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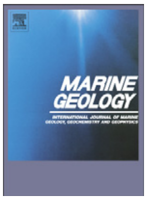

Productivity controlled cold-water coral growth periods during the last glacial off Mauritania

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ABSTRACT

Cold-water corals are widely distributed along the Atlantic continental margin with varying growth patterns in relation to their specific environment. Here, we investigate the long-term development of cold-water corals that once thrived on a low-latitude (17°40′N) cold-water coral mound in the Banda Mound Province off Mauritania during the last glacial–interglacial cycle. U/Th dates obtained from 20 specimens of the cold-water coral *Lophelia pertusa*, revealed three distinct periods of coral growth during the last glacial at 65 to 57 kyr BP, 45 to 32 kyr BP and 14 kyr BP, thus comprising the cool periods of Marine Isotopic Stages (MIS) 2–4. These coral growth periods occur during periods of increased productivity in the region, emphasizing that productivity seems to be the major steering factor for coral growth off Mauritania, which is one of the major upwelling regions in the world. This pattern differs from the well studied coral mounds off Ireland, where the current regime predominantly influences the prosperity of the cold-water corals. Moreover, coral growth off Ireland takes place during rather warm interglacial and interstadial periods, whereas off Mauritania coral growth is restricted to glacial and stadial periods. However, the on-mound sedimentation patterns off Mauritania largely resemble the observations reported from the Irish mounds. The bulk of the preserved sediments derives from periods of coral growth, whereas during periods without corals hardly any net sedimentation or mound growth took place.

1. Introduction

Cold-water corals show a high biodiversity and a worldwide distribution which makes them a unique ecosystem of the bathyal zone (Roberts et al., 2006; Weaver et al., 2009). Over a few million years, successive coral growth can form large cold-water coral carbonate mounds (Kano et al., 2007). This occurs especially in the Atlantic Ocean, where coral mounds are well-known features along the continental margins. In the eastern Atlantic, they have been discovered off Ireland (De Mol et al., 2002; Wheeler et al., 2007), on Hatton Bank (Roberts et al., 2008), off Morocco (Foubert et al., 2008; Wienberg et al., 2009) and off Angola (Le Guilloux et al., 2009). In the western Atlantic, coral mounds are common along the South Eastern USA (Mienis et al., 2010; Neumann et al., 1977; Paull et al., 2000) in the Florida Strait (Grasmueck et al., 2006), along the West Florida Slope (Grasmueck et al., 2006; Newton et al., 1987), off Colombia (Reyes et al., 2005) and off Brazil (Sumida et al., 2004; Viana et al., 1998).

Coral mounds along the Irish continental margin have been intensely studied during the past two decades. These mounds are concentrated in a depth range of 500–1200 m along the continental slope (De Mol et al., 2007; Dorschel et al., 2007; Foubert et al., 2005; Mienis et al., 2006). They occur as elongated clusters or single mounds and numerous buried mounds have been discovered (Huvenne et al., 2003; Huvenne et al., 2007; Van Rooij et al., 2003). Exposed mounds vary in height between a few meters (e.g. Moira Mounds, Porcupine Seabight; Wheeler et al., 2005) and >300 m (e.g. Logachev Mounds, SW-Rockall Trough; Mienis et al., 2007) and show a maximum lateral extension of 5 km (De Mol et al., 2002). Today several Irish mounds are covered by live cold-water corals with the framework-building species *Lophelia pertusa* and *Madrepora oculata* being most common (Freiwald, 2002). These mounds coincide with water-mass boundaries where (food-) particles accumulate and can form a nepheloid layer (Mienis et al., 2006; Mienis et al., 2007). The food particles concentrated within this depth interval are transported towards the corals by tidal currents and internal waves (White, 2007).

Cold-water corals are assumed to baffle fine grained sediments that otherwise would remain in suspension during periods with a high-current regime and, in addition, the coral framework inhibits winnowing of such fine sediments once these have been deposited

