5. Results

The down-core records of sediment texture, calcite-oxygen and -nitrogen isotopes, sedimentary organic components and their isotopes, and sedimentary inorganic components exhibit in general smooth variations suggesting at the outset a) the variations are natural and b) the sediment cores are free from post depositional perturbations such as bioturbation or turbidite or slumping. These characters of the present sedimentary records would help in reconstructing the past oceanic responses to the climate change with reasonable confidence. In the following sub-sections, I describe the salient features of the results separately for each sediment core.

5.1. Age-model and chronology

SK 117/GC08 (Figure 2):

The $\delta^{18}O_{\text{saccullifer}}$ in the core-top section is $-1.37 \%$. The lowest value of the entire down-core record is at a depth of 15 cm ($-1.65 \%$). The down-core fluctuations of the $\delta^{18}O_{\text{saccullifer}}$ are marginal up to 19 cm depth. From 19 cm the $\delta^{18}O_{\text{saccullifer}}$ rapidly increases to $-0.4 \%$ and further down up to 90 cm varies within a narrow range of $-0.2 \%$. The heaviest (0.47 %) $\delta^{18}O_{\text{saccullifer}}$ is recorded at 75 cm depth. From 90 cm to 123 cm these values significantly decrease from 0.47 up to $-0.33 \%$ and remain more or less constant $-0.2 \%$ up to 280 cm depth. The second and third lowest $\delta^{18}O_{\text{saccullifer}}$ events are located at 329 cm ($-1.10 \%$) and at 397 cm ($-1.19 \%$).

The down-core $\delta^{18}O_{\text{saccullifer}}$ profile shows well-defined Marine Oxygen Isotope Stages (MIS). The age model is constructed by tuning the down-core $\delta^{18}O_{\text{saccullifer}}$ profile to the low latitude SPECMAP stack (Bassinot et al. 1994), which is a modified version of the original SPECMAP of Imbrie et al., (1984). This enabled to demarcate the Holocene/LGP boundary (11 Ka) at 25 cm; LGP/MIS3 (24 Ka) at 105 cm; MIS 3/4 (57 Ka) at 227 cm; and MIS 4/5 (71 Ka) at 290 cm. The marine
isotopic stage boundaries are drawn at the mean of the highest and lowest oxygen isotopic values between the two adjacent warm and cold oxygen isotope events defined in the SPECMAP. Four tie-points are used to evolve fairly accurate age model, viz., 1) The Last Glacial Maximum (LGM) occurring at 18 Ka identified at 75 cm exhibiting the latest heaviest oxygen isotope event (0.47 ‰), 2) occurrence of the well-dated Youngest Toba Tuff (YTT) at ~ 72 Ka (Ninkovitch et al., 1978) identified by the presence of abundant YTT-characteristic glass-shards (Pattan et al., 2000) at 297 cm, and 3) the interstadials of MIS5, viz., MIS5.1 occurring at 330 cm and MIS5.3 at 397 cm dated to be 79 Ka and 97 Ka respectively (Bassinot et al., 1994).

