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Plate boundary bending: insight from the Permian oroclines of eastern Australia

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Curved mountain chains (oroclines) are recognized globally in both modern and ancient orogenic belts. However, the underlying tectonics responsible for orogenic curvature is still a matter of debate. Relatively gentle oroclines are common in fold-and-thrust belts (e.g. Appalachians) and are normally restricted to shallow crustal levels. In contrast, tighter oroclines that involve deep crustal rocks are known from subduction environments (e.g. Mediterranean Sea), and can involve bending of the whole subducting lithosphere. The formation of such oroclines has been attributed to rollback of narrow subduction segments accompanied by rotations of crustal blocks around vertical axes, 'escape' tectonics in response to plate convergence or crustal-scale buckling. All these models challenge the way we conceptualize continental deformation and the ways in which it can be responsible for bending a whole orogenic belt.

This contribution focuses on a series of sharp bends that are recognized in the Paleozoic to early Mesozoic New England Orogen of eastern Australia. The exact geometry of these oroclines is obscured by voluminous magmatism and still debated. We present new zircon U-Pb ages that shed new light on the oroclinal structure, showing the lateral continuity of an Early Permian (300-288 Ma) magmatic belt. This belt delineates a strongly contorted structure comprising of at least three oroclines, and possibly a fourth orocline that has hitherto not been recognized. A subsequent phase of younger magmatism (260-220 Ma) cuts across the oroclines and constrains the timing of oroclinal bending to 288-260 Ma. We discuss alternative tectonic models for oroclinal bending, involving (1) drag folding associated with strike-slip faulting; (2) sheath folding; (3) large-scale buckling and refolding; and (4) orogenic curvature promoted by subduction rollback and back-arc extension. We argue that mega-drag folding and sheath-folding cannot sufficiently explain the structure of the New England oroclines, and advocate a mechanism involving subduction rollback and oroclinal amplification by large-scale E-W contraction.