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OPTIMIZING RESOURCES

Structure Preserving Interpolation in 6D – Case Studies

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Summary

Structure PReserving INTerpolation in 6D (SPRINT6D) is a refined interpolation technique that improves upon the 5D minimum weighted norm interpolation (MWNI) for seismic processing. It is a frequency domain Fourier inversion method incorporated with a constrained a priori model to guide the inversion process. The constraint is achieved by imposing an angular weight function that is derived from a scanning of different dips of the input data in the f-$\boldsymbol{k}$ frequency-wavenumber domain. The objective is to preserve structural integrity of the data after interpolation.

Real data examples from around the world shown in this presentation demonstrate successful structure preservation for interpolation challenges posed by: (1) 3D upsampling megabin acquisition, (2) Poor 3D offset/azimuth coverage, (3) 3D block gap acquisition, and (4) 2D sparse acquisition.

Introduction

Building on the work of Liu and Sacchi (2004), the 5D interpolation method for 3D prestack seismic data by MWNI has been widely used since its introduction by Trad (2009, 2014). However, in that method there is no global data insight extracted from the frequency-wavenumber domain since an independent 4D MWNI is applied in space for every frequency slice, one slice at a time. In order to correct such deficiency, Ng et al. (2013, 2014, 2015) suggested integrating a Fourier angular stack concept into MWNI to connect data information across all frequency-wavenumbers, and thereby raising the dimension of the MWNI by one. Applying the extra dimension of angular weight (AW) to 5D MWNI for 3D prestack data results in a 6D AWMWNI. A structure preserving interpolation is desired for regularization and upsampling.

Method

The methodlogies, equations, and the proof of concepts of the angular weighted MWNI have been described in detail in the past few papers of Ng et al. (2013, 2014, 2015). The 6D is illustrated in the 2015 paper. Those who are interested are encouraged to refer to them.

Examples

Several case studies from real data examples will be presented during the talk. Here, one of the examples is illustrated. It is taken from a structurally complex data set. Figure 1 shows a vertical migrated section without SPRINT6D. Figure 2 shows the corresponding section with structural preserving interpolation SPRINT6D. Note that the steeply dipping reflectors improvements are highlighted in the green circles. Faults are more crisply defined. Figure 3 and 4 are the time slices of the without and with SPRINT6D respectively. Geological events are more continuous as indicated by the green circle highlights. This is a data regularization exercise in the COV domain. Interpolation practitioners must be cautious that interpolation does not smooth out structures or generate fictional data.

Conclusions

Through a handful of case studies in the talk, and in particalur one example given in this abstract, structure preserving interpolation in 6D is demonstrated, and uplifts in interpretation can be seen.

