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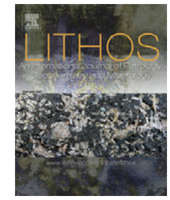

Petrology and petrogenesis of Mesoproterozoic lamproites from the Ramadugu field, NW margin of the Cuddapah basin, Eastern Dharwar craton, southern India

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ABSTRACT

Petrography, mineral chemistry, and major and trace element data are presented for the newly discovered Mesoproterozoic (1.33–1.43 Ga) lamproites from the Ramadugu field (RLF), at the NW margin of the Paleo-Mesoproterozoic Cuddapah basin, in the Eastern Dharwar craton (EDC), southern India. RLF lamproites are emplaced as dykes, have a NW–SE trend and their petrography reveal the effects of low-temperature alteration. However, their textural features, mineralogy and geochemistry are closely similar to other well-characterised lamproites worldwide, including examples from the Eastern Dharwar craton, Leucite Hills, West Kimberley, Smoky Butte and Labrador. The RLF magmas have undergone varying degrees of olivine + clinopyroxene fractionation; yet their compatible and incompatible trace element concentrations are sufficiently high to signal a primitive character. Incompatible element ratios suggest limited contamination by continental crust. Geochemical evidence indicates the derivation of RLF magmas from metasomatised harzburgite within the garnet stability field. Rare earth element inversion modelling further highlights substantial involvement of the sub-continental lithospheric mantle in their genesis. The RLF lamproites are geochemically similar to the well-known extension-related ultrapotassic lavas from eastern Virunga and western Anatolia, and exclude an affinity with orogenic lamproites, such as those from the Mediterranean region. Bulk-rock geochemical models, recently developed to infer diamond potential, reveals that RLF lamproites are non-prospective. Lamproites of the RLF, together with those from the Krishna lamproite field and Cuddapah basin are interpreted as an expression of extensional events in the Eastern Dharwar craton possibly related to the break-up of the supercontinent of Columbia between 1.5 and 1.3 Ga.

1. Introduction

Lamproites are volumetrically minor, intrusive/extrusive, mantle-derived, volatile-rich, alkaline igneous rocks characterised by an exotic mineralogy and unusual geochemistry (*viz.*, high MgO coupled with their ultrapotassic and peralkaline nature). Lamproitic magmas may be derived from great depths (>150 km), and, together with kimberlites and some ultramafic lamprophyres, constitute potential primary hosts for diamond (Bergman, 1987; Foley et al., 1987; Mitchell and Bergman, 1991; Tappe et al., 2006). Lamproites display unusual enrichment in incompatible trace elements and have extreme radiogenic isotope signatures which render them relatively immune from the effects of crustal contamination. Therefore, lamproites serve as important proxies to study the composition of the Earth's sub-continental lithospheric mantle and their petrogenetic studies assume considerable significance (*e.g.*, Davies et al., 2006; Fritschle et al., 2013; Tappe et al., 2006).

Lamproites are known from continental intra-plate anorogenic (*e.g.*, Chalapathi Rao et al., 2010; Davies et al., 2006; Mirnejad and Bell, 2006; Murphy et al., 2002) and post-collisional (orogenic) tectonic settings (*e.g.*, Mediterranean lamproites: Conticelli, 1998; Prelević et al., 2008; Tommasini et al., 2011). Lamproite emplacement ages range from the Archaean (2.74 Ga; Sergreev et al., 2007) to the Pleistocene (56 Ka; Tingey et al., 1983) and serve as time-capsules of tectonothermal events such as extension (Chalapathi Rao et al., 2004), rifting (Karmalkar et al., 2013), mantle plumes (Kent et al., 1998), post-subduction event (Prelević et al., 2008) or even lithospheric-scale tearing (Perez-Valera et al., 2013). There is, however, no universal agreement as to the mantle source regions involved in the generation of lamproites, with various competing models ranging from melting of ancient subducted material within the transition zone (Chakrabarti et al., 2007; Murphy et al., 2002) to metasomatised sub-continental lithospheric mantle sources (Tainton and McKenzie, 1994; Davies et al., 2006; Mitchell and

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Fareeduddin, 2009; Chalapathi Rao et al., 2010). Nevertheless, there is a growing consensus that lamproites, together with kimberlites and carbonatites, are ultimately derived from recycling of volatile-rich components from the earth's surface into the deep mantle and constitute an important component of the global geochemical cycle (Tappe et al., 2013).

