

Monsoon induced cobalt enrichment in *Porites* (coral) from the Arabian Sea

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Cobalt concentrations in growth bands of a reef building coral (*Porites* sp.) collected from Kalpeni atoll of the Lakshadweep group of islands (Arabian Sea), revealed that cobalt concentrations and Co/Ca ratios exhibit similar trend. Study indicates that most of the cobalt is located in non-lattice phases. Positive relations were found among cobalt concentrations, Co/Ca ratios and rainfall in the monsoonal bands. Cobalt concentrations are in tune with the intensity of land run-off which is the main source of cobalt to surface seawater. Results suggest that cobalt could be a potential proxy for paleomonsoons.

Corals record temperature and composition of seawater in which they grow. They comprise of annual bands, that can be seen in a X-radiograph as alternating dark and light bands as per their density^{1,2}. During their growth, corals lock in the information related to the temperature and composition of the surrounding seawater in the structure and composition of their skeletons³. Thus, geochemical studies on the growth bands of corals are useful in paleoclimatic reconstructions. In particular, trace metal concentrations in coral skeletal aragonitic growth bands have been suggested to reflect concentrations in surface seawater⁴ during that period. As the trace metals in seawater are regulated by the oceanographic circulation patterns, natural and man-made perturbations, studies on temporal variation in trace metals in growth bands will yield paleoclimatic information on time scales of few months to over several centuries³.

A knowledge of past variations in the intensity of the monsoon can help in development of models for monsoon forecasting. Therefore, there is a need for reliable proxies to determine the paleomonsoonal variations. The study reports, changes in cobalt concentrations in growth bands of a coral belonging to genus *Porites* from Lakshadweep islands in the Arabian Sea (Fig. 1). Due to their ubiquity, longevity and rapid growth

rate, *Porites* has been commonly used for paleoenvironmental reconstruction in the Indo-Pacific region³.

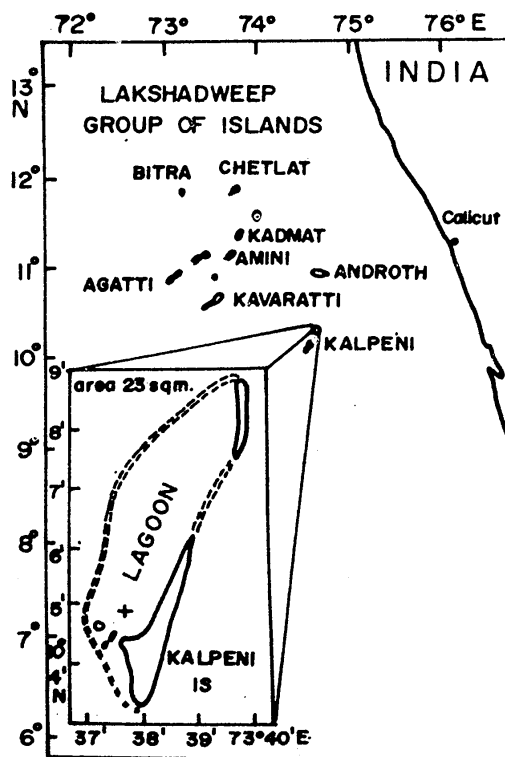


Fig. 1—Location of study area

Samples of hard coral, *Porites* sp., were collected from the lagoons of the Kalpeni atoll (lat. 10°05'N, long 73°39'E) from a depth of 1.5 m (Fig 1). Slices of coral were taken along the growth axis using a diamond cutter and X-radiography was carried out using the industrial X-ray films⁵. X-radiographs revealed alternate low and high density bands corresponding to non-monsoon and monsoon seasons, respectively. The age of the growth bands was assigned by assuming the time of collection as a baseline.

Sixteen subsamples were collected in such a way that each sample represents one seasonal band (low or high). Powdered samples (0.1 g) of each seasonal band, was treated with 10 ml of acid mixture (7ml, 48% HF and 3 ml concentrated HNO₃) in teflon beakers. This solution was transferred to a 100 ml flask in which 10 ml of 1 ppm indium solution was added as tracer to compensate for any changes in analyte signal and to improve precision of measurement by correcting for the various plasma noise sources. For the analysis, spectroscopic grade aqueous metal solutions and high purity double distilled water made from a quartz unit for multi element standards were used. Chinese limestone (GSR-6) and Belgium limestone (CCH 1) were used as standards to check the accuracy of the analysis, which was found to lie between 3-10%. The analyses were carried out by Inductively Coupled

Plasma Mass Spectrometer⁶. The rainfall data were obtained from the records of daily weather report of the India Meteorological Department, Pune.

