O4-3 3-D SEISMIC CONTINUITY ATTRIBUTE FOR MAPPING DISCONTINUITIES IN A TARGET ZONE: OPTIMUM PARAMETERS AND EVALUATION

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An enhanced imaging of structural and stratigraphic discontinuities in target zones is highly appreciated in many exploration and developments operations such as reservoir delineation, compartmentalization studies and well placement. In this paper, we highlight aspects of establishing optimum parameters for calculating a 3-D seismic continuity/similarity attribute, for a real 3-D seismic data set, using normalised cross-correlation. The applied normalised cross-correlation formula is:

$$\phi(t,d) = \frac{\sum_{k=t-N/2}^{k=t+N/2} G_k H_{k+d}}{\sqrt{\sum_{k=t-N/2}^{k=t+N/2} G_k^2 \sum_{k=t-N/2}^{k=t+N/2} H_{k+d}^2}}$$

where $\phi(t,d)$ is the correlation coefficient at time t ms and for a specified geologic dip (dip search limit) d ms/trace , G and H are the correlated traces and N is the number of samples in the correlation window.

The cross-correlation was applied in three different patterns, namely, two traces, four traces and eight traces patterns, where a trace is cross-correlated with the adjacent two, four or eight traces. As discontinuities are manifested in the form of low correlation coefficients, J. Hesthammer 1998, the minimum correlation coefficient is selected from the obtained two, four, or eight values in order to emphasize discontinuities. The geologic dip is accounted for by specifying a dip search limit, d ms/trace, where each trace in the correlation pattern is shifted up and down within the specified dip limit and the best correlation is used, Landmark Graphics User Guide 1996.

In Fig. 1 we portray the effect of using various lengths of the sliding, correlation, time window; 15 ms, 25, 50 and 75 ms for [1-1] through to [1-4] respectively. Discontinuities corresponds to lighter tones while continuity is displayed in darker tones. As the length of time window increases, major discontinuities are enhanced and the local ones are suppressed.Yet we should be cautious when using large time windows since that may result in vertical expansion of discontinuities into levels where they are not actually present. The vertical expansion, which is a result of using large time window compared to the average time thickness of the target zone, evident on image [1-4] where both the continuity bands as well as the narrow discontinuity features have been vertically exaggerated. Using a correlation time window, of one to one and half times the average time thickness of the target zone, seems to be appropriate.

In Fig. 2, [2-1], [2-2] and [2-3], the use of differing correlation patterns is shown. For a given correlation window and dip search limit, a correlation pattern of two traces is by far more efficient in imaging discontinuities as it is manifested when comparing [2-1] with either of [2-2] and [2-3]. This can explained by the fact that when having four or eight correlation coefficients, [2-2] and [2-3], from which the minimum value is assigned to the central sample in the correlation window, we have a greater chance of both picking smaller value for the minimum and having more gradual change in the correlation coefficients than when using two values, [2-1]. Fig. 2 [2-4] is the result of using a correlation time window of 35 ms, correlation pattern of two traces and a dip search limit of 8 ms/trace. The parameters used for [2-4], in the authors' view, represent the best possible combination for mapping discontinuities in the target zone using continuity attribute minimum.

A continuity attribute horizon has been extracted using the top time horizon of the target zone and the 3-D seismic continuity volume from which a window from one section, Fig. 2 [2-4], is displayed. Fig. 3 [3-1], [3-2] and [3-3] which are in grey scale and illuminated from the upper right corner, show the extracted attribute horizon disrupted by three main trends of linear discontinuity (dark); a regional trend (E), a northwest trend (A-B-C) and a north-south trend (D). Fig. 3 [3-1] is dominated is dominated by noise (N) that can be identified as circular and (curvi) linear features, J. Hesthammer 1998. Applying median filter (3x3 traces) to [3-1] resulted in image [3-2] on which the three interpreted main trends are in higher contrast with the background. Image [3-3] is a result of applying edge-detection which amount to calculating the derivative of dip, G. Jones and R.J. Knipe 1996, sharpens some features such as C, yet a quite noisy background is evident when compared with image [3-2].

In order to help quality control geologic discontinuity identification using 3-D seismic continuity attribute we recommend:
i) using two traces correlation pattern and a window size that is not greater than one and half times the time thickness of a target zone, ii) examining vertical continuity section in order to help better distinguish geologic discontinuities that would likely to have considerable spacial dimensions when compared to localized (curvi) linear noise, iii) integrating with other discontinuity-detectors such as time dip and edge(dip-derivative) maps, and iv) cross-plots of an interpreted isochrone against cross-line coordinate or in-line can be used to help verify interpreted geological discontinuities.

