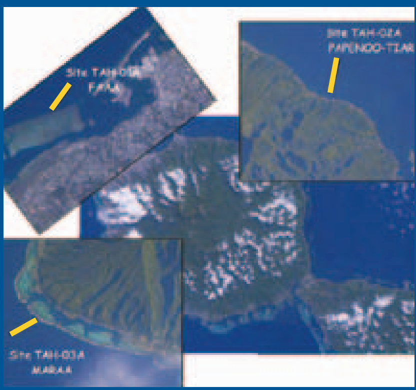
Tahiti Sea-Level Expedition

In October 2005, a team of scientists and technicians led by Dr Gilbert Camoin of CEREGE, France, and Dr Yasufumi Iryu of Tohoku University, Japan (now at Nagoya University), left Papeete on the island of Tahiti to start a 6-week expedition to investigate the fossil coral reefs around the island. The objectives of Expedition 310 Tahiti Sea Level were to reconstruct the timing



and magnitude of sea-level fluctuations, and the evolution of climate conditions during the last deglaciation, a critical period of global climate change. To meet these objectives, the last deglacial reef sequence, which occurs on successive reef terraces seaward of the living barrier reef, was cored from a dynamically positioned vessel the *DP Hunter*. A total of 37 boreholes at 22 sites were cored in water depths ranging from 41.65 to 117.54 m. Borehole logging

Drillship DP Hunter.

operations in ten boreholes at seven sites provided continuous geophysical information about the drilled reef sequence. Cores were described during the Onshore Science Party at the IODP Bremen Core Repository during February and March 2006.

Scientific goals

The major scientific objectives of Expedtion 310 Tahiti Sea Level were:

1. to reconstruct the sea-level rise following the Last Glacial Maximum, 23,000 years ago, when sea-level had fallen by more than 120 metres,

2. to reconstruct the associated climatic changes (*e.g.* sea-surface temperatures and salinities) and

3. to analyse the effects of climatic and sea-level changes on reef development.

Dates: October 6 - November 17, 2005
Platform: *DP Hunter*
Deepest hole: 161.8 m
Number of boreholes: 37
Number of cores: 726
Core recovery: 632.1 m (57.5%)
www.eso.ecord.org/expeditions/310/310.php

Studying past climates

Because the instrumental record of sea-level and climatic changes extends back only to about 150 years, the refinement of the predictions of sea-level rise and climatic changes for coming decades and centuries, and the assessment of anthropogenic influence, clearly rely on past high-to-ultra-high resolution records of the natural variability of climate and sea level over the last thousands of years (*i.e.* the last glacial cycles).

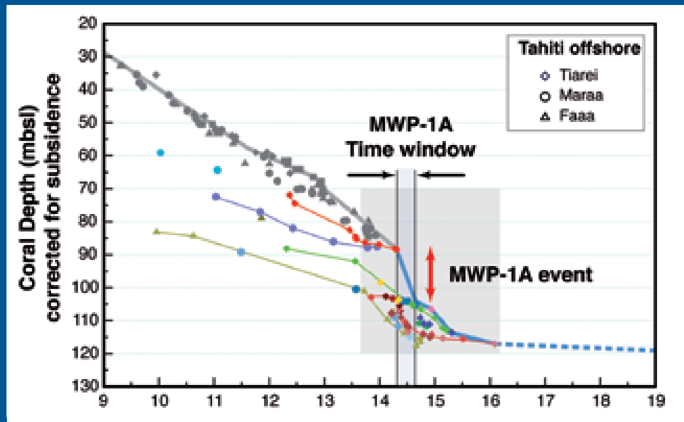
Ice-sheet in Antarctica.

Since the onset of major glaciations in the Northern Hemisphere about three million years ago, Earth's climate has, on average, slowly cooled, though the process was neither steady nor gradual. There is evidence of relatively rapid fluctuations from cold (glacial) to warm (interglacial) intervals during which the ice sheets grew and melted. By reconstructing sea-level changes for these intervals, scientists can accurately estimate the amount of fresh water (*i.e.* land-based ice and meltwater) released during deglaciation events that has been transferred between the continents and oceans during these cycles.