Cobalt content of *Porites* ranged from 1.02 to 2.38 ppm. Variations in concentrations in a given year exceeded >10% indicating that the seasonal variation is real and better than the precision. Strong seasonal change is distinct with a consistent enrichment in monsoonal bands over that in non-monsoonal bands. The lowest concentration is found in non-monsoonal band (1.02 ppm in low density band of 1982) and the highest concentration in the high density monsoonal band (2.38 ppm in 1984). Co contents, Co/Ca ratios and rainfall data are compared separately for the monsoonal and non-monsoonal bands (Fig. 2). Three periods of elevated Co contents and Co/Ca ratios occurred in 1979, 1981, and 1984 with two prominent troughs during 1980 and 1982. The Co/Ca ratios perfectly follow the cobalt concentration in both sets of data (Fig. 2). Similarity in Co and Co/Ca profiles indicate that most of the cobalt is likely to be present in "contaminant" phases (eg: authigenic, organic bound, Fe-oxide coatings and lithogenic) other than aragonitic matrix⁷.

In the monsoonal bands, cobalt and Co/Ca ratios are strongly related to the intensity of rainfall (Fig. 2). During the study period 1979, 1981, and 1984 were good monsoon years with a

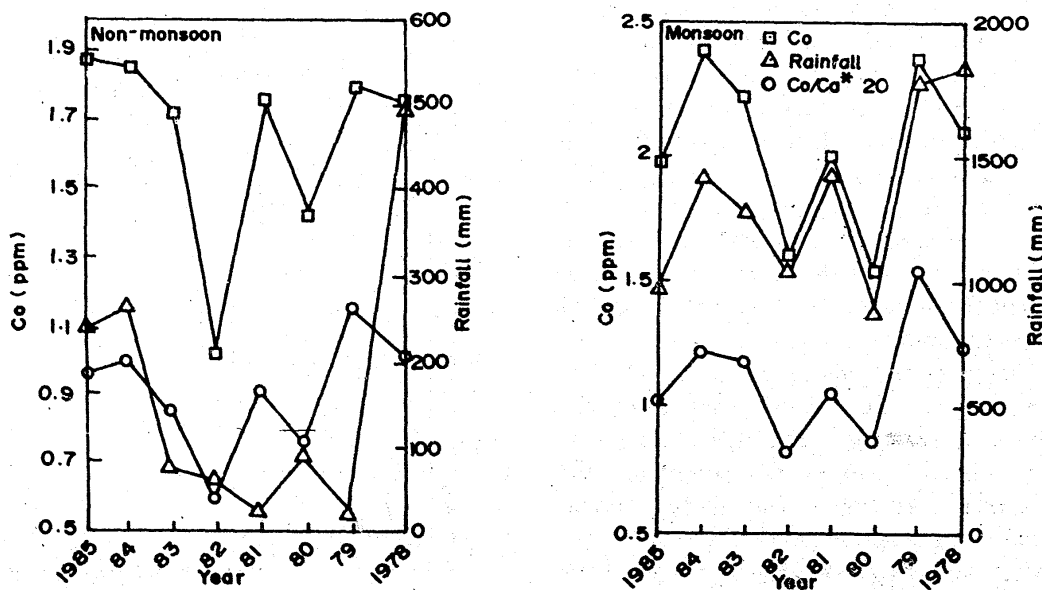


Fig.2—The distribution of Co, Co/Ca ratio in *Porites* with respect to rainfall distribution from 1978-1985 period

rainfall ≥ 1500 mm. The concentrations of cobalt are consistently high in these three monsoonal bands. Similarly, cobalt is low in the samples (1980 and 1982) when the rainfall was lower (~ 1000 mm).

A strong relationship between cobalt and rainfall intensity could be linked to the geochemistry of cobalt in oceans. Cobalt concentration in seawater⁸ is less than 0.2 Nm. Cobalt is added to surface oceans by anthropogenic and natural sources such as river input and atmospheric deposition⁹. Studies on the spatial variations in cobalt have shown that its seawater concentration increases towards the coast suggesting terrestrial inputs¹⁰. The chief suppliers of lithogenic material to eastern Arabian Sea are the rivers Narmada, Tapti and Indus¹¹. More than 80% of their annual suspended-matter discharge occurs during the southwest monsoon¹². The magnitude of land run-off depends on the monsoonal intensity. It explains the relation between cobalt and rainfall data. In the same coral, detrital particles and enrichment of light rare earth elements (LREE are susceptible for removal during run-off) are found in the monsoonal bands¹³ and have been attributed to increased land run-off.

These studies indicate that the cobalt could be a potential proxy for determining the past variations of monsoon intensity. However, studies are required on corals from more areas and other carbonate sedimentary records.

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