Geochemical signatures of volcanic rocks from kadiri greenstone belt, Dharwar craton, India: Implications on gold mineralisation

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The Neoarchean Hutti-Jonnagiri-Kadiri-Kolar composite greenstone terrane is the largest (~500km) unique belt with abundant gold mineralisation which is being mined at Hutti. Kadiri greenstone belt is situated in the south central part of this largest arcuate belt, consisting of a variety of island arc volcanic rocks such as arc basalts, Nb-enriched basalts, adakites, dacites and rhyolites resembling with Phanerozoic intraoceanic island arc volcanic rocks. In this linear belt, north of Kadiri, plume-arc accretionary processes have been established at Jonnagiri belt.

Arc basalts of Kadiri have moderate SiO_2 and MgO with slightly enriched LREE and flat HREE. Nb-enriched basalts resemble with arc basalts with high Nb content (7-10 ppm). Adakites of Kadiri have elevated Al_2O_3 (12-16 wt%), low Yb (0.77-1.25 ppm) with high $(La/Yb)_N$ (14.6-33.9 ppm), Zr/Sm (14-50) and low Nb/Ta (5.4-16.9) with positive Eu anomalies.

The enrichment of gold at the northern (Hutti) and southern end (Kolar) of this composite greenstone terrane with the occurrence of intraoceanic island arc rocks at Kadiri belt reflect on the island arc processes which appear to have deposited gold at Hutti and Kolar due to suitable structure and lithological conduits at these places. These plume-arc interaction also explains the crustal growth due to subduction accretion in the eastern Dharwar craton.

Nd-Hf isotopic composition of the upper continental crust

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Knowledge of the average composition of the upper continental crust is crucial to establish not only how it formed but also when. While well constrained averages have been suggested for its major+trace element composition (e.g., Taylor and McLennan, 1985; Rudnick and Gao, 2003), no value exists for its Nd and Hf isotopic compositions even though radiogenic isotopic systems provide valuable information on its average model age.

Here we present Nd and Hf isotopic data determined on a large number of loess deposits from several continents. We demonstrate that these deposits have very uniform Nd and Hf isotopic compositions and that these data can be used to establish an average Nd-Hf isotopic composition for the upper continental crust: ε_{Nd} = -10.3±1.2 and ε_{Hf} = -13.2±2. This average falls on the Terrestrial Array as defined by Vervoort *et al*. (1999, 2011) demonstrating that the two parent-daughter ratios are not decoupled during crust formation. Trace element data acquired on the same set of samples allow us to calculate an average $^{147}Sm/^{144}Nd$ ratio for the upper continental crust: 0.1193±0.0026, a value slightly higher than previous estimates. We estimate the average Nd extraction age of upper continental crust from the depleted mantle at T_{DM}(Nd) = 1.82±0.07 Ga. This model age is entirely consistent with previous suggestions made for example by Goldstein *et al*. in 1984.

Assuming that the Hf model age of the upper continental crust cannot be younger than its Nd model age, we can suggest a value for the very poorly known $^{176}Lu/^{177}Hf$ ratio of the upper crust. Our estimate is $^{176}Lu/^{177}Hf$ = 0.0125±0.0005, a value significantly lower than commonly used values (0.0150 - 0.0159; Griffin *et al*. 2002, Goodge & Vervoort 2006, Hawkesworth *et al*. 2010) but higher than the Rudnick & Gao estimate (0.0083). Using our preferred value, the average Hf upper crust differentiation age is about 300 Ma younger than when using a ratio of 0.0159. The impact of our new $^{176}Lu/^{177}Hf$ ratio on crustal model ages of zircon populations is not simple to evaluate in detail but the Hf model ages calculated with this new Lu/Hf ratio could be younger by up to 500 Ma.

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