

Alternative Calcium Reactor Substrates

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By Greg Hiller

As the small-polyped stony corals in my 110 gallon reef system have grown I've had to build ever larger calcium reactors to keep up with the calcification demand without having to change the reactor substrate too frequently. I first tried Super Calc Gold and Korolith medium in the reactors, but later changed over to a crushed coral I was able to obtain at about one-quarter the cost of the "premium" reactor substrates. This worked fine for a while, but I started to have enough algae growth on the glass that I needed to clean the glass more than once a week, and this increase in algae growth seemed to me to occur very soon after changing to crushed coral as a substrate. I was also having problems with fine particulates coming out of the reactor and plugging the outflow valve, and in the event of a power outage the reactor would dump a large amount of particulates into the sump when it restarted.

Several years earlier while looking for some rock to propagate corals on, I'd picked up some very clean-looking, hard white calcite-type limestone from a rock quarry in Rhode Island. The rock is a metamorphosized limestone deposited at least 630 million years ago. Although the rock worked well for propagating corals, some people complained about the unnatural look of the rocks that the corals were growing on. This material looked like the white limestone rocks that are commonly used in landscaping, and is so hard it is nearly impossible to drill with a masonry drill bit. In a reef system the rock covers quickly with coralline algae but still has an unnaturally smooth surface, and sharp edges. I wondered whether this limestone might serve as an inexpensive calcium reactor substrate.

Craig Bingman, the author of an earlier article in *Aquarium Frontiers* about calcium reactor substrates (<http://www.animalnetwork.com/fish2/aqfm/1997/aug/bio/default.asp>), gave me the name of the lab that performed an analysis of the dissolved substrates he tested. Using the protocol described in his article, I had an analysis performed on the crushed coral I had been using and on a sample of the limestone from the quarry. In contrast to Dr. Bingman's work, I found that my crushed coral sample contained approximately 12 percent by weight undissolvable (in hydrochloric acid at least) solids, and the limestone sample contained approximately 5 percent undissolvable solids. The crushed coral solids were a fine powder, whereas the limestone solids held together in more of a crystal structure reminiscent of the original piece of rock that was dissolved. I surmised that the limestone solids would thus be less likely to leave the reactor chamber and clog the outflow of a calcium reactor. The samples were digested with high purity hydrochloric acid and were 0.2 micron-filtered before being sent out to the lab.

I was pleasantly surprised by the results of the analysis (Table I). I was basically looking for something less expensive but no worse than the crushed coral I'd been using. The limestone was significantly lower than the crushed coral in a wide range of trace elements, including aluminum, boron, chromium, cobalt, copper, iron, and titanium. Of particular concern to me were the lower concentrations of iron and phosphorus in the limestone compared to the crushed coral I'd been using. If I ever became concerned about trace element depletion in my system, I figured I could always add a small amount of the crushed coral back to the reactor or

Conklin limestone	Crushed coral (Nature's Ocean brand, Atlantic crushed coral, #4 World Wide Imports, Inc)	Elements
aluminum	3.43	arsenic
0.56	0.17	< 0.0050
calcium	17467	barium
0.0010	0.0039	0.0014
lead	< 0.0030	boron
183	107	0.01
0.0015	0.0010	0.03
0.0117	0.0039	chromium
selenium	0.0408	< 0.0010
0.0010	< 0.0010	0.12
sulfur	0.29	cadmium
0.0241	5.58	< 0.0010
	vanadium	0.45
	< 0.0005	10.54
	tin	magnesium
	< 0.0500	< 0.0015
	0.17	< 0.0010
	zinc	nickel
	< 0.0005	< 0.0010
	phosphorus, silicon, sulfur, titanium and vanadium.	iron
		0.19
		0.19
		mercury
		89
		18
		silver
		<
		26
		0.0121

add the elements myself in a more controlled manner.

Comparing the limestone to the Super Calc Gold analysis performed by Bingman (<http://www.animalnetwork.com/fish2/aqfm/1997/aug/bio/default.asp>) shows the limestone significantly lower in aluminum, copper, iron, manganese, lead, mercury, nickel, silicon and zinc. Although the concentrations of phosphorus in the limestone were more than four times that of Super Calc Gold, I figured that because my tank had yet to crash using crushed coral, things could only improve using the limestone.

The only elements that I considered a bit out of bounds in the limestone sample were the barium and the lithium. Once again, the lithium was no higher than the crushed coral I'd been using — and some salt mixes are very high in lithium and still people can do well using these mixes (see the previous *Aquarium Frontiers* article on the composition of several synthetic salt water mixes, <http://www.animalnetwork.com/fish2/aqfm/1999/mar/features/1/default>). Some earlier calculations I'd done on this 110 gallon tank suggested the calcification rate was approximately 20 pounds of calcium carbonate per year. At that rate — assuming a worst case scenario of complete dissolution of the barium, no consumption in the tank and no water changes, the dissolution of the limestone would increase the barium concentration by about 0.27 milligram/liter (mg/l) within one year. Natural salt water levels of barium are about 0.05 mg/l (CRC, 1981), so this could be a concern.

Assuming the water in my tank started out near the published values for Instant Ocean Salt Mix at 0.012 mg/l barium (<http://www.animalnetwork.com/fish2/aqfm/1999/mar/features/1/default>), the tank water would have risen to 0.28 mg/l barium, which is a bit more than twice the concentration of barium in the artificial salt mix with the highest barium concentration: SeaChem's salt mix. If one includes a regimen of 10 percent water changes once per month, the barium concentration levels off at 0.21 mg/l in about three years, and with 5 percent water changes per month it levels off at 0.44 mg/l after very slowly rising for about seven years. Perhaps this concern will get me to do water changes more often!

I've been using the limestone exclusively in my calcium reactor now for 10 months. Initially it was a bit difficult to get the same output from the reactor, but I attribute this to the fact that the limestone I acquired had a particle size somewhat larger than the crushed coral I'd been using. The crushed coral was called #4 size (typically in the ¼-inch diameter range), and the limestone was also supposed to be this size but in fact it was a bit larger. As the substrate particle size decreases with time in the calcium reactor, the surface area will increase and the output of the reactor should increase, provided water flow inside the reactor is not overly restricted. I also obtained a bag of sand-sized limestone at the quarry. I added some of this to the top of my calcium reactor and was then able to derive more than adequate calcium and alkalinity maintenance.

Since switching to the limestone substrate the amount of algae on the glass of my tank has decreased to the point that I only need to clean the glass about once per week for my own viewing satisfaction. This tank has a heavy bioload of fish, and now knowing that less phosphate is being added to the system from the calcium reactor has made me feel more comfortable about feeding more often. I've also had no more problems with plugging of the outflow valve of the reactor from particulates.

On a cost basis, I was able to get Super Calc Gold for about \$2/pound, crushed coral for about \$0.50/pound and the crushed limestone for about \$0.05/pound. When I factor in the CO₂ costs (I use 40 pounds per year at \$0.50/pound), calcium supplementation for my tank (which consumes about 20 pounds of calcium carbonate/year) costs me about \$21 per year.