Hadean greenstones and the origin of the Earth's early continental crust

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Partial-melting experiments, at 1.0–3.0 GPa and 900–1100 ºC, were conducted on two greenstones of Early Archaean (Hadean) age from the Nuvvuagittuq Complex of northern Quebec. For comparison, similar experiments were also conducted on a modern boninite (from the North Tongan Arc) with compositional similarities to the Nuvvuagittuq greenstones. Partial-melts produced by these experiments are compositionally similar to some TTGs, including a 3.66 billion year old tonalite that encloses the Nuvvuagitttuq Complex. Because the degree of melting needed to produce the tonalitic melts is comparatively high (> 30 %), the relative concentrations of most incompatible elements in the melts are similar to those in their greenstone and bonninite parent rocks. Thus many of the incompatible element characteristics of TTGs may have been inherited from previously fractionated source rocks that already possessed similar characteristics. If this was true, early continental crust production may have been closely associated with some form of crustal re-cycling that duplicated many of the magmatic consequences of modern plate tectonics.

Evaluating new particle formation, growth, and CCN formation in global models

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Although observations of nucleation events often show rapid growth to CCN sizes, global aerosol models have typically shown modest sensitivities of CCN concentrations to uncertainties in nucleation rates. This may be because models lack good nucleation parameterizations, or they underestimate particle growth (e.g. by condensation of SOA). Alternatively, observations of strong growth events may be rare and play a minor role in the overall global CCN budget.

The ability of a global aerosol microphysics model to predict accurately the formation and growth of new particles is tested against observations for several locations: Atlanta, Hyytiälä, Pittsburgh, Saint Louis, and San Pietro Capofiume. Full-year model simulations are compared against size-distribution measurements for corresponding years. Metrics for comparison are nucleation frequency as well as daily nucleation rates, growth rates, condensation sink, sulfuric acid concentrations (where available), CCN formation rates and nuclei survival probability. The global model used is the TwO-Moment Aerosol Sectional (TOMAS) microphysics algorithm incorporated into the GEOS-CHEM global model. Separate model runs were performed using two nucleation schemes: ternary nucleation with a 10^{-5} tuning factor and activation nucleation.

In general, comparison results show that TOMAS does not understate the importance of nucleation to CCN concentrations, as most metrics show less than a 50% bias compared to ambient measurements. Averaged across all five sites, nucleation frequency is overpredicted in the model by 18% and 32% in the ternary and activation simulations, respectively. Growth rates are typically slightly overpredicted in both the ternary and activation model cases, with median growth rates of 2.9 nm h^{-1} and 3.4 nm h^{-1} compared to 2.3 nm h^{-1} in the measurements at Hyytiälä. At Hyytiälä, nuclei survival to 100 nm in the ternary case is found to be roughly 12% higher than observed, although the median survival probabilites approximately agree at 1.8%.