Figure 2: Marine oxygen isotope stage (MIS) boundaries recognized in the SK117-GC08 core. The age model (upper panel) is derived from tuning the G.sacculifer oxygen isotope depth curve to the tropical-stack SPECMAP. The horizontal and vertical lines indicate depth-age relationship. The numbers are the marine oxygen isotope stages. The core covers last 100 Ky time-span. YTT=Youngest Toba Tuff that occurs at 297 cm depth in core. Two lighter oxygen-isotope peaks in MIS5 are the two warm interstadials 5.1 and 5.3 separated by colder stadial 5.2.
The δ¹⁸O$_{G.sacculifer}$ in the core-top section is ~1.82‰ and remains more or less uniform up to 32 cm where it begins to increase rapidly down-core reaching ~0.00‰ at 70 cm forming the peak of the heaviest δ¹⁸O$_{G.sacculifer}$. The lightest δ¹⁸O$_{G.sacculifer}$ in the entire down-core profile occurs at 358 cm (~2.14‰). The lighter δ¹⁸O$_{G.sacculifer}$ peak is located at 15 cm depth (~2.04‰). The isotopic values remain more or less constant at around ~0.6‰ from 90 cm to 230 cm but with a marginally heavy δ¹⁸O$_{G.sacculifer}$ ~200 cm. A decrease from ~1.55‰ to ~2.2‰ is evident between 230 cm and 380 cm. This increase contains three distinct increasingly lighter δ¹⁸O$_{G.sacculifer}$ peaks down-core (i.e., at ~258 cm, at ~308 cm, and at ~356 cm). Further down-core the profile exhibits heavy δ¹⁸O$_{G.sacculifer}$ similar to that found ~70 cm depth. Thus a distinct transition from the heavy δ¹⁸O$_{G.sacculifer}$ to light δ¹⁸O$_{G.sacculifer}$ is evident between 400 cm and 360 cm depths in core. The structure of this transition is quite similar to that found between the 70 cm and 30 cm depths in the core.

The above-described depth versus δ¹⁸O$_{G.sacculifer}$ profile of SK129-CR4 core is tuned to the low latitude SPECMAP stack (Bassinot et al., 1994). Thus identified marine oxygen isotope boundaries are, Holocene/LGP boundary (11 Ka) at 40 cm, LGP/MIS3 (24 Ka) at 94 cm, 3/4 (57 Ka) at 181 cm, 4/5 (71 Ka) at 220 cm and 5/6 (122 Ka) at 358 cm. Several tie points are also used to evaluate the precision of the age model. They are, 1) the LGM (18 Ka) at 70 cm depth, 2) Youngest Toba Tuff (~72 Ka) at 224 cm, 3) Last Appearance Datum (LAD) of G. ruber (pink variety) (120 Ka) at 354 cm and, 4) the interstadials of MIS5, viz MIS5.1 (79 Ka), MIS5.3 (97 Ka) and MIS5.5 (122 Ka) at 258 cm, 308 cm, and 358 cm depths respectively. The derived age model for SK129-CR4 indicates that the core covers the last 148 Ka.
Figure 3: The age model for SK129-CR04 core. The vertical and horizontal lines are the marine oxygen isotope stage boundaries recognized in the core with corresponding ages as defined in the SPECMAP. The vertical lines with labels are the independent tie-points in the form of YTT (~72 Ka) located at 228 cm depth and the last appearance datum of *G. ruber* (pink variety) at 352 cm dated to be 120 Ka (Thompson and Duplessy, 1982). Clearly defined LGM and interstadials of MIS5 (5.1, 5.3, and 5.5) provided additional control points for the age model. The numbers are the marine oxygen isotope stages.
The core top $\delta^{18}O_{G.sacculifer}$ is $-1.83 \%$, which is nearly uniform with marginal fluctuations down-core up to $\sim 20$ cm. Further down the $\delta^{18}O_{G.sacculifer}$ increases rapidly to $-0.6 \%$ at $\sim 85$ cm. From 85 cm down to $\sim 350$ cm the increase is rather gentle (from $-0.6 \%$ to $0.2 \%$). The lightest $\delta^{18}O_{G.sacculifer}$ of the entire core ($-2.04 \%$) is recorded at 11 cm depth and the heaviest $\delta^{18}O_{G.sacculifer}$ ($0.18 \%$) is at 293 cm. Further down-core the $\delta^{18}O_{G.sacculifer}$ decrease to $-0.45 \%$ at 386 cm (bottom of the core) from $0.17 \%$ at 347 cm depth.

