Precambrian mafic dykes in Western Dharwar craton and their implications on the evolution of Dharwar craton

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Mafic dyke swarms are one of the major geologic features that represent crustal extension and rifting episodes during which basaltic material from the mantle is transferred to the continental crust. They are extensively intruded into the various Precambrian terranes of the world. Dharwar craton (DC) of Southern Peninsular India is one such well-preserved Precambrian terrane. DC is mainly composed of basement Tonalite-Trondhjemite-Granodiorite (TTG) type gneiss called Peninsular gneiss (3.40–2.56 Ga), two different generations of greenstone belts (older 3.35–3.20 Ga and younger 2.90–2.54 Ga) and also intruded by high potassic granites (2.62–2.52 Ga). Based on the age and lithological characteristics the Dharwar craton is divided into two as Eastern Dharwar craton (EDC) and Western Dharwar craton (WDC) along a N-S trending shear zone called Chithradurga shear zone. The entire craton is profusely invaded by mafic dykes. Although dykes are well distributed in Dharwar craton, only those in the eastern part of the craton have been extensively studied (French and Heaman, 2010; Kumar et al, 2012; Nagaraju et al, 2018; Srivastava et al, 2014) and less attention has been given to those in the western Dharwar Craton (WDC). Studying the mafic dykes in the WDC 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. The major dyke swarms in the WDC are concentrated in Tiptur area and around Chitradurga area where predominantly NE-SW and NW-SE dykes are well distributed. Preliminary petrology and geochemistry has been carried out for all these dykes and the major dyke swarm in the Tiptur area is considered. Based on detailed field, petrological and geochemical (major and trace elements) studies of the dykes in the Tiptur area, two distinct groups were identified. The NW–SE trending dolerite dykes were fresh, composed of medium-grained, euhedral to subhedral minerals predominantly plagioclase, clinopyroxene and orthopyroxene, though clinopyroxene being more common, and minor opaque minerals. The other group of dyke samples showed high degree of alteration and remnant ophitic textures with the preservation of very less plagioclase laths as well as original mineralogy. This group is termed meta-dolerites, because of the prominent metamorphism. The remnant ophitic texture had 50% or less plagioclase laths preserved and pyroxenes had mostly altered to amphibole. Chlorite was also present in some samples which are confined within areas of lower grade metamorphism in Dharwar craton. Opaque minerals were present in varying concentrations in almost all the samples. Mineral compositions combined with trace and rare earth element composition has been analyzed using LA-ICPMS on unaltered clinopyroxene provide important clues on petrogenesis of the dykes.

The major, trace and rare earth element characteristics of dolerites are different as compared to the meta-dolerites. The major oxides of SiO_2, CaO, Fe_2O_3 and alkalies shows only minor variations whereas MgO and Al_2O_3 show large differences. The overall chemical composition of the dykes indicated sub-alkaline tholeiitic nature with the meta-dolerites falling in the basalt field and dolerites in basaltic andesite fields. In the trace element geochemical characteristics, an overall enriched pattern is observed. Primitive mantle-normalized multi-element diagram of dolerite dykes showed an LILE enriched pattern with a negative Nb and Ta anomaly along with positive correlations for Zr and Sr (Fig.1). Meta-dolerite dykes show a slight LILE enrichment. Chondrite-normalized REE diagram shows that the dolerite dykes have an LREE enrichment and flat HREE pattern whereas a relatively flat pattern for both LREE and HREE was observed for meta-dolerite dykes. Immobile incompatible element (Th-Yb-Nb) distribution also indicate an enriched mantle source for dolerite dykes and a depleted or more primitive mantle source for meta-dolerite dykes. Preliminary Rb/Sr and Sm/Nd isotope geochemistry also has been carried out. Initial $^{87}Sr/^{86}Sr$ ratio of meta-dolerites is far lower than dolerites. Although with large errors, the isochron relations show an older age for the meta-dolerites (c. 2.87 Ga) and a younger age (c. 2.3 Ga) for the dolerites. The initial $^{143}Nd/^{144}Nd$ ratio is higher for meta-dolerites as compared to dolerites. The εNd values are positive and are high for meta-dolerites compared to dolerites which also indicates a more depleted source.

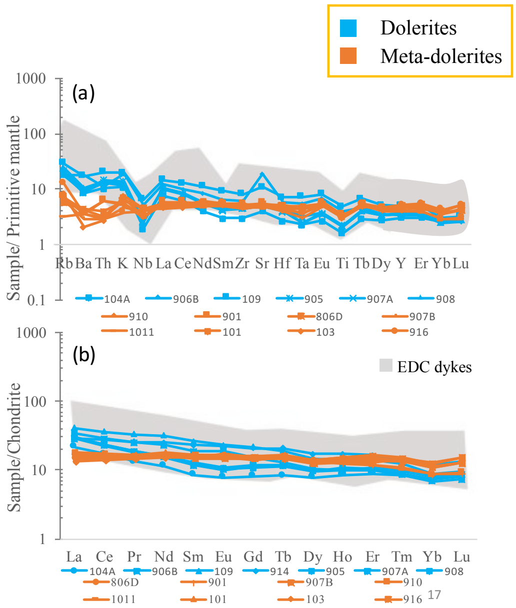

Figure 1. Primitive mantle normalized spidergram (a) and Chondrite normalized rare earth element pattern (b) for the dykes in Western Dharwar Craton

From the differences in the petrographical and geochemical characteristics, it can be assumed that the dolerites and meta-dolerites are not co-genetic rather formed from different batches of melting or source magma. The dolerites of the current study have geochemical similarities to the dykes in EDC. However, meta-dolerites from WDC do not have equivalents reported from the EDC. The tectonic evolution of the Dharwar craton suggests that the WDC is older and thicker than that of EDC, both were separate during the Precambrian and later amalgamated along the Chitradurga shear zone. It is possible to assume that the meta-dolerites might be a part of an older event, restricted to WDC and therefore might have emplaced prior to the amalgamation of WDC and EDC and carry important information on supercontinents prior to Dharwar and importantly on the mantle dynamics from middle to late Archean and through to early Proterozoic.

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