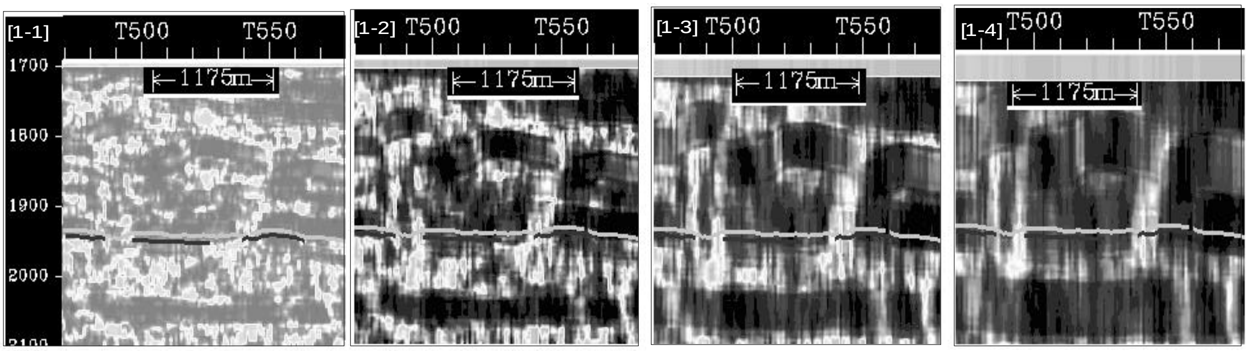

Fig. 1: Continuity-discontinuity section for sliding correlation windows; [1-1] for15 ms, [1-2] for 25 ms, [1-3] for 50 ms and [1-4] for 75 ms. and for all: correlation pattern= 2 traces and dip limit= 0 ms

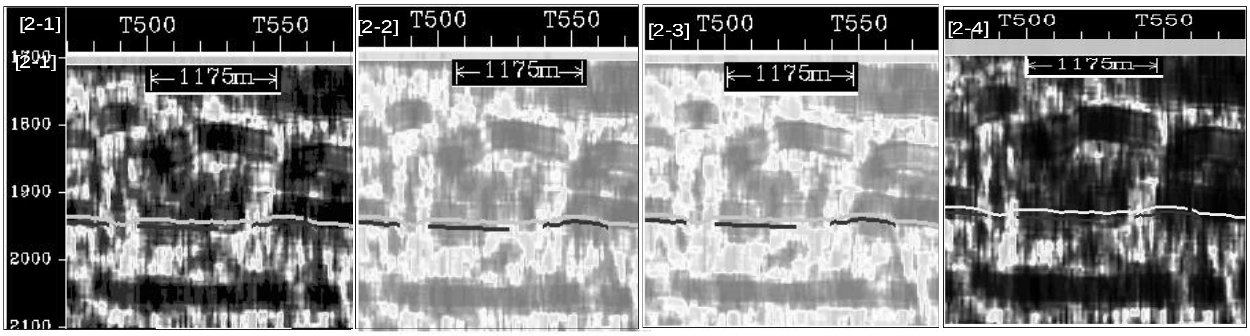

Fig. 2: Continuity-discontinuity section for correlation patterns; [2-1] for 2 traces pattern, [2-2] for 4 traces, [2-3] for 8 traces. and for 2-1,2-2, and 2-3: Correlation window= 25 ms and dip limit= 0 ms. [2-4] for the selected parameters: correlation pattern= 2 traces, window= 35 ms & dip limit= 8 ms

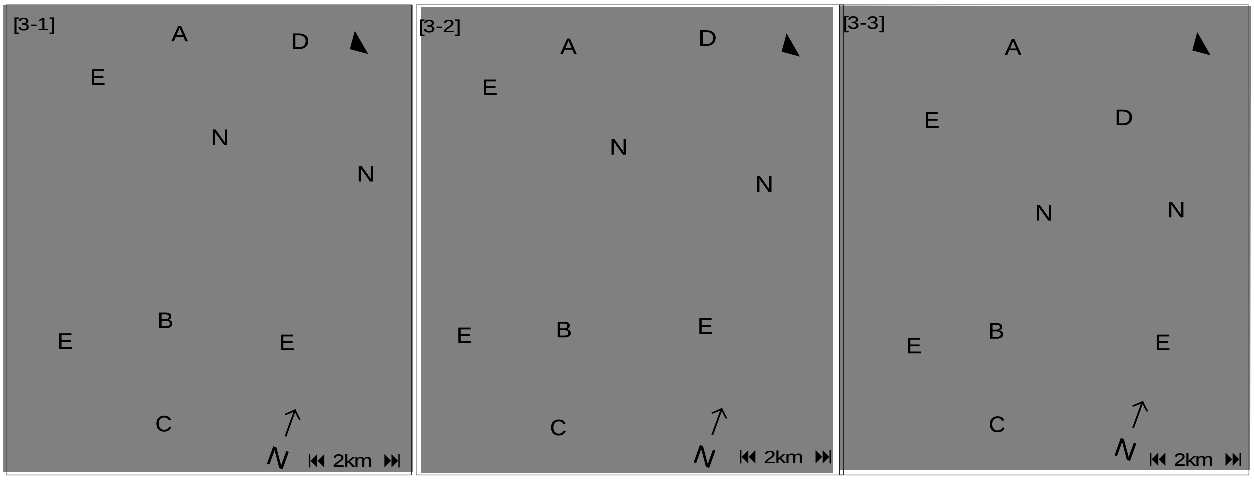

Fig. 3: Extracted continuity attribute horizon; [3-1] before applying a median filter, [3-2] after applying a median filter and [3-3] is an edge detection map. A to E interpreted discontinuities and N is noise

References

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