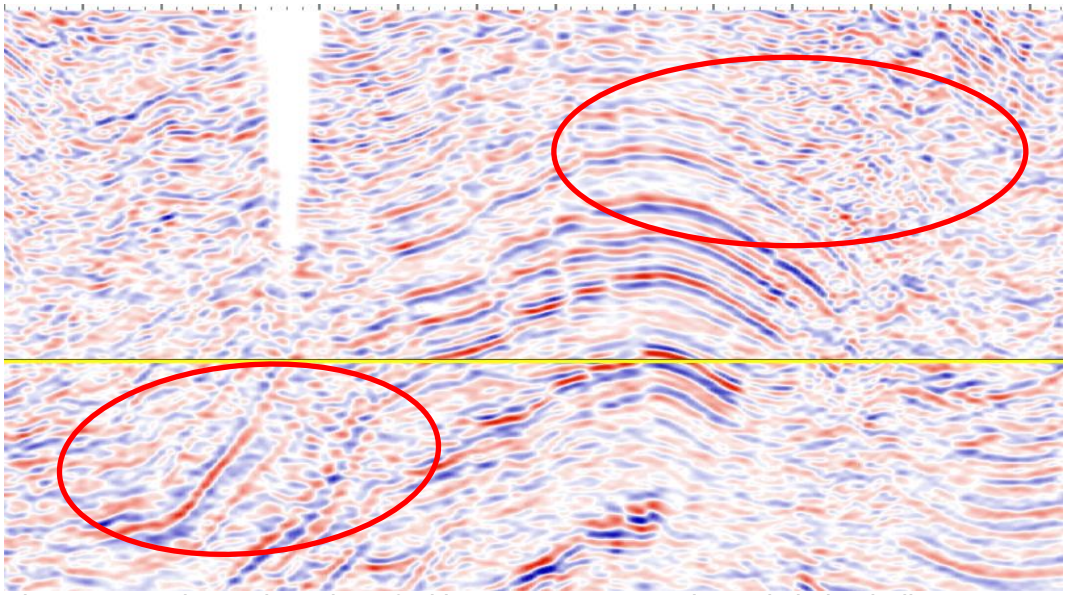

Figure 1. A migrated section of without SPRINT6D. The red circles indicate some aliased reflectors. The yellow line indicates the time where the corresponding time slice section is shown in figure 3.

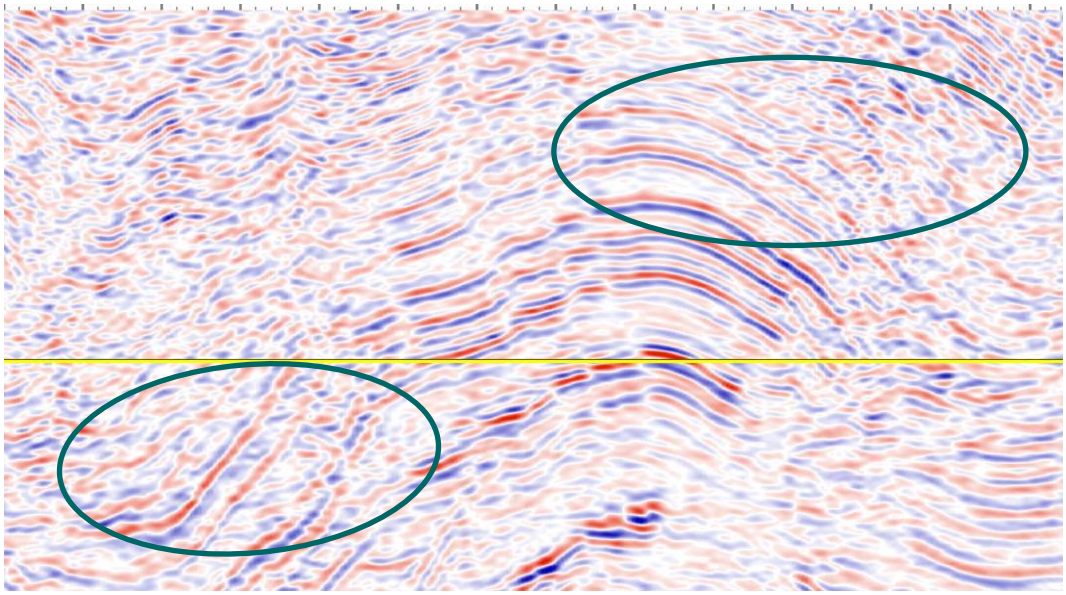

Figure 2. A migrated section of with SPRINT6D. The green circles show the recovery of steeply deeping data. The yellow line indicates the time where the corresponding time slice section is shown in figure 4.