Why study coral reefs?

Corals have strict ecological requirements and are extremely sensitive to environmental changes, natural or human-induced. They live in a sufficiently narrow or specific depth range and can be accurately dated by mass spectrometry so they can be used as absolute indicators of past sea levels. It is therefore possible to not only reconstruct the successive sea-level positions but also to reconstruct the rate and magnitude of sea-level changes. High-resolution records of past global changes are stored in the geochemical and physical parameters of coral skeletons and reef sequences; these form 'archives' that may be used to understand the long-term behaviour of the tropical ocean-atmosphere system.

Coral-based records represent an outstanding opportunity to extend sea-surface records beyond historical data and to define natural environmental and climatic variability on time scales ranging from individual seasons to thousands of years. Such records include tropical monsoons and the South Pacific 'El Niño' event, which causes extreme weather around the globe.



The deglacial Tahiti sea-level curve reconstructed from U-Th dated corals recovered in long holes drilled onshore and offshore Tahiti (respectively grey and coloured symbols). Coral depths are expressed in metres below present sea level (m.b.s.l.) and are corrected for a constant subsidence rate of 0.25mm.yr-1. The shaded time window and black arrows highlight the tight chronological constraints derived for MWP-1A from the Tahiti record (Deschamps et al., 2012).

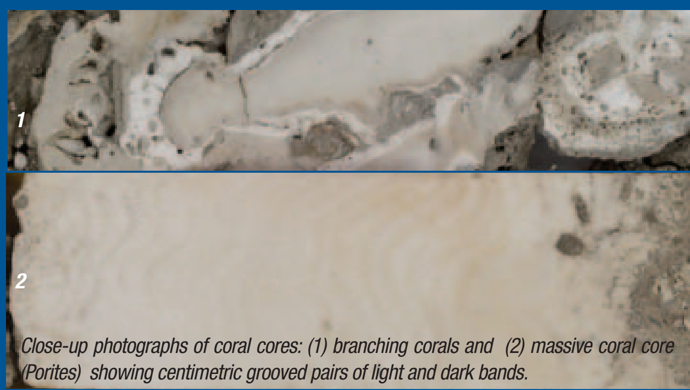
Scientific results

Finding past temperatures and past environments

The composition of calcium carbonate of the coral skeletons can provide information on sea-surface temperatures and salinities of the waters in which the corals lived. Oxygen commonly occurs in two stable isotopes, ^{16}O and ^{18}O, of which ^{16}O is much more abundant. There is a correlation between the $^{18}O/^{16}O$ ratio of the carbonate in the coral and past environments, as relatively less ^{18}O is incorporated into the skeleton at higher temperatures and lower salinities. In addition, minor amounts of metallic elements are contained in corals replacing calcium; less magnesium and more strontium are incorporated into the skeletal carbonate at lower temperatures. By integrating these records of past salinities and temperatures in coral skeletons from various ages and locations, scientists can reconstruct the palaeoceanographic evolution of the tropics.

The 'Coral Reef Crisis'

Coral reefs are one of Earth's most diverse ecosystems, hosting around 25 percent of all marine species. Reef communities have evolved over millions of years to face recurring natural environmental and climatic changes. However, over recent decades, the rate of change seems to have overtaken the rate at which they can adapt. More than 10 percent of reefs have already been lost; climate change and human-induced damage may mean that others will face degradation in the coming decades. Understanding the effects of past rapid changes will help inform scientists and the public of possible future events, earth cycles, and climate change. Conditions during the last deglaciation, 23,000 to 6,000 years ago, when sea-levels rose rapidly at times and the polar ice-sheets melted, are analogous to those that Earth now faces. By studying coral-reef records from this period we may be able to better understand the potential impact of such changes in the future.



Close-up photographs of coral cores: (1) branching corals and (2) massive coral core (Porites) showing centimetric grooved pairs of light and dark bands.

Further reading

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