Beyond Beauty: Chronicles of the world's oldest rubies from Greenland

Sampriti Basak[a] and Kristoffer Szilas[a]

[a] Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade 10, 1350 Copenhagen, Denmark (sbasak@ign.ku.dk, krsz@ign.ku.dk)

Constraining the mechanism of corundum(ruby) formation during Mesoarchaean metasomatism of mafic-ultramafic rocks in the Ujaragssuit Nûnat Complex, SW Greenland

The Ujaragssuit Nûnat Complex (UNC) in SW Greenland is an extraordinary geological terrain featuring of igneous and metamorphosed mafic-ultramafic rocks with layers and large pods of chromitite, in a vast expanse of Eoarchean orthogneiss and Mesoarchean granitoid sheets. These rocks offer a glimpse into Earth's formative stages, spanning a remarkable timeframe from approximately 4.1 billion years ago (Coggon et al. 2013) to 2.95 billion years ago (Sawada et al. 2023), encompassing much of our planet's early evolution. This large period is also considered by a large group of scientists to be the time of initiation and evolution of plate tectonics on Earth eventually making it habitable as we know today (Cawood et al. 2022 and references therein). Notably, the rocks from UNC exhibit distinct signatures of polymetamorphism and metasomatism, occurring after their initial emplacement, as evidenced by their intricate mineralogy, including the formation of corundum, which require unique physico-chemical conditions.

This study, for the first time, investigates corundum-bearing rocks from UNC to unravel the complex post-emplacement metamorphic and metasomatic history. Our findings result from an integrated analytical approach encompassing petrography, micro-textural analysis using micro-XRF, mineral chemistry, and thermodynamic phase equilibria modeling (*Perple_X*) using effective bulk rock composition. Our study unveils a sequence of metamorphic and metasomatic events: (a) initial metamorphism of mafic rocks to amphibolite facies conditions, (b) subsequent K^+ rich fluid infiltration associated with granitoid melt infiltration at ca. 2.95 Ga (Sawada et al. 2023) leading to desilication and decalcification of calcic plagioclase and amphibole, creating conditions conducive for the local crystallization of corundum (ruby) crystals within the geochemically "disturbed" metasomatic rock and (c) low-temperature retrogression event possibly at a later stage resulting in the formation of minerals such as chlorite, pumpellyite. Additional tests of isopleth thermometry is being carried out to further narrow down the exact range and P-T path of these rocks. These results will enhance our understanding of the tectonic history (possibly burial and exhumation cycles) of the North Atlantic Craton, spanning from 3 billion years ago from now and onward.

References

Coggon, J.A., Luguet, A., Nowell, G.M., Appel, P.W., 2013: Hadean mantle melting recorded by southwest Greenland chromitite 186Os signatures. *Nature Geoscience* 6, 871–874.

Sawada, H., Morishita, T., Vezinet, A., Stern, R., Tani, K., Nishio, I., Takahashi, K., Pearson, D.G. and Szilas, K., 2023: Zircon within chromitite requires revision of the tectonic history of the Eoarchean Itsaq Gneiss Complex, Greenland. *Geoscience Frontiers*, p.101648.

Cawood, P.A., Chowdhury, P., Mulder, J.A., Hawkesworth, C.J., Capitanio, F.A., Gunawardana, P.M. and Nebel, O., 2022: Secular evolution of continents and the Earth system. Reviews of Geophysics 60(4)