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Geodynamical implication of delamination on felsic crust generation during the Archean

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The geodynamic processes that were active during the Archean remain enigmatic. On the basis of geochemical and geological data, several working hypotheses exist, which suggest that the most crucial unsolved problems are: a) when and how was felsic crust generated and did this have geodynamic implications? b) how did cratonic lithosphere form and survive? c) did plate tectonics exist?
Here, we test the feasibility of some of these hypothesis with a modeling approach, in which we couple chemical evolution and melt extraction using state-of-the art mafic thermodynamic melting models with a viscoelastoplastic geodynamic finite element code. In our simulations, we test the effect of rheology of the mafic crust, melt weakening, the amount of intrusion, and the amount of melt extraction on the geodynamic deformation mode.
Our simulations show that under particular conditions, a plate like behavior occurs for a short amount of time, but also that the most stable mode of crustal recycling during the Archean is delamination of the eclogitic/restitic mafic crust. Delamination of the lower crust occurs rapidly and completely destroys the lithospheric mantle, putting the hot asthenosphere in direct contact with the mafic crust, which inducing a continuous generation of felsic crust. Continuous crustal delamination triggers significant mantle melting and thus mafic crust generation, and produces a cold crust similar to the recently proposed heat pipe model. This results in rapid mantle cooling, which suggest that the average cooling rate of the Earth has not been constant but rather fluctuated with time.
Our results show that delamination processes has several implication on felsic crust production and on the preservation of the lithospheric mantle. Providing useful insight to understand the close relation between crust and mantle.