Journal of Asian Earth Sciences 34 (2009) 493–506

Contents lists available at ScienceDirect

Journal of Asian Earth Sciences

journal homepage: www.elsevier.com/locate/jaes

Palaeomagnetic and rock magnetic study of charnockites from Tamil Nadu, India, and the 'Ur' protocontinent in Early Palaeoproterozoic times

S. Mondal [a], J.D.A. Piper [b,*], L. Hunt [b], G. Bandyopadhyay [a], S. Basu Mallik [a]

[a] Department of Geological Sciences, Jadavpur University, Kolkata 700 032, India
[b] Geomagnetism Laboratory, Department of Earth and Ocean Sciences, University of Liverpool, Liverpool L69 7ZE, UK

ARTICLE INFO

Article history:
Received 24 January 2008
Received in revised form 30 July 2008
Accepted 7 August 2008

Keywords:
Charnockite
India
Palaeomagnetism
Rock magnetism
Magnetomineralogy
Palaeoproterozoic
Ur protocontinent

ABSTRACT

Palaeomagnetic and magnetomineralogical results are reported from charnockites in basement terrane at the eastern sector of the WSW–ENE granulite belt of South India. Magnetite is the dominant ferromagnet identified by rock magnetic and optical study; it is present in several phases including large homogeneous titanomagnetites and disseminated magnetite in microfractures linked to growth stages ranging from primary charnockite formation to uplift decompression and exhumation within the interval ~2500–2100 Ma. Several components of magnetization are resolved by thermal demagnetization and summarized by four pole positions; in the northern (Pallavaram) sector these are P1 (33°N, 99°E, dp/dm = 8/9°) and P2 (79°N, 170°E, dp/dm = 3/6°), and in the southern (Vandallur) sector they are V1 (23°N, 116°E, dp/dm = 8/9°) and V2 (26°S, 136°E, dp/dm = 5/10°). These magnetizations are linked to uplift cooling of the basement and unblocking temperature spectra suggest acquisition sequences P1 → P2 and V1 → V2 in each case implying movement of the shield from higher to lower palaeolatitudes sometime between 2500 and 2100 Ma. Palaeomagnetic poles from the cratonic nuclei of Africa, Australia and India all identify motion from higher to lower palaeolatitudes in Early Palaeoproterozoic times, and this is dated ~2400 and ~2200 Ma in the former two shields. The corresponding apparent polar wander (APW) segments match the magnetization record within the charnockite basement terranes of southern India to yield a preliminary reconstruction of the 'Ur' protocontinent, the oldest surviving continental protolith with origins prior to 3000 Ma. Although subject to later relative movements these nuclei seem to have remained in proximity until the Mesozoic break-up of Gondwana.

1. Introduction

Exposures of metamorphic basement to the Precambrian shields provide the earliest insights into the history of continental crust and, unless they have been comprehensively overprinted by later geological events, they may also record the oldest segments of the palaeomagnetic record and hence the earliest kinematic history of the shields. The rocks now sampled at the surface have usually been magnetized at depth during protracted regional uplift and cooling and record magnetic remanence acquired over long periods of time.

The metamorphic basement in South India comprises a large area of deeply exposed continental basement and the rocks selected for study here come from Pallavaram near the type area of charnockite (Holland, 1893, 1900; Harley, 1989), a plutonic mineral assemblage comprising essential orthopyroxene (hypersthene) and potassium feldspar (microcline) with accessory quartz and magnetite. Charnockite is formed by a range of interrelated magmatic, metasomatic and metamorphic processes (Chacko et al., 1987; Thomson et al., 2005) and although closely analogous to hypersthene granite, it is essentially anhydrous because the presence of free water and quartz would transform these minerals into biotite and quartz; as such it preserves a deep crustal signature of early Precambrian age within the cratonic nuclei. In the study region it is located within the Madras Block in the northern granulitic segment of the South Indian Shield and is part of an E–W trending zone running across India (Fig. 1) that separates the Dharwar Craton to the north from the Madurai Block to the south.

Archaean and Proterozoic plutonic terranes appear to have been characterized by rates of uplift much slower than Phanerozoic orogenic belts (Watson, 1976) and Fermor (1936) inferred that the entire charnockite region of Peninsular India is a portion of crust formerly deeply buried to depths in excess of ~25 Km subject to slow exhumation and consolidation during late Archaean and early Proterozoic times (Crawford, 1969; Crawford and Compston, 1970; Drury et al., 1984). Protracted cooling results in the lowering and broadening of blocking temperature spectra in ferromagnetic minerals (Pullaiah et al., 1975) and the characteristics of magnetizations acquired in uplifted plutonic terranes are (i) secular

* Corresponding author. Tel.: +44 151 794 2000.
E-mail addresses: supriya0509@rediffmail.com (S. Mondal), sg04@liverpool.ac.uk (J.D.A. Piper).

