THE CARBON AND OXYGEN ISOTOPE TRENDS OF THE DEOBAN-BLAINI-KROL-TAL MICROBIAL CARBONATES FROM THE LESSER HIMALAYA, INDIA

VINOD. C. TEWARI
Wadia Institute of Himalayan Geology, Dehra Dun 248 001.

ABSTRACT

δ^{13}C records of Precambrian- Carmbrian (PC-C) boundary carbonates are known from the Siberian platform, USSR Anti Atlas, Morocco, Svalbard and East Greenland, China, Iran and the Krol Formation of Lesser Himalaya, India. In the Lesser Himalaya the isotopic trends of Deoban, Blaini-Krol-Tal carbonates depict two distinct cycles of δ^{13}C and one cycle of δ^{18}O maxima-manima along the PC-C (Riphean-Vendian-Aldanian stages) boundary. δ^{13}C signatures vary from +6.0 to -6.3%.(PDB) and δ^{18}O from + 17.2 to + 29.2%.(SMOW). The isotopic maxima-minima has been discussed in this paper.

INTRODUCTION

The Lesser Himalaya represents two major microbial carbonate successions namely Deoban Formation (Riphean) and Krol Formation (Vendian) covering a time span between 1500 Ma to 570 Ma (꩜ 624) ± 10 Ma). The thin pink microbial limestone is found in the Blaini Formation of Lower Vendian age (=650 Ma). The carbon and oxygen isotope trends of these microbial carbonates show marked shifts in δ^{13}C and δ^{18}O across the Riphean-Vendian-Tommotain/Melschucunian stages (Kumar and Tewari, 1988). Earlier workers (Tucker, 1986; Magaritz, 1986; Knoll *et al.*, 1986; Aharon *et al.* 1987; Brasier, *et al.* 1990) have studied these trends across the Vendian-Tommotian boundary and have interpreted in terms of chages in ocean biomass fertility, ocean ventillation rates, ocean chemistry and mass extinction at the close of Precambrian due to extraterrestrial impact (Hsu, *et al*. 1985) The present study suggests that isotopic variations are related to chages in carbonate sedimentation patterns. evolutionary stages of life (uni-multi cellular to skeletons) and carbon oxygen cycling. The data further supports the regional and global validity of isotopic trends of Upper Proterozoic (Riphean-Vendian)-Lower Cambrian carbonates. The atmospheric oceanic changes across the Precambrian-Cambrian boundary and the positive and negative δ^{13}C excursions in the Deoban-Blaini-Krol-Tal carbonates have been discussed.

CARBON AND OXYGEN ISOTOPE TRENDS OF DEOBAN-BLAINI-KROL-TAL CARBONATES

The carbonates for isotopic study have been sampled from Deoban Formation developed in Deoban mountain (30° 45';77° 54') and Blaini, Krol and Tal formations occurring in Korgai and Nigalidhar synclines of the Himachal Lesser Himalaya. (30° 34' 59" 70° 39 15") (Fig. 1)

Carbon and Oxygen isotope data of Deoban-Blaini-Krol-Tal carbonates are presented in Fig. 2. δ^{13}C signatures vary from +6.0 to -6.3%. (PDB) depicting two distinct cycles of δ^{13}C maxima-minima and δ^{18}O form +17.2 to +29.2%.(SMOW) showing one distinct cycle of δ^{18}O maxima-minima.

The recorded C-isotope variations represent pristine isotope signatures as these carbonate successions have not been subjected to any metamorphism, diagenesis, excessive burial and deformation; and large scale temperature variations as evidenced by sedimentary record of liquid water, life forms and development of stromatolites. The earlier workers (Aharon *et al.*1987) have also ruled out the post depositional isotopic exchange as the major cause for δ^{13}C signatures obtained by the them for PC/C boundary bed carbonates of Mussoorie syncline, Lesser Himalaya.

