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Archean S-type granites killed by hot geothermal gradients

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S-types granites are produced by partial melting of metasedimentary terranes and bear important implications for recycling of surface materials and crustal differentiation. S-type granites are rare through much of the Archean with reasons unclear. We find that this paucity of S-type granites may have been a inevitable consequence of the hotter geothermal gradients in the Archean. Owing to the strong pressure dependence of dehydration melting, the hot geothermal gradients would initiate partial melting at shallower depths, which in turn would trigger shallow exhumation and limit the maximum burial depth. By contrast, colder geothermal gradients in Phanerozoic orogens would effectively suppress melting until higher pressures and temperatures. Shallow exhumation of the Archean terranes prevented the long-range decompression and extensive dehydration melting attainable in modern cycles. Our modeling shows that melt production remains at ~10% during Archean exhumation, whereas Phanerozoic counterparts may produce 30-40% melt. This inefficient reworking may have hindered upward distallation of heat producint elements in Archean orogens, potentially delaying the long-term stabilization of the Archean crust.