ODP Proposal Log Sheet

Interior [ ] Environment [X] **519-Full2** Proposal received: March 15, 1999

[ ] New proposal [X] Revised proposal [ ] Addendum [ ] Other

The Last Deglacial Sea-Level Rise in the South Pacific: Offshore Drilling in Tahiti (French Polynesia) and on the Australian Great Barrier Reef

G.F. Camoin, E. Bard, B. Hamelin, P. Pezard, P.J. Davies, W.C. Dullo

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Brief description:

The history of sea-level and sea surface temperature variation associated with the last deglaciation is of prime interest to understand the dynamics of large ice sheets and their effects on Earth's isostasy. So far, the only sea-level record that encompasses the whole deglaciation is based on offshore drilling of Barbados coral reefs which overlie an active subduction zone, implying that the apparent sea-level record may be biased by tectonic movements. This proposal seeks to establish the course and effects of the last deglaciation in two reef settings developed in tectonically inactive areas at sites located far away from glaciated regions, in Tahiti (French Polynesia) and on the Australian Great Barrier Reef. At each site, it is proposed to realize a transect of several offshore drill holes using a Portable Remotely Operated Drill (‘PROD’) in combination with submersible (‘JAGO’) observation and mapping, downhole measurements and high-resolution seismic-reflection profiles. The study will have three major objectives. The first objective will be to reconstruct the deglaciation curve for the period 20,000 to 10,000 yrs BP in order to establish the minimum sea-level during the Last Glacial Maximum (LGM), and to assess the validity, the timing and amplitude of meltwater pulses (so-called MWP-1A and MWP-1B events; c. 13,800 and 11,300 cal. yr BP) which are thought to have disturbed the general thermohaline oceanic circulation and, hence, global climate. Secondly, we will establish the SST variation accompanying the transgression at each transect. These data will allow us to examine the impact of sea-level changes on reef growth, geometry and biological makeup, especially during reef drowning events, and will help improving the modeling of reef development. The third major objective will be to identify and to establish patterns of short-term paleoclimatic changes that are thought to have punctuated the transitional period between present-day climatic conditions following the LGM. It is proposed to quantify the variations of sea surface temperatures based on high-resolution isotopic and trace element analyses on massive coral colonies. When possible, we will try to identify specific climatic phenomena such as El Nino-Southern Oscillation (ENSO) in the time frame prior to 10,000 yrs BP.

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Abbrev. Title: Sea-Level Rise South Pacific Reefs	Key: Great Barrier Reefs	Area: SW Pacifi

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Objectives:

1. To reconstruct the deglaciation curve for the period 20,000-10,000 years BP in order to establish the minimum sealevel during the Last Glacial Maximum (LGM), and to assess the validity, timing and amplitude of meltwater pulses.
2. To establish the SST variations accompanying the transgression at each transect.
3. To identify and establish patterns of short-term paleoclimatic changes that are thought to have punctuated the transitional period between present-day climatic conditions following the LGM.

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ABSTRACT

The history of sea-level and sea surface temperature variation associated with the last deglaciation is of prime interest to understand the dynamics of large ice sheets and their effects on Earth's isostasy. So far, the only sea-level record that encompasses the whole deglaciation is based on offshore drilling of Barbados coral reefs which overlie an active subduction zone, implying that the apparent sea-level record may be biased by tectonic movements. This proposal seeks to establish the course and effects of the last deglaciation in two reef settings developed in tectonically inactive areas at sites located far away from glaciated regions, in Tahiti (French Polynesia) and on the Australian Great Barrier Reef. At each site, it is proposed to realize a transect of several offshore drill holes using a Portable Remotely Operated Drill ('PROD') in combination with submersible ('JAGO') observation and mapping, downhole measurements and high-resolution seismic-reflection profiles. The study will have three major objectives. The first objective will be to reconstruct the deglaciation curve for the period 20,000 to 10,000 yrs BP in order to establish the minimum sea-level during the Last Glacial Maximum (LGM), and to assess the validity, the timing and amplitude of meltwater pulses (so-called MWP-1A and MWP-1B events; c. 13,800 and 11,300 cal. yr BP) which are thought to have disturbed the general thermohaline oceanic circulation and, hence, global climate. Secondly, we will establish the SST variation accompanying the transgression at each transect. These data will allow us to examine the impact of sea-level changes on reef growth, geometry and biological makeup, especially during reef drowning events, and will help improving the modeling of reef development. The third major objective will be to identify and to establish patterns of short-term paleoclimatic changes that are thought to have punctuated the transitional period between present-day climatic conditions following the LGM. It is proposed to quantify the variations of sea surface temperatures based on high-resolution isotopic and trace element analyses on massive coral colonies. When possible, we will try to identify specific climatic phenomena such as El Nino-Southern Oscillation (ENSO) in the time frame prior to 10,000 yrs BP.

1 - STATE OF THE ART

The timing and course of the last deglaciation is generally considered as an essential component for understanding the **dynamics of large ice sheets** (Lindstrom & MacAyeal, *Nature,* 365, 214, 1993) and their effects on **Earth's isostasy** (Lambeck, *Tectonophysics* 233, 15, 1993; Peltier, *Science* 265, 195, 1994). Moreover, the disappearance of glacial ice sheets was responsible for dramatic changes in the freshwater fluxes to the oceans which disturbed the general **thermohaline circulation** and hence **global climate** (e.g. Stocker & Wright, *Nature* 351, 729, 1991). **Coral reefs are excellent sea level indicators** and their accurate dating by mass spectrometry is of prime importance for the determination of the timing of deglaciation events and thus for the understanding of the mechanisms driving the glacial-interglacial cycles. Furthermore, scleractinian coral colonies can **monitor sea surface temperatures (SSTs) and can be used as recorders of past SSTs.**

1.1 - SEA-LEVEL CHANGES AS A GLOBAL CLIMATE INDICATOR

Only three deglaciation curves based on coral reef records have been accurately dated for times reaching the Holocene-Pleistocene boundary: in Barbados (Fairbanks, *Nature* 342, 637, 1989; Bard et al., *Nature* 346, 456, 1990; *Nature* 345, 405, 1990) between 19,000 and 8,000 calendar years BP (cal. yr BP), in New-Guinea between 13,000 and 6,000 cal. yr BP (Chappell & Polach, *Nature* 349, 147, 1991; Edwards et al., *Science* 260, 962, 1993), and in Tahiti between 13,750 cal. yr BP and 2,380 ^{14}C yr BP (Bard et al., *Nature*, 382, 241, 1996)(Fig.1). So far, the Barbados curve is the only one to encompass the whole deglaciation because it is based on **offshore drilling**. However, this site, like New-Guinea, is located in an active subduction zone where tectonic movements can be large and discontinuous, so that the apparent sea-level records may be biased by variations in the rates of tectonic uplift. Hence, there is a clear need to study past sea level changes in tectonically stable regions or in areas where the vertical movements are slow and/or regular.

The Barbados record suggested that the last deglaciation was characterized by **two brief periods of accelerated melting** superimposed on a smooth and continuous rise of sea-level with no reversals (Fig.1). These so-called MWP-1A and MWP-1B events (*c.a.* 13,800 and 11,300 cal. yr BP) are thought to correspond **to massive inputs of continental ice** (*i.e.* about 50-40 mm/yr roughly equivalent to annual discharge rates of 16,000 km^3 for MWP-1A). The MWP-1A corresponds to a short and intense cooling between 13,900 and 14,100 cal. yr BP in the Greenland records (Johnsen et al., *Nature* , 359, 311, 1992; Grootes et al., *Nature*, 366, 552, 1993) and therefore postdates the initiation of the Bölling-Alleröd warm period at about 14,700-14,900 cal. yr BP (Broecker, *Quat. Res.* 38, 135, 1992). The sea level jump evidenced in New-Guinea at 11,000 cal. yr BP (Edwards et al.,

1993) is delayed by a few centuries when compared to the one observed at Barbados. These two meltwater pulses are thought to have induced **reef-drowning events** (Blanchon & Shaw, *Geology* 23, 4, 1995). Two 'give-up' reef levels have been reported at 90-100 and 55-65 m water depth on the Mayotte fore-slopes (Comoro Islands) and have been related to the Bolling and the post-Younger Dryas meltwater pulses (Dullo et al. In: *I.A.S. Sp. Publl.* -*Camoin & Davies eds*-, 25, 219, 1998); similar features are recorded in the southern GBR (Troedson & Davies, work in progress) and in the Caribbean (McIntyre et al., *Coral Reefs*, 10, 167, 1991; Grammer & Ginsburg, *Mar. Geol.*, 103, 21, 1992). A third *Acropora* reef-drowning event at *c.a.* 7,600 cal. yr BP has been assumed by Blanchon & Shaw (1995).

However, there are still some doubts concerning **the general pattern of sea-level rise during the last deglaciation events**, including **the amplitude of the maximum lowstand during the Last Glacial Maximum** (LGM) **and the occurrence of increased glacial meltwater with resultant accelerated sea-level rise** (Broecker, *Paleoceanography* 5, 459, 1990). Furthermore, saw-tooth sea-level fluctuations between 19,000 and 15,280 cal. yr BP (Locker et al., *Geology* 24, 827, 1996) and a sea-level fall coeval with a climatic changes around 11,000 yrs BP are still controversial topics.

Worldwide sea-level compilations indicate that local sea-level histories varied considerably around the world in relation both to the postglacial redistribution of water masses and to a combination of local processes (Lambeck, 1993; Peltier, 1994), although **significant deviations between model predictions and field data** have been noted in several regions (Camoin et al., *Coral Reefs*, 16, 247, 1997). The post Last Glacial sea-level changes at sites located far away from glaciated regions ('far field') provide basic information regarding the **melting history of continental ice sheets** and the **rheological structure of the Earth**. The effect of hydro-isostasy will depend on the size of the islands: at very small islands, the addition of meltwater will produce a small differential response between the island and the seafloor, while the meltwater load will produce significant differential vertical movement between larger islands or continental margins and the seafloor (Lambeck, 1993). There is therefore a need to establish the validity of such effects at **two ideal sites located at a considerable distance from the major former ice sheets** : on a small oceanic island, and on a continental margin. In both cases, it is essential for the sites chosen that the **tectonic signal is small or regular within the short time period proposed for investigation**, so that rigorous tests of proposed northern and southern hemisphere deglaciation curves from Barbados and New Guinea can be made. Two such places are proposed: **Tahiti and the Great Barrier Reef (GBR)**.

1.2 - CLIMATIC AND OCEANOGRAPHIC CHANGES DURING LAST DEGLACIATION EVENTS

During latest Pleistocene and early Holocene times, climatic variability was primarily related to the effects of seasonality and solar-radiation. The results of the CLIMAP Program suggested that the LGM tropical SSTs were similar to the modern ones. However, this interpretation is not consistent with snowline reconstructions and palaeobotanic data (Rind & Peteet, *Quat. Res.*, 24, 1, 1984; Anderson & Web, *Nature*, 367, 23, 1994).

The available Sr/Ca and U/Ca data from coral reef areas report SSTs **5°C colder than today during the LGM and 2°C lower around 10,000-9,000 cal. yr BP** at Barbados (Guilderson et al., *Science,* 263, 663, 1994), while studies in the west Pacific indicate that the full **amplitude of the glacial-Holocene temperature change** may have ranged **between 3 and 6°C** (Mc Culloch et al., *E.P.S.L.,* 138, 169, 1996; Castellaro et al., *Terra Nova*, 19, 612, 1997; Beck et al., *Nature*, 385, 705, 1997, Gagan et al., *Science*, 279, 1014, 1998)(Fig.1). Troedson & Davies (work in progress) define SSTs immediately south of the GBR some 4.5°C colder during the LGM and 1°C colder at 10,000 cal. yr-B.P. This casts doubt upon the phase shift of 3,000 years for climate changes between the two hemispheres that was assumed by Beck et al. (1997), in clear distinction to the apparent synchronism of the last deglaciation, inferred from various sources (i.e. coral records, ice cores, snowline reconstructions, vegetation records and alkenone paleothermometry; Bard *et al.*, *Nature*, 385, 707, 1997).

Recent studies have documented Holocene climatic variations. **1°C warmer SSTs, monsoonal rainfall and possibly weaker ENSO around 5,800 yrs B.P. in Eastern Australia** have been deduced from isotopic and Sr/Ca high-resolution measurements on corals from the Central GBR (Gagan et al., 1998). An **ENSO-like cyclic climatic variation** with a return period of 3-5 years has been evidenced in a **4,150 years** old coral from the Seychelles, although the intensity of the annual decrease in SST caused by monsoonal cooling was lower than today (Dullo et al., *Palaeogeogr. Palaeoecol. Palaeoclimatol.*, submitted).

