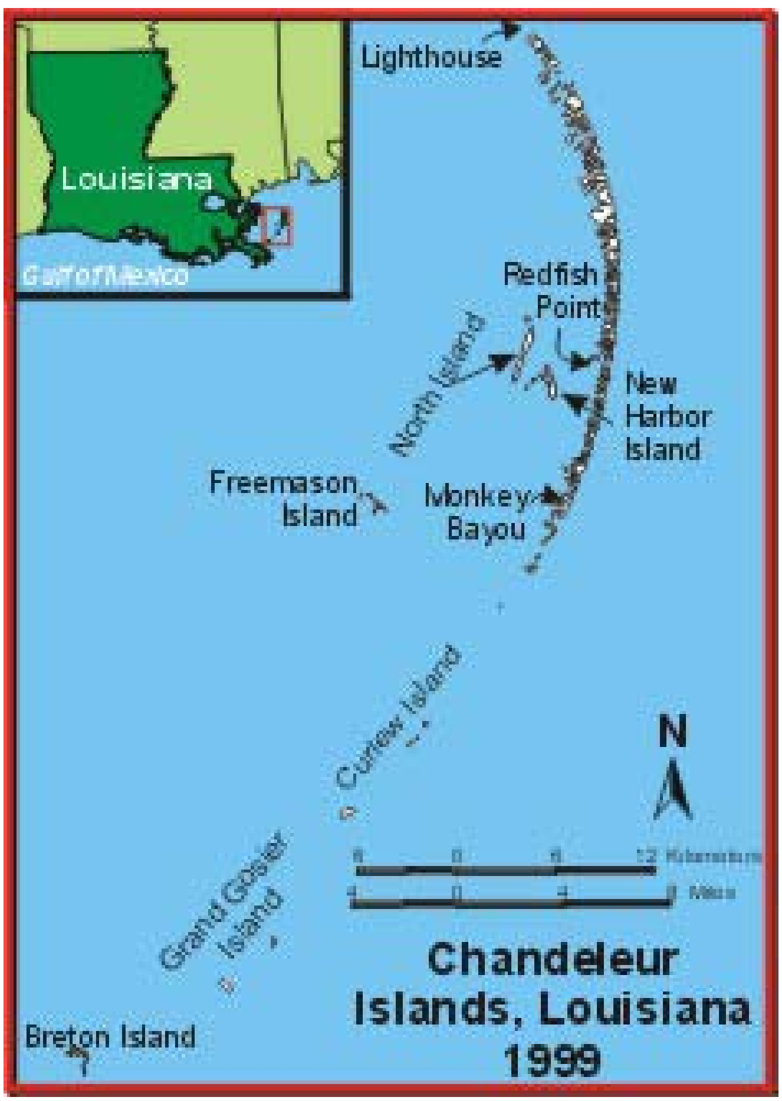
SKIPPING STONES
AN ISLAND BEACH-CHIP MYSTERY

H.J. Mitchell-Tapping Ph.D. P.G.
www.esterbaymarinelab.org

Have you ever looked closely at the stone that you throw to make it skip across the water?

Adults and children often search for the smoothest, thinnest, and flatest rock to throw in order to increase the number of skips.

However, there are found on a certain beaches, close to the water, some very unusual very thin, flat, hard, shaped like a biscuit, concretions - ideal for skipping…..and here is the tale of one such special stone.

