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New workflow for the spatial prediction of isotopic data: example from the Neoarchean Yilgarn Craton

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Geologists have been using isotopic and other geochemical data as proxies to map the evolution of craton. The different in Sm/Nd and Lu/Hf ratios in rocks and minerals resulting from radioactive decay can image the juvenile mantle input in the continental crust and/or reworking of crustal components. Such data had revealed useful constrain the continental crust formation and evolution with time. Moreover, the spatial interpolation of model age data has gained popularity over the past decade to document the crustal and associated lithospheric architecture. However, In this study, we present a large Hafnium (n=233) and Neodymium (n=551) dataset collected over the well-preserved archetypal Neoarchean Yilgarn Craton. We utilize the isotopic datasets to develop an alternative method for predicting the data using geostatistical approach, Kriging and cokriging. Spatial contouring that we obtained with this method may then be used to image the tectonic evolution of the craton. The samples are mapped at 39 different time slices, from 2.98 to 2.6Ga for every 10 million years interval to produce a continuous, 3-dimensional isotopic evolution model. For each time slice, we generate variogram models to show the spatial dependence degree among samples within the determined space and time. From the models, we map the Hf and Nd values at each time slice together with the prediction error maps. We then focus on analysing 3 time slices with varying number of samples (2.9, 2.7 and 2.6Ga) that represent the major tectonic event in Yilgarn Craton. The Hf and Nd maps show different block of juvenile and reworked crust that changes over space and time. The Kriging and cokriging approach can generate a measure of uncertainty thus help avoid misinterpretation on the results. We suggest that our approach can help to delineate the juvenile vs reworked crustal block boundaries with higher level of confidence. Furthermore, our approach allows continuous analysis of isotopic changes in space and time, rather than limited to ‘time-slices’, which enables the study of isotopic pattern behaviour in response to the tectonic event in the Neoarchean Yilgarn craton and other Archean Craton elsewehere.