Additional information is required for a better knowledge of climatic conditions in tropical regions during the last deglaciation. In these areas, the most debated points are twofold : **1)** the **quantification of SSTs and the identification of related climatic variations during the last deglaciation events**, and **2)** the **timing of the relevant postglacial warming in the two hemispheres.**

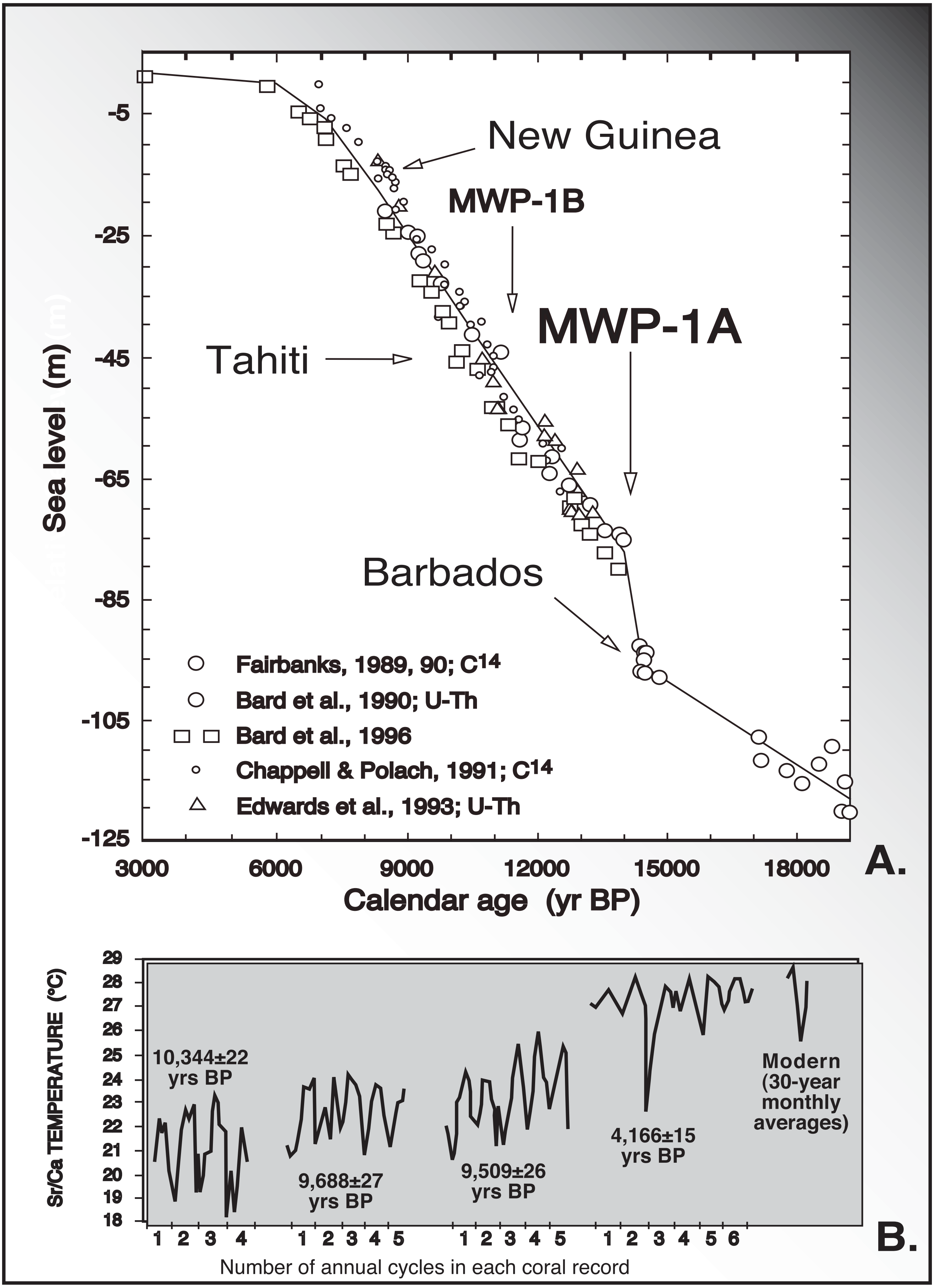


Fig. 1 - A) Sea level history reconstructed for long drill cores from Tahiti (squares), Barbados (dots) and New-Guinea (triangles)(from Bard et al., 1996).
B) Reconstructed SSTs for various time windows on corals from the Vanuatu (Beck et al., 1997)

2 - SCIENTIFIC AIMS

This proposal succeeds a preliminary proposal submitted to Joides in September 1997, to drill drowned reefs and reef terraces at Tahiti and the Australian Great Barrier Reef. The present submission is a revised version of the Proposal 519 which was assessed in Fall 1998 by the Environment SSEP. It includes some revised sections that addresses a few comments raised in the panel discussion and concerning the scientific objectives and technical/operational issues. As noticed by the ESSEP during its Fall 1998 review, « the goals are well-aligned with the high priority objectives of the Long Range Plan » (1996) and cover the two sub-themes 'Earth's Changing Climate' and 'Causes and Effects of Sea-level Change'. These aims are related to other international scientific programs such as **IGBP, PAGES** and **PAGES/CLIVAR interface.**

1. To establish the course of post glacial sea-level rise in the Great Barrier Reef and at Tahiti, ie to define **the exact shape of the deglaciation curve for the period 20,000 to 10,000 yrs BP**. The expected results are the following: **a)** to assess the validity, the timing and amplitude of MWP 1A; **b)** to assess the maximum sea-level drop during the LGM; **c)** to prove or disprove saw-tooth pattern of sea-level rise during the last deglaciation (Locker et al., 1996); **d)** to test predictions based on different ice and rheological models. The reconstruction of sea level curves will rely on the absolute dating of *in situ* corals provided by radiometric methods ($^{230}Th/^{234}U$ by TIMS, ^{14}C by AMS) and paleobathymetric informations deduced from biological communities (corals, algae and molluscs) which live in a sufficiently narrow or specific depth range to be useful as absolute sea level indicators.

2. To define SST variations for the region over the period 20,000 to 10,000 yrs BP in order to get a better knowledge of: **a)** the **regional variation of SSTs** in the south Pacific; **b)** the **climatic variability** and the identification of specific phenomena such as **El Nino-Southern Oscillation (ENSO); c)** the global variation and relative timing of post glacial climate change in the southern and northern hemisphere. Methods include stable isotope ($\delta^{18}O$) and trace element (Sr/Ca ratios by TIMS) analyses on high-resolution (i.e. at the seasonal scale) sampling of massive coral colonies. Coupled analyses of $\delta^{18}O$ and Sr/Ca on the same sample may yield estimates of both temperature and salinity; Mc Culloch et al., 1996). $\delta^{13}C$ measurements, systematically coupled with those of $\delta^{18}O$ in coral skeletons, will proovide information on other parameters, e.g. solar variations or metabolism processes. Geochemical methods will be coupled with measurements and analyses of the band widths and micro-structural variations in the coral skeletons.

3. To analyse the impact of sea-level changes on reef growth and geometry and especially: **a)** the impact of glacial meltwater phases (identification of reef drowning events); **b)** the morphological and sedimentological evolution of the foreslopes (highstand vs lowstand processes); **c)** the modeling of reef building; **d)** environmental changes during reef development. A numerical model simulating the reef building will be used in order to study the effect of a sea-level jump on the reef geometry and to assess qualitatively the effect of sea-level fluctuations on the reef shape and age-depth relationships.

The present proposal may provide the opportunity to constrain better the deglacial history (see Peltier, 1994; Fleming et al. *EPSL*, 163, 327, 1998; Okuno & Nakada *Palaeogr. Palaeoclim. Palaeoecol.,* 146, 283, 1999) by documenting, for the first time, the LGM lowstand in well-studied cores in the far-field and by comparing the MWP-1A in the Pacific and the Atlantic. Furthermore, the study of very early deglacial coral material should allow the first Sr/Ca SSTs for the LGM in the Pacific and could then complete necessarily the data on Barbados samples (Guilderson et al., 1994) and the recent study of stage 6 corals (McCulloch et al. *Science*, 283, 202, 1999).

3 - PROPOSED SITES OF STUDY

3.1 - SITE LOCATION

3.1.1 - Tahiti

Tahiti (17°50'S and 149°20'W; S=142 km^2) is the largest of the Society Islands and is composed of twin shield volcanoes which were active 1.367± 0.016 to 0.187± 0.003 Ma ago. Subsidence rates of ≈0.25mm/yr were deduced from the dating of aerial lava underlying the Pleistocene reef sequence. This island is surrounded by discontinuous fringing reefs that grade locally into a chain of barrier reefs, frequently interrupted and locally enclosing a narrow lagoon. The barrier reef complex includes, from the land seawards : a back-reef zone which corresponds to a 1km-wide bay, reaching a maximum depth of 20m, a relatively narrow reef flat zone (130m in maximum width), and an outer reef slope which consists of coral-built spurs and grooves. In the NW, the reef foreslope is gently deeping seawards until 15m deep and then steepens sharply until 50m to form an almost vertical wall between 50 and 100m (Fig.2). The occurrence of two **prominent terraces at 50m and 90-100m** dipping seawards and exhibiting living coral reef was demonstrated through a survey by the submersible 'Cyana' (Salvat et al., *Proc. 5th Int. Cor. Reef Cong.*, 2, 338, 1985) and bathymetric data from Port Autonome Papeete, SHOM and IFREMER.

3.1.2 - Great Barrier Reef

The Great Barrier Reef is the **largest epicontinental reef system** currently existing on this planet, extending 2000 km in a NW-SE direction along the northeast coast of Queensland (Davies et al., In*: S.E.P.M. Mem. 44 - Crevello et al. eds* - 233, 1989). On the outer shelf off Cooktown, as well as in the northern GBR, the reef is narrow with ribbon reefs on its eastern edge, extensive coastal fringing reefs and patch reefs; in the south it broadens with patch reefs separated by open water or narrow channels. South of 15°30'S, the reefs are generally 30 km or more off shore and reaches 100 km at 22.5°S; the coastal lagoon between the main body of the GBR and the mainland has a maximum depth of 145 m but rarely exceeds 60 m (Wolanski, *Proceed. 4th Int. Coral Reef Symp.,* 1, 375, 1981). However, the origin and age of this geologically and biologically important sedimentary system is poorly constrained. The central Great Barrier Reef defines an ideal site for the evaluation of sea level change in the period 16000 years BP to 8000 years BP. Sedimentologic and geophysical studies in the central Great Barrier Reef to the south east of Townsville have identified a succession of sub-sea morphologic structures interpreted as drowned reefs at depths of 100m, 90m, 60-50m and 35 to 40m (Harris & Davies, *Coral Reefs*, 8, 87, 1989).

Drowned reefs occur at 25m, 50m, and 70m in the upper dore-reef slope of Ribbon 5 (Fig.3). Submersible examination of the 50m and 70m drowned reefs show that they are layered, either with platey corals and/or coralline algae. The exposed upper surfaces are bored, but have no living corals on them. They give the appearance of being relatively 'fresh'. The reef at 25m appears to be a thin veneer on an erosional surface.

It is clear that a series of drowned, linear reefs occupy specific depths over at least a 30km stretch of the **outer continental shelf** in the vicinity of Hydrographer's Passage in the central GBR region. Such reefs are identifiable at 35-40m, 50-60m, 90m and 100m. Submersible examination of the 35-40m and 50-60m reefs indicate that they have also a 'fresh' appearance, but with no coral growing at the present time on the 50-60m reef and with a few plate corals growing on the 40m reef.

3.2 - SCIENTIFIC ACHIEVEMENTS ON EXISTING HOLES AND SEISMIC DATA

3.2.1 - Tahiti

Recent sedimentological and geochemical studies on Tahiti are based on 8 **vertical and inclined drill holes** carried out through the barrier reef complex facing Papeete with a Sedidrill coring-system by the French ORSTOM (Fig.2). The volcanic substrate which underlies the drilled reef dips gently seawards. Below the modern barrier reef, the reef carbonate sequence is about 120m thick and includes 30m of karstified Pleistocene limestones overlain by a 80 to 90m thick post glacial carbonate sequence (Fig.4) composed of *in situ* coralgal frameworks alternating locally with detrital beds reefs and encompassing the last 14,000 years (Montaggioni & Camoin, *Geology* 21, 149, 1993; Camoin & Montaggioni, *Sedimentology*, 41, 655, 1994; Montaggioni et al., *Geology*, 25, 555, 1997; Cabioch et al., *Sedimentology*, in press). It corresponds to the **longest continuous post glacial reef sequence** described so far. Recovery was dependent upon framework type and on the size of internal cavities, but ranged from 50 to 95% ; sections with poor or no recovery generally correspond to unconsolidated sands.

The reconstructed sea level curve for the last 14,000 years (Bard et al., 1996) indicates the presence of a **major sea level jump shortly before 13,800 cal. yr BP** which corresponds to MWP-1A in the Barbados record (Fig.1). The curve exhibits also a change of deglaciation rate between 11,500 and 11,000 cal. yr BP (*i.e.* the time of MWP-1B) but without clear evidence of a major jump, suggesting that **MWP-1B, if real, was smaller than previously thought**. Furthermore, there is no detectable meltwater pulse at about 7600 cal. yr BP on the Tahiti curve.