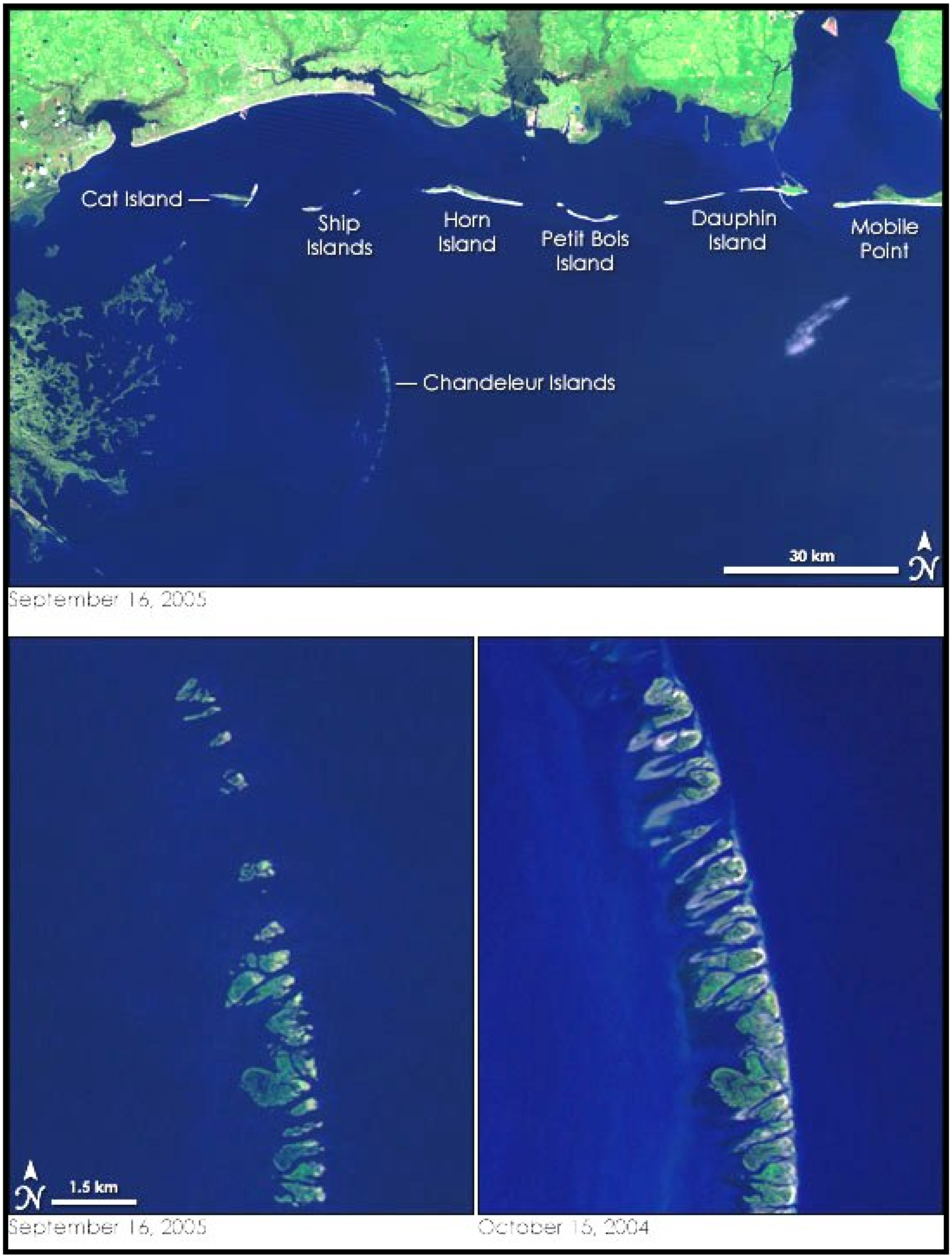


Chandeleur Island, near Redfish Point, is one of the many islands in a chain of islands named the Chandeleur Islands off the Louisiana coast in the Gulf of Mexico, and was part of an arcuate chain 60 km (35 nautical miles) south of Mississippi.

