SURVEY OF TROPICAL LANDFORMS ON THE ISLAND OF CUBA -- EPICENTER OF ANTILLEAN KARST

EXPLORERS CLUB FLAG NO. 99 EXPEDITION REPORT
EXPEDITION DATES: NOVEMBER 8 – 23, 2013
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INTRODUCTION

The Expedition objective was to survey, locate and document karst landforms in Cuba and their relation to similar features in the adjacent islands of the Greater Antilles which are Puerto Rico, Hispaniola (Dominican Republic and Haiti), and Jamaica. In past years, the author has lived on and/or conducted geological field studies on all these islands.

According to EC archives, Flag No.99 expedition was the second in history to carry the flag to Cuba. Four major karst areas (all located along the north coast) were located and photographed during the expedition, one of world-class significance. The names of the four karst areas were originated by the author and may not appear in other literature or maps. See Map No. 1 below for locations of the Greater Antillean karst areas.

As expedition leader I had the advantage of having lived and worked in Cuba for four years during and after the Revolution, with resulting intimate knowledge of the island. My daughter, Natalie, served as my assistant and was an excellent choice, having been born in Cuba and being proficient in Cuban Spanish. She was also the Expedition photographer.

Thanks to Constance Difede, our VP for Flags and Honors, for her special attention with my Flag applications for Expeditions to both Cuba and Brazil (2011). Thanks also to Emerald Nash in Member Relations for her assistance with Flag issuance and receipt.
PLANNING AND LOGISTICS

The mid-point of the 2013 Caribbean hurricane season (about September 15th) was allowed to pass before applying for the EC Flag, since an expedition could be in grave danger during a storm, especially with limited Cuban emergency relief available to a foreigner. On the other hand the endeavor had to commence prior to the December high tourist season when bus and hotel space is very limited, especially since both were arranged on a day-to-day basis without any advance reservations. As it turned out, even in November we found most hotels full, so ended up staying in casa particulares (private houses) where often only Spanish was spoken.
Since travel was along roads with provision vendors, no subsistence arrangements were required. All outfitting, including field clothing, money belts (important since only cash is accepted from US citizens in Cuba), field notebook, etc., was completed in the USA. The fact that Cuba has few if any infectious diseases, no poisonous snakes, etc., made a medical kit unnecessary. The expedition felt secure even on isolated back roads due to the hard-working and friendly nature of the rural folk, the highly controlled society, and the restricted availability of private firearms as compared with the US. There is little crime against tourists even on the poorly lighted night streets of Havana.

My travel to Cuba was permitted under a US general license for professional scientific study. My assistant Natalie, having been born in Cuba, required only a Visa from the Cuban Interest Section in Washington DC. In both cases, this allowed us to fly directly from Miami to Havana using a US government approved TSP (Travel Service Provider).

Upon arrival in Havana, we were pulled aside by immigration and asked about our plans and itinerary in Cuba – our reply was to travel the entire island. Had we been with a formal tour group these questions would probably not have been asked. During our expedition, nobody or the MININT (Ministry of Interior) security agents approached us although they had access to our movements via our passport registrations at each overnight accommodation. Basically, we had free range to go anywhere.

**ITINERARY AND ROUTE**

The expedition commenced at 2:30pm on November 8th in Miami, Florida when an American Airlines charter was boarded for a flight across the Florida Straits. Less than an hour later, the uplifted and rocky karst coast of Cuba was below, a notable change from the flat Everglades and mangrove covered tidelands of Florida Bay and the Keys. Just prior to a 3:30pm landing at Jose Marti International Airport, twin limestone hills known as the
Tetas de Managua marked the horizon some seven miles southeast of the runway and at 700 feet are the highest elevations in greater Havana.

From Havana, the expedition traveled 21 hours by intra-city bus to the town of Baracoa at the extreme eastern tip of the island where the survey commenced to seek Cuban karst landforms. From here a two-week westward journey began until the western tip of Cuba would be reached in Pinar del Rio Province. Again travel was by bus along with taxis and hired private cars for back road exploration. Frequent foot traverses were made to karst outcrops (geologic stratum which appear at the ground surface). The expedition traveled almost 2,000 miles – the island itself is over 800 miles in length. See Map No. 2 below for route followed.

Minimal time was spent in Havana, mostly for logistics and to secure long-distance bus reservations, and also to field check local karst features in the Havana area. The flight back to Miami departed on November 23rd after sixteen productive days on the island.
KARST DEFINITIONS AND CHARACTERISTICS

The term karst derives from the name of a limestone plateau in Slovenia (Europe) and refers to abrupt and often bizarre-shaped landforms resulting from weathering or dissolution by water of soluble carbonate (limestone, occasional dolomite) rocks. Karst refers to both the surface (outcrops) and the sub-surface (caves) occurrence of thick eroded limestone. These landscapes are most common in tropical to sub-tropical climates with abundant rainfall. The type of limestone is important inasmuch as the softer porous beds will be dissolved more rapidly by acid rain than will those of hard and dense nature. Limestones are usually whitish and easy to identify. To experience how rapidly carbonates can dissolve, apply several drops of dilute hydrochloric acid onto a piece of limestone and watch the rock fizz away.