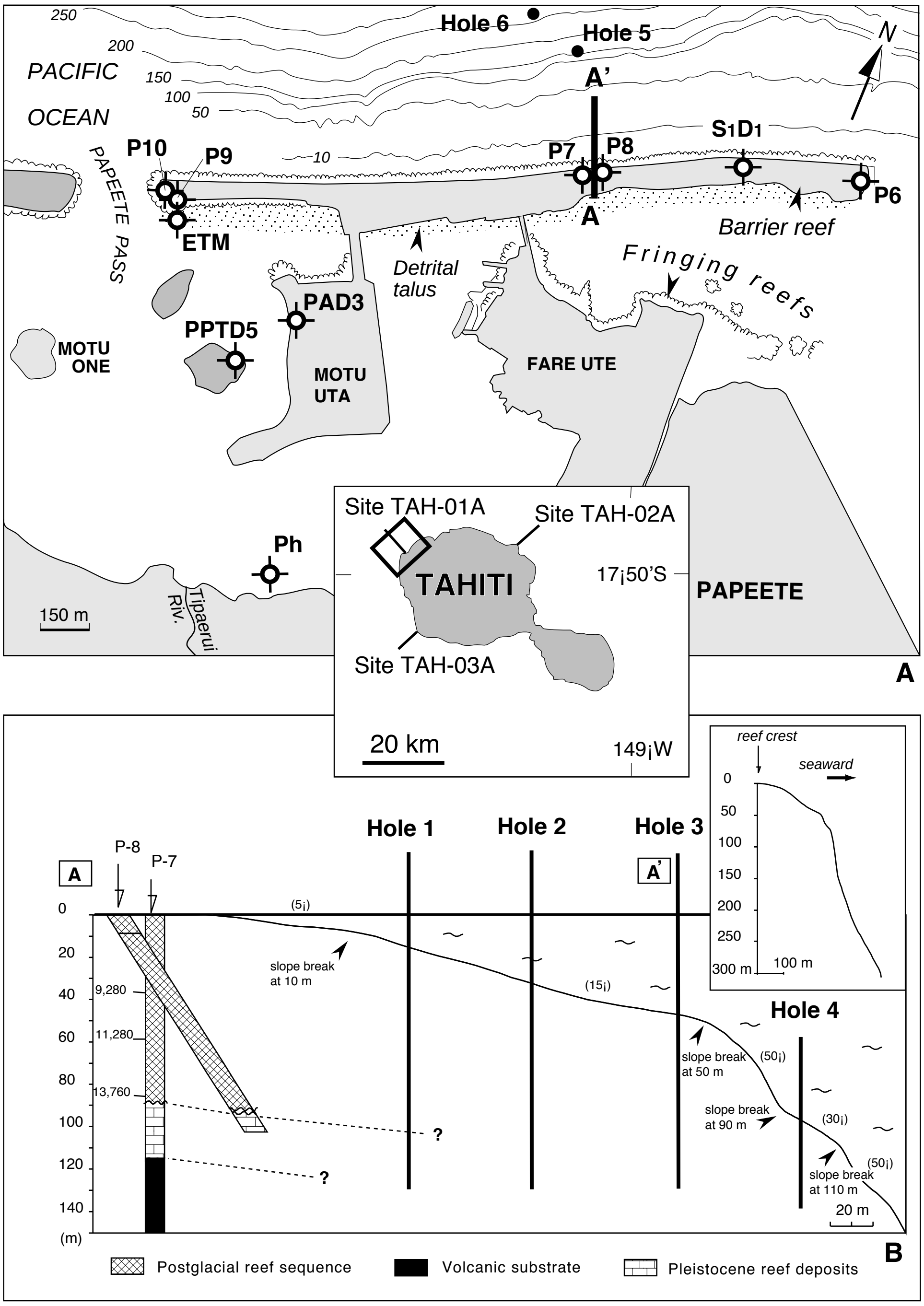
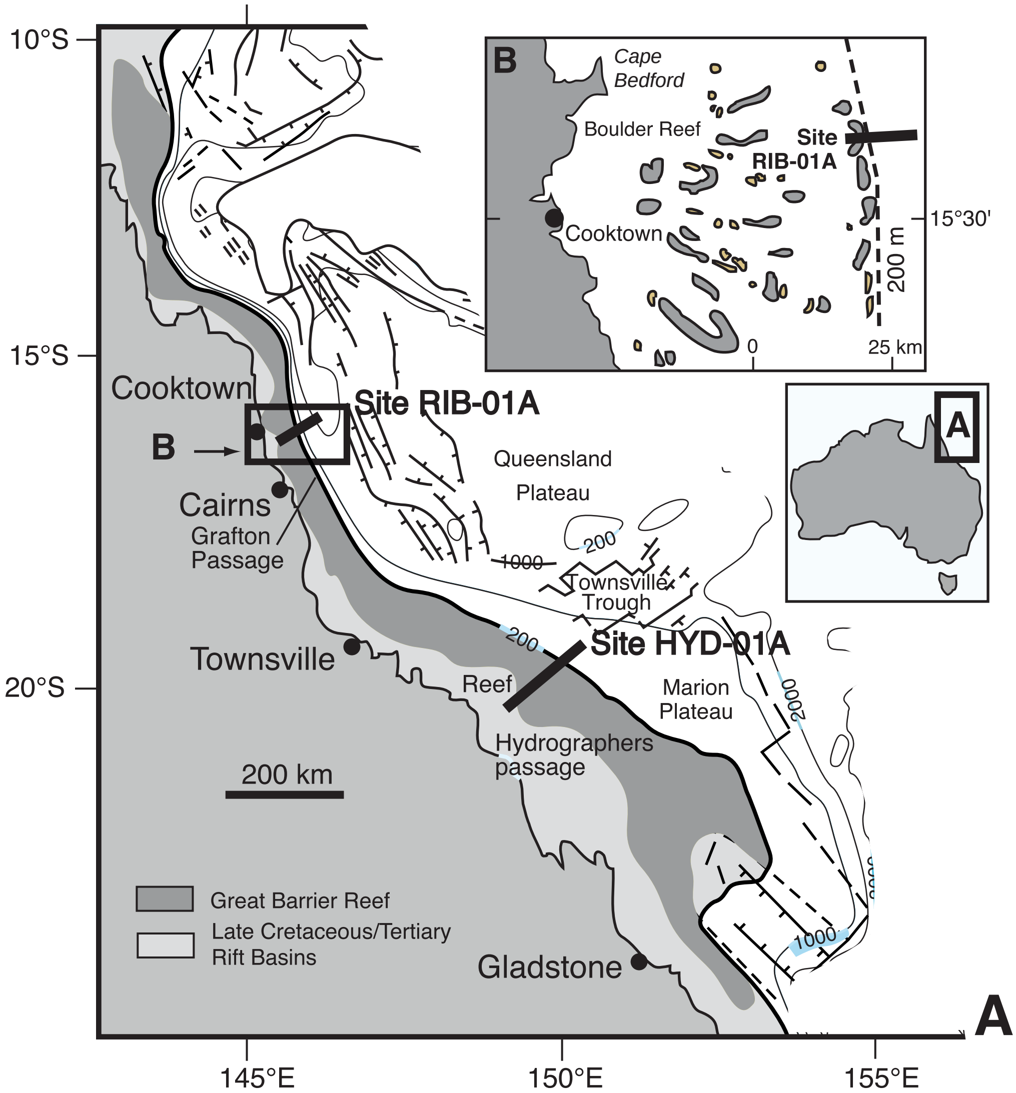


Fig.2 - Location of existing holes and proposed drill sites on Tahiti. Location map of existing drill holes and proposed drill sites (A) and cross section (B) in the area of Site TAH-01A.



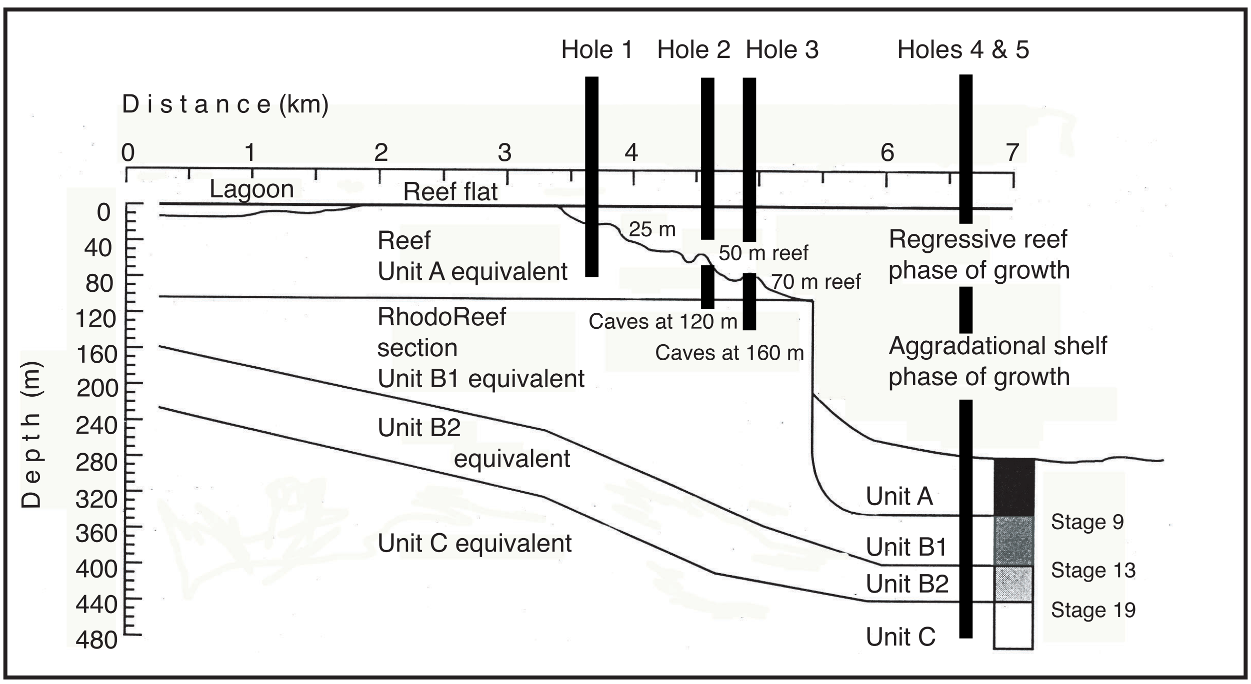


Fig. 3 - Location of existing holes and proposed drill sites in the Great Barrier Reef.
The cross section is from Ribbon n°5 (from Davies & Peerdeman, 1998).

Contrary to most postglacial reef records, the sequence in the Tahiti barrier-reef edge has formed predominantly through long-term continuous, **keep-up growth**, controlled by stable environmental conditions while the adjacent backreef areas did not start to grow up before sea level stabilization, around 6,000 yrs B.P. During this time span, reef growth was dominated by **aggradation processes**. The dominance of *Porites* communities and the coeval occurrence of branching gracile *Lithophyllum* in the lowermost part of the post glacial reef sequence suggest the prevalence of uniformly moderate to low energy conditions all over the drilled area during the early reef development. During the last 11,000 years, the reef frameworks developed continuously in a high-energy environment, at maximum water depths of 5-6m, and were dominated by the *Acropora robusta/danai-Hydrolithon onkodes* association (Montaggioni et al., 1997; Montaggioni & Bard, *Geology* 26, 479, 1998; Cabioch et al., in press). The widespread development of microbialites within the cryptic niches of the reef framework between 13,800 and 6,000 cal. yr BP may be related to increased alkalinity and nutrient availability in interstitial waters due to terrestrial groundwater seepage and periodic runoffs (Camoin et al., *Sed. Geol.*, in press). Accordingly, the only way to recover very early deglacial material is with drill holes carried out off shore as it is planned in this proposal with the PROD and as it was done previously to recover Barbados samples (Fairbanks, 1989; Bard et al., 1990a&b). In addition, simple numerical simulations of the reef building used to study the effect of a sea level jump on the Tahiti reef geometry also suggest that only **off-shore drilling** could allow the recovery of corals which were living during the period between the Last Glacial Maximum and MWP-1A (cf. Bard et al., 1996 and subsequent unpublished tests with the same model).

3.2.2 - Great Barrier Reef

Recent studies in the GBR (Mc Kenzie et al. -eds-, *Proc. ODP Sci. Res.*, 133, 1993; Davies & Peerdeman, In: *I.A.S. Sp. Publ. -Camoin & Davies eds-*, 25, 23, 1998; Troedson & Davies, In: *Mar. Geol. Sp. Publ. -Yim & Davies eds-,* in press) concentrating on the shelf edge south east of Townsville and east of Cooktown have defined the morphologic shape of the outer reef -upper continental slope and the geological origin of the GBR itself. Based on high resolution seismic profiles in the fore-reef section in front of the GBR, Feary *et al.* (in: Mc Kenzie et al. -eds-, 1993) recognized three seismic mega-sequences (0-490ms, 490-555ms and below 555ms respectively) which define a clearly **aggradational** section above, a middle sequence that is **transitional** and a lower sequence that is **progradational**.

ODP drilling in 1991 (Leg 133) defined the origin of the GBR as very young i.e. the GBR was initiated during isotope stages 9-11 (Mc Kenzie et al. -eds-, 1993; Davies & Peerdeman, 1998). A new phase of drilling in 1995 in Boulder Reef (15°23.944'S; 145°26.182'E) and Ribbon Reef (15°22.40'S; 145° 47.149'E) areas using a reef mounted jack-up platform further enhanced this story, proving that the GBR was some 100m thick, resting on a subreef subtropical red algal facies which in turn overlies a deep water temperate grainstone facies (Davies & Peerdeman, 1998).

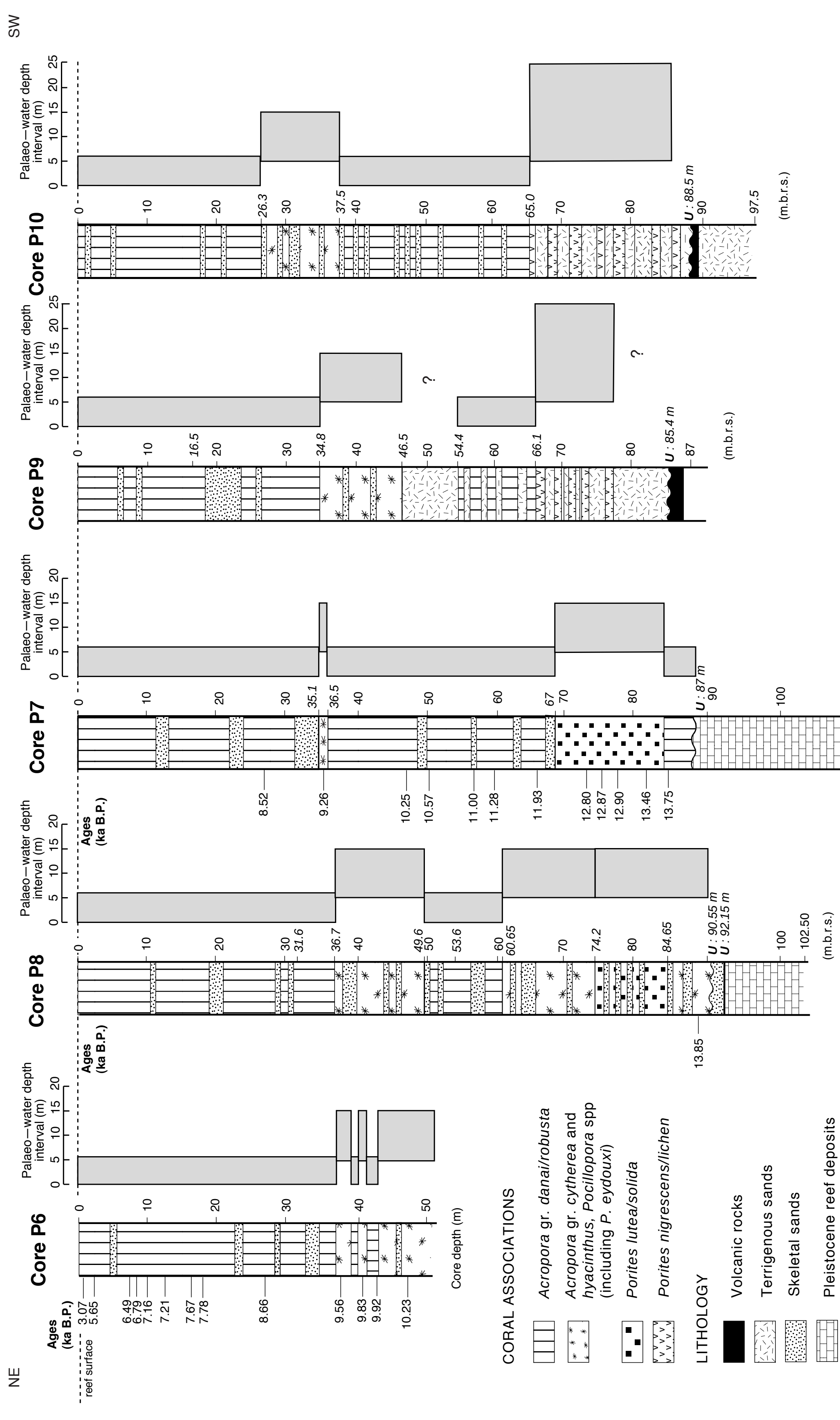


Fig. 4 - Lithologic data and radiometric ages on existing drill cores from Tahiti (see Fig. 1 for location of drill holes).

The stratigraphy of the GBR core also shows the upper part of the platform to be comprised of **repeated cycles of transgressional cool water coralline dominated carbonates topped by shallow water highstand coral reefs**. The Holocene reef however, does not show this couplet. Paradoxically, it is coral dominated from its inception at 8,000 yrs BP while SST data further south shows a **substantial temperature variation during the transgression**. We propose that the paradox is due to the reef platform being too high for the cool coralline facies to have developed, but that facies will have developed on the trangressive surface, i.e. the drowned reefs seen at 35, 50-60, 70m and 90m will represent this coralline facies. Further, we propose that the depths of growth of this facies has been controlled by the meltwater pulses identified in the data of Troedson & Davies (in press).