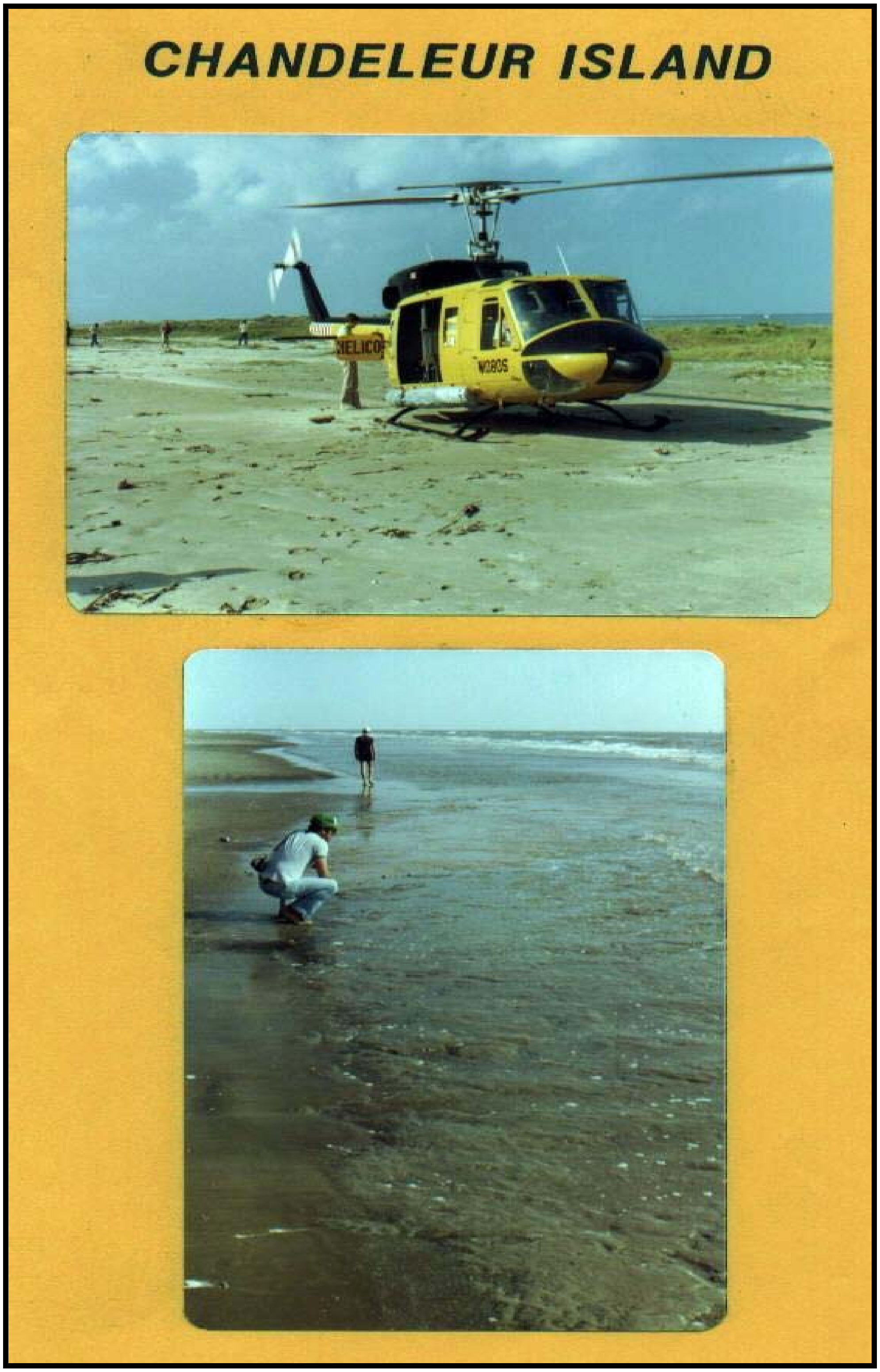
This island, typical of many of the islands in the chain, was made up of unconsolidated quartz-sand dunes covered in places with weeds and grasses.

Many of the islands in the chain were

drowned, and the lighthouse destroyed, during Hurricane Katrina, and none have recovered since.



Before and after hurricane Katrina (photos : USGS website) marine channels separate the islands from each other.



My favourite way to travel around the islands

Intertidal mudflats and brackish-water marshlands were present behind the islands, and shallow marine channels separate the islands from each other.