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between the corals (Huvenne et al., 2009). Along the Irish margin this process resulted in the development of giant coral mounds (Kenyon et al., 2003; van Weering et al., 2003) that experienced rapid vertical growth while the surrounding seabed lacked deposition of sediments (Huvenne et al., 2009). Estimated mound growth rates vary between 15 and 30 cm kyr^{-1}, and can be locally as high as 220 cm kyr^{-1} (de Haas et al., 2009; Eisele et al., 2008; Frank et al., 2009). The Irish mounds reveal a periodic growth pattern with sustained coral growth being related to warmer, mainly interglacial periods (Marine Isotopic Stage (MIS) 8, MIS 7, MIS 5 and Holocene), whereas during glacial periods coral growth is largely reduced or even absent (de Haas et al., 2009; Dorschel et al., 2005; Eisele et al., 2008; Frank et al., 2005; Frank et al., 2009; Kano et al., 2007; Mienis et al., 2009; Rüggeberg et al., 2007). In consequence, mound growth off Ireland stagnated during cooler periods (MIS 6 and MIS 4–2). This has been attributed to: (1) weak bottom currents that prevailed during glacials and led to the slow deposition of very fine sediments and/or to (2) strong bottom currents that started to re-establish with the onset of interglacials and easily eroded the unconsolidated sediments (Dorschel et al., 2005). Overall, all studies have revealed the importance of bottom currents as the main controlling factor for mound growth along the Irish margin.

This study is investigating cold-water coral mounds situated off Mauritania (Fig. 1), thus giving an example for coral mound development in the subtropical latitudes of the eastern Atlantic Ocean. The Mauritanian coral mounds show some distinct similarities to their Irish counterparts. They are aligned parallel to the slope and are restricted to water depths between 450 and 550 m (Colman et al.,