3.3 - PROPOSED DRILL SITES AND DRILLING STRATEGY

Proposed drill sites in both regions are described below and are summarized on the attached ODP Site Summary Forms. In both regions the drilling and logging operations will be conducted along **transects** perpendicular to the modern reef edge in combination with submersible observations and sampling (Figs 2&3). **The drilling targets include both the successive reef terraces and the slope** that extends seawards of the prominent cliff occurring between 90-100m and 150m water depth in both regions. This drilling strategy will allow the reconstruction of the complete stratigraphy of the post-glacial carbonate sequence, the recovery of massive coral colonies in specific time windows and the identification of the nature of the substrate. These transects will be complemented by deeper water sites with 100m holes in the sediments forming the terraces immediately in front of the reef wall.

3.3.1 - Tahiti

It is proposed to drill **two 50 to 70m holes on the reef foreslopes** (20 to 50m water depth; 200 to 300m from the reef edge), **one 50m hole on the reef terrace targets at 50m** (350m from the reef edge) **and one 50m hole at 90-100m water depth** (380 to 400m from the reef edge) along three transects around Tahiti (Sites TAH-01A, TAH-02A & TAH-03A; Fig.2). It is also proposed that **two 100m drill holes** be drilled in the sediments forming the terraces immediately in front of the cliff and **at water depths of 150 and 300m**. Based upon the drilling results of P6 to P10 carried out on the barrier reef, the depth of penetration below sea floor to reach the volcanic basement should be less than 150m at all sites.

3.3.2. - Great Barrier Reef

It is proposed to sample drowned reefs on the outer continental shelf to the north and to the south east of Townsville (Fig. 3). Two sites are proposed :

<u>Site 1</u>- The upper fore-reef slope of Ribbon 5 (Site RIB-01A; Figs 3&5). It is proposed that **two drill holes, each 50m long be drilled in the reefs at 50 and 70m water depth** (respectively at about 1 and 1.5km from the reef edge)**. A 30m drill hole will suffice in the 25m reef** (at about 500m from the reef edge).

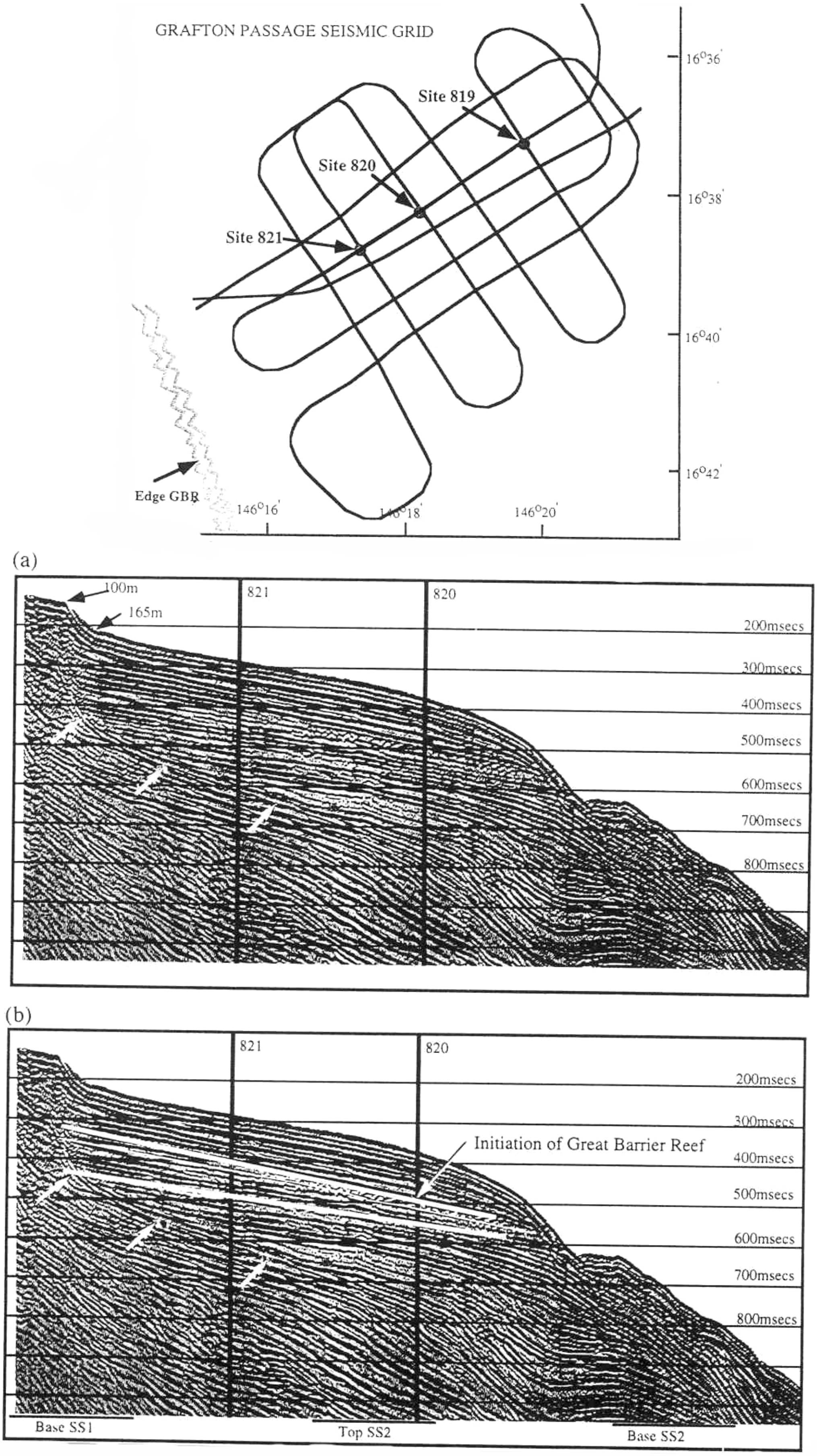


Fig. 5. Site survey seismic tracks and seismic data (a, uninterpreted; b, interpreted) through Grafton Passage and ODP sites 820 and 821 (from Davies & Peerdeman, 1998).

Site 2 - The series of **drowned reefs on the outer continental shelf** in the vicinity of Hydrographer's Passage in the central GBR region (Site HYD-01A; Figs 3&5). **It is proposed that two 50m drill holes be drilled in the reefs at 40 and 50-60m water depth, and one each in the reefs at 90 and 100m water depth.**

At both sites it is also proposed that **two 100m drill holes** be drilled in the sediments forming the terrace immediately in front of the cliff, approximately **at 250m water depth**. These holes will occupy a similar site to that drilled at site 820 on Leg 133.

4 - TECHNICAL AND SAFETY CONSIDERATIONS

4.1 - LOGISTICAL REQUIREMENTS

The proposed shallow drill sites, close to the reef edge, will not be accessible with the *Joides Resolution* and, hence, the use of an alternative drilling platform is proposed.

4.1.1 - Seismics

Site survey data will be conducted across all prospects using a boomer, multi-electrode sparker and 10 cubic inch airguns. The data will be single channel, although multichannel recording is possible. The object of the seismic data will be to integrate the reef sections with surrounding sediments. Seismic penetration of the reef is likely but will probably show only the top and base of the reef. Magnetometer, gravity meter, echosounder and sub-bottom profiler data will also be continuously collected. The JAGO can be operated and deployed from a 50m ship equipped with a 6 tons crane.

4.1.2 - Drilling techniques

The drilling will be conducted using the **Portable Remotely Operated Drill (PROD),** partly owned by the University of Sydney and operated by a private company, Benthic Geotech Pty Ltd, who have agreed its use for research purposes. Before sumission of the Full Proposal to Joides last September the PROD completed workshop tests and drilled through the workshop floor to 50 m. Since September, the PROD was successfully tested in Sydney harbour and in the Timor Sea (in conjunction with Woodside petroleum). The PROD system was presented by Pr. P.J. Davies during the last meeting of the ODP-PPG “Shallow Water Systems” (San Francisco, December 1998). The drill has the capacity to drill 100m holes but, on this program, it is proposed to drill 50m holes at distinctive bathymetric levels. The drill also has the capacity to switch repeatedly from drilling to coring, re-enter the hole, and log the hole. The realization of several drill holes along transects on the same reef, in combination with submersible observations and high-resolution seismic-reflection profiles, will provide a threedimensional view of reef anatomy in order to assess the specific responses of the various parts of the reef to sea-level changes. The PROD can be operated and deployed from a 30m ship.

4.1.3 - Physical properties and downhole measurements

The following downhole techniques, based on equipment owned and deployed by the CEREGE and Benthic GeoTech-University of Sydney can be used: **a) Physical properties**: acoustic velocities (full wave, Vp, Vs for porosity, mechanical properties and calibration of high-resolution surface seismics), electrical resistivity (for porosity and structure of the pore space) with spontaneous potential (SP for fluid movements), spectral natural gamma-ray (gamma ray, Th, U, K for the detection of alteration horizons), active nuclear measurements (neutron porosity and gamma density for acoustic impedance computation and synthetic seismograms), and magnetic susceptibility (as a paleoclimatological proxy); **b) High resolution downhole measurement**: acoustic borehole televiewer-BHTV (for a high-resolution description of the carbonate sequence, since no small diameter FMS-equivalent is available to date); **c) Fluids identification**: temperature and conductivity of fluids in the hole to identify active hydrological processes that may disturb the time sequence.

With 4 inch diameter holes, the proposed logging tools range in diameter from 1-11/16 to 2-3/4 inches. Due to the limited length of the holes, these digital tools will be run one at a time and re-entered through a mini-cone and by the means of the light submarine (JAGO) deployed at the site. The cable will be hung off the side of the ship with a crane/boom-pulley assembly. Depth reference will be made initially to the deck of the ship. Each recording, including tripping time and re-entry should take less than an hour per tool, leading to an average logging time per hole of 8 hours (for 8 runs) plus 2 hours for rigging-up/down (hence a total of 10).

4.1.4 - Submersible

Visual examination, mapping and sampling of the deep foreslopes will be conducted using the German manned **submersible JAGO** which has a diving limit of -400m. JAGO has a large front window with a diameter of 60 cm, five spotlights and two powerful flashes for underwater photography and is equipped with a manipulator and sample box. A simple but heavy duty chisel is mounted onto the keel for collecting hard rock samples. The inclination of the slope is measured using a simple clinometer and the depth is continuously recorded with a fathometer. This submersible has already been used for the same purpose around the Comoro islands (Colonna et al. *Quat. Res.,* 46, 335, 1996; Dullo et al., 1998) and on the Pedro Bank (Caribbean).

4.2 - SAFETY ISSUES AND TIME ESTIMATES

4.2.1 - Shallow water issues

Operational and safety issues during drilling operations in shallow water settings may be related to (a) the potential low recovery from shallow water sediments, (b) hydrocarbon hazards and (c) difficulties arising from swells.

(a) The PROD is equipped with a coring system which ensures good recovery in carbonate sequences.

(b) The risk of encountering gas or even traces of hydrocarbons is negligible at all sites.

(c) Drilling operations must be scheduled between April and October, with the optimum period between May and September. Furthermore, the proximity of the proposed drill sites may ensure to drill during calm weather windows.

4.2.2 - Drilling and logging time estimates

A provisional table of drilling and logging times estimates is given below.

SITE	Min. Time (days)	Max. Time (days)	Water depth (m)	Total penetration (m)
TAH-01A	6	8	20 to 300	440
TAH-02A	6	8	20 to 300	440
TAH-03A	6	8	20 to 300	440
RIB-01A	5	7	25 to 250	330
HYD-01A	6	8	40 to 250	400
Total	**30**	**39**		**2050**

4.3 - WEATHER CONDITIONS AND WATER CURRENTS

Weather and water conditions concerning the two regions, Tahiti and the GBR, are taken from syntheses published by Gabrie & Salvat (*5th Intern. Coral Reef Cong.,* 1, 1, 1985), Maxwell (*Atlas of the GBR, Elsevier,* 258 pp, 1968) and Pickard et al. (*A review of the physical oceanography of the GBR and Western Coral Sea, Aust. Gov. Publ. Serv.*, 1977), and are summarized below. **We suggest that these data demonstrate that the preferred drilling window is from April to October, with the optimum period between May and September.**

4.3.1 - Tahiti

French Polynesia is under the influence of the Southern Oscillation. The climate of Tahiti is typically tropical, with two distinct seasons: a warm rainy season from November to April (austral summer), with maximum sea surface temperatures ranging from 28 to 29°C, and a cool and dry season from May to October (austral winter), with lower sea-water temperatures

(24-25°C). The sea surface temperatures range from 24°C (austral winter) to 29°C (austral summer). Salinity is quite constant and ranges around 36 psu. Although the annual rainfall averages 1,500 mm at Papeete, there are marked variations in rain intensity throughout the year: minimum monthly values are less than 50mm in winter, while maximum values, up to 400mm, occur in January and February. The eastern trade winds predominate from October to March (average speed : 5 to 8 $m.s^{-1}$); swells generated by these trade winds occur along the long axis of the island and are generally more than 2 m in amplitude (Fig.6). From April to June, there are long calm periods (winds of less than 1 m/s); however, gusts from the south-east ('Ma'aramu') may attain 10 to $15m.s^{-1}$. Occasional cyclones generally arrive from the north-east and the north-west from November to April. The tides are semi-diurnal and their amplitude averages 0.5m; reef flats emerge at spring low tide water level and waves commonly break on the central areas of reef flats at high tide. In the surface layer, the dominant current is the Equatorial Current which is oriented westward and flows with an average speed of $20\text{-}50cm.s^{-1}$ between the latitude of 10°S and 4°N; the Tahitian zone is located in the western branch of the tropical gyre.

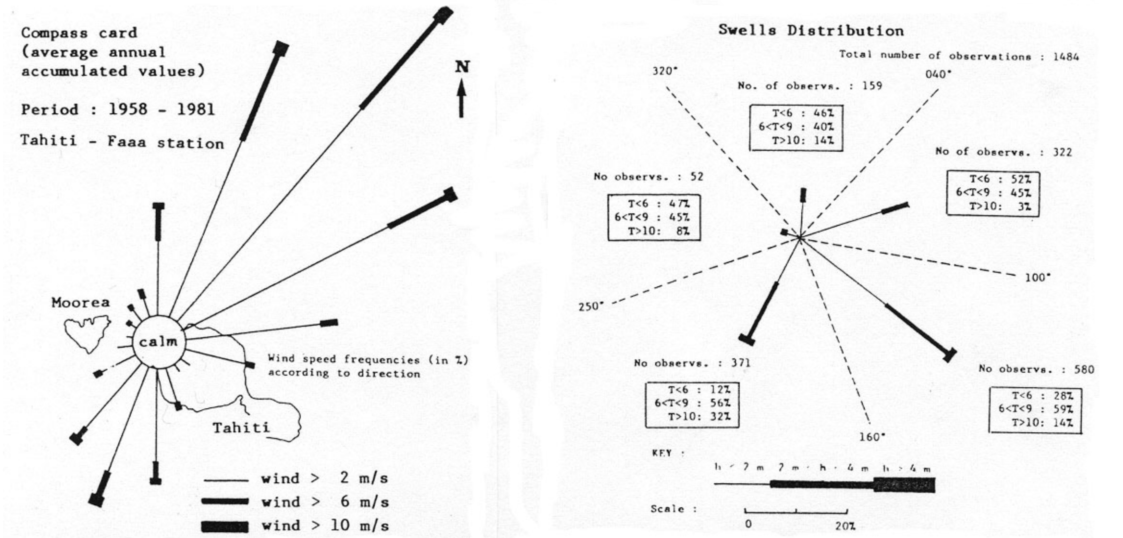


Fig. 6. Swell distribution and wind speed frequencies in Tahiti (from Gabrié & Salvat, 1985).

