet Haar is used in the 2D multiresolution analysis (2D MRA) to enhance edges in the horizontal, vertical and diagonal orientations. That system was focused on localizing the BSRs parallel to the Sea-Bottom Reflector (SBR), but frequently the BSRs are not parallel. Based on the Radon transform an automation methodology to determine the inclination angle of the non-parallel BSRs was developed [2]. The Radon transform is employed to obtain the inclination angle of the structure. The BSR is used as a geophysical interpretation marker for the presence of gas hydrates [3]. In 2014, the Intergovernmental Panel on Climate Change reported higher concentrations of carbon dioxide, methane and nitrous oxide in the atmosphere [4]. Therefore, it is essential to estimate the methane concentrations into the hydrate/free gas systems. Often, the BSR localization is done by hand-operation by a trained interpreter. Hence, an automation system specialized in localizing BSR is a useful tool.

Keywords: Pattern Recognition; Wavelet Transforms; Radon Transform; 2D multiresolution analysis (2D MRA).

Topic Code: ***Image processing, vision and artificial intelligence***

Methodology

In seismic reflection images, a pre-processed step is necessary to minimize lateral discontinuities; one of the most used technique is the automatic gain control (AGC). The AGC utilizes the amplitude average of the time window as a gain value to each data sample [1]. Once the sea bottom amplitude is maximized, the sea bottom reflector (SBR) curve is located (the dashed blue curve in Fig. 1) using the Otsu method [5]. Then, the SBR curve is straightened by shift-up $t_0^{(k)}$ units the trace $x_k(t)$ into the seismic image, $t_0^{(k)}$ is the value at which the SBR is located in the trace $x_k(t)$ [1]. Because of the SBR is straightened, the BSRs are straightened too, but they do not appear parallel to the SBR necessarily [2]. The inclination angle is determined using the Radon transform and once the angle is obtained, the seismic image has rotated that angle to have horizontal lines in the BSRs location [2]. To enhance the horizontal lines, the 2D MRA signal decomposition is used [1]. The MRA decompose the image in: HL, LH, HH and LL sub-images to enhances the horizontal, vertical and diagonal lines, respectively; the LL has the gross details. We are interested in horizontal lines only. Then, the intensity value of the HL sub-image is added by rows to build the time series $T(t) = \sum_{x=1}^{M} HL(t,x),\ t = (z-1)f_s,\ z = 1,2 \ldots, N,\ f_s$ is the sampling frequency [2]. The highest peak of $T(t)$ represents the SBR position and the BSR location is the second highest peak. To determine if the second peak is a BSR or it does not, it is used the criteria $[\bar{X} - 3SD, \bar{X} + 3SD]$, where $\bar{X}$ is the mean of $T(t)$ and SD is the standard deviation of $T(t)$. If a BSR exist, it is marked in the seismic image, like the dashed red curve in Fig. 1.

Results

A database of synthetic seismic images was created to analyze the robustness of this methodology. The synthetic seismic images simulate horizontal, diagonal and sinusoidal SBRs. It is used 15 images with parallel BSRs and 135 with BSR of inclination angle from 1° to 45° with $\Delta\theta = 1°$. The system locates the BSR accurately into the 150 synthetic images. Then, the methodology was tested with section of seismic reflection profiles located offshore southern Baja California. The seismic profiles were split in sub-images of 150 traces each one, to obtain

210 samples. The methodology determined the inclination angle of the BSR accordingly and located them accurately in all the cases.

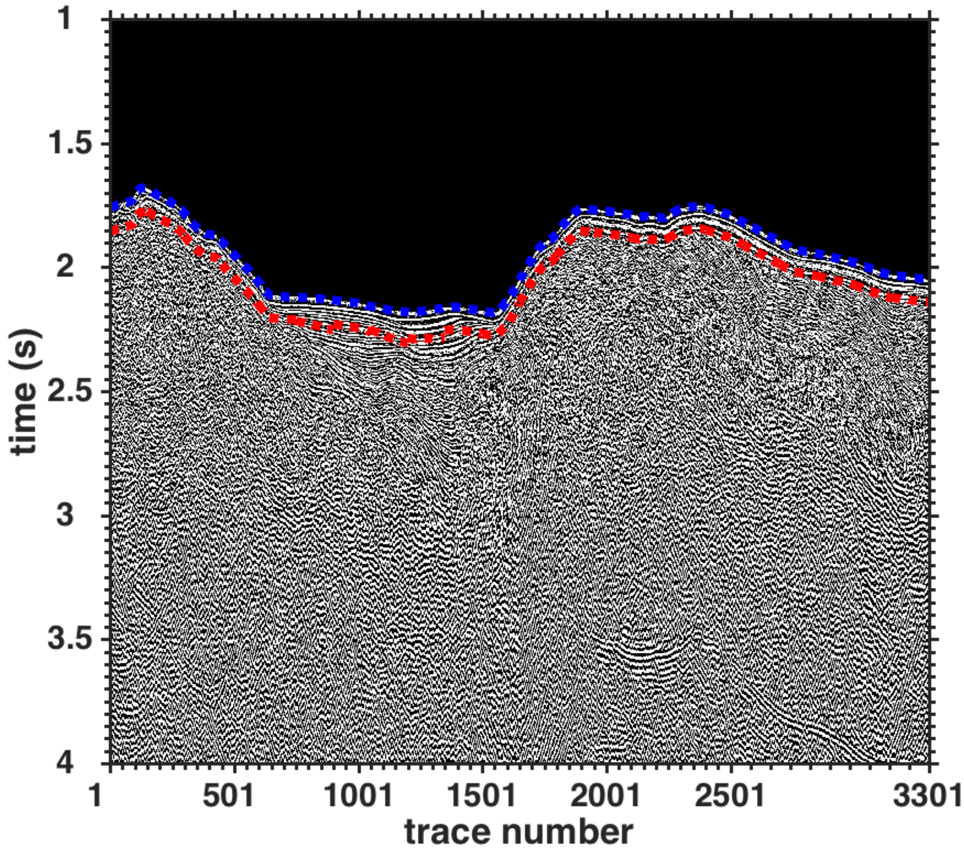

Fig. 1. Section of the seismic profile located in the geographic coordinates (25.10763° N, 109.93275° W) to (25.01640N,109.74953W) in Farallon Basin. SBR is indicated in dashed blue curve and BSR in dashed red curve.

Conclusions

The 2D multiresolution analysis and Radon transform are powerful mathematics tools to develop automation pattern recognition systems. The system localizes parallel and non-parallel BSRs in seismic reflection images accurately. The methodology is easy to be implemented in personal computers and it is appropriate to be use with parallel programming to reduce the computational cost time.

References

[1] Barba-Rojo, P.K., Solorza-Calderón, S., González-Fernández, P.K., González-Escobar, M., *Journal of Geophysics and Engineering* **15**, 2350-2369 (2018).
[2] Solorza-Calderón, S., González-Fernández, P.K., González-Escobar, M., *Journal of Applied Geophysics* **168**, 24-40 (2019).
[3] Aregbe, A.G., *Open Journal of Yangtze Gas and Oil* **2**, 27-44 (2017).
[4] Pachauri, R.K., Meyer, L.A., Climate Change 2014 Synthesis Report. Technical Report I, II, III Intergovernmental Panel on Climate Change, Geneva, Switzerland, 1-151 (2014).
[5] Gonzalez, R.C., Woods, R.E., Digital Image Processing, Pearson/Prentice Hall, New Jersey, USA, 742-747 (2008).