'Lithosphere extension' that isn't, in 3 different plate-tectonic situations: MOR rift valleys, passive continental margins and exhuming HP/LT belts.

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Attention is drawn to the magnitude and tectonic impact of T- and P-induced petrological volume changes at depth in the crust and uppermost mantle. The perspective common to all three situations to be discussed is that if a volume increase, or dilatation, occurs at depth within the lithosphere/crust the material above it experiences structural extension, but this isn't lithosphere extension and doesn't require the application of extensional plate forces.

Three kinds of dilatation are involved, different for each situation:-

(a) heat transferred into garnet peridotite mantle, at PT such that this causes solid-state phase change to spinel- and plagioclase-peridotite, converts heat into volume increase (~3%) about 30 times more efficiently than thermal expansion;

(b) heat transferred into the mid-to-lower continental crust, releasing H_2O that migrates upward within the column, but does not escape, can induce dilatation of up to several tens of percent, at least 12.5 times more thermally efficiently than thermal expansion; [This mechanism has been discounted by some petrologists but will here be defended on strong observational grounds.]

(c) retrogression of UHP and HP/LT assemblages to much lower density ones during exhumation.

Data on (a) and (b) that I published in 1973, have been confirmed and supplemented by recent work.

MORs. The ridge push generated by the current MOR model is limited (~3 x10^{12} N/m) and is insufficient by a factor of >5 to support laterally the Andes or Himalayas. Convergent margins have also undergone much foreland-directed thrusting in forearc-type settings. In response to subduction requirements for young-plate thermal buoyancy I have developed a highly successful MOR model (2000a, 2000b) which has a narrow (20cm? wide, but probably wider at depth) axial 'crack' extending to >50km depth. Magmatic heat introduced into the walls, at the phase-change-prone depth, dilates the walls (mechanism (a)), closes the crack and pushes the plates apart, which induces fresh material into the crack further along strike, where the sequence repeats. This solid-state mechanism has very large ridge-push potential. The phase-change push-apart level (shallow on EPR) deepens as the spreading rate decreases (MAR), resulting in wider rift-faulting above that level, but at even slower rates the level is too deep and the plate too cool for such faulting to occur (Reykjanes).

Passive margin initiation. Much heat spreads laterally into continental lithosphere when hot oceanic mantle starts to be emplaced beside it. This will dilate the mid-crust and upper lower-crust (mechanism (b)), causing it to 'extrude' oceanwards beneath the upper continental crust, which consequently develops an extensional structure and may also experience uplift (a widespread feature but contrary to what true extension would do). These points are made explicit by recent investigations of the Gabon, Galicia and Red Sea (Yemen) margins. In the Gabon case the lateral 'extrusion' is even seen to overthrust initial oceanic crust, demonstrating its thermally delayed occurrence and the impossibility of a 'stretching' force having been applied to the lithosphere.

Exhumational rise of HP/LT assemblages. Evidence of the high pressure to which the entire assemblage was originally subject is commonly preserved in a few small enclaves; all the rest has retrogressed to minerals of much lower density, implying a considerable dilatation (>10 vol%?). At any moment during erosion off the top, the material currently at the surface has already 'done' its dilatation but the material below it is still dilating, creating the impression of basement 'extension', to which the term 'post-orogenic collapse' has been widely applied but now appears inappropriate.

The plate dynamics implications of these findings are likely to be considerable.

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