1367-9120/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jseaes.2008.08.004

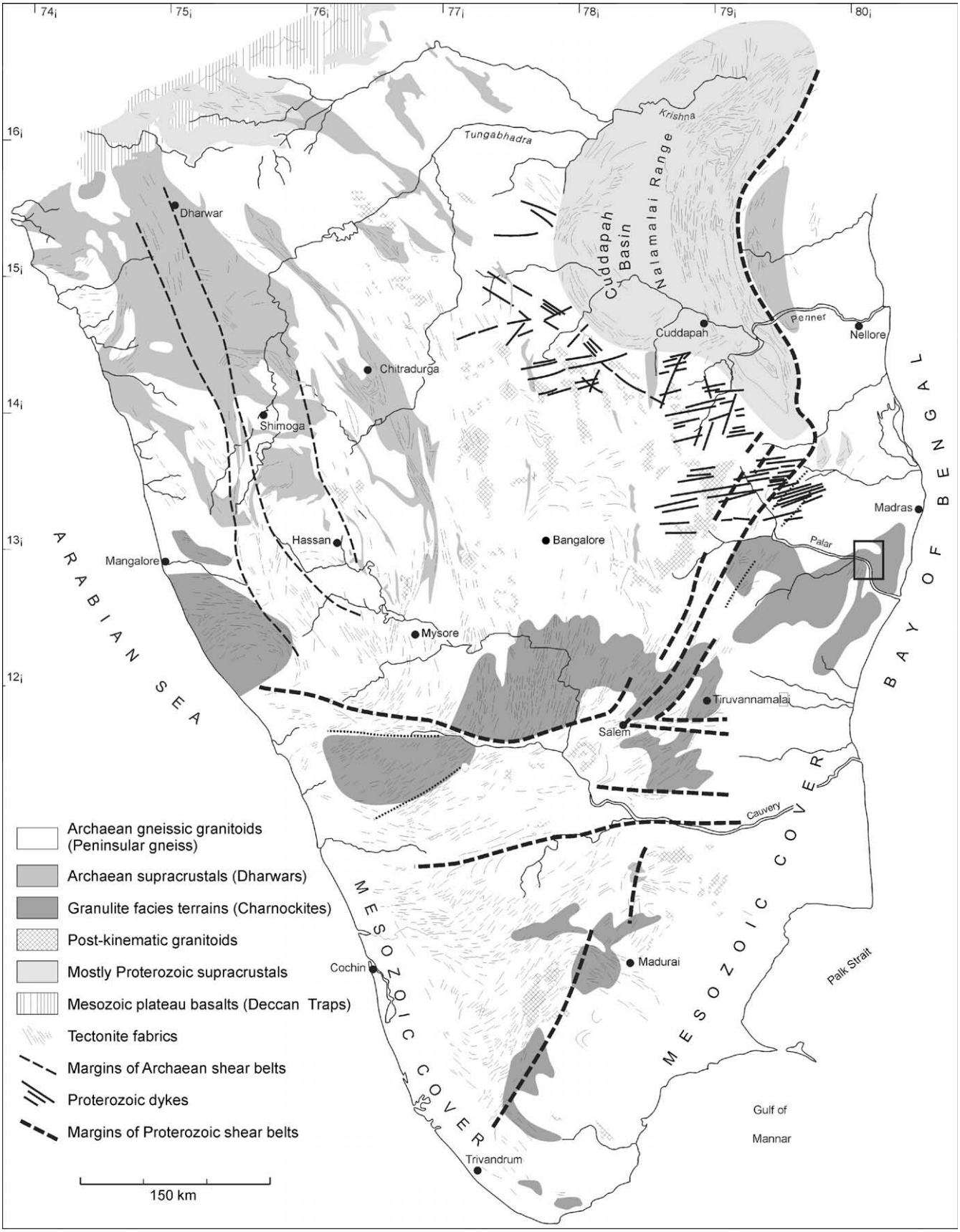

Fig. 1. Tectonic map of southern India simplified after Drury and Holt (1980) and showing the major metamorphic-structural subdivisions. The region of this study is indicated by the boxed area and shown in more detail in Fig. 3.