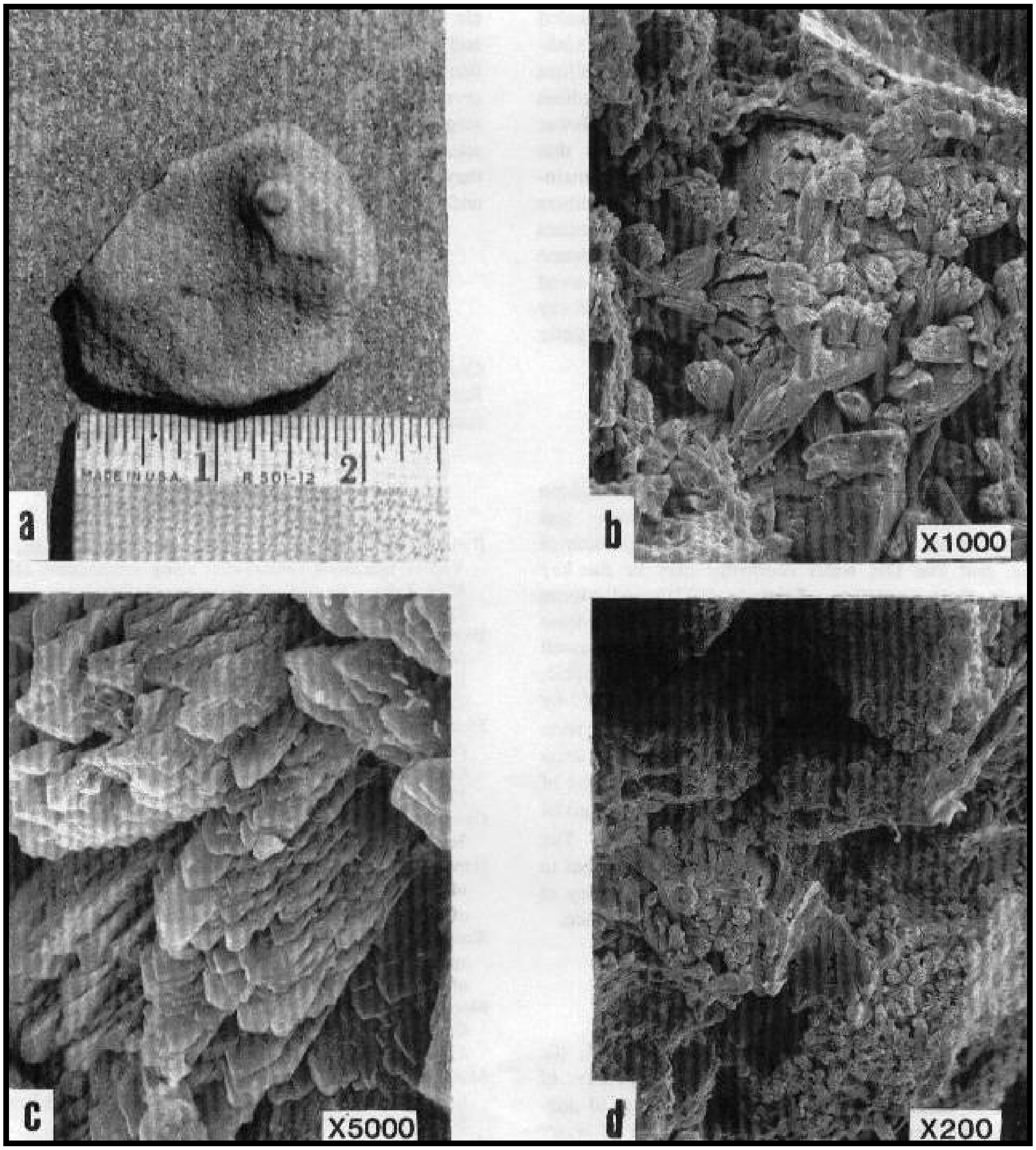
On top of the unconsolidated sand of the dunes and beach are numerous shells among which are small irregularly-shaped, biscuit-like, clumps of calcite-cemented quartz grains (about 5 cm on the longest axis), named here as beach chips.

These beach chips lie loosely on the beach surface and were observed to be near pieces of rusted iron. No chips were recovered beneath the beach surface below the high-water mark or were found in the intertidal or the mudflat areas. These beach chips have not been reported previously in the literature as occurring in a marine environment.

Massive marine beach cementation, called 'beachrock', occurring in both tropical and temperate climates, has been reported by many researchers (Field, 1919; Ginsburg, 1953; Russell, 1962; Schmalz, 1971; Moore, 1973; Hanor, 1978). Arguments as to the formation of beach rock have been introduced into the literature for many years. Among the arguments are such theories as the intermixing and evaporation of marine and meteoric waters in the intertidal zone, the degassing of groundwater by CO_2 (Field, 1919), etc.

Beachrock has also been reported on the shore of freshwater lakes (Russell and Leverett, 1908; Murphy and Wilkinson, 1980; Binkley et al., 1980). The cement morphology described in these beachrock investigations and in the descriptions of speleothems (Kendall and Broughton, 1978), at first appearance, to be similar to the cement of these beach chips of Chandeleur Island, but they are not of the same structure.

