Coral Mineralization
- Structural Details

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Coral skeletons preserve a record of:

- Ancient temperature in Sr/Ca, Mg/Ca, $\delta^{18}O$
- River discharge
- Oceanic upwelling
- ^{14}C
- Light level, cloudiness
- Lead
- Skeleton can be dated using ^{14}C and $^{230}Th/^{236}U$

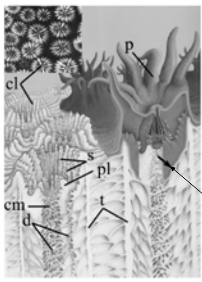
Skeletal chemistry presents a paradox

- 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 (cl)

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

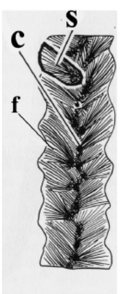


Figure 2. Detail of the scleractinian septal structure (s in Fig. 1). At right, aragonite fiber bundles (f) emerge from centers of calcifciation (c) and grouped into sclerodermites (s). Groups of sclerodermites growing upward together form the trabecula (t). This septum of *Galaxea* sp. is a palisade of trabeculae, shown at left. From Wells (1956).

Petrographic thin-section of several days of growth

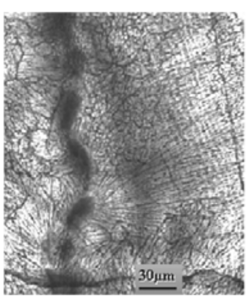


Figure 4. Petrographic thin-section of *Porites lutea* skeleton showing the vertical line of discrete centers of calcification and emergent bundles of aragonite fibers. In this specimen, the calcification centers are daily accretions. Note the fine growth bands within and perpendicular to the growth direction of the fiber bundles. During the day, osmotic pressure builds up between the skeleton and the calicoblastic ectoderm creating a space into which the crystals extend. The width of each band (2–3 μm) probably represents this daily daytime extension and is indicative of the size of the calcifying space. At night, the tissue lies flat against the skeletal surface inhibiting further growth hence the appearance of growth bands. Photo by Anne Cohen.

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.

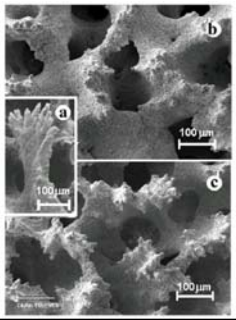
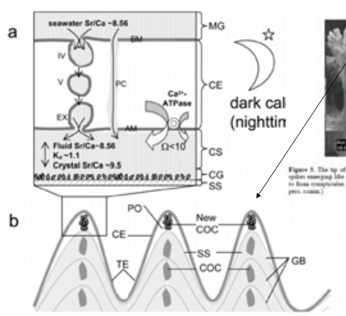


Figure 9. SEM of the tips of growing septa of *Porites lutea* over the diurnal cycle. Extension occurs by growth of fine spikes like fingers on a hand (a). At night, calcification results in elongation of the fingers by accretion of new calcification centers at the growing tips. Thus the septal surface appears spiky (c). During the day, the spaces between adjacent fingers is filled in by outward growth of aragonite fiber bundles. By the end of the day the surface of the septum has a smooth appearance. (b). Images courtesy of Dr David J. Barnes (Australian Institute for Marine Science, pers. comm)

Dark calcification



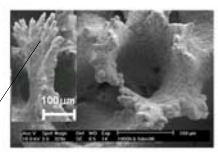
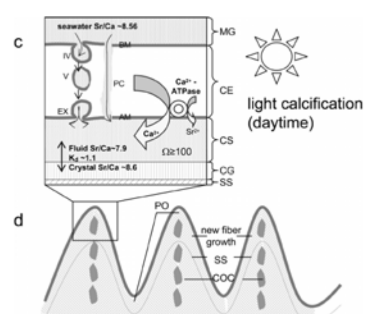
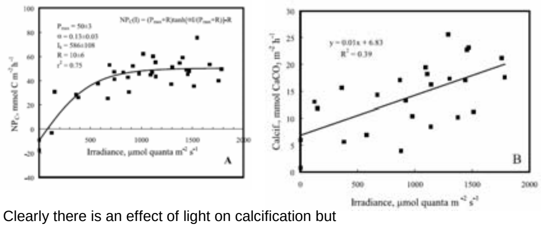


Figure 5. The tip of a growing septum is covered in dentations, each consisting of an array of fine spikes emerging like fingers from a hand (inset). Spikes from adjacent bands periodically link laterally to form synapticulae. Images courtesy of Dr. David J. Barnes (Australian Institute for Marine Science, pers. comm.)

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

Langdon and Atkinson 2005

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