4.3.2. - Great Barrier Reef

Average summer temperatures in the GBR region range from 30°C in Cairns to 26°C in Gladstone; winter temperatures range from 26°C in Cairns to 15°C in Gladstone. The Queensland coast is the wettest part of Australia and the rainy season occurs in summer; although its mean value in Cooktown and Cairns is 1800-2000 mm, annual rainfall displays strong variations and ranges from 1000 to 3000mm and from 1200 to 4200mm in Cooktown and Cairns respectively. Trade winds are strongest and most persistent from May to November, when they are prevalent between 0 and 25°S latitude. During the summer, from December to April, the Trade Wind Belt is displaced to 10-30°S. The summer Monsoon blows from the north of the Equatorial Trough for four months. Its direction varies from north-east to north-west and in February it extends as far south as 15°S latitude. The northern part of the region is defined by the narrow, fast-moving South Equatorial Current which flows north-westward as it approaches New-Guinea (Fig.7). The Trade Wind Drift which occupies the zone between the South Equatorial Current and the Tropical Convergence, fluctuates with seasonal changes in the wind pattern : from April to December it moves water in a westerly direction across the Coral Sea where it diverges with part of the northern branch flowing into the Solomon Sea and the southern branch becoming the East Australian Current; in the summer (December-March), with a strong monsoonal effect, equatorial water masses flow southward to merge with the East Australian Current. Occasional cyclones originate in the Intertropical Convergence Zone, between 8°S and 18°S in the northern Coral Sea and are most common from January to March (Fig.7). There are rough seas through autumn and winter with the south-east trade winds, and calm water in the spring (Zell, *Proceed. 4th Int. Coral Reef Symp.,* 1, 237, 1981). Tides are semi-diurnal with significant variations from springs to neaps (3.3 to 0.3m at the equinoxes, March and September); there is a considerable diurnal inequality, particularly in the height of successive high waters amounting to over 1m at times.

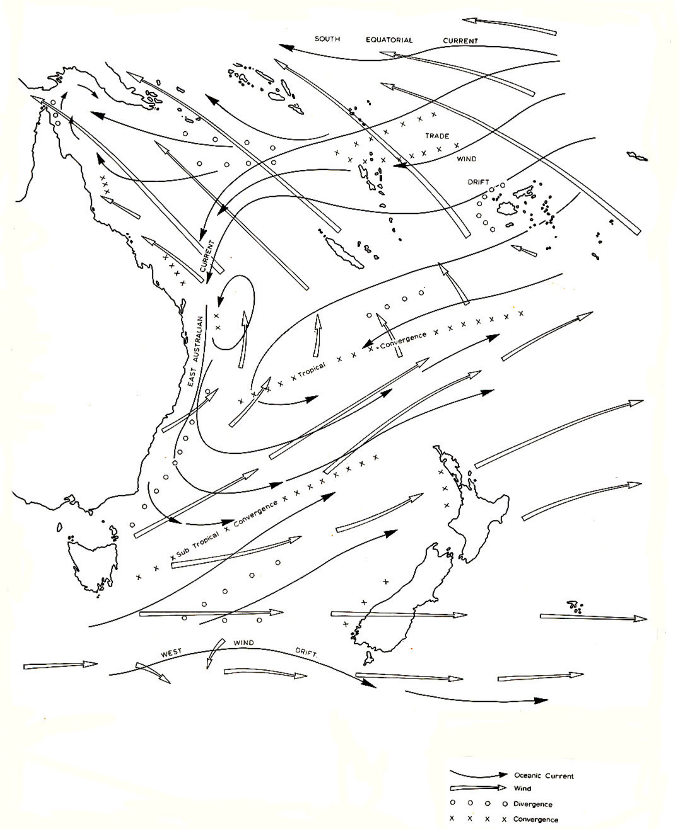


Fig. 7. Generalised circulation pattern of wind and oceanic currents in the South-West Pacific. Zones of convergence and divergence are also indicated (from Maxwell, 1968).

5 - RESPONSES TO FALL 1998 ESSEP REVIEW

Responses to the comments raised in the ESSEP discussion during the 1998 fall meeting have contributed to specify the scientific objectives and technical/operational issues. We clarify below several aspects of our drilling proposal by addressing specific comments from this panel:

- « the proponents should explain more clearly what will be gained by the new drilling that was not obtained by previous drilling. This concern is particularly important for Tahiti sites (for example, what is the likelihood of obtaining very early deglacial material, older than 14 Ky. BP?) ».

Our project will provide the opportunity to constrain better the deglacial sea level history (see Peltier, 1994; Fleming et al. *EPSL*, 163, 327, 1998; Okuno & Nakada *Palaeogr. Palaeoclim. Palaeoecol.,* 146, 283, 1999): 1) by documenting for the first time the LGM lowstand in well-studied cores in the far-field, and 2) by comparing the MWP-1A in the Pacific and the Atlantic. Furthermore, the study of very early deglacial coral material will allow the first Sr/Ca SSTs for the LGM in the Pacific. This will nicely complement the Sr/Ca record measured on Barbados samples (Guilderson et al., 1994) and the recent Sr/Ca data measured on stage 6 corals at Huon Peninsula (McCulloch et al. *Science*, 283, 202, 1999).

The existing sedimentological and geochemical data on Tahiti are based on 8 vertical and slightly inclined (up to 30° with respect to the vertical) drill holes carried out with a Sedidrill coring-system through the barrier reef complex facing Papeete. These drill holes allowed the recovery of reef deposits which developed during the last 14 kyr (dated by U-Th and thus equivalent to calendar years). Early deglaciation material very probably occur seawards, probably beyond the 50 m slope break (see Fig. 2); a similar remark applies to the GBR where vertical holes only were carried out with a jack-up rig. Previous investigations have demonstrated the occurrence of early deglacial reef deposits in both regions, French Polynesia and Great Barrier Reef. Corals which grew between the Last Glacial Maximum and MWP-1A (ranging from 15 to 18 kyr BP by U-Th) have been recovered in continuous drill holes with seaward deviations of 30 to 45°, 300 m in length, carried out on the NE rim of the Mururoa atoll (French Polynesia; Bard et al., *Radiocarbon* 35, 191, 1993). Similarly, very early deglacial corals (17 kyr BP by U-Th) have been recovered on the GBR foreslopes by submersible sampling (Veeh & Veevers, *Nature*, 266, 536, 1970). Accordingly, the only way to recover very early deglacial material is with drill holes carried out off-shore as planned in this proposal with the PROD in both regions (see Fig. 2), and as done previously in Barbados (Fairbanks, 1989; Bard et al., 1990a&b). In addition, simple model simulations of the Tahiti reef building also suggest that off-shore drilling could allow the recovery of corals which were living during the period between the Last Glacial Maximum and MWP-1A (cf. Bard et al., 1996 and subsequent unpublished tests with the same model).

- « the proponents should describe in more detail the nature of the facies change with water depth at each site (how precise are the sea level estimates likely to be?) ».

It is clear that the coral biodiversity is much higher in the Pacific than in the Atlantic implying inherently a more complex depth zonation.

First it must be reminded that the reliability of biological paleobathymetric indicators is always a statistical notion: in the papers on the Barbados cores (Fairbanks, 1989; Bard et al., 1990a&b) it is assumed that *A. palmata* samples are restricted to the upper 5 m of the water column. Indeed, this species is probably the only one to form monospecific reef framework in this depth range in the Caribbean where it has a depth habitat range restricted to about 10 m (Goreau, *Ecology*, 40, 67, 1959; Gladfelter & Monahan, *Proceed. 3rd Int. Cor. Reef Symp.*, 1, 389, 1977) although in several instances it has been reported as deep as 17 m (Goreau & Wells, *Bull. Mar. Sci.*, 17, 442, 1967). In a core drilled throughout reef deposits there is always a minor risk of dating a fossil of deeper living *A. palmata.* Nevertheless, the limited scatter of the individual sea level data around the smooth Barbados sea level curve suggests that such a problem is very unlikely. It must be emphasized that this argument applies as well to *Acropora* gr. *robusta-danai* in our previous studies of Tahiti back to 14 kyr BP (Bard et al., 1996; Montaggioni et al., 1997; Montaggioni & Bard, 1998; Camoin et al., *Sed. Geol.*, in press; Cabioch et al., *Sedimentology*, in press).

For years, extensive surveys have been carried out in the Indo-Pacific biogeographic province, especially French Polynesia and Great Barrier Reef and have fully documented a reliable depth zonation of modern coralgal communities (Camoin & Montaggioni, 1994; Montaggioni et al., 1997; Cabioch et al., *Sedimentology*, in press and references therein). These studies indicate especially that the dominance of the most common association occurring in the Tahiti cores (i.e. *Acropora* gr. *robusta-danai, Pocillopora verrucosa, Hydrolithon (Porolithon) onkodes* = APH community) characterises the high-energy reef front or upper forereef zone exposed to strong wave action, essentially restricted to 0-6 m water depth or even less than 3 m below low tide level when vermetid gastropods (*Dendropoma maximus* and *Serpulorbis annulatus*) are associated. Robust branching acroporids are considered to be the most reliable recorders of water depth in the Indo-Pacific province and can be regarded as the Indo-Pacific counterparts of the Caribbean *Acropora palmata*.. The other significant coralgal associations recovered in the Tahiti cores are less abundant and are dominated either by tabular *Acropora hyacinthus* and *A. cytherea* and domal *Porites* community which have a slightly greater depth range (6-15 m depending on local water energy level) than the APH community. The distribution of coralgal communities in Tahiti cores and the ecological zonation of their modern analogs are given below (from Cabioch et al., *Sedimentology*, in press).

Coralgal associations and distribution in Tahiti cores	**Modern depositional environment**
Branching *Porites* (*P. nigrescens/lichen*) - *Lithophyllum.*	
Corals *Porites* cf. *nigrescens, P.* cf. *lichen;* scarce *Pocillopora, Porites* cf. *lobata* and faviids. **Algae** Branching *Lithophyllum* sp., *Mesophyllum* sp.; rare *Neogoniolithon* sp. and *Hydrolithon onkodes* . **core P9** : 66.1 - 78 m & core P10 : 65 - 88.5 m	Moderate to low energy conditions relatively independent of the zonation and water depth (0-30 m; 5-30 m in the study area; adapted to low irradiance
Domal *Porites* (*P. lutea/solida*) - *Lithophyllum*	
Corals *Porites* cf. *lutea* and *P.* cf. *lobata;* scattered *Pocillopora* cf. *verrucosa* and tabular acroporids **Algae** Gracile branching *Lithophyllum, Hydrolithon onkodes* *Dermatolithon* cf. *tesselatum* and *Neogoniolithon fosliei.* **core P7** : 67 - 82 m & core P8 : 74.2-84.7 m	Outer reef flat and forereef zone and windward zone of lagoonal pinnacles in moderate to high energy conditions, at depths shallower than 15 m (6 to 15 m in the study area).
Robust branching *Acropora* (*A.* gr. *danai*) - *Hydrolithon*	
Corals *Acropora* gr.*danai/robusta;* Branching *A. humilis, Pocillopora eydouxi* and *P. verrucosa* ; Scarce domal *Leptastrea* sp., *Porites* cf. *lobata, Favia stelligera,* *F.* gr. *abdita* and *Montastrea annuligera* **Algae** Thick crusts of *Hydrolithon onkodes, Neogoniolithon fosliei, Mesophyllum* sp. Locally : *Lithophyllum* sp. *Dermatolithon* cf. *tesselatum,* *Lithoporella melobesioides* and *Mesophyllum* sp. Vermetid gastropods (*Serpulorbis annulatus* and *Dendropoma maximus*); encrusting foraminifers (*Homotrema rubrum, Carpenteria* cf. *monticularis* and *Acervulina inhaerens*). **core P6** : 0 - 37 m + some intervals between 37 and 50 m; **core P7** : 0 - 67 m (except between 35.1 and 36.5 m and 82 - 87 m **core P8** : 0-36.7 m and 49.6-60.7 m **core P9** : 0 - 34.8 m and 54.4 - 66.1 m **core P10** : 0 - 26.3 m and 37.5 - 65 m	Reef front or upper forereef zone in high energy conditions at depths less than 6 m (even less than 3 m in the study area).
Tabular Acropora (A. gr. cytherea)- Neogoniolithon	
Corals Tabular *Acropora hyacinthus, A. cytherea* and *A. clathrata* ; plate-shaped *A. danai /robusta* ecomorphs and domal *Montastrea annuligera.* **Algae** Thin crusts of*Neogoniolithon* cf. *absimile, N. propinquum,* *Dermatolithon* cf. *tesselatum* and *Mesophyllum* cf. *prolifer;* rare *Hydrolithon onkodes.* **core P6 :** 37.0 - 50.0 m; core P7 : 35.1 - 36.5 m **core P8 :** 36.7 - 49.6 m, 60.7-74.2 m and 84.7-90.6 m **core P9 :** 34.8-46.5 m; core P10 : 26.3-37.5 m	Forereef zone in moderate energy conditions at depths shallower than 15 m (6 to 15 m in the study area).

- *« the proponents should be more explicit about the location and the purpose of deep sites ».*

As described above (see section 3.3 'Proposed drill sites and drilling strategy'), besides the reef cores, we propose to drill at all sites 100m holes in the sediments forming the terraces immediately in front of the reef wall at water depths between 150 and 300 m. The exact location of these sites will be specified after a site survey around Tahiti using the French vessel 'Atalante' owned by IFREMER and for which a proposal is currently under evaluation. The objectives are to quantify the variations in sedimentation rates and to analyze the changes in sediment composition during the last deglaciation sea level rise. It has been demonstrated in Quaternary carbonate systems that sea level highstands represent periods of carbonate deposition (so-called 'highstand shedding'; Schlager et al., *J. Sedim. Res.*, B64, 270, 1994) whereas lowstands are periods of sediment starvation. Highstand shedding processes cease when the platform is drowned during a rapid sea-level rise as it was demonstrated for the last deglaciation Meltwater Pulses (Dullo et al., 1998). Combining reef deposits and deeper water sediments datasets may improve our insight in sea level history and the related sedimentary processes acting on the reef slopes.