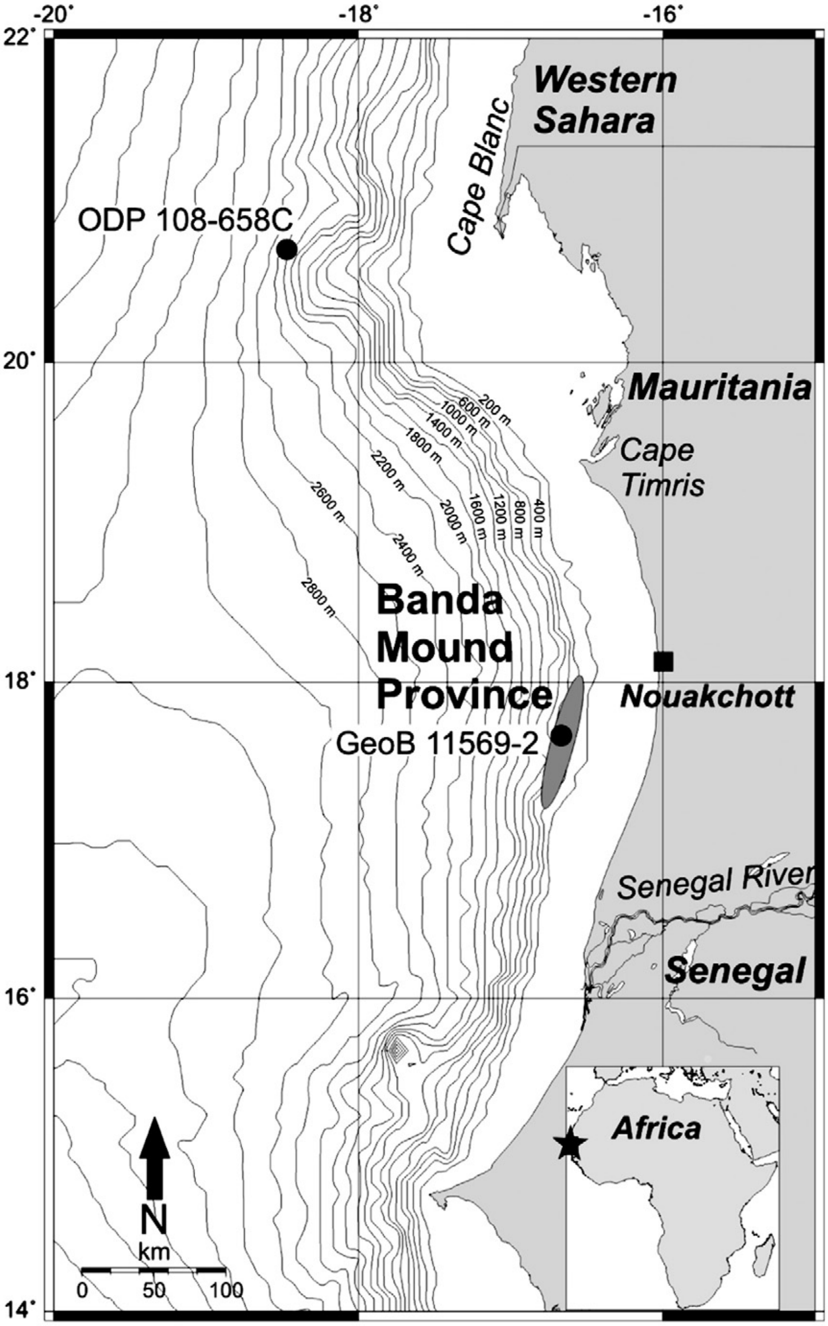

Fig. 1. Map of the working area on the NW-African continental margin. The grey oval marks the Banda Mound Province off Mauritania in ~450 m water depth. Sediment cores GeoB 11569-2 (444 m water depth, on-mound) and ODP 108-658C (2263 m water depth, palaeoenvironmental reference core) are indicated with a black dot. The black star on the overview map marks the working area.

2005). They occur as elongated clusters with the largest mounds reaching a height of 100 m and a lateral extension of 500 m. In addition to these exposed mounds, numerous buried mounds were discovered further upslope (Colman et al., 2005). Video footage and sediment samples revealed the presence of mainly fossil cold-water corals (*Lophelia pertusa*, *Madrepora oculata*, *Solenosmilia variabilis* and solitary corals), whereas live corals are an exception (Colman et al., 2005; Westphal et al., 2007). Thus it appears that the modern environmental and oceanographic conditions off Mauritania are not optimal for sustained coral growth. However, no detailed analyses have been conducted in this area in terms of coral vitality and diversity, and even more importantly, nothing is known about the long-term development of the Mauritanian coral mounds. This study presents the first high-resolution record of a coral mound situated in the Banda Mound Province (17°40′N, 016°40′W; Fig. 1). The main aim of the study is to determine periods of mound growth off Mauritania and to identify the main oceanographic and environmental factors that steer mound growth in the subtropical eastern Atlantic Ocean.

2. Oceanographic setting

The upper water column off Mauritania is composed of warm and saline Tropical Surface Water (TSW) (Stramma and Schott, 1999). It is underlain by low saline, oxygen depleted, nutrient-rich northward flowing South Atlantic Central Water (SACW) reaching down to 600 m water depth (Mittelstaedt, 1991; Pastor et al., 2008). Below the SACW follows the cooler and fresher Antarctic Intermediate Water (AAIW) (Stramma and Schott, 1999).

The Mauritanian shelf is influenced by one of the world's major coastal upwelling systems. Wind-driven upwelling takes place in a 20–30 km wide strip along the coast bringing up cold, nutrient rich SACW from depths of ~300 m (Mittelstaedt, 1991). The effects of the upwelling are restricted to the shelf waters and the upper slope. The upwelling-intensity off Mauritania is controlled by the strength and direction of local trade winds (Fischer et al., 1996; Martinez et al., 1999). During periods dominated by strong winds the coastal currents associated with the upwelling system spread over the entire shelf and even beyond the shelf break, whereas during periods of low wind intensity even the outer shelf is influenced by the offshore regime (Mittelstaedt, 1991). During summer upwelling can be inhibited seasonally by warm TSW (down to 100 m below the surface) overlaying the subsurface water masses.

The current regime in the vicinity of the coral mounds has not been investigated so far. However, video footage from mounds and nearby sea floor did not show any bedforms (as ripples or sand waves) that would indicate a high current regime. Current meter data from off mound sites show mean bottom current velocities between 8.2 and 10 cm s^{-2} (Colman et al., 2005).

3. Materials and methods

3.1. Core material

During RV *Poseidon* cruise POS 346 gravity core GeoB 11569-2 (Station no.: Pos 346-69-2) was collected from a cold-water coral mound (016°40.33′W, 17°40.01′N, 444 m water depth) in the Banda Mound Province (for details see Westphal et al., 2007). This sediment core has a diameter of 12 cm and a total recovery of 509 cm, albeit the top ~35 cm were lost (overpenetration) during coring operations. The core consisted of coral fragments embedded in a hemipelagic sediment matrix. The main coral species was *Lophelia pertusa*. Two distinct layers of coral debris and bivalve shell hash occurred at ~170 and ~35 cm core depth.

3.2. U/Th age determination on cold-water corals

From sediment core GeoB 11569-2, 20 fragments of the cold-water coral *Lophelia pertusa* were dated using the ^{230}Th/U method (Table 1). Measurements were carried out on a plasma source quadrupole mass spectrometer (ThermoFisher X-Series) as described in detail by Douville et al. (2010). The accuracy of the analyses reported here was tested through replicate measurements and by comparison with conventional thermal-ionization mass spectrometry (TIMS; see Douville et al., 2010). Subsequent TIMS measurements were carried out using the methods described by Frank et al. (2005, 2004).

