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The structural geometry and development of the central Appalachian fold-and thrust belt across the Pennsylvania salient: The effects of syntectonic loading

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The Pennsylvania salient is a classic arcuate fold-and-thrust belt that was deformed during the Late Paleozoic Alleghenian orogeny. 38 regional cross-sections with an along-strike spacing of 5 to 10 km were constructed, and show that the structural geometry varies significantly from the 030°-striking southwestern segment to 060°-striking northeastern segment. The primary competent lithotectonic unit is the 2 to 3 km thick Cambro-Ordovician carbonate sequence which is detached along a Cambrian clastic unit. The 5 to 7 km thick preserved Upper Paleozoic sequence is less homogeneous, and locally exhibits significant internal deformation.

In the southwest part of the salient, the hinterland part of the fold belt is defined by a series of imbricated Cambro-Ordovician carbonate horses with leading-edge fault-propagation style folds that have a structural amplitude of 5 to 7 km. In the central part of the fold belt, the Broadtop synclinorium exhibits little to no imbrication of the Cambro-Ordovician unit, while in the western part of the belt toward the foreland, two additional carbonate horses with leading-edge fault-propagation style folds comprise the Wills Mt. anticlinorium. In the central and eastern parts of the salient, the structural geometry toward the foreland is defined by a duplex with 4 -5 imbricate horses of Cambro-Ordovician carbonates that transitions to an antiformal stack of two to three carbonate thrust sheets comprising the Nittany anticlinorium. Toward the hinterland, the Cambro-Ordovician carbonate sequence is faulted into broadly-spaced fault-related folds, and includes the regionally continuous (>160 km) Jacks Mt. – Berwick anticline that spans both limbs of the salient.

Upon retrodeformation of the cross sections, the 060°-striking northeastern segment restoration path curves 25°-30° to the east, while the 030°-striking southwestern segment curves 20°-25° to the south. The major fault underlying the presently curved Jacks Mt. – Berwick anticline structure, as well as those structures toward the hinterland, restore to a nearly straight fault traces oriented 045°-050°. The relatively straight restored faults require a rigid indenter colliding from the southeast to impose the curvature to the salient.

The regional variation in structural style and ramp spacing may be related to the distribution of Late Carboniferous to Permian syn-tectonic loads during thrusting. Paleo-overburden thicknesses were determined from fluid inclusion microthermometry data of $CH4 \pm CO_2$ and aqueous fluid inclusions from syn-tectonic veins. In general, on the retrodeformed sections, restored overburdens are typically less above anticlinoria (<1.5 to 4.0 km), while much larger (4.3 to 6.1 km) above synclinoria. This suggests that syn-tectonic loading in the synclinoria due to sedimentation and/or overthrusting increased pore-fluid pressure enabling forelandward transport. Areas with less syntectonic overburden were prone to develop high-amplitude fold structures.