CORALS AS MONITOR OF SEASONAL RAINFALL AND CLIMATIC CHANGE

Gert D. van den Bergh, Wim Boer, Stephanie A. Verbeek & Geert-Jan Brummer*

This project was a pilot study to investigate the suitability of *Porites* coral colonies in the Berau Delta/Barrier Reef System (East Kalimantan, Indonesia) as a monitor for local and regional climatic changes on a centennial time scale.

The Berau Delta/Barrier Reef system offers a unique setting with a range of shallow marine environments from turbid near-coastal estuarine through lagoonal to open oceanic and shelf edge reef conditions. Although the Berau coastal region still has a number of pristine characteristics, it is obvious that the fragile balance between natural dynamics of the system and the impact of anthropogenic effects, such as forest clearance and fishing, is easily disturbed. During the last decades Kalimantan has been increasingly subject to severe periods of draught and forest fires, in particular during El Niño years. The anthropogenic and natural changes may have an effect on the health of coral reefs, *e.g.* by increased sediment loads supplied by the Berau River. In order to assess the possible effects of these changes on the reef ecosystems, it is necessary to know the natural variation and changes of a number of crucial parameters over an extended period in the past. Living colonies of *Porites* spp, which occur from near shore to shelf edge environments within the Berau area, can provide this information.

Proxy analysis of banded *Porites* corals is widely used as a high-resolution tool for reconstructing environmental variability, notably fluctuations in Sea Surface Temperature (SST), salinity, productivity and run-off. In order to investigate the feasibility of such studies along the East coast of Kalimantan, 41 cores of up to 40 cm long were drilled in *Porites* colonies from 14 sites (Fig. 1). A selection of these cores was used for a number of proxy analysis: δO^{18} (SST + salinity), δC^{13} (~productivity), Sr/Ca ratio, Mg/Ca ratio and U/Ca ratio (SST), Ba/Ca ratio and quantification of fluorescent banding patterns (~ river run-off & rain-fall). X-ray photographs were made in order to record (seasonal) variability in density of the aragonite coral skeleton. The δO^{18} and δC^{13} were analyzed at the Vrije Universiteit Amsterdam (VU). Trace elements were measured at NIOZ by an intensity ratio calibra-

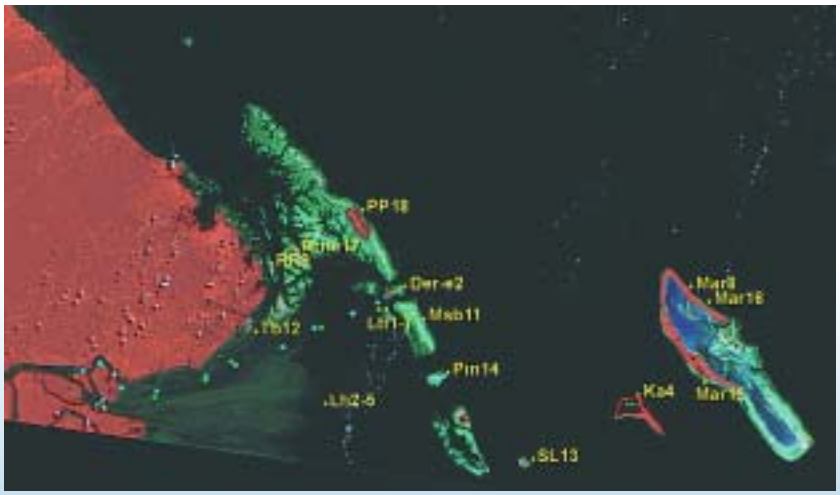

Fig. 1. Satellite image of the Berau Eastuary/Barrier Reef System with the 14 sampling locations of *Porites* spp cores.

