Mechanics of thin-skinned fold and thrust belts

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Thin-skinned fold and thrust belts have a number of geologic features in common. 1) The original sedimentary section was wedge-shaped, thickening away from the craton. 2) The basement sloped backward before deformation, down so now, and probably did so during deformation. 3) The whole wedge of sediments was shortened and thickened by the deformation. 4) Deformation occurs above a basal layer which was weaker than the rest of the wedge. Such a thin-skinned belt is modeled mathematically by the compressing flow of a perfectly-plastic wedge bounded below by a weaker layer. The solution dictates the surface slope required to make the whole wedge yield and slide over the basal layer in terms of: yield stress of the wedge and of the weak layer, thickness of the wedge, and back slope of the benecent. The surface slope can vary from the observed thickening of the wedge. The commonly observed "inversion of relief" is a natural consequence of the shortening; no additional hypothesis is needed. If the basal layer is not much weaker than the rest of the wedge, a moderate forward slope of the surface is predicted. If the basal layer is very weak, or if its back slope is large (as might occur in a continent-and-collision), a flat or even a backward sliding surface is predicted. Stress orientation depends on the yield stress of the basal layer: If the layer is very weak structures will be perpendicular near the base of the wedge. While if the layer is only moderately weak asymmetrical structures are predicted. This model explains both the shortening of the wedge and the basal shear stress; models which focus only on the surface slope cannot provide the basal shear stress but not the compression.

CATEGORIES OF ANOMALOUS TOPOGRAPHIC RELIEF WITHIN PLATES

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Most major relief on earth is associated with active plate margins. Continental and island arcs separating the two platform areas defining the maxima on the first derivative of the hypsographic curve are the main regions of relief away from active plate margins. Problematic areas of major relief away from plates and continental margins fall into these main categories: 1. Some old mountain belts (e.g. Uruguay, Appalachians, and Caledonides). These elevations (1-2 km ABS) are too high to be relics of orogenic topography and a problem is why are they high now. 2. Active intraplate volcanic areas (hot spots) in both continents and oceans, are always associated with circular to elliptical structural uplifts of 1-2 km about 200 km across (e.g. Hawaii, Tubarao). Man at sea is not able to see all the components. 3. Uplifts identical to those associated with hot spots, but with no volcanism (e.g. Mariana, Apostle plateaux, Peterman and several in Southern Africa). The presence or absence of volcanic rocks in these two categories is probably of minor significance. 4. Other areas with 1-2 km of uplift, of lesser circular plan, usually of major extent (1-2000 km). 5. Small and the Wajirai Hills are postplate margin relief associated with my old aborted convergence. The Kuril-Kamchatka, E. Brazil, Sumbawa Ridge, Raffia Island, and the Eastern Rockies are each unique in certain aspects and are therefore difficult to classify. Areas of high relief in central Asia and China are a mix of plate margin, collision and hot spot types.

ATLANTIC SALT DEPOSITS FORMED BY EVAPORATION OF WATER SPLIT FROM THE PACIFIC, TETHYS AND SOUTHERN OCEANS

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Deep ocean basin exploration by research vessels of many countries has shown that salt diapirs have a restricted distribution around the margins of the Atlantic Ocean. Assuming massive salt was deposited only where diapirs have been mapped, areas of salt developed at opening may be plotted on a pre-Atlantic opening continental reconstruction as shown here in black.

Salt areas formed by spills from 1 Tethys (-170 m.y.)
2 - Pacific (-170 m.y.)
3 - Southern Ocean (-105 m.y.)

Inspection of this map leads to the new suggestion that three separate areas of salt exist each of which was formed by waters split from a different ocean. Tethyan waters split into the grana of Morocco and generated an afar as what is now offshore maritime Canada in late Triassic time. Flooding of the Gulf of Mexico by salt waters from the Pacific was roughly contemporary. This salt extended through a complex of grana around Florida to the Old Nuana Channel and the mouth of the Casamance river but not apparently further north. In Aptian time salt was formed between the Uvalde ridge and the Biga delta by a spill from the southern ocean.

HELICOME: SEA LEVEL AND THE MARGINAL SEDIMENT HYPOTHESES

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July (1952) proposed that loading of the earth's crust by continental glacier ice would produce not only a downsnap in the center, but also a marginal bulge. The amplitude of this bulge was tested by Newman, Fairbridge and Kiehl (1953) and the isostasy theory developed by Walcott (1957), confirming the concept of a bulge extending approximately 1000 km from the maximum limit of continental ice and reaching an amplitude of 50-100 m. Subsequent to the melting of the ice sheet there should be a fairly rapid recovery of crustal equilibrium, decreasing exponentially so that very little residual remains. Tide gauge evidence of NBL behavior over the last 200 years suggests that the present recovery rate (i.e. subsidence) does not exceed 1.2 m/yr. Records of Holocene shoreline from eastern North America tend to confirm the model but are confused by controversial interpretations. Accordingly a comparison has been made with five areally distinct Holocene shoreline curves for northern Europe, all based on modern, technicly well-dated sequences by Geyh (1969), Münzer (1969), Tore (1973), Greensmith and Tucker (1973) and Tookey (1979). A 1975-updated version of the 1961 "Fairbridge Curve" based on "cleaned" equatorial to subsurface data suggests a crustal recovery in Europe comparable to that in North America. Anomallos amplitude departures in the English Channel and vicinity appear to be due to the changing tidal amplitude such as demonstrated for the Bay of Fundy (the Open Effect). This work has been partially supported by USMA.
as 1/4 or 1/5 respectively. At a sufficiently large age, however, the heat flow and depth depart from these simple relationships with respect to $t$.

The exact point at which this occurs depends on the ratio of $v/v_w$, which is the thermal diffusivity and a the thermal conductivity of the crust. The age of the Earth and depth-age curve has been extended out to 180 million years using data at JUDE.

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Cover  Topographic elevations on the Moon measured by the Apollo 15 laser altimeter. See William M. Kaula's article (from which this figure was taken) on the gravity and shape of the moon, and the Eighth GEOP Research Conference report, "Lunar dynamics and Selenodesy."

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