Technical Note #12

TEEC

Seismic Reservoir Characterisation using CRS-Stacking Techniques

H. Trappe, G. Gierse, M. Föll

This investigation demonstrates the contribution of the Common Reflection Surface Stack (CRS) technique to a reservoir characterisation study. Using this methodology an improvement in the signal/noise ratio could be obtained which results in an increased delineation of the the gas-water contact of the gasbearing reservoir. In addition the CRS results can be used to optimise special processing techniques such as seismic inversion and AVO results.

1. The Common Reflection Surface Stack Technology

The results presented here are based on the Common Reflection Surface (CRS) Stack technology developed by Hubral et al., University of Karlsruhe. The CRS Stack is a technique to derive an optimum Zero Offset Stack. This is done by calculating the stacking operator, that approximates the reflections in a multicoverage dataset best. The stacking operator depends on a couple of wavefield attributes, which are determined by coherency analysis. As results of this method not only the improved ZO Stack is calculated, but also the above mentioned wavefield attributes and coherency sections are delivered.
Figs. 1 and 1b illustrate the stacking surfaces for Migration to Zero Offset (MZO=NMO+DMO), Prestack Depth Migration (PreSDM) and CRS processing. The CRS stacking surface approximates the reflections much better and especially for the near offsets for far more traces in the vicinity of P_0 than the MZO stacking surface. Its approximation of the reflections is nearly as good when compared to the PreSDM stacking surface. The advantage of CRS stacking instead of PreSDM is, that results could be obtained without knowing an exact velocity model in depth. This model is crucial for accurate PreSDM and can only be obtained through time consuming and costly processes.

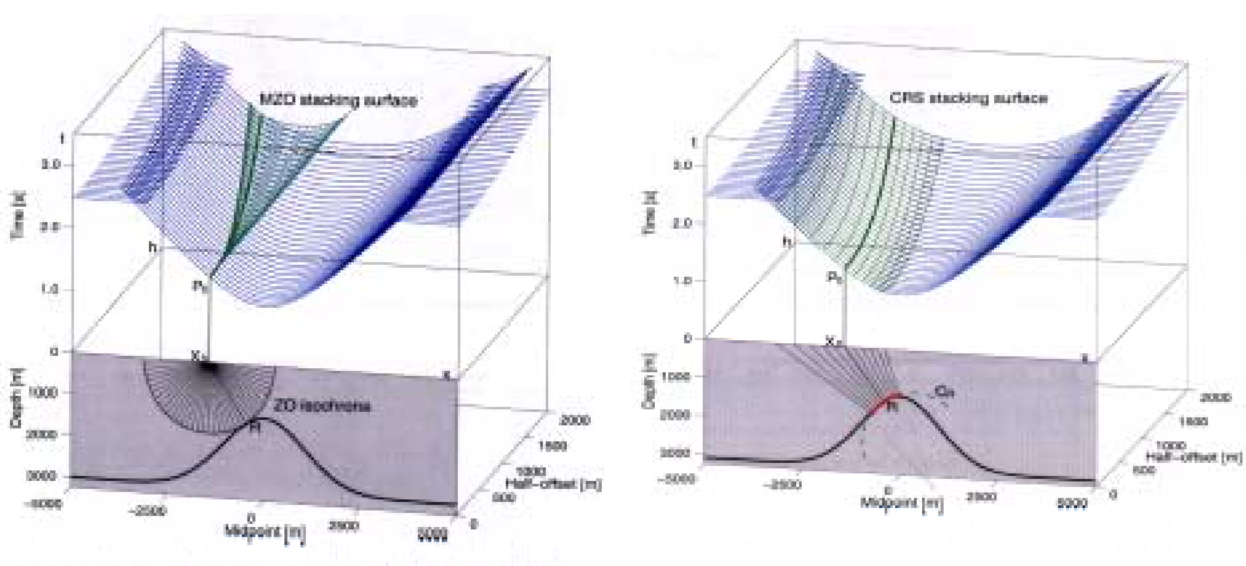


Fig.1 The lower halfs show the geological model. The upper halfs show the Common Offset reflection-time surface and the stacking surfaces for point P_0 for the different methods. (Hubral, 1999)