- *« Clearly, the success of this proposal and its science plan is, in some ways, inseparable from the successful development of the alternate drilling platform. For this proposal, it will be especially important to test the PROD in the reef facies of interest ».*

The success of scientific operations always depends on the technology used to recover material or to acquire analytic datasets. Indeed, this proposal is linked to the development of an alternate drilling equipment, the Portable Remotely Operated Drill (PROD) which has the capacity to drill 100 m holes and can be operated and deployed from a 30 m ship; it also has the capacity to switch repeatedly from drilling to coring, re-enter the hole, and log the hole. Last september, before sumission of the Full Proposal to Joides, the PROD completed workshop tests and drilled through the workshop floor to 50 m. Since September, the PROD was successfully tested in Sydney harbour and in the Timor Sea (in collaboration with Woodside petroleum). The PROD system and its performances were presented by Pr. P.J. Davies during the last meeting of the ODP-PPG "Shallow Water Systems" (San Francisco, December 1998).

iSAS/IODP Site Summary Forms:
Form 1 - General Site Information

Please fill out information in all gray boxes
Revised 31 January 2002

Revised

Section A: Proposal Information

Title of Proposal:	« The last deglacial sea-level rise in the south Pacific : offshore drilling in Tahiti (French Polynesia) and on the Australian Great Barrier Reef »
Date Form Submitted:	29 March, 2002
Site Specific Objectives with Priority (Must include general objectives in proposal)	**1.** To establish the course of post glacial sea-level rise in the Great Barrier Reef and at Tahiti, ie to define the exact shape of the deglaciation curve for the period 20,000 to 10,000 yrs BP. **2.** To define short term paleoclimatic changes, especially SST variations, for the region over the last 20,000 yrs. **3.** To analyse the impact of sea-level changes on reef growth, geometry and biological makeup.
List Previous Drilling in Area:	1990, 1992 (P6 and P7 drill holes) and 1995 (P8, P9 and P10 drill holes) by ORSTOM.

Section B: General Site Information

Site Name: (e.g. SWPAC-01A)	TAH-01A	If site is a reoccupation of an old DSDP/ODP Site, Please include former Site #	Area or Location:	TAHITI
Latitude:	Deg: 17	Min: 31	Jurisdiction:	FRENCH POLYNESIA
Longitude:	Deg: 149	Min: 35	Distance to Land:	500 m
Coordinates System:	WGS 84, Other ( )			
Priority of Site:	Primary:	Alt:	Water Depth:	20 to 300 m (transect)

Section C: Operational Information

	Sediments			Basement
Proposed Penetration: (m)	50 to 100 m (6 holes) Total penetration : 440 m			10 m
	What is the total sed. thickness?	50 to 100	m	
			Total Penetration:	450 m
General Lithologies:	Limestones and unconsolidated sands			Volcanic rocks
Coring Plan: *(Specify or Circle)*	Mission specific platform – Platform not yet determined			
	1-2-3-APC VPC* XCB MDCB* PCS RCB Re-entry HRGB			

Wireline Logging Plan:	Standard Tools	Special Tools		LWD
	Neutron-Porosity	**Borehole Televiewer**	Formation Fluid Sampling	Density-Neutron
	Litho-Density	Nuclear Magnetic Resonance	**Borehole Temperature & Pressure**	Resistivity-Gamma Ray
	Gamma Ray	Geochemical	Borehole Seismic	Acoustic
	Resistivity	Side-Wall Core Sampling		
	Acoustic			
	Formation Image		Others ( )	Others ( )

Max.Borehole Temp. :	*Expected value (For Riser Drilling)* ________ °C	

Mud Logging: *(Riser Holes Only)*	Cuttings Sampling Intervals
	from m to m, m intervals
	from m to m, m intervals
	Basic Sampling Intervals: 5m

Estimated days:	Drilling/Coring:	Logging:	Total On-Site: 6-8

Future Plan:	*Longterm Borehole Observation Plan/Re-entry Plan*

Hazards/ Weather:	*Please check flowing List of Potential Hazards* **NONE**			*What is your Weather window? (Preferable period with the reasons)*
	Shallow Gas	Complicated Seabed Condition	Hydrothermal Activity	**April-October (best sea conditons)**
	Hydrocarbon	Soft Seabed	Landslide and Turbidity Current	
	Shallow Water Flow	Currents	Methane Hydrate	
	Abnormal Pressure	Fractured Zone	Diapir and Mud Volcano	
	Man-made Objects	Fault	High Temperature	
	H_2S	High Dip Angle	Ice Conditions	
	CO_2			

iSAS/IODP Site Summary Forms:

Form 2 - Site Survey Detail

Please fill out information in all gray boxes

New ☐ *Revised* ☐

roposal #: 519	Site #: TAH-01A	Date Form Submitted: 29 March 2002

	Data Type	SSP Requir-ements	Exists In DB	Details of available data and data that are still to be collected
1	High resolution seismic reflection			Primary Line(s) :Location of Site on line (SP or Time only) TO BE COLLECTED (OCTOBER 2002) Crossing Lines(s):
2	Deep Penetration seismic reflection			Primary Line(s): Location of Site on line (SP or Time only) Crossing Lines(s):
3	Seismic Velocity†			
4	Seismic Grid			
5a	Refraction (surface)			
5b	Refraction (near bottom)			
6	3.5 kHz			Location of Site on line (Time) TO BE COLLECTED (OCTOBER 2002)
7	Swath bathymetry			AVAILABLE
8a	Side-looking sonar (surface)			TO BE COLLECTED (OCTOBER 2002)
8b	Side-looking sonar (bottom)			TO BE COLLECTED (OCTOBER 2002)
9	Photography or Video			AVAILABLE (Cyana submersible)
10	Heat Flow			
11a	Magnetics			
11b	Gravity			
12	Sediment cores			AVAILABLE (drill cores from the modern barrier reef)
13	Rock sampling			AVAILABLE + TO BE COLLECTED (OCTOBER 2002)
14a	Water current data			AVAILABLE
14b	Ice Conditions			
15	OBS microseismicity			
16	Navigation			
17	Other			

SSP Classification of Site:	SSP Watchdog:	Date of Last Review:
SSP Comments:		

X=required; X*=may be required for specific sites; Y=recommended; Y*=may be recommended for specific sites; R=required for re-entry sites; T=required for high temperature environments; † Accurate velocity information is required for holes deeper than 400m.

iSAS/IODP Site Summary Forms:

Form 3 - Detailed Logging Plan

Revised ☐

Proposal #: 519	Site #: TAH-01A	Date Form Submitted: 29 March 2002
Water Depth (m): 50 to 300	Sed. Penetration (m):50 to 100 (6 holes)	Basement Penetration (m): 10

Do you need to use the conical side-entry sub (CSES) at this site? Yes ☐ **No** ☐

Are high temperatures expected at this site? Yes ☐ **No** ☐

Are there any other special requirements for logging at this site? Yes ☐ **No** ☐

If "Yes" Please describe requirements:____

____

What do you estimate the total logging time for this site to be: 30 hours total _______

Measurement Type	Scientific Objective	Relevance (1=high, 3=Low)
Neutron-Porosity	Carbonate platform porosity	1
Litho-Density	Formation density - Synthetic seismogram	2
Natural Gamma Ray	Identification of clays, red algae and alteration processes	1
Resistivity-Induction	Porosity of the carbonate platform - Formation fluid resistivity	1
Acoustic	Compressional and shear velocities - Synthetic seismogram	1
FMS	(does not exist in small diameter)	
BHTV	High-resolution pore distribution in carbonates	1
Resistivity-Laterolog		
Magnetic/Susceptibility	Paleoclimatological proxy - Clay identification	1
Density-Neutron (LWD)		
Resitivity-Gamma Ray (LWD)		
Other: Special tools (CORK, PACKER, VSP, PCS, FWS, WSP	VSP only if small diameter tool available	2

For help in determining logging times, please contact the ODP-LDEO Wireline Logging Services group at: borehole@ldeo.columbia.edu http://www.ldeo.columbia.edu/BRG/brg_home.html Phone/Fax: (914) 365-8674 / (914) 365-3182	Note: Sites with greater than 400 m of penetration or significant basement penetration require deployment of standard toolstrings.

iSAS/IODP Site Summary Forms:

Form 4 – Pollution & Safety Hazard Summary

Please fill out information in all gray boxes

New   *Revised*

Proposal #: 519	Site #: TAH-01A	Date Form Submitted: 29 March 2002

1	Summary of Operations at site: (Example: Triple-APC to refusal, XCB 10 m into basement, log as shown on page 3.)	Mission specific platform – Platform not yet determined
2	Based on Previous DSDP/ODP drilling, list all hydrocarbon occurrences of greater than background levels. Give nature of show, age and depth of rock:	NONE
3	From Available information, list all commercial drilling in this area that produced or yielded significant hydrocarbon shows. Give depths and ages of hydrocarbon-bearing deposits.	NONE
4	Are there any indications of gas hydrates at this location?	NO
5	Are there reasons to expect hydrocarbon accumulations at this site? Please give details.	NO
6	What "special" precautions will be taken during drilling?	NONE
7	What abandonment procedures do you plan to follow:	NONE
8	Please list other natural or manmade hazards which may effect ship's operations: (e.g. ice, currents, cables)	NONE
9	Summary: What do you consider the major risks in drilling at this site?	NO MAJOR RISK

iSAS/IODP Site Summary Forms:

Proposal #: 519 | Site #: TAH-02A | Date Form Submitted: 29 March 2002

New ☐ *Revised* ☐

Sub-bottom depth (m)	*Key reflectors, Unconformities, faults, etc*	*Age*	*Assumed velocity (km/sec)*	*Lithology*	*Paleo-environment*	*Ave. rate of sediment accumulation (m/My)*	*Comments*
20 to 300		Holocene / Pleistocene	1.5	Carbonates (Reef frameworks, limestones and unconsolidated sands)	Reef environment to slope environment		
		Pleistocene		Volcanic rocks (substrate)			

iSAS/IODP Site Summary Forms:
Form 1 - General Site Information

Please fill out information in all gray boxes
Revised 31 January 2002

Revised

Section A: Proposal Information

Title of Proposal:	« The last deglacial sea-level rise in the south Pacific : offshore drilling in Tahiti (French Polynesia) and on the Australian Great Barrier Reef »
Date Form Submitted:	29 March, 2002
Site Specific Objectives with Priority (Must include general objectives in proposal)	**3.** To establish the course of post glacial sea-level rise in the Great Barrier Reef and at Tahiti, ie to define the exact shape of the deglaciation curve for the period 20,000 to 10,000 yrs BP. **4.** To define short term paleoclimatic changes, especially SST variations, for the region over the last 20,000 yrs. **3.** To analyse the impact of sea-level changes on reef growth, geometry and biological makeup.
List Previous Drilling in Area:	1990, 1992 (P6 and P7 drill holes) and 1995 (P8, P9 and P10 drill holes) by ORSTOM.

Section B: General Site Information

Site Name: (e.g. SWPAC-01A)	TAH-02A	If site is a reoccupation of an old DSDP/ODP Site, Please include former Site #	Area or Location:	TAHITI
Latitude:	Deg: 17	Min: 35	Jurisdiction:	FRENCH POLYNESIA
Longitude:	Deg: 149	Min: 20	Distance to Land:	1500 m
Coordinates System:	WGS 84, Other ( )			
Priority of Site:	Primary:	Alt:	Water Depth:	20 to 300 m (transect)

Section C: Operational Information

Proposed Penetration: (m)

	Sediments	Basement
Proposed Penetration: (m)	50 to 100 m (6 holes) Total penetration : 440 m	10 m
What is the total sed. thickness?	50 to 100 m	
	Total Penetration:	450 m

General Lithologies:

Sediments	Basement
Limestones and unconsolidated sands	Volcanic rocks

Coring Plan: *(Specify or Circle)*

Mission specific platform – Platform not yet determined

1-2-3-APC VPC* XCB MDCB* PCS RCB Re-entry HRGB

Wireline Logging Plan:

Standard Tools	Special Tools		LWD
Neutron-Porosity	**Borehole Televiewer**	Formation Fluid Sampling	Density-Neutron
Litho-Density	Nuclear Magnetic Resonance	**Borehole Temperature & Pressure**	Resistivity-Gamma Ray
Gamma Ray	Geochemical	Borehole Seismic	Acoustic
Resistivity	Side-Wall Core Sampling		
Acoustic			
Formation Image		Others ( )	Others ( )

Max.Borehole Temp. : *Expected value (For Riser Drilling)* ______ °C

Mud Logging: *(Riser Holes Only)*

Cuttings Sampling Intervals

from m to m, m intervals

from m to m, m intervals

Basic Sampling Intervals: 5m

Estimated days:

Drilling/Coring:	Logging:	Total On-Site: 6-8

Future Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

Hazards/ Weather:

Please check flowing List of Potential Hazards **NONE**

Shallow Gas	Complicated Seabed ondition	Hydrothermal Activity
Hydrocarbon	Soft Seabed	Landslide and Turbidity Current
Shallow Water Flow	Currents	Methane Hydrate
Abnormal Pressure	Fractured Zone	Diapir and Mud Volcano
Man-made Objects	Fault	High Temperature
H_2S	High Dip Angle	Ice Conditions
CO_2		

What is your Weather indow? (Preferable period ith the reasons)

April-October (best sea conditons)

iSAS/IODP Site Summary Forms:

Form 2 - Site Survey Detail

Please fill out information in all gray boxes

New [ ] *Revised* [ ]

roposal #: 519	Site #: TAH-02A	Date Form Submitted: 29 March 2002

	Data Type	SSP Requir-ements	Exists In DB	Details of available data and data that are still to be collected
1	High resolution seismic reflection			Primary Line(s) :Location of Site on line (SP or Time only) TO BE COLLECTED (OCTOBER 2002) Crossing Lines(s):
2	Deep Penetration seismic reflection			Primary Line(s): Location of Site on line (SP or Time only) Crossing Lines(s):
3	Seismic Velocity†			
4	Seismic Grid			
5a	Refraction (surface)			
5b	Refraction (near bottom)			
6	3.5 kHz			Location of Site on line (Time) TO BE COLLECTED (OCTOBER 2002)
7	Swath bathymetry			AVAILABLE
8a	Side-looking sonar (surface)			TO BE COLLECTED (OCTOBER 2002)
8b	Side-looking sonar (bottom)			TO BE COLLECTED (OCTOBER 2002)
9	Photography or Video			AVAILABLE (Cyana submersible)
10	Heat Flow			
11a	Magnetics			
11b	Gravity			
12	Sediment cores			AVAILABLE (drill cores from the modern barrier reef)
13	Rock sampling			TO BE COLLECTED (OCTOBER 2002)
14a	Water current data			AVAILABLE
14b	Ice Conditions			
15	OBS microseismicity			
16	Navigation			
17	Other			

