Precambrian Research 281 (2016) 495–520

Contents lists available at ScienceDirect

Precambrian Research

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

Basement–cover structural relationships in the Kaladgi Basin, southwestern India: Indications towards a Mesoproterozoic gravity gliding of the cover along a detached unconformity

Mrinal Kanti Mukherjee [a,*], Sohini Das [b], Kunal Modak [a]

[a] Department of Applied Geology, Indian School of Mines, Dhanbad 826004, India
[b] Geological Survey of India (Western Region), 15-16, Jhalana Dongri, Jaipur 302004, Rajasthan, India

ARTICLE INFO

Article history:
Received 19 January 2016
Revised 27 May 2016
Accepted 6 June 2016
Available online 11 June 2016

Keywords:
Gravity gliding
Kaladgi Basin
Basement–cover relationship
Unconformity
Grenvillian

ABSTRACT

Structural relations between the Archaean basement and overlying Mesoproterozoic sedimentary cover were examined in the Kaladgi Basin of south western India. The basement, that forms a part of the western Dharwar craton, is an assemblage of the Archaean Peninsular Gneissic Complex (PGC), late Archaean Hungund Schist Belt (HSB) and granites (Closepet granite). The HSB, composed of Banded Iron Formations, quartzites, metapelites and mafic metavolcanics have undergone multistage deformation (D_1, D_2, and D_3 respectively) with the development of refolded plane-non-cylindrical folds, transposed compositional banding and schistosity, crenulation lineations – all of which developed during the D_1–D_2 stage. These were mildly cross-folded along NE–SW during the D_3 stage with an overall orientation of the structural grain along the NW–SE (310°) direction. The PGC consisting of granitoid gneisses are deformed in phase with the HSB. The Closepet granite that is intrusive within the PGC and the HSB is relatively younger (c. 2.5 Ga) and is massive and undeformed, in general.

Based on type, geometry, distribution, association of structural elements, variation and relative chronology of development, the deformation structures of the Mesoproterozoic sedimentary cover rocks of the basin can be grouped to define an extensional domain in the northern sectors and a contractional domain in the south–central sectors of the basin. The extensional domain is characterized by development of a gently dipping (10°–15° due south) homocline that is affected at places by normal faults, tensile and hybrid joints, and contain torn – apart segments of the cover. In the south–central sectors of the basin, an association of WNW–ESE trending, both northerly and southerly verging, asymmetric-to-overturned, plane non-cylindrical, gently plunging folds with axial planar cleavages, E–W trending thrusts, and N–S trending strike-slip faults, together define the contractional domain. Distribution, variation and interrelationship of structural elements in the cover rocks, reveal that, the extensional and contractional domains, are spatially linked, laterally pass on to each other continuously and are related to a single deformation event of the cover.

The contrasting structural anatomy of the basement vis-a-vis Mesoproterozoic sedimentary cover indicate that (1) the Mesoproterozoic cover of the Kaladgi Basin, during its deformation, became detached from the basement and the basement thereby remained unaffected during deformation of the cover and (2) the deformation of the Mesoproterozoic sedimentary cover originated by a southerly-directed gravity gliding of the cover over the basement along the basement–cover contact (unconformity) that served as a surface for detachment.

The Mesoproterozoic gravity gliding event in the Kaladgi Basin is inferred to result from a tectonic uplift of the basement in the northern sectors, due to possible crustal flexure of the South Indian Block during terminal phases of amalgamation of North Indian Block and East Antarctica with the South Indian Block during the Grenvillian.

1. Introduction

In studies of deformed sedimentary basins, it is valuable to compare the deformation seen in the cover rocks with that in the

* Corresponding author. Tel.: +91 9431711148.
E-mail address: mrinal_km67@yahoo.co.in (M.K. Mukherjee).

http://dx.doi.org/10.1016/j.precamres.2016.06.013
0301-9268/

underlying basement. It is common to observe complex deformation pattern in the basement as the basement frequently is much older, and it may have experienced multiple orogenic events before the cover rocks were deposited. Conversely major deformations of the cover may sometimes be represented in the basement, if the latter is included in the relatively younger deformation event of the cover. Nevertheless, in some basins we see major deformations in the cover which is not represented in the basement. Basement–cover relationships (Harris et al., 1987; Gibbons, 1989; James and Mortensen, 1992; Marquer and Burkhard, 1992; Narr and Suppe, 1994; Teixcell, 1996; Muñoz et al., 2002), may therefore indicate 'thick-skinned' tectonics (Coward, 1983; Butler et al., 2004; Pfiffner, 2006) when basement is involved or 'thin-skinned' tectonics (Gwinn, 1964; Cook et al., 1979; Kokkalas et al., 2013) when there is a detachment separating basement units from a post-detachment cover. Thin skinned deformation styles are diverse and include such types as (a) nappes riding over a rather undeformed subsurface along plane well lubricated thrust faults (e.g. Meissner et al., 1981), (b) progressive series of rotational displacements of allocthonous units emplaced in a foreland propagating sequence with varied fold-thrust geometries including duplexes, imbricated thrusts, out-of-sequence thrusts, etc. (Pérez-Estaún et al. 1988), (c) small to large gravity driven deformation of sedimentary sequences involving bodies of sediments that are translated basinwards over detachment surfaces with extensions in the updip portion and contractions in downdip region (e.g. Peel et al. 1995; Alves and Elliot, 2014; Peel, 2014) and many others. Thick skinned deformation is defined by structural style where single thrust faults or fold structures affect the entire continental crust or even the upper mantle to produce large scale basement uplifts (e.g. Moores and Twiss, 1995; Pfiffner and Hitz, 1997; Wu et al., 1997). Tectonic settings that involve thick skinned deformation are the collisional orogens. Thin skinned deformation is common in tectonic settings that include passive margins where gravity tectonics may cause significant deformation of the cover without involving the basement, and in outer parts of foreland thrust belts, where the cover has moved on a basal decollement. A prudent evaluation of basement–cover structural relationship in a deformed sedimentary basin therefore helps to identify the tectonic settings that control the deformation and can be significant in exploration of resources; for example, hydrocarbons (cf. Karakitsios and Rigakis, 2007).