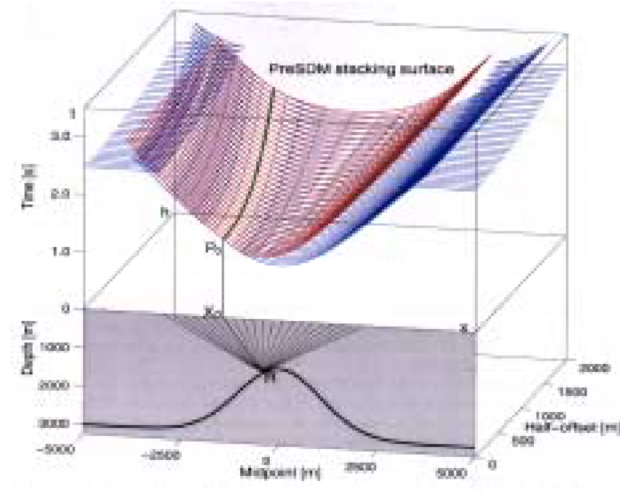


Fig.1b Common reflection time surface for the PreSDM stacking (Hubral, 1999)

2. NMO/DMO Stack versus CRS Stack

Because of the improved approximation of the reflection-traveltime-curves by the CRS method, the resulting stack has a superior signal/noise ratio. This is due to the fact, that CRS stacking results in a better imaging by using all the information which is provided by the multicoverage dataset. This point is demonstrated by the profile presented in Fig. 2. This profile crosses a gas field which is located below the horst block at a depth of about 800 ms. The resulting stacks of a conventional NMO/DMO and the CRS processing are shown. One can easily recognize the enhancement in quality, that is obtained by using the CRS technique. In the depth range of the reservoir the CRS section gives a clearer picture resulting in an additional event which becomes now visible. This event most likely indicates the gas water contact as suggested by the calibration of seismic and well data.

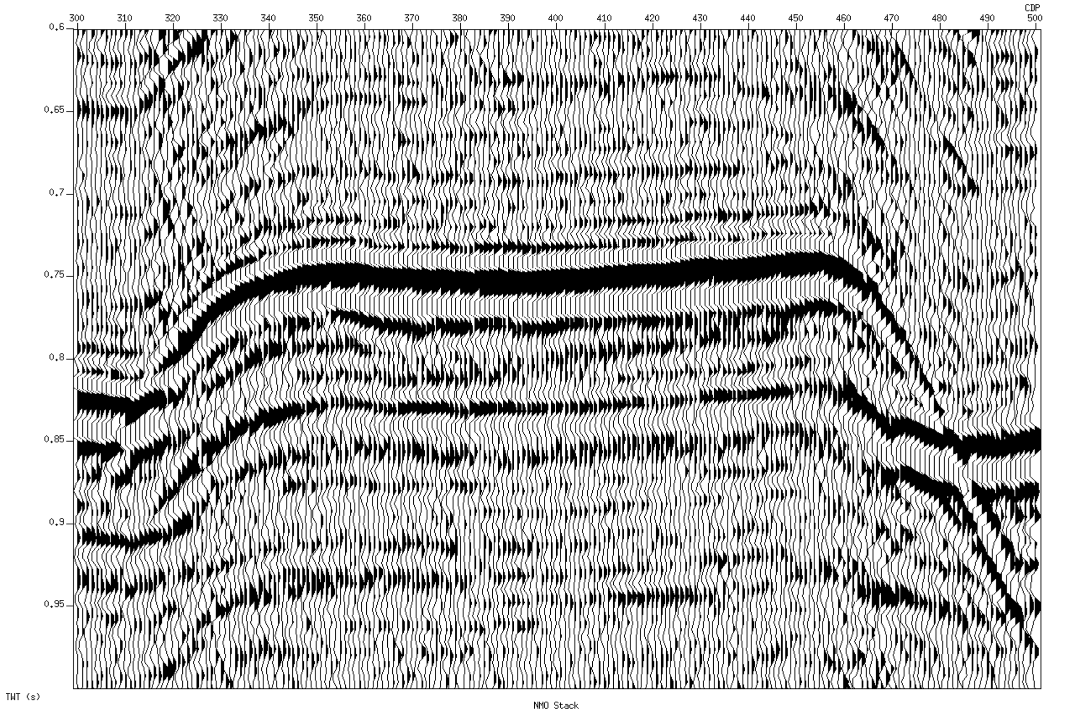
Because the CRS technique calculates a velocity value for each seismic sample one of the additional output parameters is a detailed velocity field. Fig. 3 gives a comparison between the NMO and CRS velocity fields with the location of the top reservoir horizon. Please note the increased lateral and vertical variation of the velocity field for the CRS technique. The lowest velocities occur on top of the structure. which correlates to the outline of the expected gas extension.

