Isotopic mapping of the continental crust: A new area selection tool

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The area selection process is a critical component of exploration targeting. It requires incremental down-scaling, from the planetary-scale, through continent, terrane, and regional scales, using predictive methods, to the belt-scale, where detective methods can be used. Despite the constant search for new tools and technology, the value of new discoveries is currently less than the exploration investment, across a wide range of commodities. This is unsustainable, and demonstrates an urgent need to: (1) push into new search spaces which may be deep, covered, or remote; and (2) develop more effective multi-scale exploration tools for use in these new spaces. Over last 10-15 years, the large-scale spatial application of isotopic data has been shown to effectively image the cryptic architecture of continental areas. Lithospheric and crustal architecture – the framework of major tectonic blocks, terranes and their boundaries – represents a fundamental first-order control on ore deposits and the location of world-class mineral camps. Focused mainly (but not exclusively) within Archean cratons, researchers have constrained the time-resolved lithospheric architecture of large swathes of the continental crust. Champion and Cassidy (2007) used regional Sm-Nd isotopic data to map the crustal architecture of the Yilgarn Craton (Western Australia), and Mole et al. (2013) demonstrated the association between that lithospheric architecture and BIF-hosted iron, orogenic gold, and komatiite-hosted Ni-Cu-PGE systems. Those results demonstrated the underlying control of lithospheric architecture and the potential for isotopic mapping as a greenfields area-selection tool. Further work by Mole et al. (2014), using Lu-Hf isotopes, demonstrated that the technique could account for mineral systems of different ages, showing how Ni-Cu-PGE systems migrated with the evolving continental margin of the Yilgarn Craton, from 2.9 to 2.7 Ga. Similar work has since been performed in West Africa (Parra-Avila et al., 2017), Tibet (Hou et al. 2015), and Canada (Lu et al. 2013; Bjorkman et al. 2015). Collectively, these studies demonstrate that, at the continent-, craton-, and terrane-scales, isotopic mapping can identify prospective regions for multiple commodities, potentially reducing search space from >100,000s to 1000s of km2, a reduction of 99%. A primary goal of the new Metal Earth project at Laurentian University is to apply this technique to the Superior Craton, Canada. This will produce a craton-wide Lu-Hf isotopic map that will be available as an area selection tool for large-scale exploration activities. This is contribution MERC-ME-2019-210 of the Mineral Exploration Research Centre (MERC) Metal Earth project.