Calcitic Pisolites Forming in Travertine Cascade Deposits

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On a recent geological trip to the Southern Peninsula of Haiti, the writer came upon an active multi-terraced travertine deposit in which pisolites are abundant and appear to be forming at the present time. This brief article proposes to describe the conditions under which the travertine deposit is being built and to record data on the size, structure, and composition of the pisolites.

Location and Geology of Deposit

Sault du Baril, the local name given to the waterfall and cascades where the travertine is being deposited, is located a few kilometers inland from the coastal village of Petite Rivière some 20 kilometers west of Miragoane (Fig. 1). Here, at the head of a valley over a hundred meters

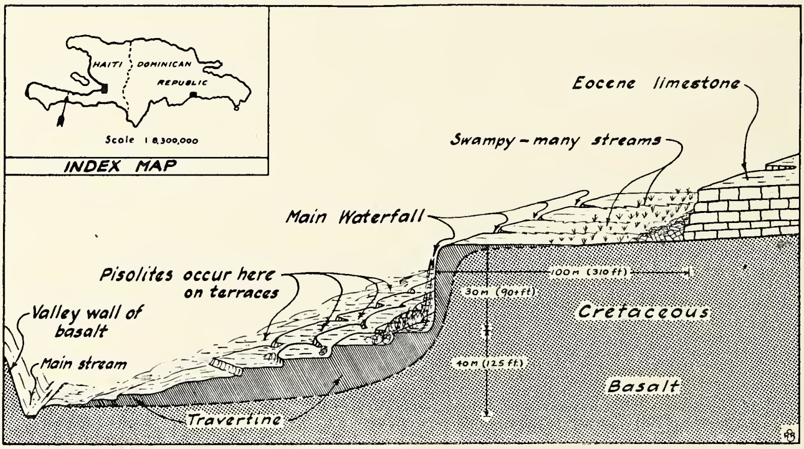

Fig. 1. Diagram of Sault du Baril showing relations of travertine cascade deposit to waterfall and underlying bedrock. The view is looking northeast. Pisolites occur in abundance on the terraced deposits at the base of the great waterfall.

deep, water heavily charged with calcium carbonate flows out along the contact between Eocene limestone and underlying Cretaceous basalt and, after a short course across a flat swampy terrace, plunges over the crest of a spectacular travertine deposit, in a dozen individual streams, and falls in a turbulent mist to the terraced deposits over thirty meters (100 ft.) below (Fig. 1). The fallen waters then gather themselves together into individual streams which flow swiftly and sinuously downward, across an extensive ever-growing deposit of travertine, ultimately joining along the narrow valley bottom and thence flowing on to the sea near Petite Rivière.

Through the centuries, for the falls seems to have been in existence for a long time, the spring-born waters have been extending the crest of the waterfall until there is now a great wedge of travertine built against the upper part of the basalt valley wall (Fig. 1). At the foot of the almost vertical waterfall there is a broad, multi-terraced deposit of travertine which reaches down to the very bottom of the valley. This deposit seems also to have the shape of a wedge because it becomes thinner toward the valley bottom and at one point near the bottom a low knoll of the underlying basalt shows through.

The cool spring-born waters, saturated with calcium carbonate, almost immediately start precipitating their load as they become warmer and more turbulent. One sees many evidences of this early precipitation of calcium carbonate in the ashen-gray coatings on vegetation adjacent to the streams and in the heavy coatings left as shells around roots and tree trunks and around pieces of limestone lying on the surface. One sees further evidence as he walks or rides along the path following the crest of the falls. Here many small streams of swiftly flowing water follow narrow channels in travertine bounded by smooth "botryoidal" sides.

As one descends afoot the steep, crumbly face of the waterfall far to the left of the present flow, he sees everywhere great masses of sponge-like travertine containing leaves, twigs, branches, and even whole trunks of trees, all encased in a hard shell of rocky calcium carbonate. This situation is the one which often gives rise to the idea that the waters are "petrifying." On the gentler slopes and terraced segments around the base of the precipitous slope, one sees many tubular shells of concentrically stratified calcium carbonate lying about, doubtless the remnants of tree coatings from which the wood has disappeared.

Having attained the base of the precipitous part of the travertine deposits, one now has to thread a tortuous path through low bushes, ashen-gray with their limy coating, across many fragile steps and terraces of travertine which are literally growing out of the swiftly flowing streams which course beneath the bushes. After following a guide for perhaps a hundred meters, one comes out onto a broad, gently convex, somewhat terraced surface developed on friable travertine.

Here one has an excellent opportunity to examine this material called *travertine* which Webster's International Dictionary defines as "a white concretionary calcium carbonate, soft and chalklike to hard and semi-crystalline, deposited from the water of springs or streams holding lime in solution." The definition fits the Haitian material perfectly. Here, at Sault du Baril, lime-laden waters have deposited such a mass of gray to light brown, friable to firmly cemented travertine—some as coatings and films on rocks and trees; some as loose or solid rock. Precipitation of the calcium carbonate takes place through loss of carbon dioxide which may be due to rise in temperature, aeration of the water during its turbulent fall and flow, or to the action of certain plants.

The result is this spectacular deposit which makes one think of a gigantic stairway leading to a stage with the curtain a 30-meter high, 100-meter long precipitous rock wall vertically banded with streams of shimmering white water losing themselves in mist at the base. The sight is well worth the 3½-hour horseback ride from the point where the river empties into the sea.