In India, lamproites, or rocks belonging to their clan, have been recorded from various cratons and mobile belts (see Fig. 1A for locations)

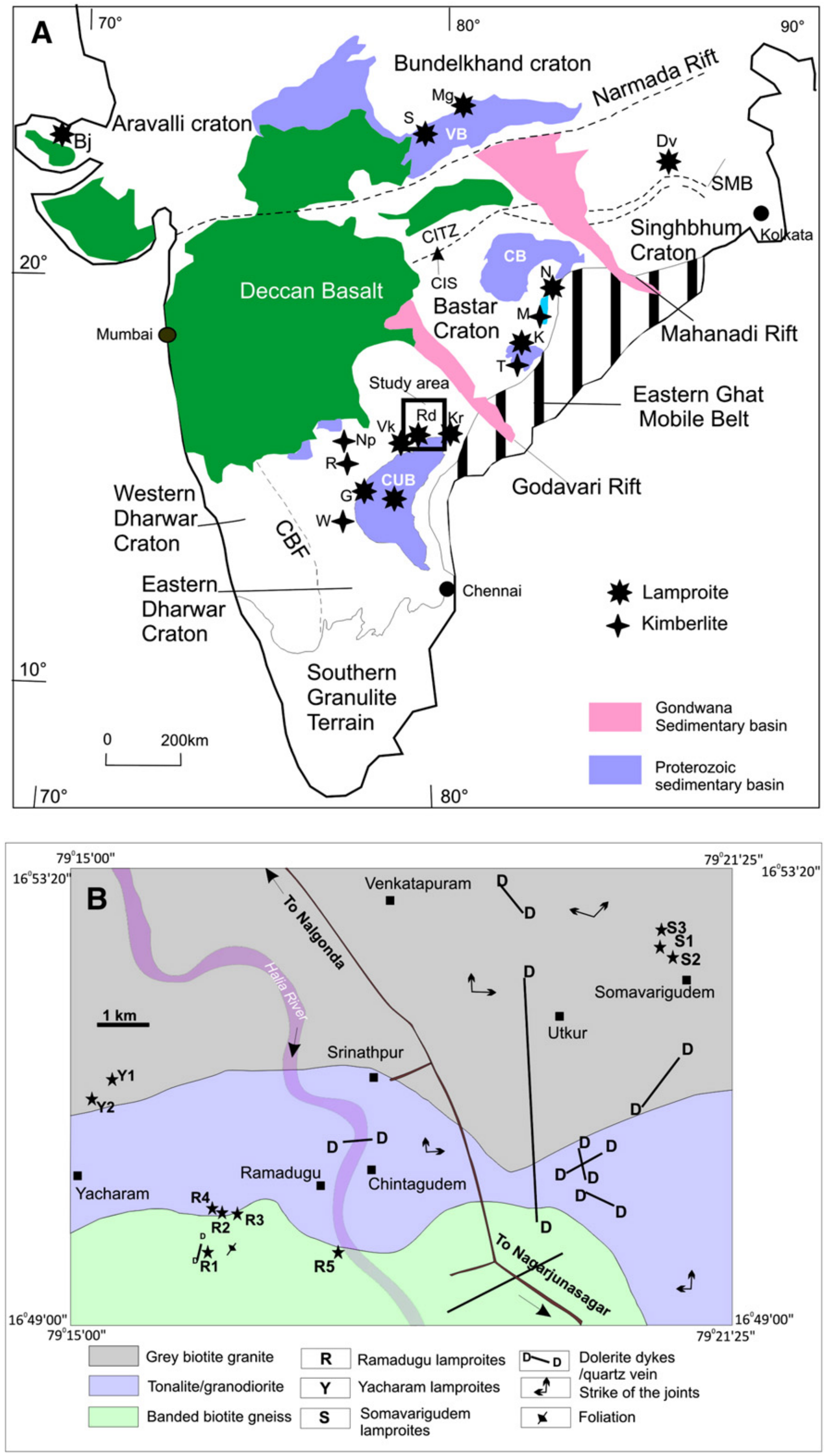

Fig. 1. (A) Generalised geological map of India showing the location of the Ramadugu lamproites in the Eastern Dharwar craton, southern India. The occurrence of other lamproites and kimberlites in various cratons (geology after Naqvi and Rogers, 1987; Sahu et al., 2013) is also shown. CBF = Chitradurga boundary fault; CITZ = central Indian tectonic zone; CUB = Cuddapah basin; CB = Chhattisgarh basin; VB = Vindhyan basin; SMB = Singhbhum mobile belt; CIS = Central Indian shear zone; W = Wajrakarur kimberlite field; R = Raichur kimberlite field; Bj = Bhuj lamproite field; Np = Narayanpet kimberlite field; T = Tokapal kimberlite; M = Mainpur kimberlite (orangeite) field; Dv = Damodar valley; Mg = Majhgawan; S = Saptarshi; K = Khadka; N = Nuapada; G = Garledinne; Vk = Vattikod; Kr = Krishna; Rd = Ramadugu. (B) Geological map of the Ramadugu lamproite field showing the disposition of various lamproites (after from Sridhar and Rau, 2005).