The Kaladgi Basin in southwestern India is an intracratonic sedimentary basin with an Archaean basement and a Mesoproterozoic sedimentary cover that is deformed and overlain by relatively undeformed Neoproterozoic sediments separated by unconformities. Several aspects of this basin have been studied over the last few decades including facies analyses and depositional environments (Kale et al., 1996, 1998; Bose et al., 2008), sediment geochemistry and palaeo-weathering (Dey et al., 2008, 2009a), palaeobiology (Kulkarni and Borkar, 1997, 1999; Sharma et al., 1998; Gowda, 1999), broad deformation patterns and structures (Jayaprakash et al., 1987; Jayaprakash, 2007), uranium mineralization (Chaki et al., 1999; Jayaprakash, 2007), and hydrocarbon prospects (Kalpana et al., 2010). Nevertheless, there still exists in general, a lack of systematic and detailed data regarding the deformational architecture of the sedimentary cover of the basin. Caveats include (a) incomplete documentation and analysis of structures, (b) lack of data on inter-relationship of the structural elements, (c) data gaps in the modes of occurrence, distribution, and variations of structural elements along and across the general trend of the basin, (d) incomplete relative chronology of development of structural elements, (e) poor relationship of deformation structures between the basement and cover in terms

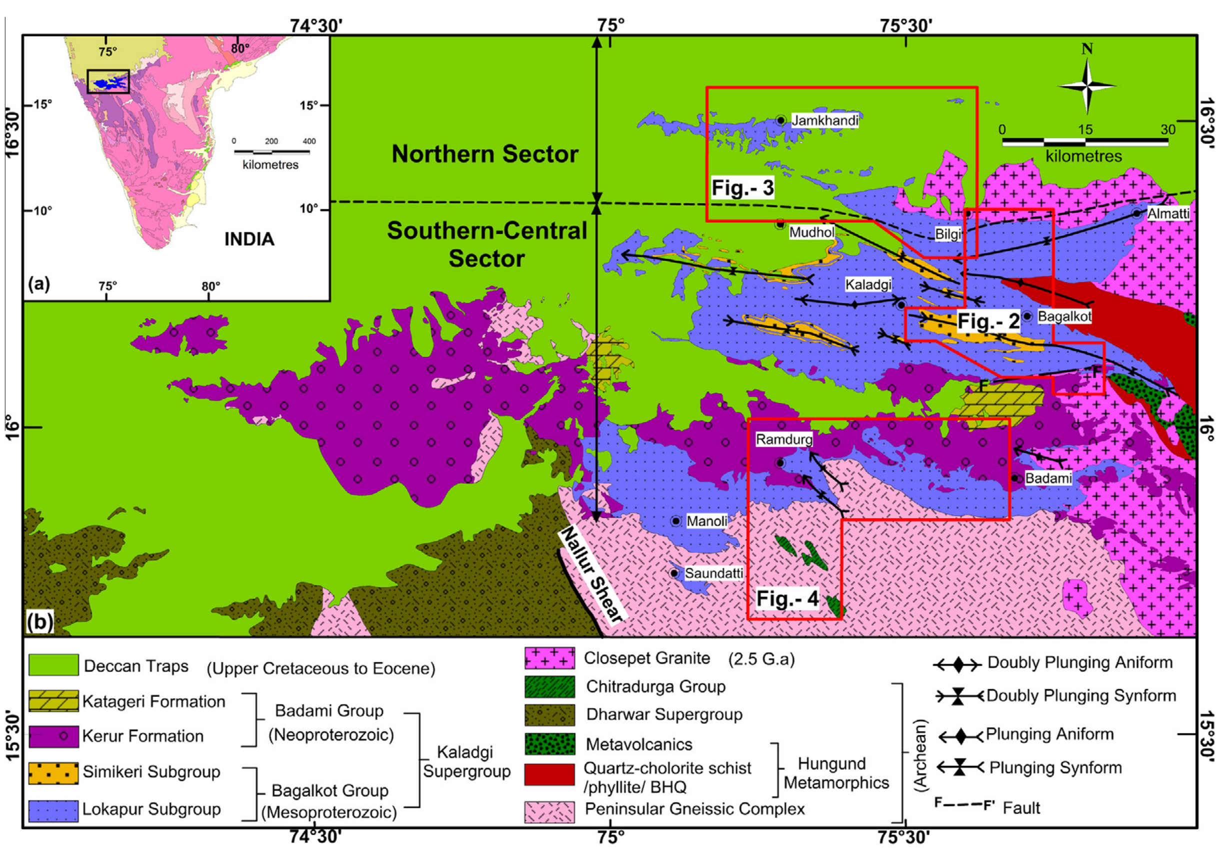

Fig. 1. Simplified geological map of the Kaladgi Basin (modified after Jayaprakash et al., 1987). Three study areas are outlined that are detailed in respective figures whose numbers are indicated therein.