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Seismic Characterization of the Internal Fault Architecture from a Deepwater Fold and Thrust System, Niger Delta

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Deep water settings offer spectacular opportunities to understand the kinematic evolution of thrusts because of the unrivalled quality of seismic data. Nevertheless, there is still considerable uncertainty concerning the detailed geometry of forelimbs of thrust-related folds and of the thrust zones themselves that ramp through these regions. Forelimbs are increasingly seen as exerting a critical influence on trap and seal effectiveness. Gaining greater insight on the organization of different fault strands and the stratal geometries is the goal of this research. In this contribution, a detailed description of the thrust and fault architecture of a 3D seismic dataset from the deep water fold and thrust system of the western lobe of the Niger Delta is presented. The results of volume image processing using SVI Pro are presented. To track the main dipping discontinuities (thrusts) we first performed noise cancellation through the seismic volume and then produced a steering volume using structurally-oriented dip and azimuth filters. Using the redefined seismic cube, the main reflectors and fault systems have been systematically mapped to obtain a contour map (in TWT) of the main stratal horizons. The dip and azimuth steering volumes were then reprocessed using a detailed structurally-oriented image processing to compute different seismic attributes. Instantaneous phase, discontinuity and coherency attribute cubes as well as coherency maps (figs 1a to d) along different time slices bring out the orientation of the faults. Extracting the faults as geobodies permits the better definition and the 3D variability of the overall thrust and faults architecture. The main faults thrust and damage imaged clearly shows a branched and dendritic geometry, with interconnected double verging thrusts. In both the time-dip and coherence map the main fault structures appear as bands defined by a patchwork of small curvilinear discontinuities and non rotated but disrupted reflections. A comparison between the instantaneous phase attribute map and phase based dip maps can be used locally to extract coherent features within these bands. But extreme caution is needed when interpreting such a small structures that have offset or curvatures within the time window specified for autotracking (50-100meter). We argue these small features could represent the basis for identifying small scale structures associated with subseismic strain. Along the dip and azimuth directions the main thrusts structures show 3D variability evolving laterally from fold propagation folds (fig 1a), trishear–like (fig 1b), detachment folds to "pop-up"-like structures (bivergent thrust pairs. figs 1c and d). These are analyzed in a companion presentation.

Based on this analysis we conclude that:

- Using appropriate seismic volume image processing workflows, the 3D complexity of thrust architecture can be revealed and visualized.
- The 3D thrust geometry and inferred damage distribution observed cannot be described or predicted by any of the existing classical fold and thrust models.

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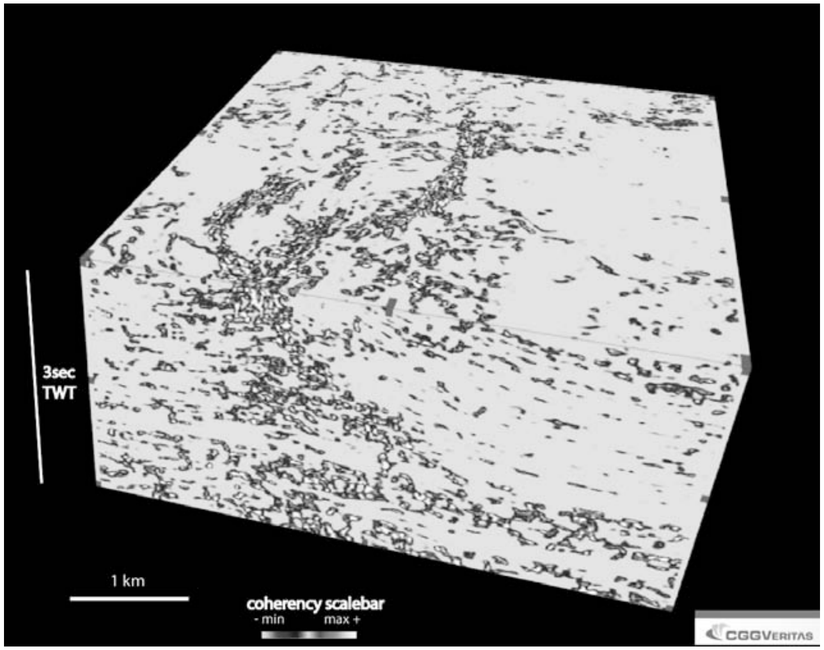
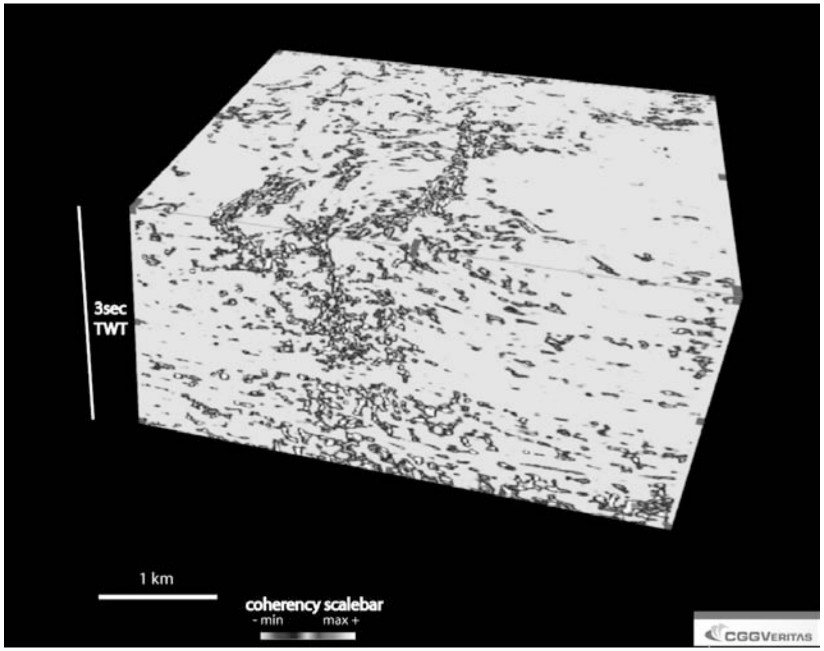
Figures



