Coral Mineralization
- Structural Details

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Coral skeletons preserve a record of:
- Ancient temperature in Sr/Ca, Mg/Ca, δ¹⁸O
- River discharge
- Oceanic upwelling
- ¹⁴C
- Light level, cloudiness
- Lead
- Skeleton can be dated using ¹⁴C and ²³⁰Th/²³⁶U

Skeletal chemistry presents a paradox
- Many elements (Ca, Sr, Mg, Pb, U) and even small particles appear in the skeleton in proportion to their abundance in seawater.
- However, isotopes of oxygen and carbon exhibit considerable fractionation relative to their relative abundances in seawater.
- This must tell us something interesting about the mechanisms whereby these elements are transported to the site of calcification.
Detail of coral skeleton

- Plane view of coralites (c)
- Thin section view of polyp and skeletal elements
  - Polyp (p)
  - Septa (s)
  - Theca (t)
  - Dissepiments (d)
  - Columella (cm)
  - Paliform lobes (pl)
  - Site of calcification

Detail of septal structure

Figure 2. Detail of the scleractinian septal structure (c as Fig. 1). At right, organic fibers bundles (f) merge into centers of calcification (c) and grouped into sclerodermatous (s). Groups of sclerodermatous growing upward from the theca (t). This septum of Goniopora sp is a palate of trilobites, shown at left. From Wells (1986).

Petrographic thin-section of several days of growth

Figure 4. Petrographic thin-section of Pinctada sinicola showing the vertical line of diagenetic centers of calcification and numerous bundles of organic fibers. In this specimen, the calcification centers are daily increments. Note the thin growth bands within and perpendicular to the growth direction of the fiber bundles. During the day, the corallites are covered by thin polygonal plates of calciicarbonate. In the thin section, the calcification occurs forming a small spot on which the calcite is oriented. The width of each band (2-3) and probably represents the daily periodic extension and in accordance with the size of the calcifying spaces. As right, the tissue line (l) against the calcareous, before abrading further growth shows the appearance of growth bands. Photograph by J. O. C. Wells.
Diurnal cycle of growth

Elongate at night by accreting centers of calcification (COC).

Fill in during the day by adding lateral bundles of fibers.

At night the septa surface develops a rough surface and during the day the surface becomes smoother.

Dark calcification

Light calcification
Effect of light on coral photosynthesis and calcification

Clearly there is an effect of light on calcification but there is not a simple direct coupling between photosynthesis and calcification. 

Effect of light on coral photosynthesis and calcification

Organic matrix model

- Organic material is found in almost all instances of biomineralization.
- Role of the material seems to be:
  - Framework
  - Seed for nucleation, controls axis of crystal growth
- Type of control unknown
  - Promotional
  - Inhibitory: recent evidence leaning this way (Clode and Marshall (2002))
- Difficult to study because the material is unstable EM prep procedures and is lost or displaced when the skeleton is decalcified.
- Another problem is that the organic matrix is difficult to separate from other organic matter in the skeleton, i.e. endolithic algae.

Organic matrix

Figure 3. (a) shows a cross-section view of a corallite. The arrows indicate the organic matrix between the coral tissue and the calcitic skeleton. (b) shows a microphotograph of the organic matrix within a cavitation feature. The matrix is 5-10 µm thick and can be seen to be composed of multiple fibrils (shown at higher magnification in inset). The fibrils are 2-3 µm in diameter and are arranged in parallel bundles. The matrix is located between the coral tissue and the calcitic skeleton and can be seen to be composed of multiple fibrils (shown at higher magnification in inset). The fibrils are 2-3 µm in diameter and are arranged in parallel bundles.