3. CRS and advanced Processing Techniques

The above mentioned features of the CRS technique are not only interesting in terms of stacking, but also in terms of AVO analysis and seismic inversion. One key problem in AVO analysis is the observation, that NMO corrected reflection events are not exactly aligned along a constant traveltime. A residual moveout of the hyperbola still exists. Generally this is corrected by removing the residual moveout manually. Due to the non-hyperbolic velocity estimation this problem does not occur by using the CRS method. A comparison of the AVO attribute *Gradient x Amplitude* is presented in Fig. 4 for the depth interval of the reservoir. Due to the improved velocity estimation and the resulting increase in signal/noise ratio by the CRS method, the AVO anomaly (red positive values) of the gasbearing reservoir now becomes much stronger. In other places artificial AVO-anomalies were observed resulting from a poor signal to noise ratio. Using the CRS-technique this problem could be better suppressed.

Due to the general increase in resolution found in CRS-processed sections also methods such as seismic inversion would certainly benefit from this methodology.

In conclusion the CRS technique has shown to be able to increase the seismic data quality which is one of the preconditions for a reliable reservoir characterisation.



NMO Stack

CRS Stack

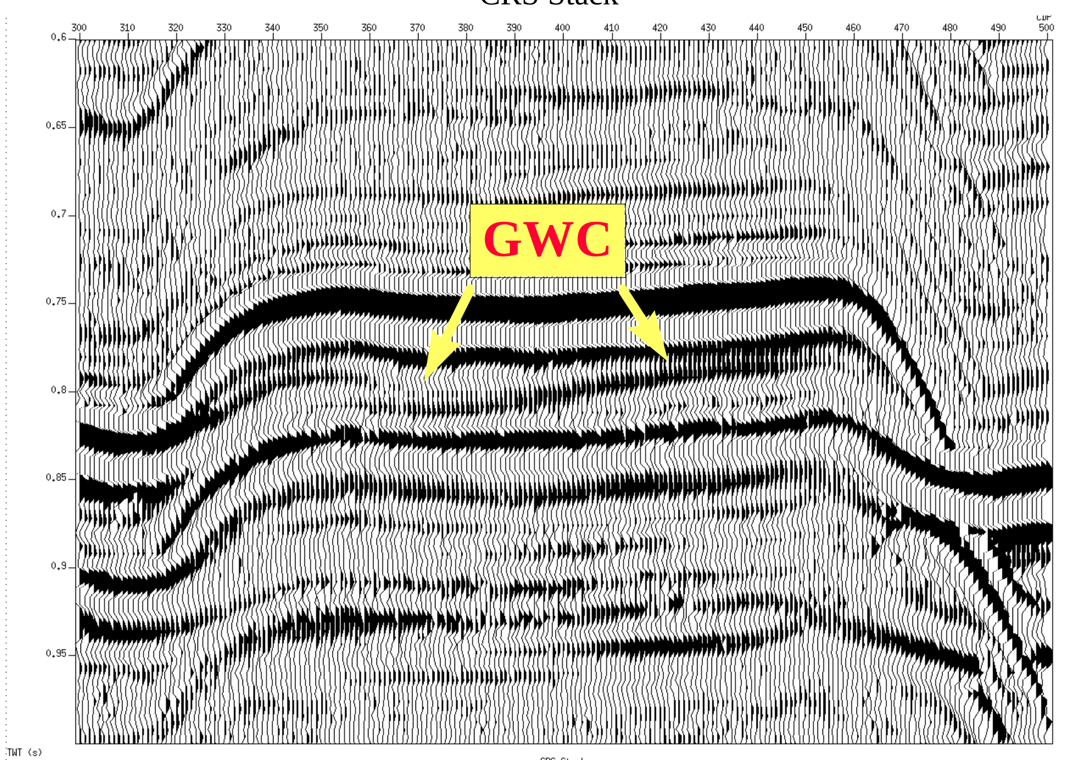


Fig. 2 Conventional NMO Stack (upper panel) compared with CRS Stack (lower panel). Note the improvement in the imaging of the gas-water-contact at about 800 ms TWT.