*Corresponding author: gertb@nioz.nl

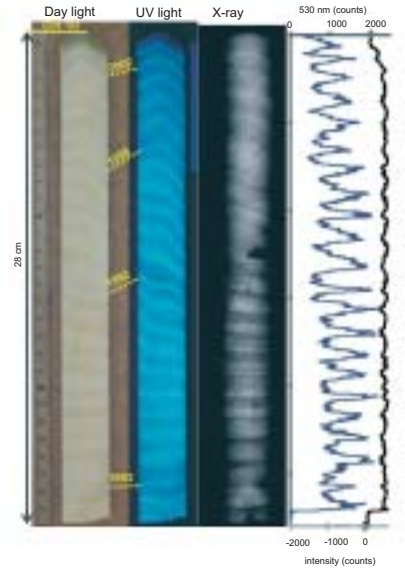

Fig. 2. Daylight, UV, X-ray images and the corresponding luminescence record of a coral core from locality RR-9. Note that the El Niño years (in yellow), are characterized by weakly developed luminescent bands.

tion method on a HR-ICP-MS (ThermoFinnegan, Element-2). Luminescence measurements were obtained at VU at a resolution of 10 measurements per mm.

δC^{13} is usually found to be inversely related to photosynthetic activity of the zooxanthellae symbionts, unicellular algae that support skeletal growth of their coral host. In the Berau area, in particular in near-shore corals, this proxy was found inversely related to local rainfall (~river discharge) records, suggesting that during the wet season, photosynthetic activity decreases. The Ba/Ca ratio and luminescence on the other hand, were found positively related to rainfall. This correspondence is better developed in the near-shore samples from relatively turbid waters. During dry El Niño years, when river run-off is limited, luminescence peaks are clearly weaker developed than during non El Niño years (Fig. 2). The δO^{18} is inversely related to SST, but shows poor correlation with other SST proxies and air temperature records, because of strong fluctuations in salinity. The Sr/Ca ratio on the other hand, shows a strong correlation with the Southern Oscillation Index (SOI) and local air temperature records (Fig. 3).

The study has shown that *Porites* spp. colonies from the Berau area are excellent monitors of environmental and climatic change. Moreover, *in situ* time-series measurements of environmental parameters (SST, turbidity, salinity) and meteorological data, in combination with dyeing of living coral surfaces, could allow for calibration of the various proxy signals. Cores obtained from large *Porites* spp colonies present in the area, will enable the reconstruction of fluctuations in frequency and intensity of ENSO cycles and local environmental trends over hundreds of years. Quantification of the luminescence records can provide a tool for establishing temporal changes in sediment supply to the Berau reef setting, which constitutes important information for environmental studies and CZM purposes.

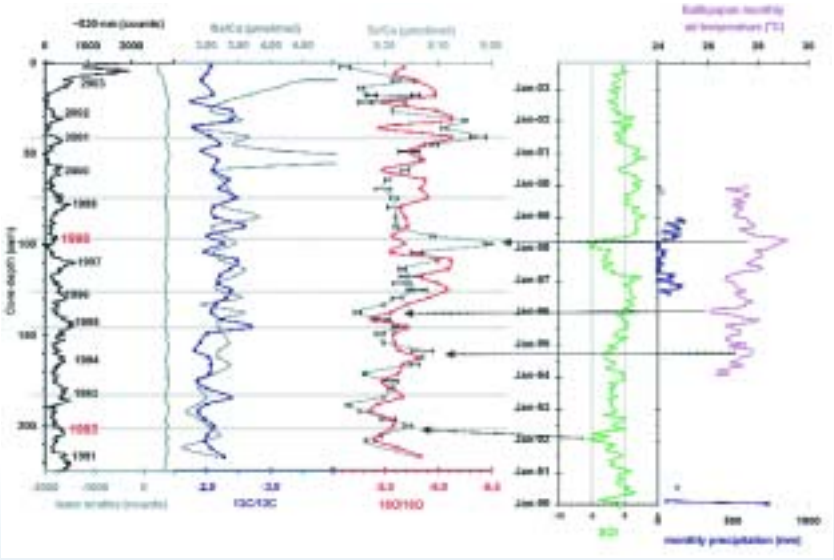

Fig. 3. Correlation of various proxy records from locality SL-13 (Fig. 1) and correspondence with the Southern Oscillation Index (SOI) and local climatic record (incomplete) to the right. Disproportional values at the top are caused by the presence of coral tissue. During dry El Niño years (in red) luminescence peaks are weaker developed. The Sr/Ca ratio, shows an excellent match with the Balikpapan monthly air temperature data.