The South India Precambrian crust and shallow lithospheric mantle: Initial results from the India Deep Earth Imaging Experiment (INDEX)

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We present here the most comprehensive study of the thickness and composition (Vp/Vs ratio) of the South India Precambrian crust and the nature of shallower mantle inferred from analysis of teleseismic receiver functions from 70 broad-band seismic stations operated as a part of the India Deep Earth Imaging Experiment (INDEX). South India could be broadly divided into regions with thin crust (32–38 km) and thick crust (38–54 km). Thin crust domains include the East Dharwar Craton (EDC), Cuddapah basin and Madurai/Kerala Khondalite Block. The thicker crust domain includes the Western Dharwar Craton (WDC) and northern part of Southern Granulite Terrain. The WDC shows progressive increase in thickness from 38 km in north to 46–54 km in south, compared to an almost flat Moho beneath the EDC. Compositionally, most of the crustal domains are felsic to intermediate ($Vp/Vs \sim 1.69$–1.75) except the mid Archean block in the southern WDC where it is mafic ($Vp/Vs > 1.81$). Considering erosion depth in the WDC, we argue for Himalaya like ∼70 km thick crust beneath it during the Archean. Variation in crustal thickness does not have a first-order influence on regional topography in South India and suggests significant role for the crustal composition. We also present evidence of mid-lithospheric low velocity at ∼85–100 km beneath South India.

1. Introduction

Most of our knowledge about the evolution of continents and their crust and mantle signature is restricted to terrains younger than ∼3.3 Ga due to large scale thermal modifications prior to this age. Two prominent continental crust forming events at ∼3.3 Ga and 2.7 Ga have been reported during the Archean (de Wit *et al.* 1992; Rudnick 1995; Condie 2005; Hawkesworth and Kemp 2006; van Kranendonk 2011; Dhuime *et al.* 2012). It remains highly speculative about the process responsible for its evolution. It is widely accepted that plate-tectonic processes operated at least as far back as 2.7 Ga (Calvert *et al.* 1995; White *et al.* 2003). Middle Archean terrains (3.6–3.0 Ga), however, lack most of the features associated with convergent plate boundaries and could possibly have evolved through melting of thick mafic crust (Davies 1992; de Wit 1998; Zegers and van Keken 2001; Nagel *et al.* 2012). Scientific opinion, however, remains divided on the process responsible for the formation and evolution of the early and middle Archean continental crust. In order to achieve comprehensive definition of the crust evolution process(es) during Precambrian and its modification

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