The comparison of the $\delta^{18}O_{G.sacculifer}$ depth-profile with the SPECMAP suggests that the core appears to cover a maximum of 24 Ka, i.e., the Holocene and LGP. The Holocene and the LGP boundary and the isotopic variation within this time-span can be appreciated by referring to the compressed inset and the exploded versions of the isotope-depth profiles together in Figure 4. The Holocene/LGP boundary (11 Ka) is located at 44 cm depth and LGP/MIS3 boundary (24 Ka) appears to be at 386 cm depth. There were no independent tie-points available to verify the accuracy of this age model, but based on the structure of the isotope-depth profile, the derived age model appears to be fairly accurate. The latest heaviest $\delta^{18}O_{G.sacculifer}$ ($0.18 \%$) at 293 cm depth is considered as the LGM. However, the AMS $^{14}C$ dating would help to overcome any ambiguity if at all evident in the present age model.
Figure 4: Depth versus oxygen isotope profile used for the Age-Model of SK117/GC-02 core. The compressed inset on the right-hand-side is presented for ready comparison with the SPECMAP. The upper exploded panel is the depth-age curve used to define the age-model. Vertical and horizontal broken lines indicate the marine oxygen isotope stage boundaries and corresponding ages. LGM=Last Glacial Maximum (~18 Ka) identified as the latest heaviest oxygen-isotope event in the depth profile.
5.2. Sedimentation rates:

The changes in marine sedimentation rates in the proximity of continents provide preliminary clues about the past variation in aeolian dust, fluvial erosion input, and the marine productivity (Prins et al., 2000; Sirocko et al., 1993). The sedimentation rates are essential to estimate the mass accumulation rates of the components at the seafloor, which eliminates the bias (due to dilution effect) associated with interpreting direct weight concentrations in sediments with varying physical properties. In the present case, the sedimentation rates in GC2 and GC8 from the shelf and slope off Goa are expected to provide a cumulative scenario of fluvial erosion input from the Mandovi-Zuari river draining the hinterland of Goa (part of Deccan Mountain belt), continental dust input mainly from the adjoining Indian peninsula by the winter monsoon winds and the water column productivity. On the other hand, sedimentation rates in the third core (CR4) would dominantly indicate changes in productivity, because this core is far removed from the land and the winter monsoon wind influence is less dominant. The calculated sedimentation rates using the depths at which various isotope stage boundaries are defined, isotope stage boundary timings, and the total thickness of the sediment represented by each isotope stage are presented in Table 4.

Table 4: Linear sedimentation rates

<table>
<thead>
<tr>
<th>Core</th>
<th>Sedimentation rate (cm/ky)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Holocene</td>
</tr>
<tr>
<td>SK117/GC02</td>
<td>4.0</td>
</tr>
<tr>
<td>SK117/GC08</td>
<td>2.3</td>
</tr>
<tr>
<td>SK129/CR04</td>
<td>3.6</td>
</tr>
</tbody>
</table>
From Table 4 it is clear that the sedimentation rates in all the three cores are highest during the LGP. The Holocene sections exhibit moderately varying sedimentation rates, i.e., 2-4 cm/ky in all the cores. The GC-02 core (continental self) shows extremely high sedimentation rate (by ~6 times) during the LGP than during the Holocene. The deep-water core (GC-08) from the same longitude exhibits three times higher rate of sedimentation during the LGP than during the Holocene. The southern EAS deep-water core (CR-04), on the other hand shows marginal increase during the LGP. This core records nearly similar sedimentation rate during the penultimate glacial period (MIS6) as that during the LGP. In the GC08 the sedimentation rates during the MIS5 through MIS3 time-slice are same (~4 cm/ky) and are nearly two times higher than the Holocene.

5.3. Sediment texture

SK117/GC08 (Figure 5):

In general the +63 μm (sand) fraction exhibits decreasing trend down-core. The variation is of an order of magnitude (between ~25 % and ~2 %). The Holocene section contains high percentage (Av. ~22%) than the sections corresponding to other time periods. The LGP contains on an average ~10 % sand but with a peak of ~20 % at ~16 Ka. The MIS3 period exhibits two minor peaks of sand at ~30 Ka (14 %) and ~50 Ka (12 %) separated by broad trough of nearly 20 ky time-span. The
sand content in the MIS4 and MIS5 sections is the lowest (~3%) of the entire record without any significant variation.

