Petrology and geochemistry of post-tectonic of dykes in Tiptur area, Western Dharwar craton, Southern India

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Southern peninsular India forms one of oldest continental crusts that records Earth's history dating back to about 3.4 billion years. Peninsular India comprises of six Archean to early Proterozoic cratons separated by tectonic boundaries and mobile belts. The southern part of the peninsular India is occupied by high-grade granulite terrain and a major craton to its north called the Dharwar craton. The Dharwar craton is mainly composed of Archean gneisses and low-grade greenstone belts overlain by younger volcaincs and Proterozoic sedimentary basins. Based on the lithologic and tectonic differences Dharwar craton is divided into Eastern Dharwar craton and Werstern Dharwar craton along the N-S trending Chitradurga shear zone. Similar to other Archean cratons worldwide the Dharwar craton is also cut across by numerous mafic dyke swarms. These dykes represent crustal extension episodes during which basaltic material derived from the mantle is transferred to the continental crust. The study of these dykes will help to understand the nature and composition of the mantle source and also provide clues regarding the evolution of sub-continental lithospheric mantle. The emplacement of dykes is regarded as one of the final stages of cratonization and hence the study of these dykes throws light into the accretionary history of the cratons.

Although dykes are well distributed in Dharwar craton, only those of Eastern Darwar craton are extensively studied (French and Heaman, 2010; Kumar et al., 2012; Meert et al., 2010; Srivastava et al., 2014) and less attention has been given to the detailed petrologic, geochemical and geochronological studies of the dykes in the Western Dharwar craton. Studying the mafic dykes in the western Dharwar craton will help to understand the activity of the craton during Late Archean to early Proterozoic and this will help to obtain a complete picture of the tectonic evolution of Dharwar craton. One of the major dyke swarm in western Dharwar craton is Tiptur dyke swarm where NE-SW as well as NW-SE dykes are densely spread. Preliminary petrological studies were carried out to understand the nature and composition of this dyke swarm. This includes petrography of thin sections and bulk rock geochemical analysis using XRF to understand the magma genesis and evolution characteristics. Trace and rare earth element characteristics will throw a light into nature of mantle derived melts and crustal contamination, if any and provide indication on time and space evolution of mantle sources beneath the craton.

Petrographic studies have been carried out and samples were divided into two distinct groups based on the degree of alteration although they lack any geographic correlation. The first group belonging to the unlatered ones were composed predominantly of plagioclase and pyroxenes with minor opaque minerals. The minerals were subhedral to anhedral grains showing good poikilitic or ophitic texture. Samples were medium to coarse grained. Simple and polysynthetic twinning were common in plagioclase and compositional zoning was also observed. A few samples also showed myrmekitic texture. The other group of samples showed high degree of alteration but the remnants of original mineralogy as well as ophitic/ subophitic textures were preserved. Although in different degrees opaque minerals were present in almost all the samples.

For the preliminary geochemical characterisation, bulk rock geochemical analysis using XRF has been conducted and various discrimination diagrams were plotted. Loss on ignition were found to be less than 1% for all the samples except one, indicating less of alteration. In the wt% of major oxides, SiO_2, CaO, Fe_2O_3 and alkalies shows smaller variations whereas MgO and Al_2O_3 show very large differences, 5-17 wt% and 9-16 wt% respectively. Cr and Ni also show large variation of their concentrations for two samples in the bulk rock geochemical data (Fig. 1a). The overall chemical composition of the dykes indicate sub-alkaline tholeiitic nature with the samples falling in two distinct groups into basalt and basaltic andesite fields. This also coincides with the SiO_2 contents, with the low silica group falls in basalt field and high silica falls in basalt andesite field.

A positive correlation was observed for SiO_2 and Zr and Sr as well as alkalies. MgO and SiO_2 has a negative correlation as observed for normal magmatic crystallisation patterns. Mg# was calculated and variation diagrams were plotted against trace elements. Mg# shows a positive correlation with Cr and Ni whereas it shows distinct negative trends for Zr, Y, Sr and Nb. High Mg# is shown by low silica group which indicate that they might have been formed from a primary mantle melt. The high silica group shows less Mg# suggesting they might have crystallised from slightly evolved melt. Two samples show very high Ni and Cr concentration which might have been derived from a primary melt with very less fractional crystallization. A trace element model by Condie et al. (1987) was used to understand the melting and differentiation processes. The two groups showed slightly different percentage of melting and different fractional crystallization trends. The two samples with high Cr and Ni concentration showed around 20% melting of the lherzolite mantle with around 5% of fractional crystallization of olivine. The samples with low silica content is found to have formed from a higher degree of melting and less olivine fractionation. This also indicate they might have derived from a primary mantle melt. The samples with high silica content shows low percentage of melting but more fractionation of olivine which might be formed from a slightly evolved melt. A Zr/Y- Nb/Y ratio diagram was also plotted to understand the magmatic evolution and the possibility of crustal contamination (Fig. 1b). Low silica samples plot close to the primordial mantle whereas high silica samples are more scattered and shows affinity towards the crust. The sample that plot close to the average continental crust also have a high Sr content.

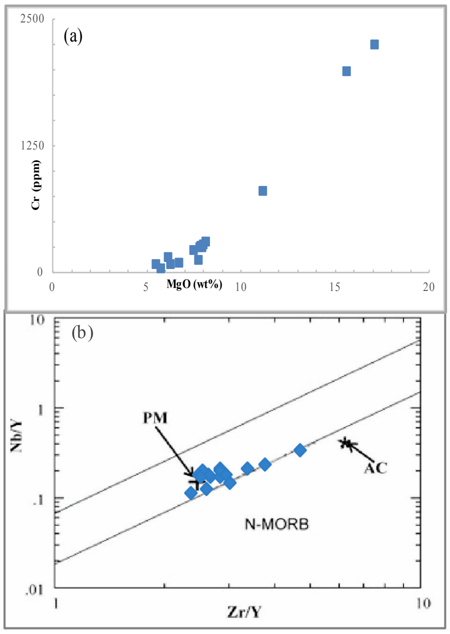

Figure 1(a) Geochemical variation diagram for MgO (wt%) and Cr (ppm). (b) Nb/Y vs. Zr/Y ratio plot comparing the present samples and N-MORB, PM-primordial mantle (after McDonough and Sun, 1995), and AC- average continental crust (after Rudnick and Fountain, 1995)

At this stage, samples can be divided into Low silica group and High silica group. Low silica group might have formed from a primary mantle melt with a high degree of melting of the mantle source and a less fractional crystallization. This group doesn't show any indication of crustal contamination. High silica group, on the other hand, might have formed from slightly evolved melt with low degree of melting of the source but more fractionation of olivine. The samples of this group show an affinity towards the continental crust. This could be due to assimilation or crustal contamination but currently the data is inadequate to confirm crustal contamination. Detailed geochemical characterization and isotope analysis will give more clues to understand the spatial and temporal evolution of the mafic dyke swarms and will throw light into the lithospheric evolution of the craton.

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