The isotopic data presented in Fig. 2 show that δ^{13}C maxima of +4.9% and +6.0% (PDB) relate to major carbonate succession of Deoban and Krol and δ^{13}C minima of -4.0% and -6.3% (PDB) to minor carbonate succession of Blaini and Tal respectively. The marked increase in carbonate sedimentation during Deoban and Krol time intervals would imply increased fixation of carbon dioxide in the form of carbonate carbon(C_{carb}). Deoban and Krol carbonate sedimentation continued during lower to middle Riphean and Late Vendian times (Tewari, 1984b, 1989). The increased fixation of carbon dioxide in the form of C_{carb} will therefore mean increased availability of CO_2 in the prevailing environment during Deoban and Krol times. Deoban and Krol carbonate succession are mainly stromatolitic/microbial in nature (Tewari, 1984 a, b; 1989; Tewari and Qureshy, 1985; Shukla *et al.* 1986) and their large scale deposition indicate increased built up to stromatolitic bio-

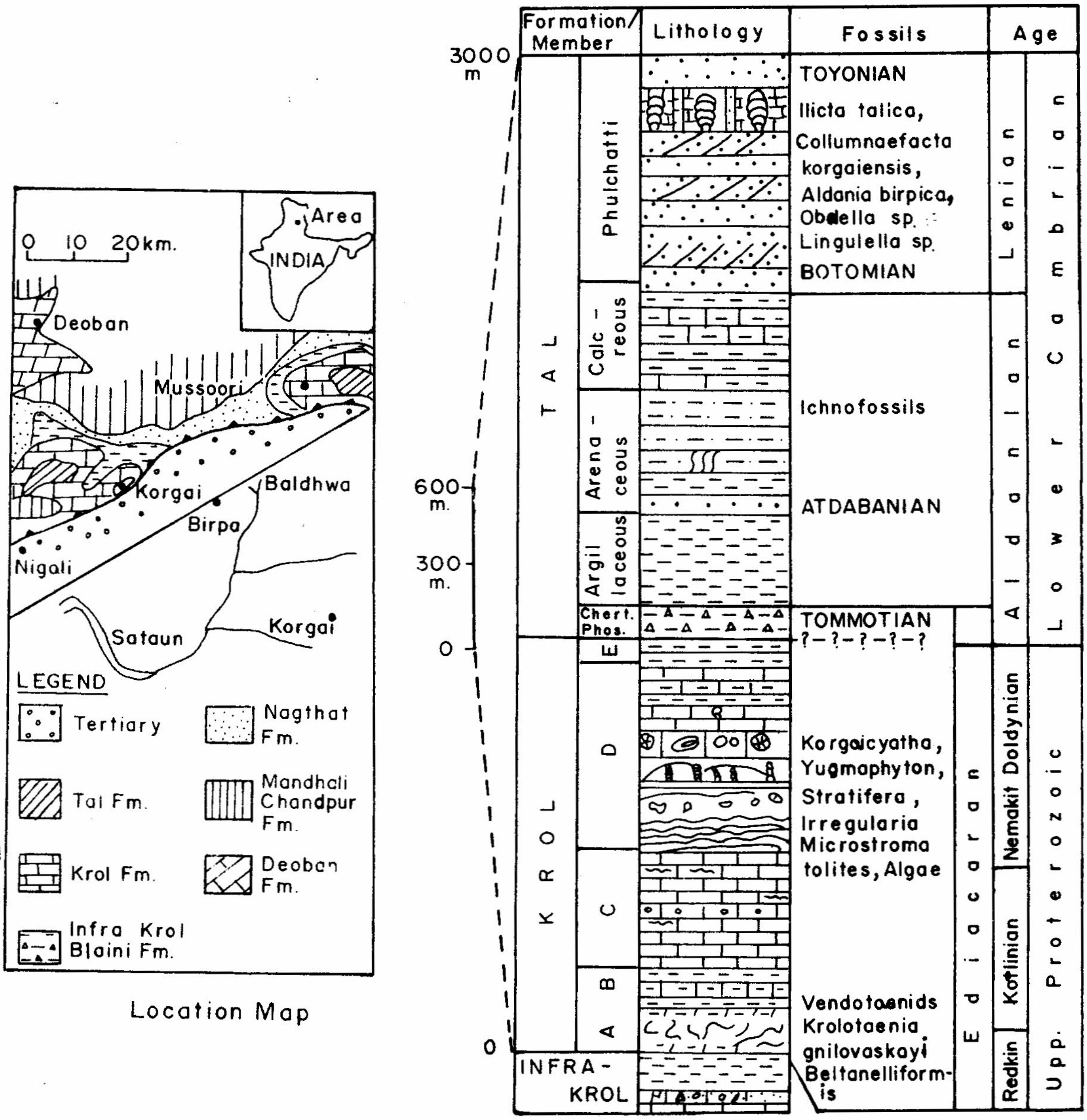

Fig. 1 Simplified geological map showing Deoban, Blaini-Infra Krol-Krol-Tal succession in Deoban, Nigalidhar, Korgai and Mussoorie areas. Litholog shows the distribution of Precambrain/Cambrian biota.

communities which preferentially fixes $\delta^{12}C$ in the form of organic carbon (C_{carb} + C_{org}) budget, increased availability of carbon dioxide in the prevailing environment, enhanced rate of photosynthesis, and possibly warmer climates and alkaline Ph conditions may relate to decrease in sedimentary carbon (C_{carb} + C_{org}) budget as evident from field observations and marked negative $\delta^{13}C$ signatures; lower concentration of CO_2 in the prevailing environment; and possibly colder climates (glaciation) and acidic Ph conditions. The colder climate for Blaini Formation may be due to its palaeoposition and association with Varangian glaciation event.

The biostratigraphic studies on Blaini and Tal sedimentary succession show that these formations are related to different evolutionary stages of life than to biomass extinction (Tewari, 1990 and mss). Blaini (including Infra Krol) and Krol contact marks the first appearance of metazoans and metaphytes (Tewari, mss) and Krol-Tal contact (Tommotian/Meischucunian stage) the first appearence of skeletonized fauna (Bhatt, *et al.*. 1983; Brasier and Singh, 1987). Therefore, the relation of $\delta^{13}C$ minima associated with Blaini and Tal formations to mass extinction is not well explained. The minima

