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Kinematic 3-D retro-deformation of an orogenic bend and modeling of the incremental internal strain distribution within the South Limón fold-and-thrust belt, eastern Costa Rica

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Analyzing salients and syntaxes is an important step toward understanding the geodynamics of orogens, but the analysis of curved fold-and-thrust belts remains a challenge, because of the varying structural orientations within a deformed belt. The backarc area of the southern Central American island arc in Costa Rica is characterized by the South Limón fold-and-thrust belt. This fold-and-thrust belt has a strong bend at the northern edge, where the strike of the thrust planes bend through 90°. The area is covered by a 3-D net of seismic reflection lines and can therefore act as a natural laboratory for the analysis of curved orogens. Based on the seismic interpretation, we created a 3-D subsurface model with the software package MoveTM, containing three major thrust faults and three stratigraphic horizons. Based on this model, 3-D kinematic retro-deformation modeling was carried out to analyze the evolution of the fold-and-thrust belt. The maximum amount of displacement on each of the faults is (from hinterland to foreland); thrust 1: 800 m; thrust 2: 600 m; thrust 3: 250 m. The model was restored sequentially to its pre-deformational state. At every step of the retro-deformation, the strain history of the stratigraphic horizons in the model was calculated. The results show that the internal strain pattern has an abrupt change at the orogenic bend. Contractional strain occurs in the forelimbs of the hanging-wall anticlines, while a zone of dilative strain spreads from the anticline crests to the backlimbs. The modeling shows that a NNE-directed transport direction best explains the structural evolution of the bend. This would require a left-lateral strike-slip zone in the north to compensate for the movement and thereby decouple the South Limón fold-and-thrust belt from northern Costa Rica. For the South Limón fold-and-thrust belt, transport-parallel simple shear can be ruled out, because the offset along the thrusts is mainly constant, even along strike of the bend. Uniform displacement/uniform shortening (NNE directed in the bend and NE directed in the main part of the fold belt) would be therefore a more suitable kinematic classification for the South Limón fold-and-thrust belt.

References

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