An examination of a chip in thin-section under a petrological microscope and using a scanning electron



A = a skipping stone ***B, C, D = SEM micrographs at various magnification***

microscope (SEM), shows that the calcite crystals that cement the quartz and mica grains of these beach chips are elongate parallel to the c-optic axis, and are composed of bunches of crystallite pointed blades. These bunches appear to be of similar thickness and length, about 80 µm long and 10 µm wide. The crystallite blades of each crystal bunch are pointed and are similar to but are more bladed than the cement crystals found in freshwater lakes (Binkley *et al.*, 1980). At high magnification, the crystallites appear to have accreted by the addition of crystalline blades from the center outward. At lower magnification, the crystallites appear as bunches that have grown from one crystal nucleus and have maintained the nucleus character, unless it joined with others to form a base on which further crystallite bunches developed. The intercrystallite pore space contains no fine calcite silt as was observed in the lake sample by Binkley *et al*. (1980). X-ray diffraction revealed the presence of iron in this calcite cement.

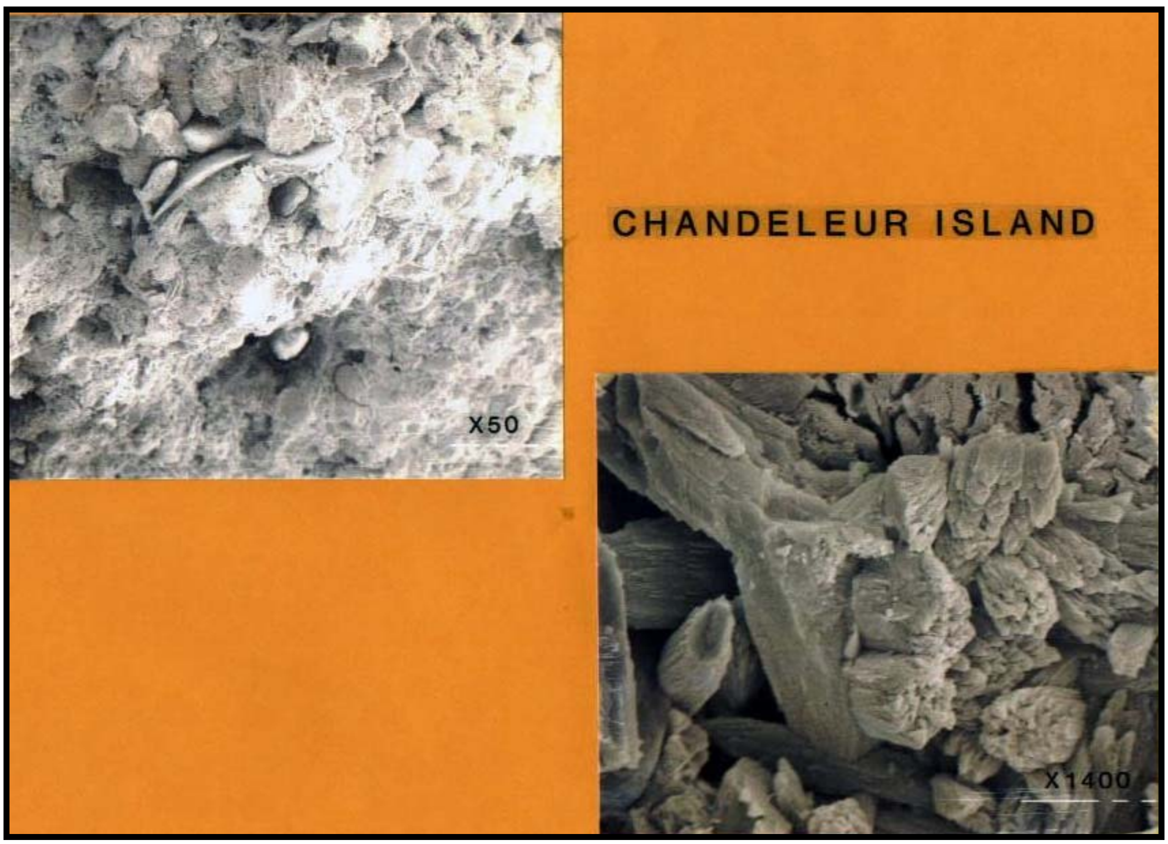
Binkley et al. (1980) and Kendal and Broughton (1978) have proposed that lake beachrock and speleothems are a product of low salinity precipitation of calcite, and that this water chemistry may be the key factor in their formation. Schmalz (1971) and Moore (1973) favor the intermixing of meteoric and marine water chemistry, while Ginsburg (1953) and Russell (1962) consider groundwater evaporation as responsible, and CO_2 degassing of groundwater has been proposed by Hanor (1978) and Binkley *et al*. (1980) for the formation of beachrock. Crystal growth experiments by Ricketts (1980) have shown that controlled high concentration of Mg-calcite can control calcite crystal growth given enough time and the dehydration of Mg^{2+} ions.

