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Depth anomalies in old oceanic lithosphere

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Variations in seafloor heat flow and depth with lithospheric age are the two major constraints on models for the thermal evolution of oceanic lithosphere as it cools, subsides and moves away from the midocean ridges. The halfspace model predicts that depths will increase proportionally to the square root of lithospheric age and heat flow will decrease at a rate inversely proportionally to the square root of lithospheric age. Alternatively, for the plate model the lithosphere behaves as a halfspace until an age at which the effects of the lower boundary cause the depth and heat flow to "flatten", varying more slowly with age. The plate model was developed because for ages older than about 50-70 million years, the average sea floor deepens more slowly than predicted by the halfspace model. Similarly, the heat flow at older ages "flattens" and so it is better fit by a plate model.

For lithosphere older than about 70 million years, it is sometimes assumed that oceanic lithosphere evolves as expected for the halfspace model in the absence of additional heating, for example from hotspot activity or other mantle upwelling. Thus, areas whose depths are similar to those predicted by the halfspace model are assumed to be less reheated and should have lower heat flow compared to shallower areas with depths nearer those predicted by the plate model. Alternatively, if the oceanic lithosphere evolves as expected for a plate model, then some shallow or deep depth anomalies at a regional scale may result from dynamic topography, due to convection and variations within the sublithospheric mantle. In this scenario these areas would have no significant thermal effect on the oceanic lithosphere and thus no impact on the surface heat flow. Here, the relationship between heat flow and depth anomalies for older lithosphere is examined to better understand controls on the evolution of oceanic lithosphere.