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3-D geometry analysis of a fault-related structure in frontal part of fault-and-thrust belt, NW Taiwan

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In the frontal part of a fold-and-thrust belt of in-sequence and ongoing development, any fault-related structures represent the initial features that may shed some influences on the following structural evolution. In the outer foothills belt of northwestern Taiwan, a train of fault-related folds are segmented and geometrically affected by a set of pre-existing transcurrent faults. In the southernmost part of the structural domain, the subsurface structure of the largest gas-field in Taiwan, the Tiechengshan anticline, appears as an intact fault-related fold in the frontal part of the fault-and-thrust belt. However, the subsurface fold-forming fault geometry is still unclear and in debate. The main purpose of this study is to use a grid of seismic sections and well bore data to reconstruct a 3-D geometry of the fold and the interpreted fold-forming thrust. We converted the time sections into depth sections of identical V/H scale and analyzed the angular relationship between each pair of limb, termination of reflectors and, the most importantly, the subsurface thrust constrained by drilled wells to build the 3-D geometry of subsurface fold and thrust structure.

On the surface, the Tiechenshan structure is characterized by two segmented anticlines offset by a tear fault striking at high angle to the fold axis. However, the subsurface geometry of the structure built by a series of seismic lines indicates that the frontal structure is composed of two folds of opposite vergence that are softly linked in the transfer zone. The opposite vergence implies that the separated folds are related to slip along thrusts with opposite dip direction. On the surface, the axial surfaces extending from both anticlines form multiplly bend fold strcucture in the transfer zone.

For the fold segment of forelandward vergence in the northern part of the structure, the angular relationship and variable lengths among the limbs and crest favor a shear fault-bend fold model for the structure. The subsurface trajectory of the thrust can be defined by axial surface and reflector termination. Yet, the calculated back-shear angle is larger than 70 degrees and yet there is a noticeable intersectional angle between the unparallel thrust ramp and backlimb, suggesting that the shear fault-bend fold is not a simple step strcucture. The depth of the lower flat of thrust decreases southward to the transfer zone. On the other hand, the fold segment of hinterlandward vergence in the southern part of the structure is interpreted as a fault-propagation fold, which might be originated from normal fault reactivation. The interpretation is not only indicated by the fold shape but also supported by the shallower part of the fault plane with normal fault sense of slip.