SSP Classification of Site:	SSP Watchdog:	Date of Last Review:
SSP Comments:		

X=required; X*=may be required for specific sites; Y=recommended; Y*=may be recommended for specific sites; R=required for re-entry sites; T=required for high temperature environments; † Accurate velocity information is required for holes deeper than 400m.

iSAS/IODP Site Summary Forms:

Form 3 - Detailed Logging Plan

Revised

Proposal #: 519	Site #: TAH-02A	Date Form Submitted: 29 March 2002
Water Depth (m): 20 to 300	Sed. Penetration (m):50 to 100 (6 holes)	Basement Penetration (m): 10

Do you need to use the conical side-entry sub (CSES) at this site? Yes ☐ **No** ☐

Are high temperatures expected at this site? Yes ☐ **No** ☐

Are there any other special requirements for logging at this site? Yes ☐ **No** ☐

If "Yes" Please describe requirements:________________________________

What do you estimate the total logging time for this site to be: 30 hours total _______

Measurement Type	Scientific Objective	Relevance (1=high, 3=Low)
Neutron-Porosity	Carbonate platform porosity	1
Litho-Density	Formation density - Synthetic seismogram	2
Natural Gamma Ray	Identification of clays, red algae and alteration processes	1
Resistivity-Induction	Porosity of the carbonate platform - Formation fluid resistivity	1
Acoustic	Compressional and shear velocities - Synthetic seismogram	1
FMS	(does not exist in small diameter)	
BHTV	High-resolution pore distribution in carbonates	1
Resistivity-Laterolog		
Magnetic/Susceptibility	Paleoclimatological proxy - Clay identification	1
Density-Neutron (LWD)		
Resitivity-Gamma Ray (LWD)		
Other: Special tools (CORK, PACKER, VSP, PCS, FWS, WSP	VSP only if small diameter tool available	2

For help in determining logging times, please contact the ODP-LDEO Wireline Logging Services group at: borehole@ldeo.columbia.edu http://www.ldeo.columbia.edu/BRG/brg_home.html Phone/Fax: (914) 365-8674 / (914) 365-3182	Note: Sites with greater than 400 m of penetration or significant basement penetration require deployment of standard toolstrings.

iSAS/IODP Site Summary Forms:

Form 4 – Pollution & Safety Hazard Summary

Please fill out information in all gray boxes

New ☐ *Revised* ☐

Proposal #: 519	Site #: TAH-02A	Date Form Submitted: 29 March 2002

1	Summary of Operations at site: (Example: Triple-APC to refusal, XCB 10 m into basement, log as shown on page 3.)	Mission specific platform – Platform not yet determined
2	Based on Previous DSDP/ODP drilling, list all hydrocarbon occurrences of greater than background levels. Give nature of show, age and depth of rock:	NONE
3	From Available information, list all commercial drilling in this area that produced or yielded significant hydrocarbon shows. Give depths and ages of hydrocarbon-bearing deposits.	NONE
4	Are there any indications of gas hydrates at this location?	NO
5	Are there reasons to expect hydrocarbon accumulations at this site? Please give details.	NO
6	What "special" precautions will be taken during drilling?	NONE
7	What abandonment procedures do you plan to follow:	NONE
8	Please list other natural or manmade hazards which may effect ship's operations: (e.g. ice, currents, cables)	NONE
9	Summary: What do you consider the major risks in drilling at this site?	NO MAJOR RISK

iSAS/IODP Site Summary Forms:

Proposal #: 519 | Site #: TAH-02A | Date Form Submitted: 29 March 2002

New ☐ *Revised* ☐

Sub-bottom depth (m)	*Key reflectors, Unconformities, faults, etc*	*Age*	*Assumed velocity (km/sec)*	*Lithology*	*Paleo-environment*	*Ave. rate of sediment accumulation (m/My)*	*Comments*
20 to 300		Holocene / Pleistocene	1.5	Carbonates (Reef frameworks, limestones and unconsolidated sands)	Reef environment to slope environment		
		Pleistocene		Volcanic rocks (substrate)			

iSAS/IODP Site Summary Forms:
Form 1 - General Site Information

Please fill out information in all gray boxes
Revised 31 January 2002

Revised

Section A: Proposal Information

Title of Proposal: « The last deglacial sea-level rise in the south Pacific : offshore drilling in Tahiti (French Polynesia) and on the Australian Great Barrier Reef »

Date Form Submitted: 29 March, 2002

Site Specific Objectives with Priority (Must include general objectives in proposal):

5. To establish the course of post glacial sea-level rise in the Great Barrier Reef and at Tahiti, ie to define the exact shape of the deglaciation curve for the period 20,000 to 10,000 yrs BP.
6. To define short term paleoclimatic changes, especially SST variations, for the region over the last 20,000 yrs.
3. To analyse the impact of sea-level changes on reef growth, geometry and biological makeup.

List Previous Drilling in Area: 1990, 1992 (P6 and P7 drill holes) and 1995 (P8, P9 and P10 drill holes) by ORSTOM.

Section B: General Site Information

Site Name: (e.g. SWPAC-01A)	TAH-03A	If site is a reoccupation of an old DSDP/ODP Site, Please include former Site #	Area or Location:	TAHITI
Latitude:	Deg: 17	Min: 45	Jurisdiction:	FRENCH POLYNESIA
Longitude:	Deg: 149	Min: 35	Distance to Land:	1500 m
Coordinates System:	WGS 84, Other ( )			
Priority of Site:	Primary:	Alt:	Water Depth:	20 to 300 m (transect)

Section C: Operational Information

	Sediments		Basement
Proposed Penetration: (m)	50 to 100 m (6 holes) Total penetration : 440 m		10 m
	What is the total sed. thickness?	50 to 100 m	
		Total Penetration:	450 m
General Lithologies:	Limestones and unconsolidated sands		Volcanic rocks
Coring Plan: *(Specify or Circle)*	Mission specific platform – Platform not yet determined 1-2-3-APC VPC* XCB MDCB* PCS RCB Re-entry HRGB		

Wireline Logging Plan:	Standard Tools	Special Tools		LWD
	Neutron-Porosity	**Borehole Televiewer**	Formation Fluid Sampling	Density-Neutron
	Litho-Density	Nuclear Magnetic Resonance	**Borehole Temperature & Pressure**	Resistivity-Gamma Ray
	Gamma Ray	Geochemical	Borehole Seismic	Acoustic
	Resistivity	Side-Wall Core Sampling		
	Acoustic			
	Formation Image		Others ( )	Others ( )

Max.Borehole Temp. :	*Expected value (For Riser Drilling)* °C			
Mud Logging: *(Riser Holes Only)*	Cuttings Sampling Intervals			
	from m	to m,	m intervals	
	from m	to m,	m intervals	
	Basic Sampling Intervals: 5m			
Estimated days:	Drilling/Coring:	Logging:	Total On-Site: 6-8	
Future Plan:	*Longterm Borehole Observation Plan/Re-entry Plan*			

Hazards/ Weather:	*Please check flowing List of Potential Hazards* **NONE**			*What is your Weather window? (Preferable period with the reasons)*
	Shallow Gas	Complicated Seabed Condition	Hydrothermal Activity	**April-October (best sea conditons)**
	Hydrocarbon	Soft Seabed	Landslide and Turbidity Current	
	Shallow Water Flow	Currents	Methane Hydrate	
	Abnormal Pressure	Fractured Zone	Diapir and Mud Volcano	
	Man-made Objects	Fault	High Temperature	
	H_2S	High Dip Angle	Ice Conditions	
	CO_2			

iSAS/IODP Site Summary Forms:

Form 2 - Site Survey Detail

Please fill out information in all gray boxes

New ☐ *Revised* ☐

roposal #: 519	Site #: TAH-03A	Date Form Submitted: 29 March 2002

	Data Type	SSP Requir-ements	Exists In DB	Details of available data and data that are still to be collected
1	High resolution seismic reflection			Primary Line(s) :Location of Site on line (SP or Time only) TO BE COLLECTED (OCTOBER 2002) Crossing Lines(s):
2	Deep Penetration seismic reflection			Primary Line(s): Location of Site on line (SP or Time only) Crossing Lines(s):
3	Seismic Velocity†			
4	Seismic Grid			
5a	Refraction (surface)			
5b	Refraction (near bottom)			
6	3.5 kHz			Location of Site on line (Time) TO BE COLLECTED (OCTOBER 2002)
7	Swath bathymetry			AVAILABLE
8a	Side-looking sonar (surface)			TO BE COLLECTED (OCTOBER 2002)
8b	Side-looking sonar (bottom)			TO BE COLLECTED (OCTOBER 2002)
9	Photography or Video			AVAILABLE (Cyana submersible)
10	Heat Flow			
11a	Magnetics			
11b	Gravity			
12	Sediment cores			AVAILABLE (drill cores from the modern barrier reef)
13	Rock sampling			TO BE COLLECTED (OCTOBER 2002)
14a	Water current data			AVAILABLE
14b	Ice Conditions			
15	OBS microseismicity			
16	Navigation			
17	Other			

SSP Classification of Site:	SSP Watchdog:	Date of Last Review:
SSP Comments:		

X=required; X*=may be required for specific sites; Y=recommended; Y*=may be recommended for specific sites; R=required for re-entry sites; T=required for high temperature environments; † Accurate velocity information is required for holes deeper than 400m.

iSAS/IODP Site Summary Forms:

Form 3 - Detailed Logging Plan

Revised ☐

Proposal #: 519	Site #: TAH-03A	Date Form Submitted: 29 March 2002
Water Depth (m): 20 to 300	Sed. Penetration (m):50 to 100 (6 holes)	Basement Penetration (m): 10

Do you need to use the conical side-entry sub (CSES) at this site? Yes ☐ **No** ☐

Are high temperatures expected at this site? Yes ☐ **No** ☐

Are there any other special requirements for logging at this site? Yes ☐ **No** ☐

If "Yes" Please describe requirements:____

____

What do you estimate the total logging time for this site to be: 30 hours total ________

Measurement Type	Scientific Objective	Relevance (1=high, 3=Low)
Neutron-Porosity	Carbonate platform porosity	1
Litho-Density	Formation density - Synthetic seismogram	2
Natural Gamma Ray	Identification of clays, red algae and alteration processes	1
Resistivity-Induction	Porosity of the carbonate platform - Formation fluid resistivity	1
Acoustic	Compressional and shear velocities - Synthetic seismogram	1
FMS	(does not exist in small diameter)	
BHTV	High-resolution pore distribution in carbonates	1
Resistivity-Laterolog		
Magnetic/Susceptibility	Paleoclimatological proxy - Clay identification	1
Density-Neutron (LWD)		
Resitivity-Gamma Ray (LWD)		
Other: Special tools (CORK, PACKER, VSP, PCS, FWS, WSP	VSP only if small diameter tool available	2

For help in determining logging times, please contact the ODP-LDEO Wireline Logging Services group at: borehole@ldeo.columbia.edu http://www.ldeo.columbia.edu/BRG/brg_home.html Phone/Fax: (914) 365-8674 / (914) 365-3182	Note: Sites with greater than 400 m of penetration or significant basement penetration require deployment of standard toolstrings.

iSAS/IODP Site Summary Forms: **Form 4 – Pollution & Safety Hazard Summary**

Please fill out information in all gray boxes

New ☐ *Revised* ☐

Proposal #: 519	Site #: TAH-03A	Date Form Submitted: 29 March 2002

1	Summary of Operations at site: (Example: Triple-APC to refusal, XCB 10 m into basement, log as shown on page 3.)	Mission specific platform – Platform not yet determined
2	Based on Previous DSDP/ODP drilling, list all hydrocarbon occurrences of greater than background levels. Give nature of show, age and depth of rock:	NONE
3	From Available information, list all commercial drilling in this area that produced or yielded significant hydrocarbon shows. Give depths and ages of hydrocarbon-bearing deposits.	NONE
4	Are there any indications of gas hydrates at this location?	NO
5	Are there reasons to expect hydrocarbon accumulations at this site? Please give details.	NO
6	What "special" precautions will be taken during drilling?	NONE
7	What abandonment procedures do you plan to follow:	NONE
8	Please list other natural or manmade hazards which may effect ship's operations: (e.g. ice, currents, cables)	NONE
9	Summary: What do you consider the major risks in drilling at this site?	NO MAJOR RISK

Proposal #: 519	Site #: TAH-03A	Date Form Submitted: 29 March 2002

Sub-bottom depth (m)	*Key reflectors, Unconformities, faults, etc*	*Age*	*Assumed velocity (km/sec)*	*Lithology*	*Paleo-environment*	*Ave. rate of sediment accumulation (m/My)*	*Comments*
20 to 300		Holocene / Pleistocene	1.5	Carbonates (Reef frameworks, limestones and unconsolidated sands)	Reef environment to slope environment		
		Pleistocene		Volcanic rocks (substrate)			

iSAS/IODP Site Summary Forms:
Form 1 - General Site Information

Please fill out information in all gray boxes
Revised 31 January 2002

Revised

Section A: Proposal Information

Title of Proposal:	« The last deglacial sea-level rise in the south Pacific : offshore drilling in Tahiti (French Polynesia) and on the Australian Great Barrier Reef »
Date Form Submitted:	29 March, 2002
Site Specific Objectives with Priority (Must include general objectives in proposal)	**7.** To establish the course of post glacial sea-level rise in the Great Barrier Reef and at Tahiti, ie to define the exact shape of the deglaciation curve for the period 20,000 to 10,000 yrs BP. **8.** To define short term paleoclimatic changes, especially SST variations, for the region over the last 20,000 yrs. **3.** To analyse the impact of sea-level changes on reef growth, geometry and biological makeup.
List Previous Drilling in Area:	- 2 drill cores in the reef : one on the inner shelf (Boulder Reef) + one on the outer-shelf (Ribbon Reef 5) – International Consortium for Great Barrier Reef Drilling. - Transect of 3 ODP sites (Leg 133) in the periplatform sediments.

