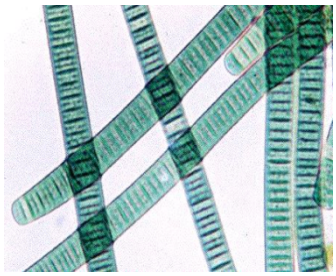
Renewability/Sustainability
Carbon Sequestration
Data

Oolitic Aragonite

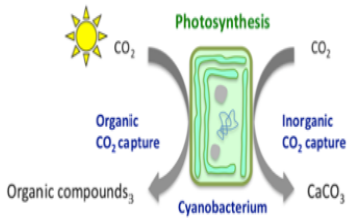
Oolitic aragonite - the world's only biogenic, recent origin, renewable and sustainable performance calcium carbonate mineral

Oolitic Aragonite - Sandy Cay's Calcean and Bio-Cal

Exceptionally Pure Calcium Carbonate (CaCO3)
The Natural Birth Process

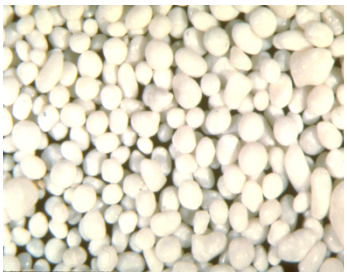


Cyanobacteria (10 to 20 µm)



Calvin Cycle - $CaCO_3$ Precipitation

"Whitings" in the Bahamas



Precipitated Oolitic Aragonite

The Beauty of Nature in the recurring and sustainable birth of Oolitic Aragonite:

- Natural Blooms of Phytoplankton (Cyanobacteria) cross the Great Bahama Banks.
- Photosynthesis in the Blooms creates Dual Carbon Fixing - sequesters CO_2 and precipitates Oolitic Aragonite.
- The Grand Bahama Banks in the Bahamas have over 50 to 100 billion tons of Oolitic Aragonite.
- Sandy Cay's Sea Bed Lease area (500 square miles) has over 1 to 2 billion tons of Oolitic Aragonite.
- Annual Blooms of Cyanobacteria ("Whitings") precipitate and deposit an additional ~1.8 million tons of Oolitic Aragonite.
- Every Year the Whitings process sequesters 5,700 metric tons of carbon dioxide (CO_2) from the atmosphere.
- The Carbon Footprint for "harvesting" the Oolitic Aragonite is far less intrusive than blasted and mined calcium carbonate.

Oolitic Aragonite at Sandy Cay's island Ocean Cay in the Bahamas				
Sustainability:				
500 square mile Reserves (estimated at):	**1 to 2 Billion Metric Tons**			
Annual Natural Generation through "Whitings" events:	**266,000**	mts/yr - low	**2,310,000**	mts/yr - high
Carbon Sequestration:				
Air to Sea Carbon (CO_2) Gas Fluxes in Whitings (Photosynthesis):			**19.2**	mts per year
Carbon (CO_2) Calcification in Whitings (Mineralize CO_2 to recalcitrant carbonates):			**5,682**	mts per year

Sandy Cay Development Ltd. produces Aragonite Sand, a naturally precipitated high surface area calcium carbonate in the crystalline form "Oolitic Aragonite" (Orthorhombic System: Bipyramidal). Sandy Cay's operations are located adjacent to the Holocene and Pleistocene carbonate shoals at Ocean Cay, just south of Bimini in the Bahamas. These tidal shoals and deltas of Sandy Cay's lease area collectively form a 17 mile wide 50 mile long oolitic aragonite sand belt. Scientific studies on this unique mineral and the resulting ability to precipitate in the water column began in the 1950's. The phenomenon in which aragonite is formed is described as a "Whitings" event. The sustainable precipitated carbonate material in a Whitings event is driven by photosynthesis within blooms of cyanobacteria passing over the Bahama banks and precipitating from 266,000 mts to 2,310,000 mts per year of calcium carbonate in the 500 square mile Sandy Cay lease area alone. In addition this process of the chemical action of photosynthesis and calcification sequester approximately 5,700 mts of carbon dioxide from our environment. Making a cleaner environment.

