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Shonkinites from Salem, southern India: Implications for Cryogenian alkaline magmatism in rift-related setting

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ABSTRACT

Alkaline and potassic igneous rocks, although minor components of the continental crust, provide important constraints on magma processes and tectonic settings. Here we report petrology, mineral chemistry, whole rock geochemistry, zircon U–Pb and Lu–Hf data on shonkinites from the Salem Block in the Southern Granulite Terrane of India. The shonkinite is composed mainly of porphyritic clinopyroxene, K-feldspar and olivine, and intrudes into the surrounding ultramafic rocks composed of wehrlite (clinopyroxene and olivine) and dunite (mostly olivine with minor spinel). The geochemical data on shonkinites from Salem show alkaline and ultrapotassic features with marked enrichment in incompatible elements, and high K_2O and K_2O/Na_2O ratios suggesting magma derivation from metasomatized lithospheric mantle. Their HFSE depletion relative to LILE compositions, coupled with positive Nb anomalies suggests continental rift setting. The zircon grains in shonkinite show typical magmatic crystallization features and their LA-ICP-MS U–Pb data yield weighted mean age of 818 ± 6.3 Ma (MSWD = 0.32). The zircon ε_{Hf} values range between −11.1 and −12.7, consistent with magma derivation from an enriched mantle, with depleted mantle model ages (T_{DM}) in the range of between 2406 and 2513 Ma, indicating the involvement of Neoarchean–Paleoproterozoic subduction-related components. Together with similar-aged alkaline plutons with comparable geochemical features, we envisage a major alkaline magmatic event associated with rifting during Cryogenian in the northern part of the Southern Granulite Terrane.

1. Introduction

Volatile-rich, ultramafic to mafic alkaline and potassic igneous rocks are minor constituents of the continental crust. However, their petrogenesis has been the focus of several studies in understanding mantle dynamics and crust-mantle interaction since the primitive melts from which these rocks crystallized are often strongly enriched in many incompatible elements and therefore many workers have correlated their genesis with enriched/metasomatized continental mantle (e.g. Bailey, 1987; Fraser et al., 1985; Hawkesworth et al., 1985; Menzies et al., 1987). Alkaline rocks occur in different tectonic environments including intraplate settings of continental rift systems or subduction zone magmatic suites in convergent margins (Fitton and Upton, 1987).

The Southern Granulite Terrane (SGT) in India witnessed subduction of oceanic lithosphere associated with the closure of the Mozambique Ocean during Neoproterozoic in relation to the tectonics associated with the global assembly of the Gondwana supercontinent (Collins et al., 2007; Santosh et al., 2009). While convergent margin tectonics operated along the Palghat-Cauvery Suture Zone with a southward subduction polarity, the slab pull force also generated an aborted rift to the north extending roughly E–W and swinging NE in the eastern domain (Santosh et al., 2014). This aborted rift is garlanded with a series of alkaline plutons including carbonatites, pyroxenites, alkali syenites and granites, among other rock types (Renjith et al., 2014; Santosh et al., 2009, 2014). In the domain of this rift at the southern periphery of the

