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Integrative stratigraphy during the Early Triassic biotic recovery time

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A Lower Triassic section at Mud, Spiti Valley (India) is a candidate section for the GSSP of the Induan-Olenekian Boundary (IOB). The succession was deposited in a deep-shelf setting on the southern margin of the Neotethys Ocean. A significant, two-step radiation phase in ammonoids and conodonts occurs close to the Induan-Olenekian boundary. These diversifications are coupled with a short-termed positive $\delta^{13}\text{C}_{\text{carb}}$ excursion of global evidence. The Spiti $\delta^{13}\text{C}_{\text{carb}}$ excursion displays, however, different amplitude and biostratigraphic position than in other relevant sections for this time interval. In this study, we analyzed $\delta^{13}\text{C}_{\text{carb}}$, $\delta^{13}\text{C}_{\text{org}}$, and $\delta^{15}\text{N}_{\text{org}}$ as well as major, trace, and REE concentrations for a 16-m-thick interval spanning the mid-Griesbachian to early Spathian substages, to better constrain the chain of events. Prior to the first radiation step, high difference gradient between the $\delta^{13}\text{C}_{\text{carb}}$ values of tempestite beds with shallow carbonate and carbonate originated in deeper water is interpreted as a sign of a stratified water column. This effect disappears with the onset of better oxygenated conditions at the time of the ammonoid-conodont radiation, which correspond as well to $\delta^{13}\text{C}_{\text{carb}}$, $\delta^{13}\text{C}_{\text{org}}$ and $\delta^{15}\text{N}_{\text{org}}$ positive excursions. A decrease in Mo and U concentrations occurring at the same point suggests a shift toward locally less reducing conditions. The second step coincided with the change from terrigenous to almost pure carbonate sedimentation. This new set of data demonstrates from on hand the rapidity of radiation of the pelagic fauna in the aftermath of the Permian-Triassic extinction as soon as environmental conditions were favourable again.