Sustainability:

Oolitic Aragonite is generated through the chemical fixation of Carbon Dioxide (CO_2) to the naturally present Calcium (Ca) in the ocean's water, which results in the precipitation of Calcium Carbonate ($CaCO_3$). This process is fueled by the photosynthesis within the blooms of phytoplankton; picoplankton: specifically cyanobacteria and unicellular green algae as they drift across the warm water banks of the Bahamas. Cyanobacteria has a Carbon Dioxide Concentrating Mechanism (CCM); this is a biochemical system that allows the cells to raise the concentration of CO_2 at the site of the carboxylating enzyme rubulose (RUBISCO) by up to 1,000 times the surrounding medium. In addition the cyanobacteria excretes organic polymeric substances to form extracellular

formations. These Exopolymeric Substances (EPS) serve as a nucleation surface for mineralization, accelerating the calcium carbonate generation process. The combination of the CCM and the presence of the EPS within the surrounding medium of the warm shallow waters of the Bahamas which are already supersaturated with the element Ca^{++} and carbonate, Ca^{-3}, ions (Ca^{++} concentrations are at over 10 millimolar) readily result in the phenomenon of "Whitings", cloudy precipitation of oolitic aragonite ($CaCO_3$) with a unique crystal morphology. This process continually produces millions of tons per year of oolitic aragonite within the Bahamas.

Confirmation of new produced mineral: The results of Radiocarbon Analyses (ASTM D6866 - 11) on samples of Oolitic Aragonite from the Bahama banks around Ocean Cay were analyzed by the USDA testing facility at Iowa State University. ASTM Method 6866 is a standard analytical test that is used to determine the exact percentage of a solid liquid or gas that is derived from renewable sources. The test utilizes C14 analysis to determine the age of the carbon in the material. C14 is a weak radioactive isotope of carbon formed when solar radiation causes some of the carbon in atmospheric CO_2 to change from C12 to C14. When the CO_2 is taken up and no longer exposed to the atmosphere the C14 will decay back to C12. The rate of this decay is: 50% of the C14 will decay back to C12 every 5700 years (5000 year half-life). ASTM D6866 analysis measures the C14 content in a sample to determine ratio of carbon of recent origin to the total carbon in the sample. According to Glen Norton of the USDA testing Laboratory at Iowa State University (Co-Author of ASTM 6866), carbon of recent origin is defined as material containing carbon fixed in the last 3-5 years. The samples analyzed indicated that 62% of the carbon in the sample was fixed in the last 3 to 5 years. This result indicates that the oolitic aragonite shoals around Ocean Cay are receiving new material and are thus a renewable resource.

Carbon Sequestration:

Photosynthesis drives the engine of both forms of carbon sequestration by cyanobacteria:

1. Reducing CO_2 to organic compounds at the same time producing Oxygen (O_2) through the Calvin-Benson-Bassham cycle.
2. Mineralizing CO_2 to recalcitrant carbonates; Calcium Carbonate ($CaCO_3$).

Cyanobacteria photosynthesis is responsible for removing approximately 20 tons per annum of CO_2 from the atmosphere, and the activity of Cyanobacteria Mineralization removes approximately 5,680 tons per annum of CO_2 from the atmosphere. To put this in perspective; 5,700 tons of carbon sequestration is the equivalent to removing the CO_2 generated by 570 power plants producing one Gigawatt per annum.

Additionally, the process in which oolitic aragonite is acquired has a far lower carbon footprint than that of calcite derived from limestone deposits using traditional blasting and crushing methods at inland mining sites.

Oolitic Aragonite is a sustainable mineral which through its formation sequesters carbon from the atmosphere. Dual environmental benefits which create a unique mineral.

Sandy Cay Development Ltd.
Nassau, Bahamas

Information herein noted is compiled, analyzed and based upon the following resources:

L.L. Robbins ,K Yates, G Shinn, P. Blackwelder; Bahamas Journal of Science 10/1996; "Whitings to the Great Bahama Bank: A microscopic solution to a macroscopic mystery"

L.L. Robbins, Y. Tao, C.A. Evans; Geology 1997; "Temporal and spatial distribution of whitings on Great Bahama Bank and a new lime mud budget"

L.L. Robbins, Yates; 2001; “Direct Measurement of CO2 Fluxes in Marine Whitings”

Kamennaya, Ajo-Franklin, Northen and Jansson; October 2012; “Cyanobacteria as Biocatalysts for Carbon Mineralization”