The magma-mixed granitoid system, Eastern Dharwar Craton, India: evidences from the mafic enclaves and syn-plutonic dykes from Madugulapalli

J. Nagamma[1], Ch. Ashok[2,*] and J. Ratnakar[3]
[1]State Mines and Geology Department, Nalgonda 508 001, India
[2]CSIR National Geophysical Research Institute, Hyderabad 500 007, India
[3]Sri Shailaja Emerald, Dilsukhnagar, Hyderabad 500 060, India

To understand the fundamental processes for the generation of granites, associated rock types and compositional diversity, we studied the Madugulapalli granitoids that constitute a part of the Eastern Dharwar Craton (EDC) of southern India. The Madugulapalli area consists of three rock types, including a host granitic rock (GN, syeno-monzogranite), mafic microgranular enclaves (MME) and syn-plutonic dykes (SPD). The MME and SPD are characterised by (a) spherical and ellipsoidal shapes with associated chilled margins, (b) the presence of megacrysts of K-feldspar and plagioclase and (c) the presence of acicular apatite, ocellar quartz and plagioclase with oscillatory zoning and resorption surfaces, all suggesting that they are globules of mafic magma derived from the mantle sources and SPD are injected into the crystal mush of the felsic host. Geochemical analyses suggest that MME and SPD are derived from the mixing of a partial melt from heterogeneous mantle and crustal source. The MME and SPD exhibit colinear compositions with the host GN, suggesting that they are the products generated by magma mixing in different proportions of injected mafic melts and the host granite. During various stages of crystallisation, granitic magma interacted with a smaller amount of mafic magma. Based on mixing calculations, a mass fraction of felsic magma (xA = 0.71) mingled with mafic magma to generate hybrid rocks in the Madugulapalli region. Field, petrographic and geochemical evidence suggests that they are generated in a subduction environment in which large-scale mantle and crustal-derived magmas are produced and mixed at the crustal emplacement level. Hence, the Madugulapalli rocks represent a magma-mixed granitoid system from the EDC.

Keywords: Fractional crystallisation, granitoid system, heterogenies, magma mixing and mingling, subduction

anisms behind forming granitic plutons/batholiths is crucial for unravelling the wide range of compositional variations seen in the continental crust. The formation of granitoids, particularly those that exhibit spatial-temporal associations with mafic rocks derived from the mantle, is believed to occur via intricate processes including magma mixing, fractional crystallisation, hybridisation and assimilation[2]. Mafic microgranular enclaves (MME) and synplutonic dykes (SPD) play a significant role in determining the composition of granites and offer valuable insights into magmatic processes occurring inside magma chambers at the crustal level. The genesis of MME and SPD in granitic plutons is linked to magma mixing and mingling[3-5]. Magma mixing may also play a significant role in the development of intermediate rocks like diorite and quartz diorite, and mixing may occur at any moment throughout the evolution of the granite magma system inside the magma chamber[6,7]. Several variables, such as the viscosity, crystallinity, temperature, density, relative volume and rheological behaviour of magmas, affect the mixing of two magmas with different chemical compositions[6,7]. During mixing, there are two forms of interaction, the 'chemical' and 'mechanical'[8]. Often, chemical interaction produces a hybrid, homogenous rock, and the mingled magmas lose their original identity. In mechanical contact, magmas will undergo the mingling process but will preserve the identity of the original magmas; mixed and undercooked MME globules experience varying degrees of chemical equilibration[9], which leads to the development of a heterogeneous rock[8]. These characteristics are recorded from portions of the EDC[5,10-12].

Geology of the Dharwar Craton

The Dharwar Craton (DC) (Figure 1 *a*), located in southern peninsular India, is considered as one of the oldest cratons. It has been dated to be 3.4–2.5 billion years and has preserved evidence of magmatic events from the Palaeo to