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Provenance and structural constraints of the early Permian Nambucca Block (eastern Australia), and implications for the origin of the New England oroclines

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The late Paleozoic to early Mesozoic southern New England Orogen of eastern Australia exhibits a remarkable omega-shaped orogenic curvature (orocline), but the geodynamic processes responsible for the formation of the orogenic curvatures (oroclines) are still unclear. Oroclinal bending took place during the early Permian, simultaneously with the development of rift-related sedimentary basins (Sydney, Gunnedah and Bowen basins), which bound the oroclines to the west. The Nambucca Block is part of another early Permian rift basin that is situated farther east, in the core of the oroclinal structure. We present new stratigraphic, structural and geochronological data from the Nambucca Block in an attempt to better understand its provenance, tectonic history and its role in the formation of the oroclines. Four phases of folding and associated structural fabrics are recognised in the Nambucca Block. 40Ar/39Ar age of metamorphic micas from the second deformational phase provides a minimum depositional age constraint at 275-265 Ma. This age overlaps with the timing of oroclinal bending, suggesting that the first two phases of deformation resulted from the same mechanism that formed the oroclines. Detrital zircon geochronology (U/Pb ICP-MS ages) of six samples from the Nambucca Block constrains the maximum depositional age of the sequence to 280 Ma. The sedimentary succession, though extremely polymictic, is unimodal in its sources, and is therefore interpreted to consist mainly of recycled detritus from a Devonian-Carboniferous accretionary complex. We propose a model for oroclinal bending involving three stages. The first stage, starting at about 293 Ma and including the deposition of the sequence of Nambucca (i.e. overlaps with the 280-265 Ma time constraint), was associated with formation of rift basins in an extensional backarc setting. This was followed by N-S contraction, which gave rise to second-order oroclinal structures. The third and final stage involved contractional deformation that gave rise to recumbent folds and penetrative sub-horizontal structural fabrics at 275-265 Ma and further tightened the oroclinal structure.