The similarity of the Chandeleur Island beach-chip cement to that of the freshwater Ore Lake beachrock (Binkley *et al*., 1980) must be considered more than a coincidence. The evidence of ionic concentration control, the groundwater degassing evaporation, and the location of Chandeleur Island in the Gulf of Mexico seem to suggest that the beach-chip cement is a product of water chemistry, especially in the presence of high concentrations of calcite and iron.

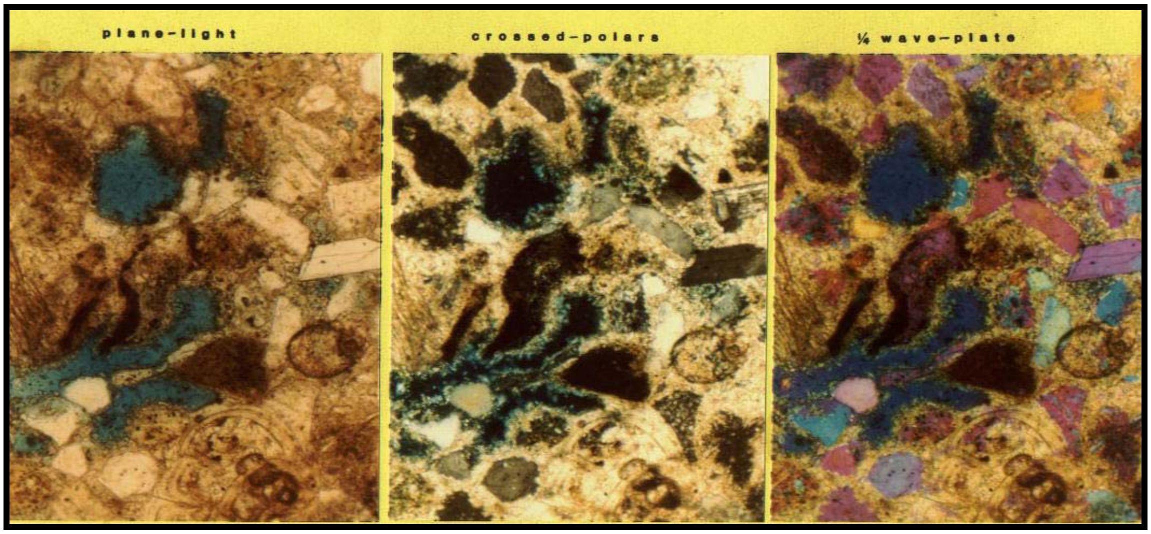
It is concluded that the fresh water, provided by rainfall, may be held in the inter-granular pore spaces and be bonded to the dry quartz-grain surfaces by ionic attraction. Marine spray atop and saline water concentrated underneath may form a sandwich or envelope effect at the micropore level, allowing a rapid growth and precipitation of calcite crystals in the freshwater-saturated pore spaces contained in the envelope. This highly saline sandwich effect may also delay the rapid evaporation of the freshwater interparticle fluid. This delay may also account for the bladed and pointed appearance of the crystallites and the lack of fine silt in the micropores. The crystals, however, did not grow in a two-phase fluid condition, but in a single-phase low-salinity fluid which completely saturated the pore spaces. The crystal shape and size may have been controlled by time (before dehydration) and not by air-water contact.

So, the next time you throw that flat stone, look at it carefully.