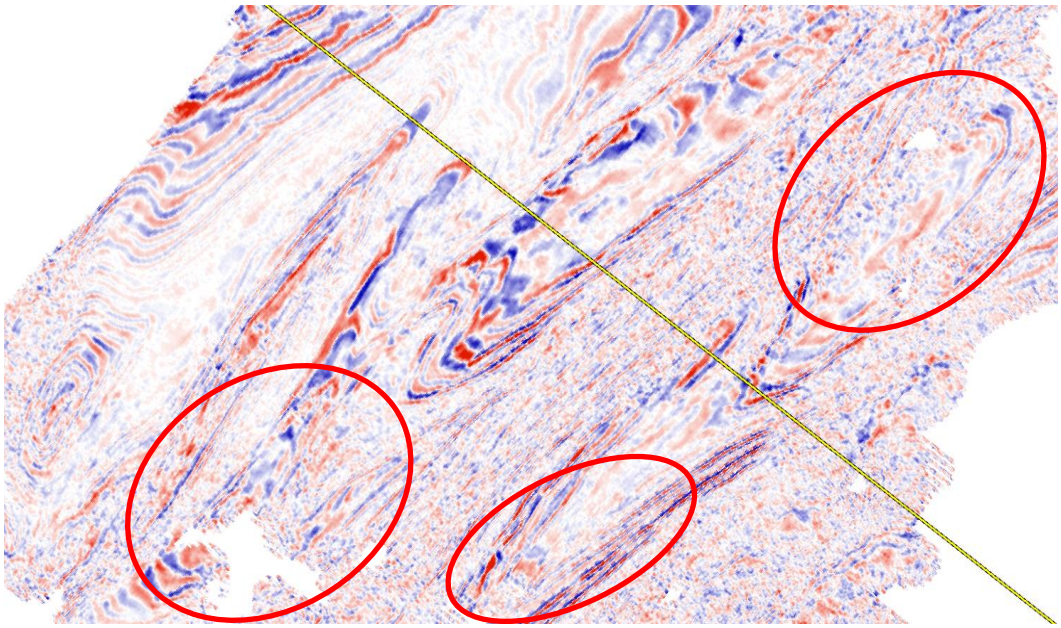

Figure 3. A time slice of the migrated section without SPRINT6D. The red circles indicate some broken up reflectors. The yellow line indicates the corresponding vertical section shown in figure 1.

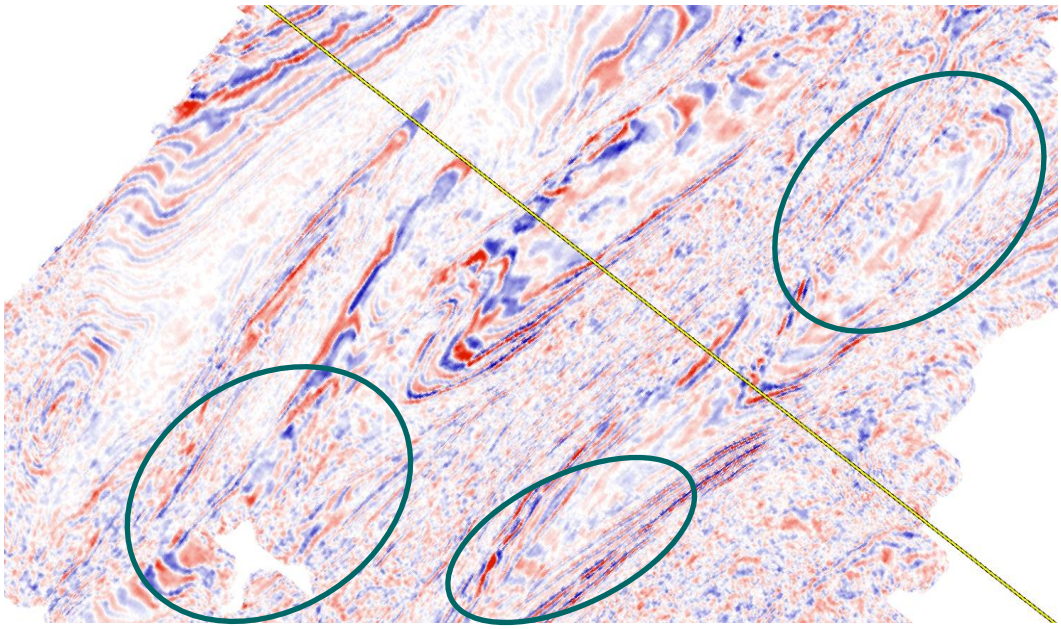

Figure 4. A time slice of the migrated section with SPRINT6D. The green circles indicate the recovery of reflectors. The empty spots are filled in with reasonable data. The yellow line indicates the corresponding vertical section shown in figure 2. (Note: Improvements may seem subtle in this small display scale.)

References

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