The silt- and clay-fractions exhibit an interesting mirror-image temporal-trend independent of sand. The clay content varies between 20% and 50%. The dominant fraction of the sediment is the silt, which varies between 40% and 65%. The LGP interval exhibits highest silt content (~65%) and lowest clay content (~20%). The Holocene period records ~42% silt and ~35% clay. Nearly equal content (~45%) of both these fractions dominate the rest of the time period prior to the beginning of the LGP. The only significant feature of the pre-LGP silt-clay variation is the second highest silt-lowest clay pairing (62% vs 32%) at around the closure of MIS5.

SK129/CR04 (Figure 6):

Down the core, the sand fraction increases from 20% (core-top) to 38% at ~9 Ka, reduces to ~18% (~16 Ka), and remains more or less constant ~20% through the MIS3 period. A further reduction by ~10% through the MIS4 section results in the lowest (~7%) sand content at ~72 Ka. The second peak of ~40% sand is located at MIS5.5 (~122 Ka) and further down-core reduces to ~10% through the MIS6. Interestingly, the sand fraction monotonously increases through all the three glacial events leading to peaked concentration at the commencement of succeeding warm events. The structure of the temporal sand profile for the Holocene and the MIS5.5 appear to be very similar. The silt and sand exhibit more or less opposite trend. The prominent low-silt events in the core are identified at ~9 Ka (40%), ~82 Ka (45%) and ~123 Ka (36%), where as, the high-silt events are located at 17 Ka (59%) and 73 Ka (~72%). The rest of the silt distribution varies marginally around 50% throughout. Even though the clay is second abundant sediment fraction, it follows partly the sand and partly the silt. There are three low clay events located at ~15 Ka (22%), ~72 Ka (28%) and ~125 Ka (31%). Overall marginally high clay content is restricted to the warm stages like Holocene and the MIS5.
SK117/GC02 (Figure 7):

Except for few spikes around the beginning and closure of the LGP, the sediment fractions exhibit smooth variation. The variation of sand fraction is exactly opposite to both silt and clay, which are strongly coherent with each other in the core. The Holocene section exhibits highest content of sand (~80 %) and reaches the lowest of <5 % at ~11 Ka. At the commencement of the LGP, the sand content is very low (<10 %) and drastically increases between ~21 Ka and ~18 Ka (i.e., around...
LGM) to as high as >60 %. On the other hand, the lowest silt and clay contents are recorded during the Holocene followed by during the early part of the LGP (-22 Ka-~18 Ka), which overtake the sand dominance at ~18 Ka until ~11 Ka. The overall clay fraction is higher (~12 %) than the silt (~3 %) in the Holocene interval. Whereas, during the LGP the clay and silt contents are nearly equal and vary between 20 % and 40 %.

5.4. Time-series record of sedimentary inorganic components

5.4.1. Calcium carbonate

SK117/GC08 (Figure 8):

The calcium carbonate (henceforth only carbonate) content varies from 18 % to 49 %. There are four elevated carbonate intervals in the core, which are at around the latest Holocene, mid-LGP, early-MIS3 and MIS5.3. A fifth peak of ~35% carbonate is at MIS5.1, which is formed due to two lowest content (<20 %) troughs of carbonate at the commencement of MIS4 and at the MIS5.2. The former peaks exhibit nearly constant carbonate content of ~45 %. The other characteristics of the carbonate distribution in this core are, a) a drastic increase through the Holocene and MIS4, and marginal variation (within ±5 %) during the LGP through MIS3 timeslice, and b) extreme variations (~20 % to ~45 %) through MIS4 and in MIS5.