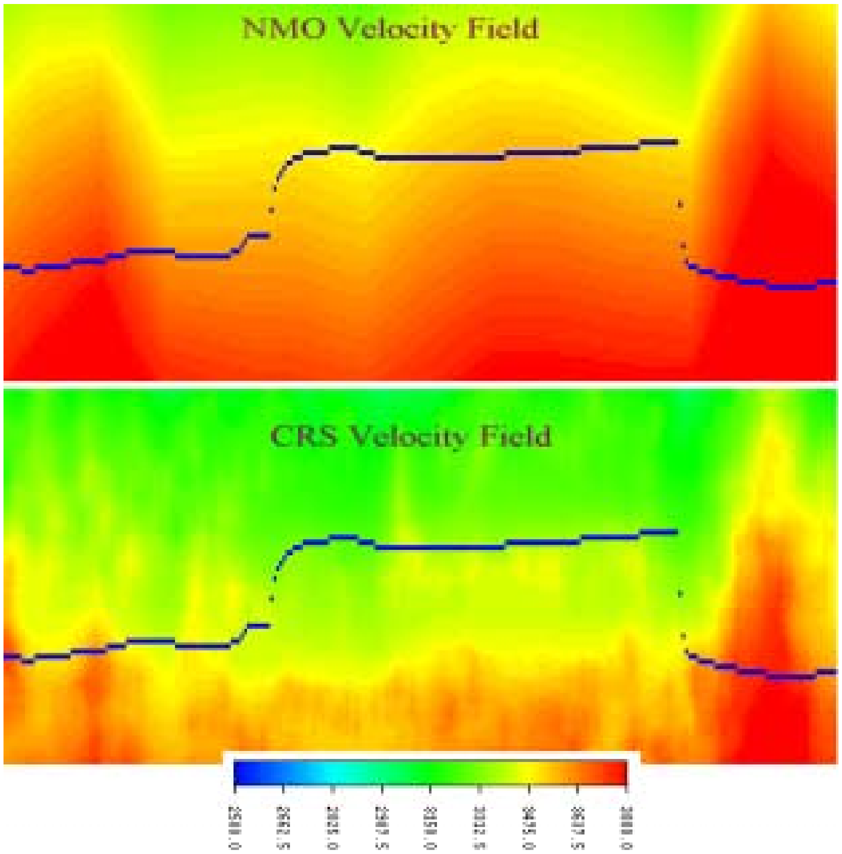
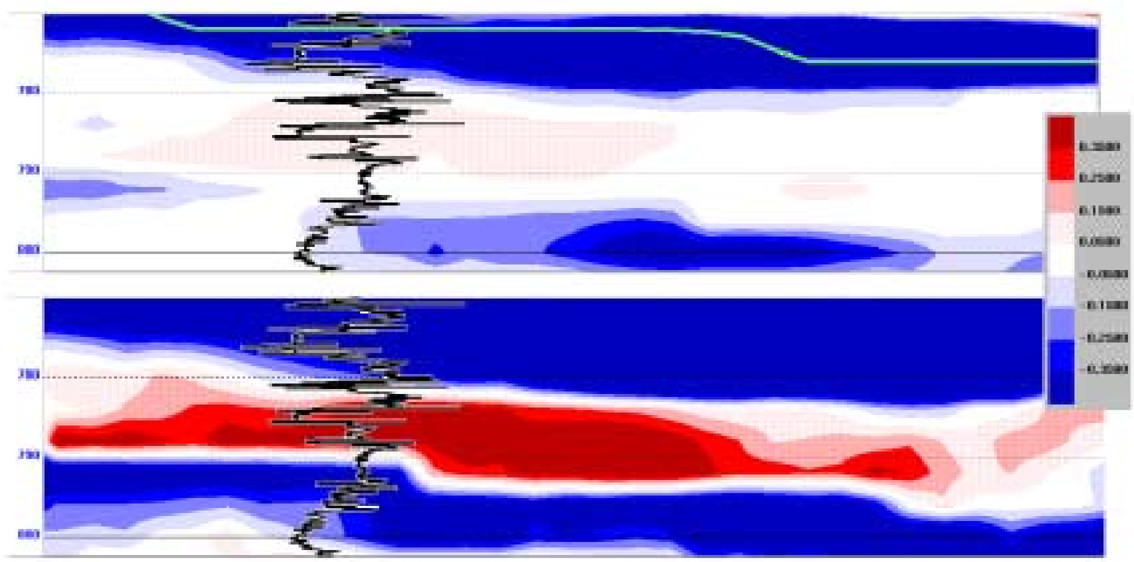


Fig. 3
top Velocity field obtained from conventional NMO stacking
bottom CRS velocity field

Fig. 4 AVO analysis
top Gradient x Amplitude derived from conventional CDP gathers at depth of reservoir
bottom same display but the CRS velocity field was used. The sonic log is shown.



Reference

P. Hubral et al., 1999. Seismic Illumination. The Leading Edge, Vol.18, No.11, pp. 1268-1271.

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