U-series concentrations and isotope ratios of standards are reproducible and consistent at less than 5‰ for U and 8–10‰ for Th (Douville et al., 2010). U-series measurements on corals provided similar precision for U-isotopes, while the uncertainty of ^{230}Th measurements was on average higher due to the lower ^{230}Th levels leading to age uncertainties ranging from 0.8% to 7% (2 sigma). However, largely sufficient precision and accuracy of ±220–4000 yrs age was achieved to clearly distinguish coral growth intervals during the past 70 to 14 kyrs. Analytical procedures such as sample selection and cleaning followed closely the ones published previously (Frank et al., 2004). The initial δ^{234}U-ratio is given in Table 1 ($\delta^{234}U_T$)-value. The δ^{234}U-values plotted within a range of ±15‰ around modern value, therewith showing a sufficient reliability.

3.3. Age model for core ODP 108-658C

To relate coral growth phases off Mauritania to distinct palaeoenvironmental settings, the U-series coral ages obtained (i.e. times of coral prosperity) were compared to the palaeoceanographic records of core ODP 108-658C (20°45′N, 18°35′W, 2263 m water depth) from the same region 300 km to the northeast (Fig. 1). To allow for a detailed correlation with the coral age dataset, the age model of this core as proposed by Zhao et al. (2006) was partly revised. The AMS ^{14}C based stratigraphy of the upper part of ODP core 108-658C (core top to 4.1 m core depth), that comprised the past 22.9 kyr BP (deMenocal et al., 2000), has not been changed. The δ^{18}O/magnetic susceptibility based composite age model suggests that the lower core portion between 4.1 m and 22.4 m covers the period between 22.9 ka BP and 147 kyrs BP as suggested by Zhao et al. (2006). However, for this lower part of the core, which comprised the period prior to the Last Glacial Maximum (LGM), the age model of Zhao et al. (2006) has been revised (Fig. 2). The conspicuous sea-surface temperature (SST) drops in ODP 108-658C, reconstructed from the $U^{k}_{37'}$ alkenone record (Zhao et al., 1993), were correlated to Heinrich Stadials (HS). The SST record unambiguously traces the HS (Zhao et al., 1995) although the radiocarbon ages of deMenocal et al. (2000) imply, that HS 2 is not represented by the extreme negative peak in the SST record at ~23 kyr BP. We suggest that HS 2 was displayed in a smaller temperature decrease (to 17.9 °C) at ~4.4 m core depth (~26 kyr BP). The ages for HS 2 and HS 3 are taken from the NGRIP-δ^{18}O ice-core record (NGRIP Members, 2004). For HS 4 to 6 the ages provided by Sanchez Goñi and Harrison (2010) have been assigned to the matching HS in core ODP 108-658C based on the SST record. In the revised age model (older than 22.9 kyr) ages in between the HS have been linearly interpolated.

4. Results

A total of 20 U-series dates were conducted on *Lophelia pertusa* fragments from sediment core GeoB 11569-2 and revealed three distinct clusters of coral ages (i.e. growth periods) during the past 65 to 14 kyr BP (Table 1 and Fig. 2). The coral ages (n = 11) from the lower part of the core (core base at 509 cm to 170 cm core depth) clustered between 65 and 57 kyr BP. The coral ages (n = 8) from the central part of the core (170 to 35 cm core depth) ranged from 45 to

Table 1
Details on the U/Th age determinations carried out on core GeoB 11569-2. Only the results of the ICP-QMS-analyses are displayed (for details see Douville et al., 2010). The different shadings mark the different age clusters.