Figure 8: Temporal variation of calcium carbonate in the SK117/GC08 core. Note the distinctly elevated carbonate in the post-MIS4 period, which begins to increase from ~20% at the commencement of MIS4 and reaches a high of ~45 % in the earliest MIS3. The largest variation is found during the MIS5 period.
SK-129/CR04 (Figure 9):

The average carbonate content in the core is ~50 % with a minimum at ~72 Ka. The Holocene through MIS3 section exhibits relatively narrow variation within ±5 % around an average of 55 %. The carbonate content shows a monotonous increase through the MIS4 from ~25 % at the commencement to ~50% at the closure. The MIS5 section on the other hand contains three high carbonate peaks separated by three low carbonate troughs. The structure of the carbonate variation during the MIS5 though appears to resemble the stadial-interstadial pattern recognized in the oxygen isotope curves, but do not exactly correspond to their timings. The high-low carbonate events are rather located at the transition of stadial-interstadial events in MIS5. A common feature in carbonate variation during all the three glacial events is that of increasing trend through the glacial period towards the succeeding warm intervals.

Figure 9: Temporal variation in carbonate content of the SK129/CR04 core from the southern-EAS region. Note the drastic increase of carbonate content through the MIS4 and the typical stadial and interstadial type structure in the MIS5 (downward arrows). Block arrow indicates that the MIS6 continues further down-core. The shaded bars are the glacial periods numbered at the top.
SK117/GC02 (Figure 10):

The Holocene average carbonate content is ~80 % without significant variations except for a rise at ~5 Ka. On the other hand, the LGP section records extreme variation. The LGP begins with a drastic increase from 20 % (at ~ 24 Ka) reaching to 60 % (at ~ 22 Ka) (i.e., 40 % increase in 2 kyr span). The rise continues gradually up to a maximum of ~70 % at ~17 Ka. During the latest part of the LGP (15 Ka onwards) the carbonate content gradually decreases to ~55 % at its termination.

Figure 10: The carbonate variation during the LGP through the Holocene recorded in SK117/GC02 core. Note a drastic increase (from ~20 % to as high as 60 %) in the carbonate content during beginning of the LGP.
5.4.2. Particulate-Mn and scavenged-Al variation (Figure 11):

The particulate Mn-oxide and the detrital silicate unsupported-Al (scavenged-Al) could be the indicators of water column redox conditions and surface water productivity respectively (Banakar et al., 1998; Dickens and Owen, 1994; Murray and Leinen, 1993). The core exhibits highest Mn$_{\text{excess}}$ (~250 ppm) in the earliest part of the LGP decreasing to ~40 ppm at around 15 Ka. Further later, it increases to ~100 ppm in the latest part of the LGP, followed by monotonous decrease to 50 ppm through the Holocene. The Al$_{\text{excess}}$ variation in this core is nearly similar to that of the Mn$_{\text{excess}}$. The lowest concentration troughs in the time-series are centred ~17 Ka.

![Figure 11: Sedimentary Al$_{\text{excess}}$ and Mn$_{\text{excess}}$ variation in continental shelf core (GC02). The shaded area is the time period covered by the LGP. The double head arrow marks the beginning of increase in excess Al & Mn around the beginning of deglaciation.](image)

5.5. Time-series records of sedimentary organic components:

The data of sedimentary organic components comprising organic carbon ($C_{\text{org}}$), total nitrogen ($N_{\text{tot}}$), and alkenones was obtained for only one deep-water core (GC08) due to certain analytical constraint. I am aware of this limitation because modern biogenic-flux across the deep Arabian Sea greatly varies in space (Haake et
al., 1993; Nair et al., 1989). Nevertheless, the present data-set for the GC-08 forms the nearly complete climate proxy record and hence should be able to provide important clues regarding EAS responses to past climate variability.

