Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 20/1	Graz 2014
PANGEO AUSTRIA 2014	Graz, 14. September 2014 – 19. September 2014		

Variety of geological settings for continental silicic melts formation in the early Archean

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The relevance of modern tectonics to the formation of the Archean terrains is a matter of international debate. Higher mantle temperatures together with higher radiogenic heat production had a great impact on the thickness and composition of the continental crust. As a consequence of secular cooling, there is generally no modern analog to assist in understanding the tectonic style that may characterize the early-middle Archean. For this reason, well-constrained numerical modeling is an appropriate tool to evaluate hypotheses of Archean crustal formation based on the fragmentary evidence preserved in the geological record.

The main lithologies of the Archean terranes are sodic rocks including tonalite, trondhjemite and granodiorite (TTG). One of the crucial point for the Archean petrology is the change from sodic (TTGs) to potassic (granites) granitoids at circa 3.2 Ga. That raises one of the main questions for the Precambrian: which tectonic processes prevailed in the early Archean and were responsible for the unique construction of the Archean crust?

The most accepted model for TTGs formation at the moment is melting of the hydrated basalts at garnet-amphibolite or eclogite facies. Together with a possible contact of TTG melts with mantle peridotites there appeared an idea of their formation within a subduction zone. Nevertheless there is a series of other models such as for example melting at the bottom of thickened continental crust or fractional crystallization of basaltic melts under water-saturated conditions.

We present some results of a newly-developed 2D coupled petrological–thermomechanical numerical model appropriate to the Paleo-, Mesoarchean conditions. Based on a single model we show a variety of simultaneous geodynamical settings for possible granitoids formation: melting of basalts during small-scale delamination of the lower crust, melting of the locally thickened crust, basalt melting during small-scale crustal overturns, and fractional crystallization of crustal underlying basaltic melts. We believe that the simultaneity of the proposed mechanisms is able to cover the variety and complexity of the granitoids in the early Archean.