Lab code	Sample	Core depth (cm)	$[^{238}U]$ ppm		$[^{232}Th]$ ppb		$\delta^{234}U_M$ (‰)		$(^{230}Th/^{238}U)$		$(^{230}Th/^{232}Th)$		Age (kyr)		$\delta^{234}U_T$ (‰)	
Gif– 1187	1L	13	1.658	±0.001	0.991	±0.002	135.5	±2.2	0.1391	±0.0017	712	±9	14.24	±0.22	141.1	±2.2
Gif– 1199	3L	40.5	7.606	±0.009	3.834	±0.013	132.4	±3.5	0.2916	±0.0066	1,768	±40	32.33	±0.96	145.1	±3.5
Gif– 1200	4L	51.5	2.920	±0.003	2.688	±0.008	130.8	±3.5	0.3506	±0.0098	1,164	±33	40.23	±1.50	146.5	±3.5
Gif– 1201	5L	73	3.008	±0.002	6.151	±0.013	138.1	±2.1	0.3053	±0.0051	456	±8	33.89	±0.73	152.0	±2.1
Gif– 1188	6L	88.5	3.405	±0.003	10.127	±0.037	133.0	±3.5	0.3230	±0.0081	332	±8	36.40	±1.21	147.4	±3.5
Gif– 1189	7L	103	3.019	±0.004	13.156	±0.108	131.9	±4.2	0.3347	±0.0102	235	±7	38.02	±1.55	146.9	±4.2
Gif– 1202	8L	116.5	3.218	±0.011	3.899	±0.100	134.3	±4.9	0.3867	±0.0146	976	±44	45.15	±2.34	152.6	±4.9
Gif– 1203	9L	145	3.454	±0.006	1.584	±0.005	130.4	±5.8	0.2928	±0.0072	1,952	±48	32.55	±1.12	143.0	±5.8
Gif– 1204	10L	154	3.056	±0.002	6.344	±0.014	125.9	±2.4	0.3442	±0.0050	507	±7	39.56	±0.80	140.8	±2.4
Gif– 1190	12L	175	3.069	±0.005	1.946	±0.067	113.4	±5.0	0.4669	±0.0226	2,251	±134	58.83	±4.10	133.9	±5.0
Gif– 1205	14L	220	2.907	±0.002	2.035	±0.004	124.3	±2.2	0.4636	±0.0049	2,024	±22	57.40	±0.95	146.2	±2.2
Gif– 1193	17L	305.5	3.803	±0.003	2.233	±0.048	120.2	±3.0	0.4667	±0.0187	2,429	±110	58.25	±3.27	141.7	±3.0
Gif– 1206	19L	330	3.106	±0.002	4.439	±0.006	113.9	±1.9	0.5062	±0.0028	1,082	±6	65.36	±0.65	137.0	±1.9
Gif– 1194	21L	369	3.187	±0.003	3.683	±0.023	117.5	±4.4	0.4832	±0.0161	1,278	±43	61.18	±3.05	139.6	±4.4
Gif– 1207	22L	381	2.890	±0.002	6.420	±0.013	115.3	±2.0	0.4736	±0.0020	652	±3	59.71	±0.49	136.4	±2.0
Gif– 1195	23L	400	3.452	±0.003	7.594	±0.044	122.1	±4.1	0.4904	±0.0103	681	±15	62.00	±2.07	145.5	±4.1
Gif– 1196	24L	424.5	3.373	±0.004	2.874	±0.027	120.4	±3.8	0.4745	±0.0147	1,702	±55	59.50	±2.71	142.4	±3.8
Gif– 1208	25L	440.5	3.173	±0.002	3.818	±0.011	115.4	±2.7	0.4668	±0.0076	1,186	±20	58.58	±1.44	136.2	±2.7
Gif– 1209	26L	457	3.202	±0.002	1.832	±0.002	112.7	±1.8	0.4731	±0.0024	2,527	±13	59.80	±0.53	133.4	±1.8
Gif– 1197	28L	500.5	2.552	±0.002	6.287	±0.012	124.0	±2.8	0.4874	±0.0077	605	±10	61.34	±1.51	147.5	±2.8