5.5.1. Sedimentary organic carbon and nitrogen (Figure 12):

The temporal variation of $C_{\text{org}}$ and $N_{\text{tot}}$ exhibit strictly similar trends as normally expected for the unaltered marine organic matter (Peters et al., 1978). The carbon is enriched nearly by an order of magnitude than the nitrogen. The $C_{\text{org}}$ ranges from 0.5 to 1.8%, while the $N_{\text{tot}}$ varies between 0.06% and 0.21% in the core. During the major part of the LGP and MIS3 both these components are distinctly higher than the mean contents of 1% and 0.13% respectively in the core. In the MIS3 section the $C_{\text{org}}$ and $N_{\text{tot}}$ attain highest concentrations (up to 1.8% and 0.21% respectively). The $C_{\text{org}}$ content in the Holocene is not only less than the core average, but also is the second lowest average content (~0.8%). Through the MIS4, both the components gradually decrease from ~1.2% and 0.15% to 0.5% and 0.07% respectively. The MIS5 stadial exhibits higher $C_{\text{org}}$ and $N_{\text{tot}}$ (~1.2% and 0.16% respectively) than the interstadials (~0.5% and 0.06%). The $C_{\text{org}}$ and $N_{\text{tot}}$ in the LGP are distinctly higher than the Holocene.

![Figure 12: The temporal variation of the sedimentary organic-carbon and total-nitrogen in GC08. The replicated behaviour of these components suggests negligible fractionation. The carbon content is nearly 8 times higher than the nitrogen, nearly in accordance with the Redfield Ratio for marine organic matter (~7).](image-url)
5.5.2. Alkenone variation during the LGP to Holocene (Figure 13):

The temporal variation of the \( \Sigma \)alkenones (sum of di- and tri Unsaturated ketones C37, C38 and C39) exhibit extremely low content in the Holocene section (<0.1 ppm) as compared to very high concentrations up to 1.6 ppm in the LGP. The Holocene- \( \Sigma \)alkenones show nearly constant value (<0.1 ppm), while in the LGP the content ranges between 0.6 ppm (~18 Ka) to ~1.5 ppm (~20 Ka & ~14 Ka). The average \( \Sigma \)alkenones content in the LGP (~1 ppm) is higher by an order of magnitude than the Holocene. The actual rise in \( \Sigma \)alkenones appears to begin around the commencement of the LGP and reaches the peaked concentration at the beginning of the deglaciation.

![Figure 13: Temporal variation of \( \Sigma \)alkenones during the last 27 Ka in GC08. The concentrations in the LGP sections are enriched by an order of magnitude compared to the concentrations in the Holocene. The block arrow indicates that the MIS3 continues further down-core. The shaded vertical bar is the LGP.](image)

5.5.3. Time-series record of organic carbon isotopes (\( \delta^{13}C_{\text{org}} \)) (Figure 14):

The temporal variation of sedimentary carbon \( \text{org} \) isotopes is within −19 %o and −17 %o. The most depleted \( \delta^{13}C_{\text{org}} \) are evident around the latest Holocene, mid-MIS3, commencement of MIS4, and at MIS5.2 with a value of ~ -19.3 %o. The enriched \( \delta^{13}C_{\text{org}} \) is evident at the commencement of the Holocene (~17.7 %o) and at around MIS5.1 (~18.1 %o). The \( \delta^{13}C_{\text{org}} \) curve exhibits steep slopes leading to rapid peak and
troughs. The most prominent and largest excursion of around 2.4‰ is noticed in the Holocene section, where the δ^{13}C_{org} with ~ -17‰ at the beginning of the Holocene decreases to ~ -19.5‰ in the latest Holocene (core top) section. Both the interstadials of MIS5 exhibit distinctly enriched δ^{13}C_{org} than the stadial.

5.5.4. Time-series record of sedimentary nitrogen isotopes (δ^{15}N) (Figure 15):

The sedimentary nitrogen isotopes (δ^{15}N) show distinct alternating enrichment and depletion during the last 100 Ky. Similar to the sedimentary organic-carbon isotopes, the LGP section exhibits near uniform concentration of the δ^{15}N (~7‰). Prominent peaks and troughs are evident throughout the pre-LGP period. The lowest δ^{15}N (5.8‰) is evident in MIS4 followed by MIS5.1 and MIS5.2 interstadials.
The MIS5.1 and MIS5.2 low $\delta^{15}N$ events are separated by a maximum enrichment (9.4 %) event centred on MIS5.2. The MIS3 section also contains a prominent peak of enriched $\delta^{15}N$ (~9.2 %) at ~45 Ka. Through the Holocene the $\delta^{15}N$ increases from ~7 % at its commencement to 8.5 % in the recent most (core-top) section. Another important aspect of the $\delta^{15}N$-temporal record is that the enrichment events appear to have spaced at about 45 Ky intervals, if relatively less prominent intruding peak at ~72 Ka is ignored.