Occurrence and Nature of Pisolites

The pisolites are abundant in the friable gray travertine constituting the numerous terrace segments and inter-terrace slopes directly below the part of the waterfall where water was coming over at the time of our visit (May 11, 1945). Little if any water was flowing across the area where the loose pisolites were picked out of the friable travertine. The area seemed to be one of past rather than present deposition. It was assumed, from observations made at the time of the visit, that the concretions form at the base of the falls, where the water is broken into spray, and in the swiftly coursing waters which gather from the mist and find their way downward across existing travertine deposits. Bits of rock, leaves, twigs, etc., act as nuclei to start precipitation, and deposition once started continues as long as conditions are favorable. Many of the concretions have not been transported far, if at all, from the place where they grew judging from their shape and surface features; some, however, because of their spherical shape and polished surface probably were transported from the site of formation, though they could also

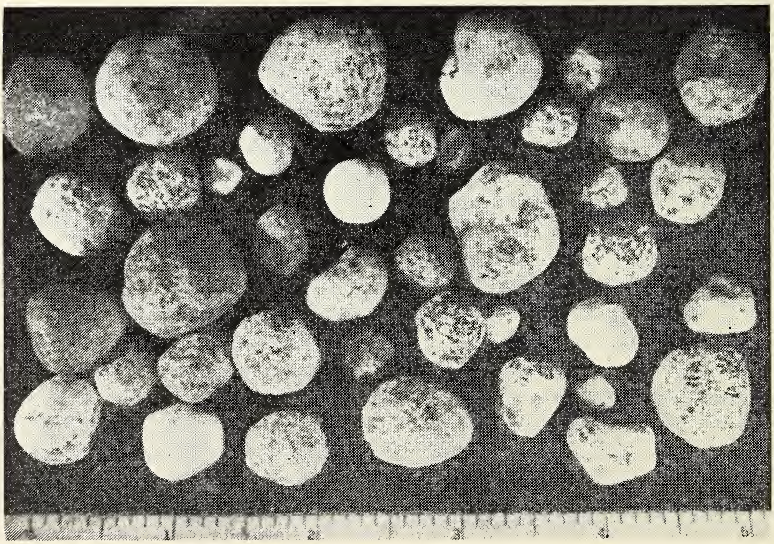

Fig. 2. Typical pisolites from the travertine cascade deposits at Sault du Baril, Haiti. The scale is in inches (1″=25 mm.).

develop those features by being rolled about in an enclosed basin of turbulent water.

The pisolites range in diameter from less than 2 mm. to more than 30 mm. Smaller irregular concretionary particles were seen; these, however, did not appear to be true concretions of oolite size but rather tiny aggregations of crystals. Some of the smaller pisolites are almost perfect spheres, many are spheroidal or ellipsoidal, and some of the larger are ovoid or irregular in shape because of rounded protuberances (Fig. 2). Generally the surface is hard and more or less smooth but occasional pisolites have a granular surface due to the porous, friable nature of the material.

Internally the pisolites are composed of concentric shells of denser, and stronger material separated by a zone of poorly cemented grains

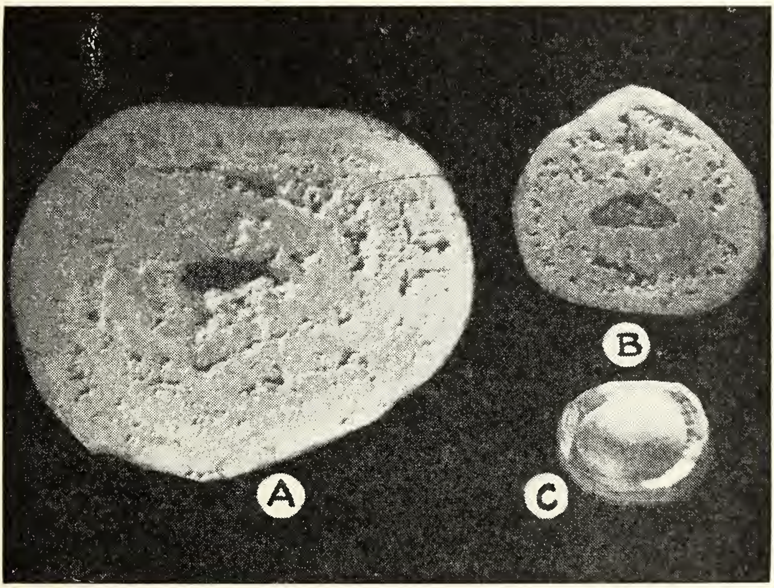

Fig. 3. Cross-sections of typical pisolites. A. Large, concentrically banded pisolite with hollow center. B. Medium-sized pisolite with a nuclear fragment of basalt. C. Small specimen with part of outer shell broken away. (All figures are magnified x 2.8).

which show no structure (Fig. 3). Each type of material was X-rayed and both were found to be calcite.* The difference in structure seems to be a matter of cementation and recrystallization. No radial structure was observed in any of the concretions.

Most of the pisolites that were broken or sectioned showed no visible nucleus but some did have a prominent cavity at the center suggesting

* I am indebted to Dr. H. W. Fairbairn, Massachusetts Institute of Technology, for making the X-ray analysis.

the possibility that there may once have been some sort of nuclear material. In one specimen (Fig. 3) a tiny bit of basalt constitutes the nucleus.

Under the conditions which prevail at the cascades, it is probable that any tiny bit of foreign matter—leaf, twig, rock fragment, or loose grain of travertine—would initiate precipitation and act as a nucleus around which a concretion could grow. Deposition once started would continue as long as conditions were favorable. All field evidence supports the view that the pisolites were formed as free, discrete bodies which later came to rest, in some instances after transportation, in the midst of granular travertine.

It seems altogether probable that with increasing age and burial the structure of the pisolite may change from alternating zones or shells of dense and porous material to a fairly uniform dense texture.

When the pisolites are dissolved in normal hydrochloric acid, there is violent evolution of carbon dioxide. After all chemical action has ceased the solution contains some gelatinous material. A small portion is organic and disappears on ignition. The remainder is iron oxide and silica.