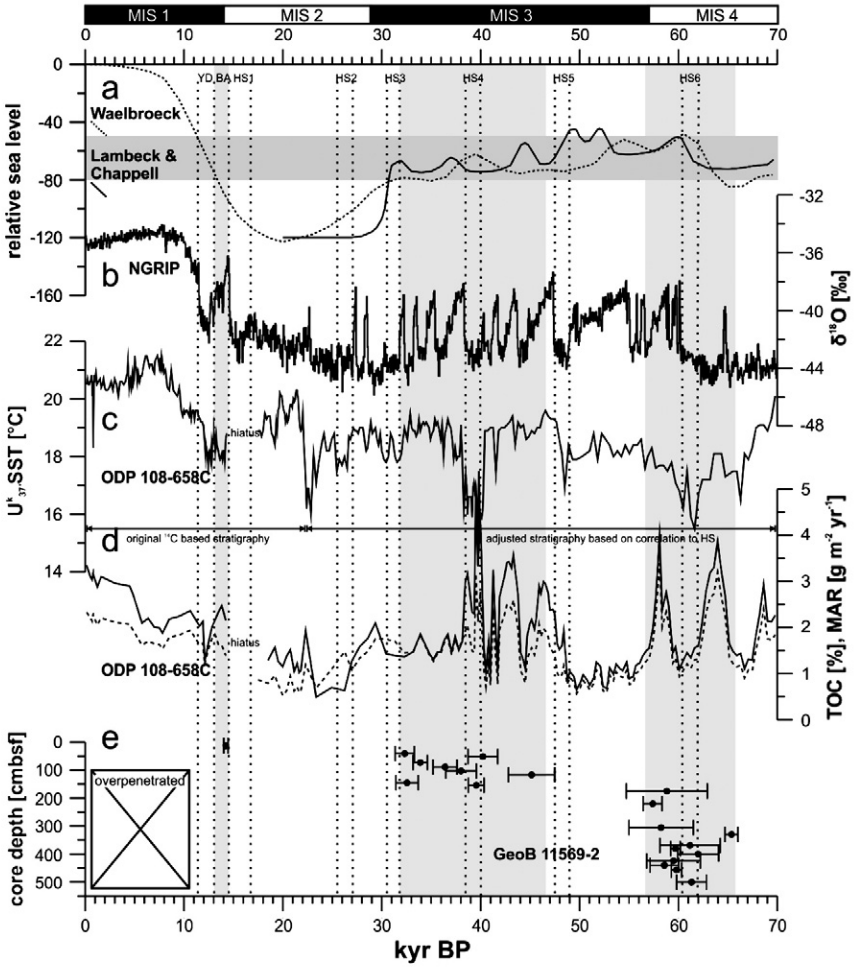

Fig. 2. a) Relative palaeo-sea-level (Lambeck and Chappell, 2001; Waelbroeck et al., 2002), the dark grey bar indicates the palaeo-sea-level coinciding with coral occurrences b) $\delta^{18}O$ record of the NGRIP ice core (NGRIP Members, 2004); c) $U^{k}_{37'}$ SST record of ODP core 108-658C modified after Zhao et al. (1993) d) TOC-mass accumulation rate (MAR) (solid line) and TOC content (dashed line) of ODP-core 108-658C modified after Zhao et al. (2006). e) Coral ages vs. core depth of core GeoB 11569-2. The light grey bars mark periods of coral growth. On the upper x-axis, the Younger Dryas (YD), the Bølling–Allerød interstadial (BA), Heinrich Stadials (HS) and Marine Isotopic stages (MIS) are indicated as summarised by Lisiecki and Raymo (2005).

32 kyr BP (MIS 3), with the bulk of the coral ages clustering between 38 and ~32 kyr BP. The uppermost dated coral fragment at 13 cm core depth revealed the youngest age at 14.2 kyr BP (Table 1 and Fig. 2).

The first growth period (65–57 kyr BP) showed the highest vertical mound growth rate observed in the core (~28 cm kyr^{-1} on average), albeit the coral ages are not arranged consecutively downcore (age reversals). The second growth period (45–32 kyr BP) showed lower vertical growth rates (~10 cm kyr^{-1} on average) than the first one; again age reversals were common. The third growth period was represented by only one single coral age (14.2 kyr BP).

The sedimentary boundaries between these growth periods at 170 cm and 35 cm core depth are marked by layers of shell hash indicating hiatuses comprising approximately 12 kyr and 18 kyr, respectively. As both hiatuses exhibited an identically inclined orientation within the sediment core, we assume that the core was obtained from the mound flank. Since the coral ages were not linearly decreasing upcore (Table 1 and Fig. 2), we hypothesise that the core represents either collapsed *in situ* coral framework or accumulations of coral rubble deposited at the mound's flank.

The δ^{234}U-values (Table 1) for most dated specimen fall within the commonly stated reliability interval of 149.6 ± 10‰ (e.g. Robinson et al., 2006). Corals from the first period between 65 and 57 kyr BP ranged between 133.4 and 147.5‰, corals from the second period between 45 and 32 kyr BP ranged between 140.8 and 152.6‰, and the coral at 14.2 kyr BP showed a value of 141.1‰ for δ^{234}U. Five corals from the first growth period fell below the reliability interval. But since their coral material was pristine aragonite, we consider this pattern as a reflection of a potentially lower initial δ^{234}U-value in the seawater during that period and hence the reported ages as reliable (Frank, unpublished data).

