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Vertical extrusion of high-pressure nappes indicated by inclusion-trail patterns

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The formation and exhumation of high-pressure nappes is considered in the light of similar orientation patterns of porphyroblast inclusion trails found in two different settings: (1) The alochtonous metamorphic complexes of NW-Iberia, which are remnants of a Variscan subduction complex, and (2) the Nevado-Filabride tectonic window, a deeply exhumed thrust nappe in the (Alpine) Betic Cordillera. High pressure conditions (>15 kbar) at both locations were previously deduced from the mineralogy of porphyroblast inclusion trails, but without much attention to geometric details. It is shown that these inclusion trails exhibit well-developed horizontal and vertical preferred orientations, and represent successively formed foliations rather than a single one. This evidence allows to consider that deep burial (subdiction) and following fast exhumation of continental rocks are driven primarily by bulk crustal shortening and subvertical foliation development. A diapir-like general structure of orogens is envisaged in which buoyancy contrasts between crust and mantle combined with forced extrusion of weak, lower crust between converging pates are the principle elements. In this model, Peninic-type thrust nappes initially form as tight upright folds that are extruded in subvertical root zones after which they continue to spread gravitationally towards the foreland. The transition from extrusion to spreading in nappes is thought to be reflected in high-pressure subvertical inclusion trails overprinted by lower-grade subhorizontal ones. Despite experimental verification as early as 50 years ago (Bucher, 1956), this pure-shear dominated model has been disfavoured compared to simple-shear dominated models for the development of high-grade nappes such as progressive thrust stacking, underthrusting, or corner flow. Although these mechanisms share important geometric aspects with the here advocated extrusion-spreading model, they are at odds with observations at the microscopic scale.

Bucher, W.H., 1956. Role of gravity in orogenesis. Geological Society of America

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