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Paleosol occurrences along the Archean–Proterozoic contact in the Aravalli craton, NW India

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ABSTRACT

The Archean–Proterozoic contact (APC) comprises a large scale folded surface around Udaipur in NW India. The APC is exposed on both eastern and western flanks of a synclinorium formed during thick skinned thrusting of the Archean basement and the Paleoproterozoic cover units. Paleosol occurrences on both the limbs of this structure imply an originally continuous paleoweathering horizon and not individual pockets of paleosol as seen today. Preservation of paleosol sections along the Archean–Proterozoic interface in the Aravalli craton is strongly controlled by the structural grain. Complete paleosol sections are recognized in the eastern flank of the Udaipur synclinorium in low strain regions with respect to the regional F1 and F2 folding. In this sector the Tulsi Namla paleosol section represents an ancient lateritic weathering profile with an iron depleted pallid lower zone (lithomarge) and an iron enriched upper zone (mottled zone to ferricrete). Original kaolinite in the saprolite and pallid zone has been transformed into kyanite during metamorphism and subsequently to white mica during retrograde overprint, while Fe rich clay and goethite were probably the primary minerals for the chloritoid and hematite which now constitute the upper zone. At the western flank of the synclinorium the contact is heavily sheared and Archean basement and Proterozoic units show interfingering on a small scale. Here, the paleosol sections are incomplete.

The weathering interval can be inferred by the stabilization of the craton at ~2.5 Ga and deposition of rift related sequences of the Aravalli basin (Delwara formation) at ~2.15 Ga. The Udaipur paleosols, especially in the eastern flank, represent the most complete Archean–Paleoproterozoic paleosol sections in India.

1. Introduction

Soils result from intense atmosphere–rock interaction (weathering) and are important archives of information useful in interpreting the climatic conditions during their formation (Retallack, 1990). With the emergence of new quantitative techniques, paleopedology has come a long way in reliably reconstructing the paleoclimate. Most such studies are confined to the geologically younger paleosols (fossil soil profiles) which are well preserved and not significantly altered (*for a review see* Sheldon and Tabor, 2009). Paleosols developed over geologically very old terranes, also archive evidence of atmosphere–rock interaction (analogous to their more younger counterparts) and can potentially be employed to infer the past atmosphere, for which no direct evidence is available (e.g. Holland and Zbinden, 1988; Holland, 1992; Ohmoto, 1996; Sheldon, 2006). However, there is need for caution in the case of Precambrian terranes where original signatures may have been significantly modified during multiple phases of metamorphism and deformation. Moreover, unfavorable conditions for paleosol preservation and subsequent erosion during prolonged geological history often make it difficult to locate well preserved 'in situ' paleosols and to distinguish them from the metamorphosed alumina silicate rich rocks.

Precambrian paleosols are unique for being the only source of information on paleoclimatic conditions due to absence of any biological evidence. Paleosols occurring over Archean basement are known from all the major Archean terranes. In the Pilbara craton in Australia the Mt. Roe paleosols are developed over 2.78–2.76 Ga flood basalts (MacFarlane et al., 1994; Yang et al., 2002). Paleosols developed on a granite–greenstone terrane in the Canadian Shield (Gay and Grandstaff, 1980; G-Farrow and Mossman, 1988; Panahi et al., 2000; Murakami et al., 2001; Nedachi et al., 2005) have been described as one of the best preserved Precambrian paleosols while the Hekpoort Paleosol, developed over mafic lavas of Transvaal Supergroup in South Africa (Rye and Holland, 2000;