Section B: General Site Information

Site Name: (e.g. SWPAC-01A)	RIB-01A	If site is a reoccupation of an old DSDP/ODP Site, Please include former Site #	Area or Location:	GREAT BARRIER REEF
Latitude:	Deg: 15	Min: 30	Jurisdiction:	AUSTRALIA
Longitude:	Deg: 145	Min: 40	Distance to Land:	About 100 km
Coordinates System:	WGS 84, Other ( )			
Priority of Site:	Primary:	Alt:	Water Depth:	40 to 250 m (transect)

Section C: Operational Information

	Sediments			Basement
Proposed Penetration: (m)	30 to 100 m (5 holes) Total penetration : 330 m			10 m
	What is the total sed. thickness?	50 to 100	m	
			Total Penetration:	340 m
General Lithologies:	Limestones and unconsolidated sands			Limestones
Coring Plan: *(Specify or Circle)*	Mission specific platform – Platform not yet determined			
	1-2-3-APC VPC* XCB MDCB* PCS RCB Re-entry HRGB			

Wireline Logging Plan:

Standard Tools	Special Tools		LWD
Neutron-Porosity	**Borehole Televiewer**	Formation Fluid Sampling	Density-Neutron
Litho-Density	Nuclear Magnetic Resonance	**Borehole Temperature & Pressure**	Resistivity-Gamma Ray
Gamma Ray	Geochemical	Borehole Seismic	Acoustic
Resistivity	Side-Wall Core Sampling		
Acoustic			
Formation Image		Others ( )	Others ( )

Max.Borehole Temp. : *Expected value (For Riser Drilling)* ____________ °C

Mud Logging: *(Riser Holes Only)*

Cuttings Sampling Intervals			
from	m to	m,	m intervals
from	m to	m,	m intervals

Basic Sampling Intervals: 5m

Estimated days:	Drilling/Coring:	Logging:	Total On-Site: 5-7

Future Plan: *Longterm Borehole Observation Plan/Re-entry Plan*

Hazards/ Weather:

Please check flowing List of Potential Hazards **NONE**			*What is your Weather window? (Preferable period with the reasons)*
Shallow Gas	Complicated Seabed Condition	Hydrothermal Activity	**April-October (best sea conditons)**
Hydrocarbon	Soft Seabed	Landslide and Turbidity Current	
Shallow Water Flow	Currents	Methane Hydrate	
Abnormal Pressure	Fractured Zone	Diapir and Mud Volcano	
Man-made Objects	Fault	High Temperature	
H_2S	High Dip Angle	Ice Conditions	
CO_2			

iSAS/IODP Site Summary Forms:

Form 2 - Site Survey Detail

Please fill out information in all gray boxes

New ☐ *Revised* ☐

roposal #: 519	Site #: RIB-01A	Date Form Submitted: 29 March 2002

	Data Type	SSP Requir-ements	Exists In DB	Details of available data and data that are still to be collected
1	High resolution seismic reflection			Primary Line(s) :Location of Site on line (SP or Time only) **Available** Crossing Lines(s):
2	Deep Penetration seismic reflection			Primary Line(s): Location of Site on line (SP or Time only) **Available** Crossing Lines(s):
3	Seismic Velocity†			
4	Seismic Grid			**see Leg 133 site-location tracks and *Rig Seismic* 1987 site-survey tracks**
5a	Refraction (surface)			
5b	Refraction (near bottom)			
6	3.5 kHz			Location of Site on line (Time) **Available (Grafton Passage and offshore Cairns)**
7	Swath bathymetry			**Available (Grafton Passage and offshore Cairns)**
8a	Side-looking sonar (surface)			
8b	Side-looking sonar (bottom)			
9	Photography or Video			
10	Heat Flow			
11a	Magnetics			**Available (Grafton Passage and offshore Cairns)**
11b	Gravity			
12	Sediment cores			**- 90m and 210 m long drill cores from Boulder Reef and Ribbon Reef 5 sites (International Consortium for Great Barrier Reef Drilling).** **- Sites 819, 820 & 821 (Grafton Passage); Site 822 (offshore Cairns)**
13	Rock sampling			
14a	Water current data			
14b	Ice Conditions			
15	OBS microseismicity			
16	Navigation			
17	Other			

SSP Classification of Site:	SSP Watchdog:	Date of Last Review:
SSP Comments:		

X=required; X*=may be required for specific sites; Y=recommended; Y*=may be recommended for specific sites; R=required for re-entry sites; T=required for high temperature environments; † Accurate velocity information is required for holes deeper than 400m.

iSAS/IODP Site Summary Forms:

Form 3 - Detailed Logging Plan

Revised ☐

Proposal #: 519	Site #: RIB-01A	Date Form Submitted: 29 March 2002
Water Depth (m): 25 to 250	Sed.Penetration (m):30 to 100 (5 holes)	Basement Penetration (m): 10

Do you need to use the conical side-entry sub (CSES) at this site? Yes ☐ **No** ☐

Are high temperatures expected at this site? Yes ☐ **No** ☐

Are there any other special requirements for logging at this site? Yes ☐ **No** ☐

If "Yes" Please describe requirements:_______________

What do you estimate the total logging time for this site to be: 30 hours total _______

Measurement Type	Scientific Objective	Relevance (1=high, 3=Low)
Neutron-Porosity	Carbonate platform porosity	1
Litho-Density	Formation density - Synthetic seismogram	2
Natural Gamma Ray	Identification of clays, red algae and alteration processes	1
Resistivity-Induction	Porosity of the carbonate platform - Formation fluid resistivity	1
Acoustic	Compressional and shear velocities - Synthetic seismogram	1
FMS	(does not exist in small diameter)	
BHTV	High-resolution pore distribution in carbonates	1
Resistivity-Laterolog		
Magnetic/Susceptibility	Paleoclimatological proxy - Clay identification	1
Density-Neutron (LWD)		
Resitivity-Gamma Ray (LWD)		
Other: Special tools (CORK, PACKER, VSP, PCS, FWS, WSP	VSP only if small diameter tool available	2

For help in determining logging times, please contact the ODP-LDEO Wireline Logging Services group at: borehole@ldeo.columbia.edu http://www.ldeo.columbia.edu/BRG/brg_home.html Phone/Fax: (914) 365-8674 / (914) 365-3182	Note: Sites with greater than 400 m of penetration or significant basement penetration require deployment of standard toolstrings.

iSAS/IODP Site Summary Forms:

Form 4 – Pollution & Safety Hazard Summary

Please fill out information in all gray boxes

New ☐ *Revised* ☐

Proposal #: 519	Site #: RIB-01A	Date Form Submitted: 29 March 2002

1	Summary of Operations at site: (Example: Triple-APC to refusal, XCB 10 m into basement, log as shown on page 3.)	Mission specific platform – Platform not yet determined
2	Based on Previous DSDP/ODP drilling, list all hydrocarbon occurrences of greater than background levels. Give nature of show, age and depth of rock:	NONE
3	From Available information, list all commercial drilling in this area that produced or yielded significant hydrocarbon shows. Give depths and ages of hydrocarbon-bearing deposits.	NONE
4	Are there any indications of gas hydrates at this location?	NO
5	Are there reasons to expect hydrocarbon accumulations at this site? Please give details.	NO
6	What "special" precautions will be taken during drilling?	NONE
7	What abandonment procedures do you plan to follow:	NONE
8	Please list other natural or manmade hazards which may effect ship's operations: (e.g. ice, currents, cables)	NONE
9	Summary: What do you consider the major risks in drilling at this site?	NO MAJOR RISK

Proposal #: 519	Site #: RIB-01A	Date Form Submitted: 29 March 2002

Sub-bottom depth (m)	*Key reflectors, Unconformities, faults, etc*	*Age*	*Assumed velocity (km/sec)*	*Lithology*	*Paleo-environment*	*Ave. rate of sediment accumulation (m/My)*	*Comments*
25 to 250		Holocene / Pleistocene	1.5	Carbonates (Reef frameworks, limestones and unconsolidated sands)	Reef environment to slope environment		
		Pleistocene		Limestones	Reef environment		

iSAS/IODP Site Summary Forms:
Form 1 - General Site Information

Please fill out information in all gray boxes
Revised 31 January 2002

Revised

Section A: Proposal Information

Title of Proposal:	« The last deglacial sea-level rise in the south Pacific : offshore drilling in Tahiti (French Polynesia) and on the Australian Great Barrier Reef »
Date Form Submitted:	29 March, 2002
Site Specific Objectives with Priority (Must include general objectives in proposal)	**9.** To establish the course of post glacial sea-level rise in the Great Barrier Reef and at Tahiti, ie to define the exact shape of the deglaciation curve for the period 20,000 to 10,000 yrs BP. **10.** To define short term paleoclimatic changes, especially SST variations, for the region over the last 20,000 yrs. **3.** To analyse the impact of sea-level changes on reef growth, geometry and biological makeup.
List Previous Drilling in Area:	

Section B: General Site Information

Site Name: (e.g. SWPAC-01A)	HYD-01A	If site is a reoccupation of an old DSDP/ODP Site, Please include former Site #	Area or Location:	GREAT BARRIER REEF
Latitude:	Deg: 18	Min: 40	Jurisdiction:	AUSTRALIA
Longitude:	Deg: 147	Min: 40	Distance to Land:	About 100 km
Coordinates System:	WGS 84, Other ( )			
Priority of Site:	Primary:	Alt:	Water Depth:	40 to 250 m (transect)

Section C: Operational Information

	Sediments				Basement
Proposed Penetration: (m)	50 to 100 m (5 holes) Total penetration : 400 m				10 m
	What is the total sed. thickness?	50 to 100	m		
			Total Penetration:	410	m
General Lithologies:	Limestones and unconsolidated sands				Limestones
Coring Plan: *(Specify or Circle)*	Mission specific platform – Platform not yet determined				
	1-2-3-APC VPC* XCB MDCB* PCS RCB Re-entry HRGB				

Wireline Logging Plan:	Standard Tools	Special Tools		LWD
	Neutron-Porosity	**Borehole Televiewer**	Formation Fluid Sampling	Density-Neutron
	Litho-Density	Nuclear Magnetic Resonance	**Borehole Temperature & Pressure**	Resistivity-Gamma Ray
	Gamma Ray	Geochemical	Borehole Seismic	Acoustic
	Resistivity	Side-Wall Core Sampling		
	Acoustic			
	Formation Image		Others ( )	Others ( )

Max.Borehole Temp. :	*Expected value (For Riser Drilling)* ______ °C

Mud Logging: *(Riser Holes Only)*	Cuttings Sampling Intervals
	from m to m, m intervals
	from m to m, m intervals
	Basic Sampling Intervals: 5m

Estimated days:	Drilling/Coring:	Logging:	Total On-Site: 6-8

Future Plan:	*Longterm Borehole Observation Plan/Re-entry Plan*

Hazards/ Weather:	*Please check flowing List of Potential Hazards* **NONE**			*What is your Weather window? (Preferable period with the reasons)*
	Shallow Gas	Complicated Seabed Condition	Hydrothermal Activity	**April-October (best sea conditons)**
	Hydrocarbon	Soft Seabed	Landslide and Turbidity Current	
	Shallow Water Flow	Currents	Methane Hydrate	
	Abnormal Pressure	Fractured Zone	Diapir and Mud Volcano	
	Man-made Objects	Fault	High Temperature	
	H_2S	High Dip Angle	Ice Conditions	
	CO_2			

iSAS/IODP Site Summary Forms:

Form 2 - Site Survey Detail

Please fill out information in all gray boxes

New ☐ *Revised* ☐

roposal #: 519	Site #: HYD-01A	Date Form Submitted: 29 March 2002

	Data Type	SSP Requir-ements	Exists In DB	Details of available data and data that are still to be collected
1	High resolution seismic reflection			Primary Line(s) :Location of Site on line (SP or Time only) Available + new data to be collected (Sept. 2002) Crossing Lines(s):
2	Deep Penetration seismic reflection			Primary Line(s): Location of Site on line (SP or Time only) Available + new data to be collected (Sept. 2002) Crossing Lines(s):
3	Seismic Velocity†			
4	Seismic Grid			see Leg 133 site-location tracks and *Rig Seismic* 1987 site-survey tracks
5a	Refraction (surface)			
5b	Refraction (near bottom)			
6	3.5 kHz			Location of Site on line (Time) Available (Townsville Trough))
7	Swath bathymetry			Available (Townsville Trough))
8a	Side-looking sonar (surface)			Available
8b	Side-looking sonar (bottom)			
9	Photography or Video			To be collected – ROV (September 2002)
10	Heat Flow			
11a	Magnetics			Available (Townsville Trough))
11b	Gravity			
12	Sediment cores			Sites 815 & 816 along the southern margin of the Townsville Trough.
13	Rock sampling			
14a	Water current data			Available
14b	Ice Conditions			
15	OBS microseismicity			
16	Navigation			
17	Other			

SSP Classification of Site:	SSP Watchdog:	Date of Last Review:
SSP Comments:		

X=required; X*=may be required for specific sites; Y=recommended; Y*=may be recommended for specific sites; R=required for re-entry sites; T=required for high temperature environments; † Accurate velocity information is required for holes deeper than 400m.

iSAS/IODP Site Summary Forms:

Form 3 - Detailed Logging Plan

Revised ☐

Proposal #: 519	Site #: HYD-01A	Date Form Submitted: 29 March 2002
Water Depth (m): 40 to 250	Sed.Penetration (m):50 to 100 (6 holes)	Basement Penetration (m): 10

Do you need to use the conical side-entry sub (CSES) at this site? Yes ☐ **No** ☐

Are high temperatures expected at this site? Yes ☐ **No** ☐

Are there any other special requirements for logging at this site? Yes ☐ **No** ☐

If "Yes" Please describe requirements:____________________

What do you estimate the total logging time for this site to be: 30 hours total _______

Measurement Type	Scientific Objective	Relevance (1=high, 3=Low)
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FMS	(does not exist in small diameter)	
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Magnetic/Susceptibility	Paleoclimatological proxy - Clay identification	1
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iSAS/IODP Site Summary Forms:

Form 4 – Pollution & Safety Hazard Summary

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New ☐ *Revised* ☐

Proposal #: 519	Site #: HYD-01A	Date Form Submitted: 29 March 2002

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5	Are there reasons to expect hydrocarbon accumulations at this site? Please give details.	NO
6	What "special" precautions will be taken during drilling?	NONE
7	What abandonment procedures do you plan to follow:	NONE
8	Please list other natural or manmade hazards which may effect ship's operations: (e.g. ice, currents, cables)	NONE
9	Summary: What do you consider the major risks in drilling at this site?	NO MAJOR RISK

New ☐ *Revised* ☐

Proposal #: 519	Site #: HYD-01A	Date Form Submitted: 29 March 2002

Sub-bottom depth (m)	*Key reflectors, Unconformities, faults, etc*	*Age*	*Assumed velocity (km/sec)*	*Lithology*	*Paleo-environment*	*Ave. rate of sediment accumulation (m/My)*	*Comments*
40 to 250		Holocene / Pleistocene Pleistocene	1.5	Carbonates (Reef frameworks, limestones and unconsolidated sands) Limestones	Reef environment to slope environment Reef environment		