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Earliest evidence of life preserved in ca. 3.5 Ga old marine sediments of the Daitari Greenstone Belt, Singhbhum Craton, India

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Low-grade volcano-sedimentary rocks older than 3.2 Ga are rare in the geologic record. In this contribution, we provide insights from the c. 3.30 to 3.55 Ga old Badampahar Group exposed in the Daitari Greenstone Belt (DGB) of the Singhbhum Craton, India [1]. The DGB preserves a ~ 7 km thick volcano-sedimentary succession that underwent low-grade metamorphism [2]. We studied ~3.5 Ga old marine carbonaceous cherts and shales to gain information on the origin of the carbonaceous matter. Total organic carbon (TOC) content of carbonaceous cherts of the Kalisagar, Talpada, Sindurimundi and Tomka formations [2] range from 0.03 to 1.14 wt.%, while their $\delta^{13}C$ values vary between –34 and –12 ‰. Shales of the Sindurimundi Formation preserve remarkably high TOC contents up to 4.3 wt.% and $\delta^{13}C$ values range from –28 to –14‰. Relatively heavy $\delta^{13}C$ values are attributed to locally enhanced metamorphic overprinting/devolatilization processes. Bulk $\delta^{15}N$ composition of shales range from –1.6 to 5.1 ‰, whereas their corresponding extracted kerogen $\delta^{15}N$ composition ranges between –1.3 and 5.9 ‰. Based on high TOC content and isotopically depleted $\delta^{13}C$ composition, we conclude that a diverse consortium including methane-cycling microbes as well as photoautotrophs were prevalent. The $\delta^{15}N_{(bulk\text{-}kerogen\ extract)}$ values indicate biological N_2 fixation 3.5 Ga ago.

1. Hofmann et al. (2022), Earth Science Reviews. 103994.
2. Jodder et al. (2023), Precambrian Research. 106997