

Field Observations, Structural Analysis and Petrographic Study of Dolerite Dykes in Cacra, North Goa, India

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Abstract

This study examines the mafic dyke swarm exposed along the Cacra coast, North Goa, to interpret its structural orientation, petrography, and magmatic evolution. Field mapping and geophysical data reveal nine doleritic dykes trending ENE–WSW, NW–SE, N–S, and NNW–SSE, with CD-1 confirmed as N–S oriented. Although dyke host contacts are obscured, adjacent metagreywacke exposures likely represent the country rock. Petrographic analysis indicates medium- to coarse-grained dolerite comprising plagioclase, clinopyroxene, opaques, and alteration minerals such as chlorite, biotite, and iddingsite. Textures including porphyritic, sub-ophitic, and symplectic intergrowths with zoned plagioclase suggest a two-stage crystallization slow cooling at depth followed by rapid quenching. These features collectively indicate emplacement under dynamic magmatic conditions governed by pre-existing fractures within the Proterozoic basement of the Dharwar Craton.

Keywords: Dykes, Dolerite, Petrographic Analysis, Geophysical Survey

Introduction

The dyke swarms in Goa are predominantly doleritic and basaltic, and they display a range of trends, with some exhibiting significant local variations. These swarms are best exposed along the coastal regions of Goa, particularly at Aguada, Baga, Vagator-Chapora, and Arambol-Keri headlands. The dyke swarm is especially prominent in the talukas of Bardez and Pernem, where dykes cut through the Proterozoic basement rocks, including argillites, metagreywackes, and quartzites, belonging to the Sanvordem Formation of the Goa Group (Gokul, 1985; Fernandes, 2009; Dessai, 2018; Gadgil *et al.*, 2019). The Goa dyke swarm contains around 60 individual dykes, some of which represent multiple magmatic injections.

The present study investigates the dolerite dykes of the Cacra region, North Goa, focusing on their field characteristics, structural features, and petrographic attributes. Detailed petrographic analysis aims to elucidate the emplacement history, mineralogical composition, and tectonic significance of these dykes, with comparisons to other coastal dyke swarms along North Goa. Mafic and ultramafic dykes across the western coast and cratonic regions of India, including Goa, record major magmatic episodes related to the Mesozoic rifting of western India (Ashutosh *et al.*, 2025; Salve

et al., 2024; Patel *et al.*, 2020; Dongre *et al.*, 2017). Halls *et al.* (1982) reported an age of 2367 ± 0.1 Ma for an E–W trending diabase dyke, indicating widespread early Proterozoic dyke activity across the Dharwar Craton. This study contributes to the growing body of literature on dyke swarms in India and aims to provide valuable insights into the geological history of the region.

Geological Setting

The geology of Goa is dominated by Archean to Proterozoic rocks of the Dharwar Supergroup. Gokul *et al.* (1985) classified the Goa Group into four formations such as Barcem, Sanvordem, Bicholim, and Vagheri. Later revised by Dessai (2018) into two groups, the Barcem and Ponda, separated by an unconformity. Goa hosts mafic intrusions forming part of the supracrustal assemblage, including peridotite gabbro complexes, gabbroic intrusions, and mafic dykes (Dessai, 2018). These intrusions, younger than the metasediments, show minimal deformation (Dessai, 2011, 2018). The older intrusions peridotites, epidiorites, and metagabbros or metadolerites are Proterozoic, while younger dykes related to Deccan Trap volcanism show komatiitic to tholeiitic chemistry. The sequence begins with peridotites, followed by epidiorites, metadolerites, and tholeiitic dykes. Peridotites trend ENE–WSW and show low greenschist facies metamorphism; epidiorites trend NNW–SSE to N–S and are often altered to clay in mining zones; metadolerites trend NNW–SSE to NNE–SSW. Coastal dolerite dykes between Aguada and Palolem trend WNW–ESE to