



## Short communication

## Stratigraphic position of the ~1000 Ma Sukhda Tuff (Chhattisgarh Supergroup, India) and the 500 Ma question

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## ABSTRACT

U–Pb ages of magmatic zircons in tuff horizons in the Chhattisgarh and the Vindhyan Supergroups in India, backed up by paleomagnetic data, suggest that most Proterozoic basins in India are about 500 Ma older than the current consensus. The issue is hotly debated including questions about the stratigraphic positions of the tuff horizons. Thus, the geologic significance of the ~1000 Ma age of the rhyolitic tuff near Sukhda and Sapos villages in the Chhattisgarh Supergroup in central India hinges on its proper stratigraphic placement. If the tuff is near the top of the Chhattisgarh Supergroup, then the Chhattisgarh and its equivalent sediments were deposited in the Mesoproterozoic and not, as has been the general notion, in the Neoproterozoic. The tuff lies conformably on the platform-facies Saradih Limestone of the Raipur Group (upper Chhattisgarh) and not on an Archean-Proterozoic basement; it is overlain by fluvial volcanoclastic conglomeratic lithologies of the Sarnadih Sandstone. Had this sandstone belonged to the basal Lohardih Formation deposited in fan-deltas of an opening basin, as is currently believed, it would have been overlain by prodelta deposits including mature quartz arenites and floored by crystalline rocks. Formation-mapping, facies analysis, and petrologic considerations place the Sarnadih Sandstone, and thus the ~1000 Ma Sukhda Tuff, near the top of the sedimentary sequence of the Chhattisgarh basin. Consequently, rocks below the Sukhda Tuff must be pre-Neoproterozoic in age. Hence, rocks and tectonics of these Proterozoic basins are irrelevant to arguments about the Cryogenian or break-up of Rodinia, but are related more to the assembly of Rodinia and the break-up of Nuna. Metazoan and animal life forms, reported from the Chhattisgarh and equivalent basins, must also have originated and evolved in pre-Neoproterozoic time.

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## 1. Introduction

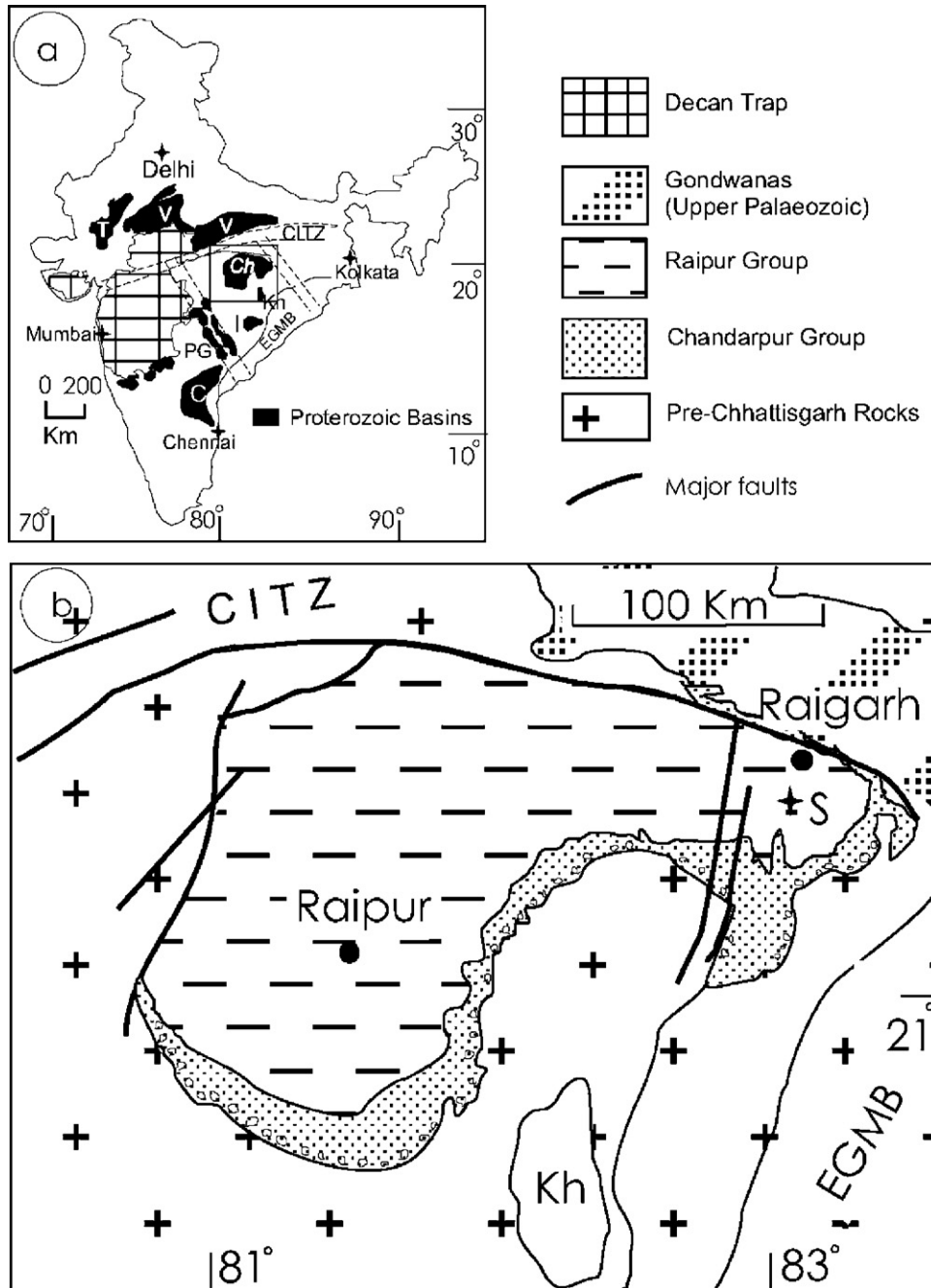
Rhyolitic tuffs near Sukhda and Sapos villages (Mukherjee and Sahoo, 2003) in the Proterozoic Chhattisgarh (*var.* Chattisgarh) Basin (Fig. 1), in Janjgir District of Chhattisgarh State in central India, erupted ~1000 Ma ago as determined from U–Pb SHRIMP ages of magmatic zircons in the tuff (Patranabis-Deb et al., 2007). Mapping and stratigraphic considerations strongly suggest that the lithostratigraphic position of the tuff horizons (Sukhda Tuff for nomenclatural convenience) is near the top of the sedimentary succession of the Chhattisgarh Supergroup (Patranabis-Deb, 2001, 2004; Patranabis-Deb and Chaudhuri, *in press*). This implies that most of the Chhattisgarh Supergroup and its equivalents, such as the virtually unmetamorphosed sedimentary successions in the Vindhyan (Chakraborty and Paul, 2008; Malone et al., 2008),