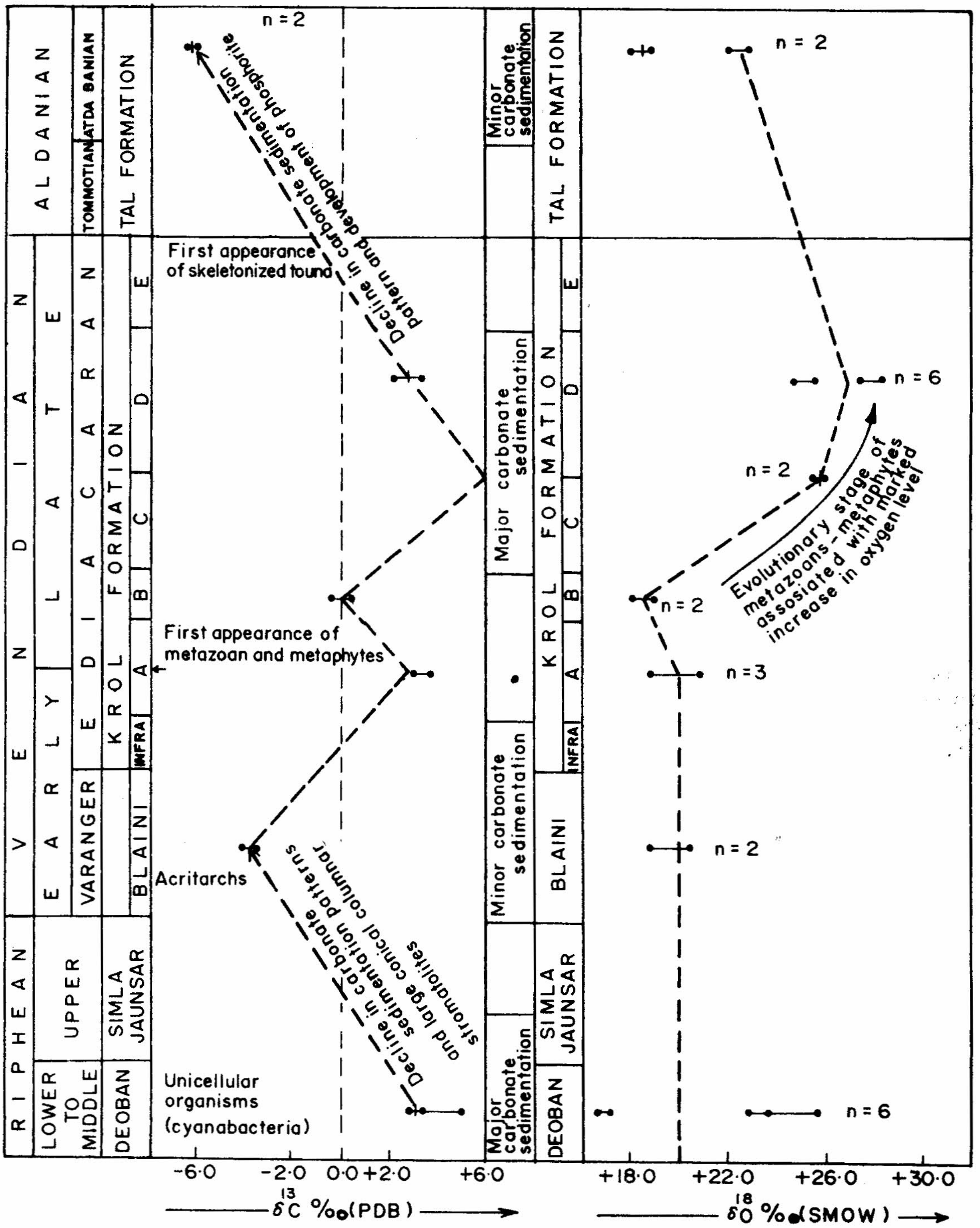

Fig. 2 Carbon($\delta^{13}C$) & oxygen($\delta^{18}O$) isotope variations in Deoban-Blaini-Krol-Tal carbonates across Riphean-Vendian-Aldanian Stages in the Lesser Himalaya.

rather reflect a decrease in preservation of carbon ($C_{carb.}$ + $C_{org.}$) in sedimentary environment. The link between the appearence of Ediacaran metazoans and metaphytes in the Infra Krol-Krol Formation and the decline of Riphean stromatolites and biota (Fig.2) from Deoban-Jaunsar/Simla-Blaini Formations in the Lesser Himalaya is related with the evolutionary stages of the metazoa/metaphyte in the Indian subcontinent (Tewari, 1984 a,b,1989,1990, mss).

The $\delta^{18}O$ records of Late Precambrian-Cambrian carbonates are considered to be artifacts of diagenetic alterations or post depositional isotope exchange equilibration processes, but it is suggested that this could not be the only possible reason. Deoban and Krol carbonates have largely varying oxygen isotope ratios (+17.2 to 29.2% vs SMOW) which overlaps the $\delta^{18}O$ range for Phanerozoic carbonates, while Blaini and Tal carbonates oxygen isotope data lie in a narrow range of +18.4 to 20.7%.(SMOW) (Fig. 2). Therefore relatively enriched $\delta^{18}O$ values (< 24% vs SMOW) for Deoban and Krol carbonates may relate to environmental oxygen level similar to or higher than present oxygen level. The higher environmental oxygen level during Deoban and Krol carbonate sedimentation is futher supported by their association with $\delta^{13}C$ maxima and possibly enchanced rate of photosynthesis. The Krol sedimentary cycle depicting a distinct cycle of $\delta^{18}O$ maxima (cf. Fig, 2) is related with evolutionary stages of life from unicellular or multicellular metazoans and metaphytes which must have originated in high oxygenated environments. In conclusion, the present isotopic study indicate that the $\delta^{13}C$ and $\delta^{18}O$ variations across the Riphean-Vendian and Precambrian/Cambrian boundary are related to marked changes in carbon and oxygen budget.

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