a



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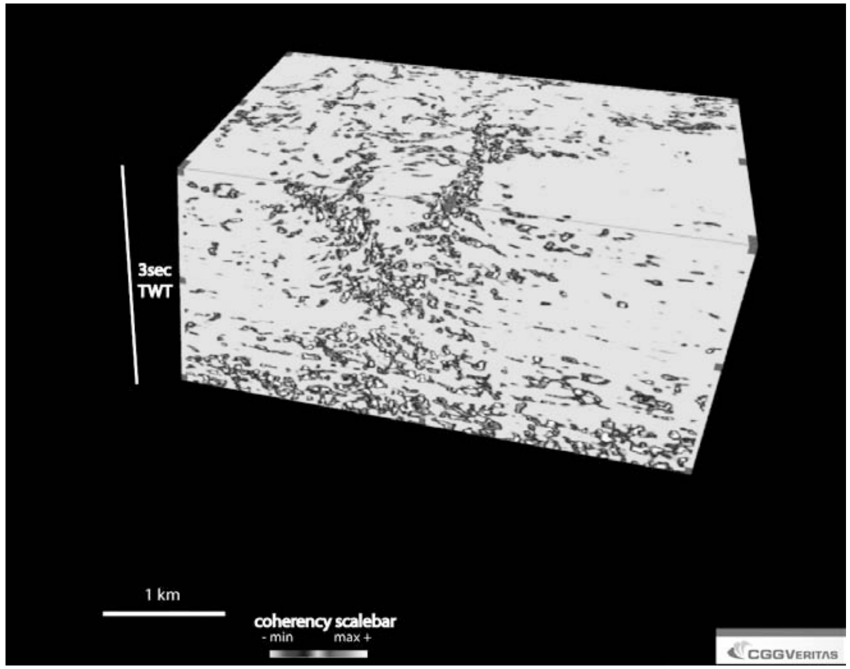

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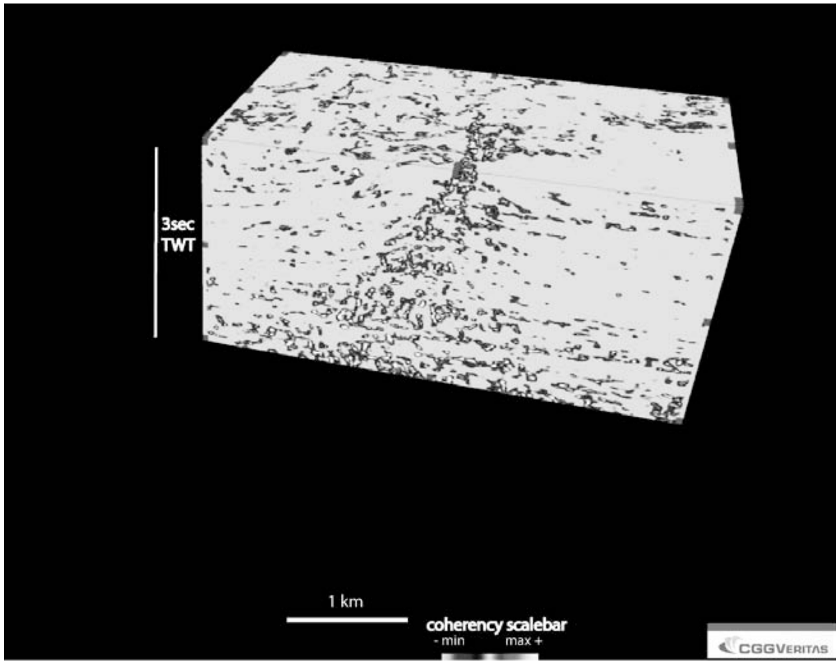

d

Figure 1. Serial sections cut through the seismic coherency cube, illustrating the lateral variations in thrust and fold geometry. The images were created using the seismic volume image processing software SVI Pro, (ffA).