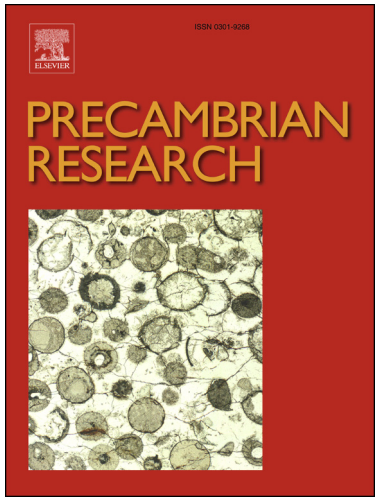

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Partial melting of metabasic rocks and the generation of tonalitic–trondhjemitic–granodioritic (TTG) crust in the Archaean: constraints from phase equilibrium modelling

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ABSTRACT

Rocks of tonalitic–trondhjemitic–granodioritic (TTG) composition preserved in Archaean terranes represent fragments of the Earth's earliest-formed continental crust, and are thought to have formed via partial melting of hydrated metabasalt. The geodynamic environments in which such high-grade metamorphism and anatexis may have occurred in the early Earth is strongly debated. Constraining the pressure (P) and temperature (T) conditions at which melts of appropriate composition can be derived from protoliths containing plausible mineral assemblages is central to addressing this question. Phase equilibrium modelling has been undertaken for an enriched Archaean tholeiite bulk composition—a suggested protolith for early-Earth TTG magmas—using newly parameterised thermodynamic models that were specifically developed to evaluate the anatectic behaviour of metabasalt. Assuming minimal H_2O saturation at the wet solidus, the potential fertility of the studied metabasalt is greatest if the solidus is crossed at a pressure of ~11 kbar, where the solidus temperature reaches a minimum of ~610 °C. Major-element compositions and proportions of calculated partial melts show the best correlation with those of natural Archaean TTGs when in the P–T range ~800–950 °C and ~10–18 kbar, which we suggest are optimal conditions for their petrogenesis. Normative