5. Discussion

5.1. Periods of cold-water coral growth off Mauritania

Stratigraphic studies concerning the long-term development of cold-water corals in the NE Atlantic revealed different major coral growth phases for the high (>50°N) and temperate latitudes. Off Norway, *Lophelia pertusa*-reefs established directly after the retreat of the glaciers and developed throughout the Holocene (Freiwald et al., 1999). Along the Irish margin coral growth is also related to moderate (i.e. interstadial) and warm (i.e. interglacial) climate conditions (de Haas et al., 2009; De Mol et al., 2007; Dorschel et al., 2005; Eisele et al., 2008; Frank et al., 2005; Frank et al., 2009; Roberts et al., 2006; Rüggeberg et al., 2007). In contrast, coral growth in the temperate NE Atlantic, stretching from the Bay of Biscay as far south as the Moroccan margin, prevailed during the last glacial (Schröder-Ritzrau et al., 2003; Wienberg et al., 2009). The coral ages obtained from the Banda Mound Province fit well into this pattern of predominantly glacial coral growth in the temperate latitudes of the NE Atlantic Ocean. Moreover, coral growth off Mauritania seems to be restricted to specific time intervals within this cold climate period (Fig. 2).

The cold-water coral growth periods along the Mauritanian margin during MIS 4, 3 and 2 coincided with palaeo-sea-level variations within the narrow range of 50–80 m below modern sea level (Fig. 2) (Lambeck and Chappell, 2001; Waelbroeck et al., 2002). One most likely consequence of the changing sea-level in the region has been a narrowing of the high productivity zone over the shelf and shelf-break as well as the displacement of this zone towards the open ocean (Bertrand et al., 1996). Thus, by moving the high productivity zone towards the cold-water coral habitats, the food supply for the corals would have been increased, and hence promoted the onset of prosperous coral growth episodes. The coral growth periods identified for the Banda Mound Province off Mauritania correlate well with periods of enhanced primary productivity in the region as traced by the total organic carbon (TOC) mass accumulation rate of ODP core 108-658C (Fig. 2; Zhao et al., 2006). As this core has been taken from an area further offshore and ~300 km northeast of the Banda Mound coral record, it might not directly reflect the palaeoproductivity conditions for the Banda Mound region. Nevertheless, it provides a reliable record for the general palaeoproductivity pattern along the NW African upwelling region (e.g. Itambi et al., 2009).

The first period of coral growth (65–57 kyr BP) is tied to two major peaks in the palaeoproductivity record that occurred between 65 and 62 and between 59 and 57 kyr BP. The second coral growth phase (45–32 kyr BP) coincides again with conditions of increased productivity that were rather stable from 47 to 27 kyr BP, albeit less pronounced compared to the previous period. However, at ODP site 658 conditions of high productivity persisted for 5 kyr beyond the end of the second coral growth phase. The decline of the corals at ~31 kyr BP coincided with a drastic drop in sea level from −70 m to −120 m below present day sea level (Fig. 2; (Lambeck and Chappell, 2001)). By shifting the coast line in the Banda Mound region during the LGM almost to the shelf break (varying off Mauritania between 110 m (Hanebuth and Lantzsch, 2008) and 200 m water depth (Colman et al., 2005)), the local upwelling regime probably collapsed which resulted in reduced food supply (Bertrand et al., 1996; Martinez et al., 1999), and subsequently in the demise of the corals. The youngest coral age (14.2 kyr BP) coincided with the Bølling–Allerød interstadial (14.7–12.7 kyr BP). During this time, the sea level experienced a rapid rise and productivity once more increased after the pronounced productivity minimum associated with the LGM (Fig. 2).

A high primary productivity regime is indicated for the entire Holocene from the TOC-records of core ODP 108-658 C (Fig. 2). However, this period is not documented in core GeoB 11569-2 due to coring disturbances (overpenetration). Nevertheless, by considering the two prior glacial coral growth periods with vertical growth rates varying between 10 and 28 cm kyr^{-1}, (thickness of sediment package/maximum age range of corals) the missing 35 cm of the core most likely would not cover the last 14 kyr. The fact that the core has been obtained from the mound flank instead from the summit probably has no major impact on the calculation of accumulation rates, as data e.g. from Galway Mound reveal no major differences in accumulation rates between mound summit and flanks (Eisele et al., 2008). In combination with the sparse present occurrence of living cold-water corals in the Banda Mound region (Colman et al., 2005; Westphal et al., 2007), these observations indicate that coral growth was not persistent throughout the Holocene. Although recent temperature (11 °C) and salinity (35.3‰) conditions at the intermediate depth interval occupied by the Banda Mounds (Westphal et al., 2007) fit the ecological requirements of the main reef-forming coral *Lophelia pertusa* described in present-day settings (Davies et al., 2008; Roberts et al., 2006), it can be speculated that under very high sea-level settings (less than ~40 m below present sea level) productivity is mainly restricted to the shelf. This would imply a reduced seaward advection of organic particles, and thus, inhibit sustained coral growth at the upper continental slope.