Kurnool (part of Cuddapah), Kaladgi–Badami–Bhima, Khariar, and Indravati basins in peninsular India (Kumar et al., 2005; Naqvi, 2005; Maheshwari et al., 2005), are also older than ~1000 Ma. Based on detrital zircon ages and paleomagnetic data, Malone et al. (2008) have shown that the maximum age of the top of the Vindhyan Supergroup is ~1000 Ma.

If so, inferences about the Neoproterozoic history of Earth, as deduced from sedimentary rocks found in peninsular India are rendered irrelevant. It is no puzzle that glacial deposits, such as those in the Cryogenian Snowball Earth, are absent in these basins (Williams and Schmidt, 1996; Chaudhuri et al., 1999; Kumar et al., 2005). The absolute age of the tuffs implies that these basins opened and closed before the complete assembly of Rodinia. Therefore, reconstructions of Rodinia with India in it (e.g., Dalziel, 1997) cannot draw from the sedimentary tectonics of these basins. In fact, there is a growing body of convincing evidence that India was not a part of Rodinia any way (Malone et al., 2008; Cawood et al., 2007; Kröner and Cordani, 2003; Meert and Torsvik, 2003; Torsvik et al., 2001). Hence, the impetus to put India in Rodinia based on the assumed

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**Fig. 1.** (a) Distribution of major Proterozoic Basins in India. V=Vindhyan, T=Trans-Aravalli; Ch=Chhattisgarh; Kh=Khariar; C=Cuddapah; I=Indravati; PG=Pranhita-Godavari; CITZ=Central Indian Tectonic Zone; EGMB=Eastern Ghat Mobile Belt. (b) Simplified geological map of the Chhattisgarh Basin (modified from Chakraborty and Paul, 2005) showing Group boundaries, locations of Lohardih and Sarnadih sandstones, and Sukhda Tuff. S=Location of Sukhda Tuff and Sarnadih Sandstone.

Neoproterozoic age of these basins is based on false assumptions. Finally, the new absolute ages also demand that the life forms, including metazoans and small shelly fossils (SSF) that have been reported from the strata in these basins are all much older. Because this implies that metazoan life started and evolved in deep time (Bengtson et al., 2007; Basu, 2008), the exact stratigraphic placement of these fossils needs to be verified through careful resampling of in-place material.

The Sukhda Tuff and its enclosing sedimentary package have been placed by some in the lower part of the Chhattisgarh Supergroup (Subba Rao et al., 2006; Mukherjee and Ray, 2008; GSI, 2005a,b). If so, there arises a 500 Ma problem in Indian Proterozoic stratigraphy. This is a matter of much verbal public discussion

(e.g., International conferences at ISI, Kolkata, January, 2008, and, at IIT, Mumbai, December, 2007 and February, 2008; see also Mukherjee and Ray, 2008). The purpose of this short note is to present arguments from our formation-mapping, facies-mapping and petrologic observations (optical and SEM-BSE-CL) to show that the Sukhda Tuff (Fig. 2) indeed is located near the top of the Chhattisgarh Supergroup. This finding requires a bold re-assessment of the Proterozoic geology of peninsular India.

## 2. Lithostratigraphy

There is no dispute over gross lithologies and geographic locations of outcrops in the Chhattisgarh Basin, the eastern part of

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