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Oroclines - a century of discourse about curved mountain belts (Petrus Peregrinus Medal Lecture)

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Exactly a century ago, in early 2014, a discussion appeared in the Journal of Geology by William H. Hobbs entitled “Mechanics of formation of arcuate mountains”. In it, he notes how the concept of nappes “has now overcome all opposition in Switzerland” and, presumably in other countries just as much. With horizontal transport so central to the nappe concept, this must have paved the way for the idea that emplacement of trust sheets may have involved rotations. Where such rotations form a coherent regional pattern, a curved mountain belt may be the result. While the paper by Hobbs does not mention the word orocline, and while the dynamics of the situation is not yet illuminated, one must give credit to him for his foresights.
The term “orocline” was introduced by S. Warren Carey of Tasmania in 1955, as part of a kinematic analysis of rhomb- and triangle-shaped basins and curved mountain belts. When the displacements involved in the analysis are undone, as he did, for instance, in the western Mediterranean, a grand scheme of simple convergent and divergent patterns emerges. Noteworthy is, of course, the fact that this mobilistic analysis preceded plate tectonics by more than a decade. From Carey (although not exactly in his words) we have inherited the definition of orocline, as “a thrust belt or orogen that is curved in map-view due to it having been bent or buckled about a vertical axis of rotation”.
Because oroclinal bending involves rotations, the declinations of paleomagnetic studies can be utilized to support and quantify them, and early efforts were already made in the 1960’s and early 1970’s to do so (e.g., Krs in the Carpathians; Ries & Shackleton in Cantabria; Roy, Opdyke & Irving in the Central Appalachians; Packer & Stone in Alaska). Curved mountain belts everywhere were subsequently investigated, and typically shown by paleomagnetists to be of the oroclinal variety. Few curved belts turned out to be curved from the start. Because these studies were generally carried out in fold- and trust-belts, the allochthony of the rotated limbs of the thin-skinned belts implied transport above a basal décollement plane located in the upper crust. Some examples of these thin-skinned oroclines will be given. However, in recent years oroclines have also been proposed as resulting from buckling of ribbon continents (e.g., Panama; D’Entrecasteaux) with the noteworthy Great Alaskan Terrane Wreck, as discussed by Stephen Johnston of the University of Victoria, as prime example. And oroclines of truly continental dimensions have been presented on the basis of paleomagnetic and structural data in Hercynian Europe and Asia (the Kazakhstan and Mongol-Okhotsk oroclines).
Because most of the fold- and trust-belt oroclines contain thick carbonate formations; paleomagnetists frequently find that these have been remagnetized in geological episodes that are coeval with mountain building nearby in time and space. A connection between remagnetization and clay diagenesis is a possibility that is currently being investigated. If this is shown to be the case, the last word on oroclines will not have been printed.