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# Pyroxene Exsolution Textures and P-T Conditions of Anorthosite - Gabbro Rocks of Chimakurthi Pluton, Southeast India

P.V. Nageswara Rao

*Department of Geology, Acharya Nagarjuna University, Nagarjuna Nagar-522510, Guntur, Andhra Pradesh, India*
*(E-mail: drpvn.rao@gmail.com)*

## Abstract

The Chimakurthi Pluton is located on the western margin of the Eastern Ghats Mobile Belt which falls under the Ongole domain of Krishna province from southeastern India. It is an elliptically shaped and concentrically zoned pluton consisting of an olivine clinopyroxenite unit in the centre and olivine gabbronorite unit on the outer margin, with an arcuate shaped anorthosite body towards the northwestern part of the pluton. The anorthosite and olivine gabbronorite consists of variable amounts of cumulus and inter-cumulus phases of plagioclase, olivine, clinopyroxene, orthopyroxene, ilmenite, and magnetite assemblages, respectively. The rocks units registered several igneous and some deformational textures. Electron Probe Micro Analysis was performed to assess the chemical composition of clinopyroxene host ($En_{44.2-36.1}$ $Fs_{17.0-12.3}$ $Wo_{46.5-43.3}$), orthopyroxene lamellae ($En_{75.9-66.0}$ $Fs_{30.7-23.0}$ $Wo_{3.1-0.9}$), olivine ($Fo_{81.0-72.0}$) and plagioclase ($An_{74.0-56.0}$) from anorthosite, and clinopyroxene host ($En_{42.2-38.8}$ $Fs_{18.9-14.2}$ $Wo_{46.9-40.2}$), orthopyroxene lamellae ($En_{71.5-59.0}$ $Fs_{40.0-25.0}$ $Wo_{3.3-0.5}$), olivine ($Fo_{73.0-60.0}$) and plagioclase ($An_{81.0-72.0}$) from olivine gabbronorite, respectively. The $K_D$ values of the exsolved pyroxenes of all samples range from 0.53 to 1.85, consistent with igneous equilibrium conditions in the pluton. The $K_p$ values range from 0.68 to 1.97, suggesting the influence of post-cumulus solid-state deformation forces following crystallization of the high-temperature primary magma of the pluton. The conversion of pigeonite to orthopyroxene results in considerable amounts of orthopyroxene lamellae growing within the clinopyroxene host and undergoing exsolution due to the sub-solidus re-equilibration during a significant period of slow cooling. The temperature - pressure estimate of exsolved pyroxenes from the present rock units revealed very broad range from 874 to 1226$^0$C and 5 to 14 kbars, respectively. However, the overall pressure increase and temperature decrease from the middle zone anorthosite unit (1101$^0$C, 9.2 kbars) to the outer zone olivine gabbronorite unit (1079$^0$C, 11.2 kbars) suggested the syn-tectonic emplacement of the Chimakurthi pluton into metapelitic country rocks through the Terrane Boundary Shear Zone, associated with the impact of a regional shear-related ductile deformation event (D2) caused by the collision between the juxtaposed Western Dharwar Craton and Eastern Ghats Mobile Belt of India during 1450-800 Ma.

*Keywords:* Anorthosite, Olivine Gabbronorite, Chimakurthi Pluton, Exsolution Textures, P-T Conditions, EGMB, South India.

## Introduction

Proterozoic massif-type anorthosites are composed of leuconorite, leucogabbro, and leucotroctolite (Xu and Morse, 1993). They are commonly associated with high-grade metamorphic terranes (Maji *et al.*, 2010). Mineralogy, petrology and geochemical studies on mafic (Nageswara Rao *et al.*, 2008; Hanumanthu *et al*., 2008) and massif-type anorthositic rocks formed during the Proterozoic era have been reported from all continents (Ashwal, 1993; Seifert *et al.*, 2010; Anoop *et al.*, 2012; Debeleena Sarkar *et al*., 2024). Deformational forces have played an important role in modifying the original structure and forms of various types of bodies, such as lensoid, dome, and diaper types (Martignole and Schrijver, 1970; Nagaraju and Chetty, 2005; Nagaraju *et al.*, 2008).

Massif-type anorthosites are characterized by preservation of magmatic features such as ophitic and sub-ophitic textures, cumulus and inter-cumulus phases, pyroxene and ilmenite exsolution, and zoned textures (Leelanandam, 1997; Ashwal and Wooden, 1989; Rao *et al.*, 1998; Dharma Rao *et al.*, 2004; Joshi *et al*., 2006; Song *et al.,* 2009; Bhattacharjee *et al*., 2012). The exsolusion textures including other igneous textures are very common in the massif anorthositic rocks of Chimakurthi Pluton (CP) in the Eastern Ghats Mobile Belt (EGMB), India. CP is a Proterozoic massif-type anorthosite body, mafic to ultramafic range in composition and lacking of layers. It is composed of a lithology of olivine gabbronorite, anorthosite, and olivine clinopyroxenite units.

Exsolution textures are crucial in understanding their cooling and decompression histories and in estimating the original high temperatures and pressures at which the host minerals first crystallized (Song *et al*., 2009). Pyroxenes are one of the best-known multi-component systems in mineralogy (Lindsley, 1983), and the result of unmixing in Ca–Mg–Fe pyroxenes is commonly seen as sets of thin exsolution lamellae (Champness and Copley, 1976; Robinson *et al*., 1977). Pyroxene phenocrysts exhibit a variety of exsolution features, which have long been reported by

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