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Subaqueous Archean continental flood basalts were emplaced on hot continental crust

Nicolas Flament (1,2,3), Patrice Rey (3), Nicolas Coltice (1,2), Gilles Dromart (1,2), Nicolas Olivier (1,2)

(1) Université de Lyon, (2) CNRS, UMR 5276, 2, rue Raphaël Dubois, 69622 Villeurbanne cedex, France, (3) Earthbyte Group, School of Geosciences, The University of Sydney NSW 2006, Australia (nicolas.flament@sydney.edu.au)

Large basaltic provinces up to 15 km thick are common in Archean cratons. Despite significantly contributing to the thickening of the continental crust, many Archean flood basalts that show continental contamination remained below sea level during their eruption. In this contribution, we suggest that one possible way of maintaining basaltic piles several kilometers thick below sea level is via gravity-driven lower crustal flow of hot continental crust. Using numerical experiments, we show that the characteristic time to remove the anomaly in crustal thickness associated with a continental flood basalt (CFB) decreases exponentially with Moho temperature (T_M) from 2.5 Gyr for $T_M \approx$ 300 °C to 5 Myr for $T_M \approx$ 1050 °C. Therefore, the removal of the thickness anomaly associated with CFBs erupted on cold continents occurs by a combination of brittle deformation and erosion, two processes of time scale of a few tens of million years. This is consistent with observations for Phanerozoic CFBs that are subject to important erosion and would not be preserved in the geological record over billions of years, contrary to subaqueous Archean CFBs. We show, based on sedimentary and structural observations, that the subsidence of the $\leq$ 1.4-km-thick basalts of the Kylena Formation and lower 600-m-thick basalts of the Maddina Formation in the Meentheena Centrocline (Pilbara Craton, Western Australia) occurred without any significant tectonic extension in $\leq$ 15 Myr and $\leq$ 11 Myr, respectively. We interpret our observations as the surface expression of the removal of thickness anomaly by the flow of lower continental crust. From our modeling results, the subsidence of these basalts over such time scales requires Moho temperatures $\geq$ 900 °C. The example of the Fortescue Group illustrates that thick subaqueous Archean CFBs are the result of the accumulation of several basaltic packages, each erupted over $\preceq$ 30 Myr. Moho temperatures $\succeq$ 800 °C are required to maintain such basaltic packages below sea level by lower crustal flow. Thus, the prevalence of subaqueous CFBs in the Archean record suggests that they were dominantly emplaced on hot, weak continental crust and that Archean continental geotherms were significantly warmer than their modern counterparts.