Characterizing thrust-related folds in 3D: an example from offshore NW Borneo

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Fold and thrust belts are best described in 3D because they exhibit strong variations in deformation styles along strike and dip. Successful 3D characterizations of compressional structures are still limited, although such studies are needed for better understanding of structural geometries and kinematic evolutions in the fold and thrust belts. This is because many studies suffer from the absence of geometrical constraints (e.g., erosion of hangingwalls in the field and seismically wiped-out fold limbs) and much of tools in structural geology only handle with 2D, cross-sectional geometries.

This contribution presents an approach to characterize 3D deformation style of a fold-thrust array, with consideration of along-strike variations in fold-thrust geometry and fault kinematics. Our example comes from the continental slope of offshore NW Borneo, Malaysia. In this region, turbidite sandstones and related claystones of Neogene to recent in age have deformed into a submarine fold and thrust belt from Late Miocene onward. We use a 3D seismic data to map two fold trains associated with thrust faults. Across the fold-thrust array, we determine fault heaves, shortening amounts and fold strains (interlimb angle and forelimb dip) on serial dip-sections spaced at 250 m interval. We then plot these structural measurements on strike projections and evaluate along-strike variations to examine the compatibility of structural interpretation and to assess the kinematics of folding and faulting.

Results show that the measurements plotted on the strike projections provide useful tools to accomplish geologically reasonable interpretations in 3D when seismic images are ambiguous –an interpretation associated with a measure that deviates from an overall tendency is examined and modified if necessary while checking consistency with seismic images. Especially, fault heave can be used for quick verification of a structural interpretation, on time display, because the fault heave is largely unsusceptible to the seismic depth conversion. The strike-projection profiles of fault displacement and fold strains also inform how bulk shortening is partitioned into folding and thrusting, which helps to understand how folds and thrusts develop together to maintain kinematic coherency across individual or group of structures. Consequently, comprehensive understanding of the 3D structural geometry and associated kinematics are obtained.

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