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Determination of stable lithospheric upper mantle heat flow using xenoliths and its variation in lithospheres of different ages

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Mantle xenoliths, pieces of mantle lithosphere entrained in magmas and brought to the surface by volcanism, generally retain mineral and chemical equilibria representative of their pressure (depth) and temperature of origin. Some of these equilibria may be used to estimate the depths and temperatures from which the xenoliths were erupted If multiple xenoliths were erupted from different depths in the same eruption or from eruptions in the same locality and within the same time period, then the gradient of temperature versus depth, the geotherm, can be determined. Using experimental data from mantle xenoliths, a temperature-dependent relation for the conductivity of the upper mantle has been determined. A new transform has been developed between the xenolith temperatures and the temperature-dependent upper-mantle thermal conductivity that allows heat flow to be calculated from the slope of the transformed temperature vs. depth data. This allows xenolith data to be used both to determine the mantle lithosphere geotherm and heat flow with temperature-dependent thermal conductivities.

Mantle heat flow from stable lithosphere determined by this technique is approximately 15 mW m^{-2}. There is a measureable offset in mantle temperatures from Archean through Phanerozoic stable lithosphere consistent with a small change in average modern surface heat flow that is observed in lithospheres of different ages. Younger lithosphere is slightly warmer than older lithosphere.