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Evidence of back folding in the Himachal Himalaya: A reassessment of the tectonic models in light of new evidence

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Understanding how the geological architecture of the Himalaya has been constructed demands well-constrained tectonic models supported and validated by field observations. The channel flow model has been used to explain the structural architecture in many different sectors of the Himalaya. However, the model appeared to have failed in the classic example of the Himachal Himalaya, so in 2007 Webb proposed the Tectonic Wedge Model. But the key to this model is the existence of a regional-scale recumbent anticline, illustrated in many different papers and in textbooks. This structure is known variously as the Phojal fold, or the Sikhar nappe, or the Kalath anticline. Webb's Tectonic Wedge Model requires the South Tibetan Detachment (STD) to also be recumbently folded, along with the Phojal fold. Our detailed field observations are contrary to the regional structures proposed in the existing models. First, it is evident that 'photo geology' has produced an optical illusion. Field mapping shows that the Phojal Fold is a north-east vergent reclined back fold. Thus, despite having been developed on the km-scale, the Phojal Fold has nothing to do with the formation of the earlier formed recumbent folds. There is no doubt that an early period of recumbent folding has produced regional-scale structures in the NW Himalaya. These folds post-date the first recognized period of Barrovian metamorphism. However, because the axial-plane cleavage of the recumbent folds is a pressure-solution cleavage, it can be inferred that these metamorphic rocks had cooled and been exhumed to shallow crustal levels prior to the start of the early recumbent folding event. The second period of Barrovian metamorphism was associated with the STD, which post-dates the earlier recumbent folds, but pre-dates back folding. The underpinning of the Tectonic Wedge Model has been removed. Hence the validity of the model is on trial.