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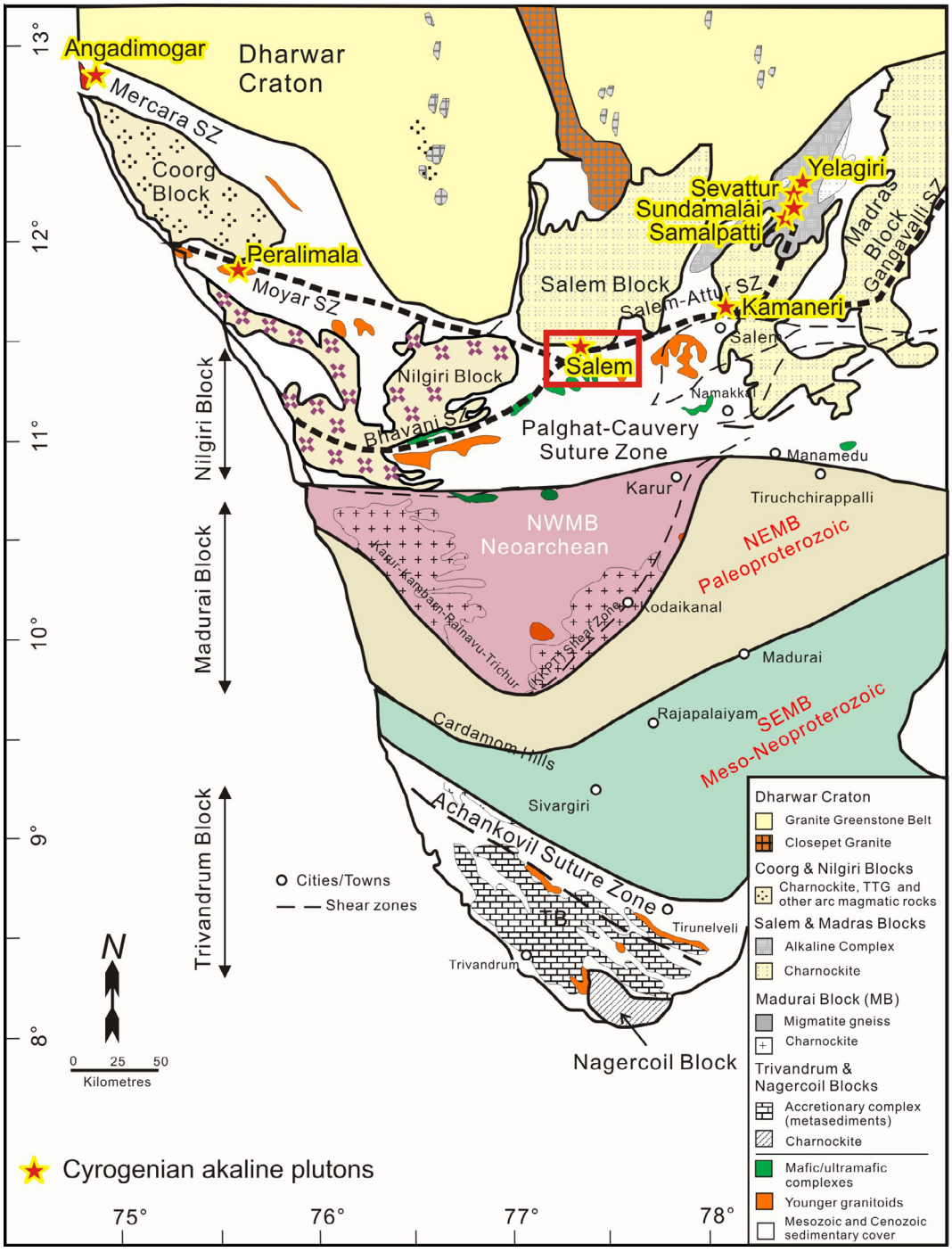

Fig. 1. Generalized geological map of the Southern Granulite Terrane in India showing the major alkaline plutons and the study area. After Santosh et al. (2014, 2013), Collins et al. (2014), and Plavsa et al. (2012).

Salem Block (Fig. 1) shonkinite in association with other ultramafic rocks have been reported (Reddy et al., 1995).

In this study, we investigated the shonkinites and associated ultramafic rocks in terms of petrology, geochemistry and zircon U–Pb geochronology and Lu–Hf isotopes. The data are used to evaluate the petrogenesis of the alkaline rocks and their implications on the Cryogenian plate tectonic processes in the region.

2. Geological background

The Southern Granulite Terrane (SGT) at the southernmost domain of Peninsular India (Fig. 1) is characterized by a collage of crustal blocks carrying protoliths ranging in age from Eoarchean to latest Neoproterozoic (Santosh et al., 2009, 2015; Collins et al., 2014). The crustal blocks are dissected by major lithospheric-scale transpressional zones (Chetty and Bhaskar Rao, 2006), many of which are identified as the traces of oceanic sutures (Collins et al., 2007) ranging in age from Neoarchean to latest Neoproterozoic-Cambrian (Santosh et al., 2009).

The Salem Block represents one of the major blocks in the northern domain of the SGT, immediately to the south of the Archean Dharwar Craton. The basement of the block is considered to have formed during Neoarchean and was metamorphosed during early Paleoproterozoic at P–T conditions of 14–16 kbar, and