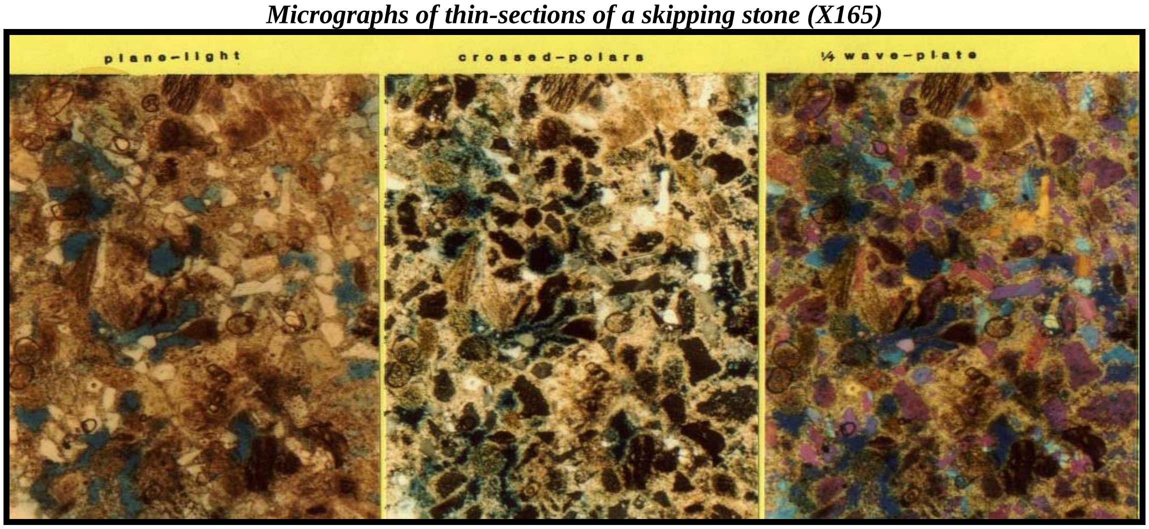
You may be throwing away a mystery!!

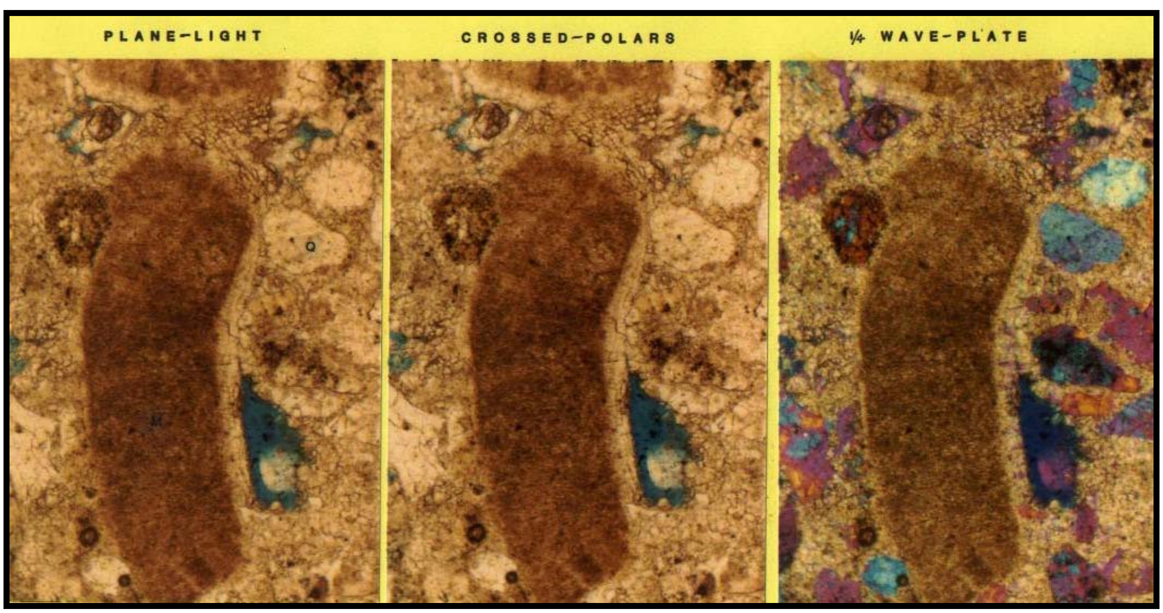


SEM micrographs



Micrographs of thin-sections of a skipping stone (X165)





A mollusk shell surrounded by quartz grains and carbonate cements