Kinematics and dynamics of basin inversion

The scale, style and degree of basin inversion varies from the collisional inversion of continental margin rift complexes to the subtle and gentle inversion of intracontinental rifts and from gentle whole basin uplift to major structural inversions with substantial thrust remobilization of earlier extensional structures. Some inversion mechanisms are intrinsic to the existence and lithospheric structure of the basin. Others, especially those involving simple basin uplift are coincidental. The causes of inversion are many and may include:

1 Regional temporal variations in stress patterns within plates, resulting from forces caused by changes in plate boundary configuration, the blocking of subduction zones by buoyant crust (collision) and changes in relative motion at nearby plate boundaries.
2 Global, episodic, intraplate, stress changes from deviatoric compression during the collisional assembly of Pangaea-type continental configurations to deviatoric tension in assembled configurations to deviatoric compression in dispersed configurations. Inversions are commonly associated with rifted margin breakup unconformities caused by the transition from rift–phase tension to ridge push compression.
3 Local inversion in strike–slip rhombohedral pull-aparts as a natural consequence of alternating phases of transtension with negative flower structure and transpression with positive flower structure.
4 Complex alternating phases of extension and shortening at the margins of upper crustal rotational flakes in strike–slip zones.
5 Progressive diminution of the ratio of crustal to lithospheric thickness during slow extension causing whole basin uplift.
6 Uplift on lithospheric flexural arches and hotspots.
7 Body force mechanisms including salt mud diapirism, salt/mud decollement tectonics, gravity spreading, sliding and consequent relaying of heel extension to toe thrusting.
8 Inversion of strong negative isostatic gravity anomalies in confined deep basins caused by upper crustal stretching. Critical to whether a basin becomes inverted are, also, the timing of a compression phase relative to the initial basin-forming extensional event and the extensional strain rate. Short extension–compression intervals and high extensional strain rates facilitate basin inversion. Inversion may be prevented by long intervals and low strain rates.

The way in which extension is balanced through the lithosphere determines the style of subsequent shortening inversion. Upper crustal extensional basins lead to long distance compression relaying along mid-crustal detachments while preserving their negative gravity anomalies. Whole lithospheric extension with substantial crustal thinning and Moho pull-up leads to mantle involvement in thrust complexes and positive gravity anomalies in inverted basins.

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