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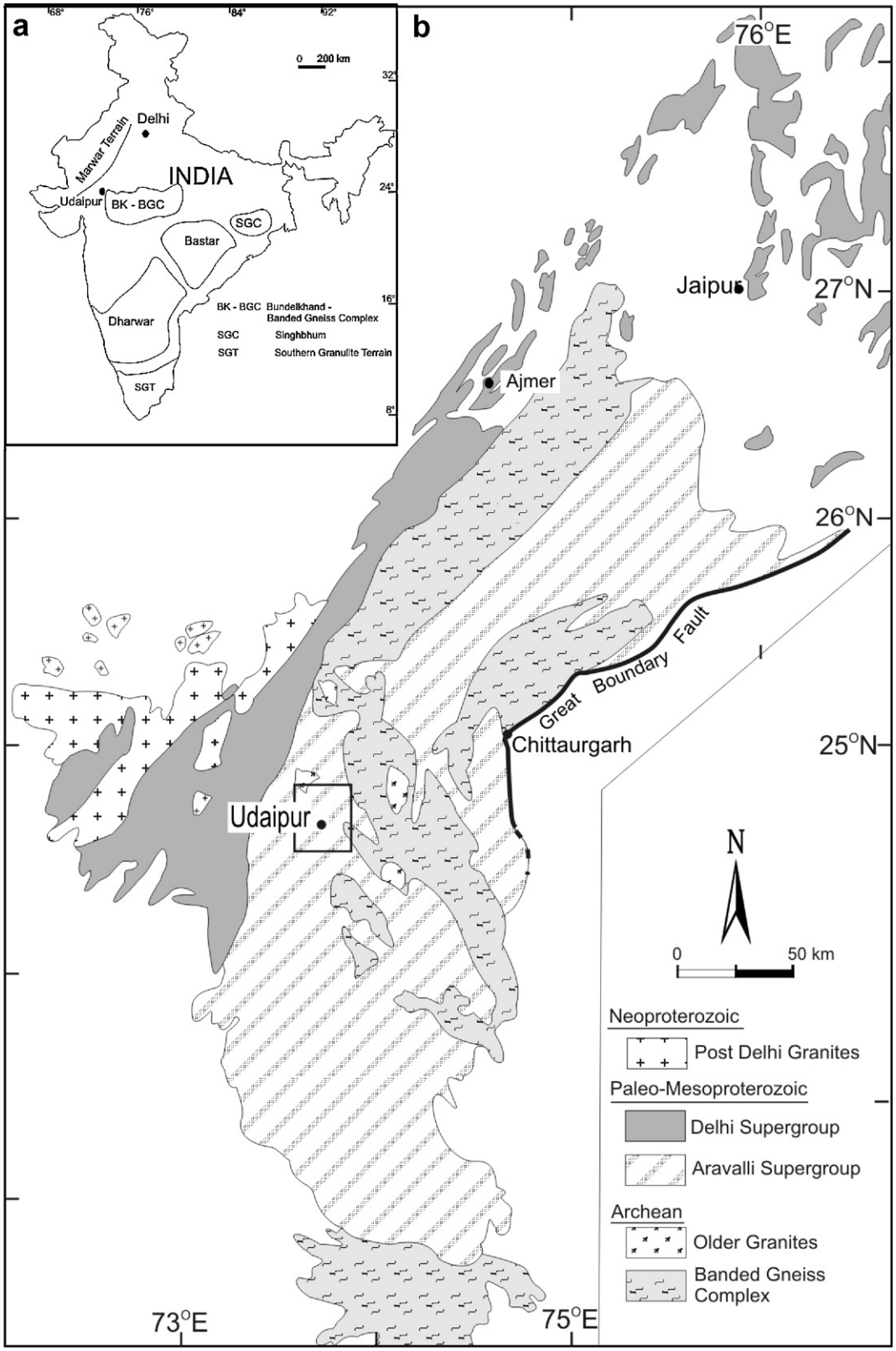

Fig. 1. (a) Map showing distribution of Archean and Early Proterozoic cratons in India. (b) Simplified Precambrian geological map of Aravalli mountain region (adapted from Heron, 1953; Sharma, 1988; Gupta et al., 1997) showing location of study area around Udaipur (box) in NW India.

Yang and Holland, 2003) can be regarded as the most cited one. Precambrian rocks constitute the major part of the Indian peninsular shield, which has evolved around three prominent Archean nuclei (Dharwar in south, Singhbhum–Bastar in east and Banded Gneiss Complex (BGC)–Bundelkhand in north), and associated Proterozoic mobile belts (Fig. 1). Precambrian paleosol occurrences, however, are reported from a few localities only, such as Eastern Ghats (Andhra Pradesh, Orissa; Sreenivas and Srinivasan, 1994),