5.6. Time-series record of $G.\, sacculifer$ carbon isotopes (Figure 16):

The temporal record of the calcite carbon isotopes obtained from the skeletons of the $G.\, sacculifer$ exhibit large scatter. Nevertheless, few distinct trends are noticeable. Therefore, to bring-out those trends the data is smoothed by two point running averages.

In the GC-08 core (panel A) the $\delta^{13}C_{\, G.\, sacculifer}$ variation exhibits a decreasing trend through both the glacial stages (LGP and MIS4), where it decreases from ~1.1% at their commencement to ~0.6 % at their closure. A monotonous increase from 0.6 % to 1.05 % is evident through the MIS3. However, during the Holocene and the MISS the $\delta^{13}C_{\, G.\, sacculifer}$ fluctuations are rather gentle (within ±0.3 %) around an average of 0.9 %. These minor fluctuations within both the warm periods do not exhibit any discernible trends. The lowest $\delta^{13}C_{\, G.\, sacculifer}$ are evident around 13 Ka and 56 Ka.

The $\delta^{13}C_{\, G.\, sacculifer}$ variation in CR04 core (Panel B) is more complex. The fluctuations through the last ~100 Ky are within a narrow margin of ±0.3 % around an average of ~1.2 %. The MIS4 exhibits minimum variation of <0.2 % as compared to the rest of the 100 Ky time-span. The most interesting and the prominent feature in this core is a major positive shift from ~0.6 % at ~128 Ka, to ~1.3 % at ~100 Ka. This 0.7 % shift is nearly double than those recorded in other time-slices in the core.
and marks a major event in the last 150 Ky $\delta^{13}C_{G.sacculifer}$-record. Prior to this shift, in the latest part of the MIS6, the $\delta^{13}C_{G.sacculifer}$ remains $\sim 0.8\%$ with a fluctuation of $\pm 0.3\%$. Thus there are two levels of $\delta^{13}C_{G.sacculifer}$-trends in the core, viz., the enriched $\delta^{13}C$-trend ($\sim 1.2\%$) during post-100 Ka period, and depleted $\delta^{13}C$-trend ($0.8\%$) prior to the Glacial Termination 2 (GT2) (or the commencement of MIS5 warm period). Thus the GT2 marks a major positive shift in the calcite carbon isotopes.

![Graph](image)

Figure 16: Time-series $G.sacculifer$ calcite-$\delta^{13}C$ record in the Eastern Arabian Sea sediment. The two long-term records of the deep-water cores (A & B) exhibit nearly comparable temporal variation suggesting robustness of the carbon-isotopic record despite large fluctuations. The last glacial fluctuations appear more complex than during the Holocene in the high-resolution record of the GC02 core. Note a major positive shift of the $\delta^{13}C_{G.sacculifer}$ at the Glacial Termination 2 through the MIS5 in the CR4 (B). Panel A = GC08, Panel B = CR04 and Panel C = GC-02.
The high-resolution $\delta^{13}C_{S.saccular}$ curve in GC02 core does not exhibit any distinct variations (Panel C). The overall range of variation is between 0.8 % and 1.2 % with an average of 1 %. The Holocene record contains a gradual change with only one $\delta^{13}C_{S.saccular}$-enriched event of ~1.1 % at ~5 Ka flanked by two -depleted events of 0.9 % at ~2 Ka and ~10 Ka. The later half of the LGP (17-11 Ka) contains high frequency fluctuations of ±0.4 %. In contrast the earlier half of the LGP shows a gradual variation within ±0.2 %.