5.2. Coral mound accretion patterns

The long-term development of coral mounds has been intensely studied along the Irish margins, where available data indicate a tight coupling between vertical mound growth and a vigorous current regime (e.g. Dorschel et al., 2005). Strong bottom currents are crucial for a sustained prosperity of cold-water corals, by definition an indispensable component of coral mounds. On the one hand, strong bottom currents supply food particles to the suspension feeding corals and prevent them from burial by hemipelagic sediments (Dorschel et al., 2005; Huvenne et al., 2005). Overall, coral growth and sedimentation rates need to be balanced to guarantee a sustained development of cold-water corals. On the other hand, cold-water corals are known to (1) baffle fine silty sediments that usually remain in suspension under high current velocities and (2) inhibit re-erosion by trapping these fine sediments within their skeletal framework (Huvenne et al., 2009). Along the Irish margin these processes resulted in the development of coral mounds that reach heights of >300 m (Kenyon et al., 2003; Mienis et al., 2007). However, detailed stratigraphic and sedimentological analyses revealed a rather periodic mound growth pattern that is strongly related to the Late Quaternary climate cycles (de Haas et al., 2009; Dorschel et al., 2005; Frank et al., 2005; Kano et al., 2007). On the Irish mounds mainly interglacial/interstadial sediment sections interspersed with corals are preserved. These consistent sequences are bordered by hiatuses comprising largely glacial/stadial times (de Haas et al., 2009; Dorschel et al., 2005). It is assumed that these hiatuses result from the erosion of the glacial/stadial sediments that were not stabilised by coral framework. The timing of erosion is linked to the re-establishment of a vigorous interglacial bottom current regime that is connected with the recurring presence of Mediterranean Outflow Water along the Irish margin (Dorschel et al., 2005).

To our knowledge the data presented here provide the first long-term record from a large coral mound outside the Irish margin in the eastern North Atlantic. Interestingly, this Mauritanian record resembles the general growth pattern observed off Ireland. The records of both major growth periods in core GeoB 11569-2 are marked by several age reversals (Fig. 2 and Table 1), indicating that the coral sequence rather represents accumulations of coral rubble (produced by short-distance downslope transport or by collapsed *in situ*-frameworks). With the end of coral growth and no further deposition of baffled sediments in between the coral rubble, either a non-depositional setting has been established or non-stabilised sediments have been deposited and subsequently eroded. The only remains of these periods are the shell hash layers marking the two major hiatuses in the core. Thus, it is assumed that the same basic processes – with intense sediment baffling in the coral framework during periods of prospering corals and very low net sedimentation during periods of coral absence – control mound growth off Mauritania and off Ireland. Finally, the mound heights (Mauritania: up to 100 m, Ireland: >300 m; Colman et al., 2005; Kenyon et al., 2003; Mienis et al., 2007) and the mound growth rates (Mauritania: ~14 cm kyr^{-1} comprising both growth periods and the hiatus, this study; Ireland: ~13 cm kyr^{-1} long-term average comprising several growth periods and hiatuses (Kano et al., 2007)) are also rather similar along the Mauritanian and Irish margins.

6. Conclusions

In summary for the Late Quaternary, the growth patterns of large coral mounds off Ireland and off Mauritania are similar showing a periodic growth characterised by sequences of coral bearing hemipelagic sediments marked by numerous hiatuses that comprise periods without coral growth on the mounds. Thus, prosperous coral growth and sufficient background sedimentation appear to be the prime factors allowing for vertical mound growth, with the consequence that coral mound growth is ultimately linked to coral growth. Periods without coral growth are not preserved in sedimentary mound records. However, the most prominent local forcing for sustained coral growth off Ireland (→ bottom currents) differs from that off Mauritania (→ surface ocean productivity) as does the stratigraphic pattern for coral growth at both sites. The new data from Mauritania presented here provide further support for a cold-water coral see-saw in the NE Atlantic: 1) sustained coral growth south of 50°N (as far south as Mauritania) bound to glacial/stadial climate settings in contrast to 2) flourishing corals north of 50°N during interglacials.

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