Mega surface karst types include ‘positive’ features termed towers (isolated and near vertical), haystacks, cones, pinnacles, along with ‘negative’ features such as potholes and sinkholes. Mega sub-surface karst includes caves and underground rivers. Sometimes caves become elevated and isolated in karst towers due either to lowering of the tower bases by erosion or by uplift of the towers following cave development. Buttes and pinnacles of Monument Valley, Arizona, may exhibit similar landforms as karst, but are not inasmuch as they are composed of sandstone rather than limestone.

Minor surface karst types include limestone pavements, sharp-edged rocks called Diente de Perro (Dog's Teeth), stone forests, stone cities, isolated stone stacks, and are termed ‘Karren.’ These often develop in horizontal carbonate beds as remnants at the end of an erosional cycle.

Karstlands frequently originate in structurally uplifted areas of hard carbonate rocks. The uplift itself commonly induces faulting and fracturing that provide a path of entry for surface waters and resulting erosion. Other factors in karst development are depth to the water table and age of the
rocks. In Cuba the older Jurassic and Cretaceous outcrops exhibit better development than younger sediments.
KARST AROUND THE WORLD

While karst landscapes are present on most continents, world-class examples are mainly present in Asia including Guilin, China, Halong Bay, Vietnam, and Phangnga Bay/Krabi, Thailand. Cuban karst is the most spectacular in the Americas and of world-class status, some protected since 1985 by UNESCO as a World Heritage Site along with a Biosphere Reserve covering some 100 square miles. The maximum karst tower height in Guilin is 1,600 feet while similar towers (Mogotes) in Vinales Valley, Cuba sometimes reach 1,300 feet above the valley floor.

KARST IN ART

Over the years karst landscapes have become elevated to an art form as a result of the dramatic and mystic beauty of the scene. Early Chinese painters were intrigued by the natural beauty of Guilin. Europeans were no exception as illustrated by the Dutch artist Vincent Van Gogh with his paintings of karst landforms in Provence, France. Cuban artists have also produced karst art. Good examples are shown below and on cover page.

Guilin, China by Chinese artist

Apilles (Little Alps) Karst in St. Remy, France, by Van Gogh
The Caribbean is one of the world’s premier karst regions with 90 percent of these landforms present in the Greater Antilles. Karst is one of two important landscape types, the other being volcanic terrain with recently active volcanoes present in the Lesser Antilles.

Since Columbus discovered the Greater Antilles, karstlands have been both beneficial and detrimental to human habitation. Pre-Colombian people used karst caves for shelter while later the survivors used caves as refuges against the encroaching Colonials. In Jamaica, remote cockpits (sinkholes) served as hideouts for people who resisted Colonial authority. On the northeast coast of Cuba, the Sierra Cubitas karst provided cover and security for pirates who operated along that coast. The inland Colonial town of Camaguey resisted pirate attacks by developing a maze-like street plan to confuse these attackers and finally drove them back to the coast and their Cubitas cave and ravine lairs.

Agriculture in karst areas has suffered from the lack of rivers and surface waters. The sinkholes and crevices of karstlands allow rainwater to rapidly sink into the subterranean, leaving the soil parched between rainfalls. The lack of rivers and lakes hinders water storage for dry season irrigation. Rivers are known to disappear into a sinkhole and reappear downstream. Rapid rainfall runoff in porous karst can result in surface pollutants being carried underground to mix with and make drinking water unsafe.

‘Negative’ karst features can pose danger to modern habitation. Sink holes can unexpectedly appear and swallow houses, animals, cars, and people, especially in areas where ground water levels are lowered due to overproduction of water resources such as in west central Florida. On the other hand a beneficiary of karst land is ecotourism, especially if the karst is near a major city like Havana. Karst offers cave exploration, rock climbing, underground river tours, archeological sites, and isolated areas with indigenous wildlife and forest cover. For years small karst hills within the city of San Juan, Puerto Rico, have been conveniently quarried to
provide limestone for landfills, along with construction materials and cement for roads and buildings.

Lastly, the isolation and low population density -- with lessened human release of ozone destroying gases -- of most Caribbean karst areas is a positive factor, if only small, in climate change prevention.

**GREATER ANTILLEAN KARST**

**Puerto Rico**

While limestone outcrops all along the north coast of Puerto Rico, the major karst area is the inland northwest corner of the island (south of Arecibo) in the Lares Formation of Oligocene age. Here the karst is both surface (ubiquitous, small, forested, haystack type hills) and sub-surface (caves and underground rivers). This is not a developed agricultural area due to its rocky and isolated nature along with a lack of roads. In the 1960s I conducted geological field studies in this karst zone -- prior to oil exploration drilling which had negative results, a boon to the island's environmental protection.

In 1964, EC member Russell Gurnee carried Flag No. 178 to the Rio Camuy area to explore the underground course of the river with the recommendation that a park be developed. In 1986 the Rio Camuy Cave Park was opened and today is visited by over 150,000 annually. The main attraction is the Clara cave which connects to the world’s third longest subterranean river. Another attraction is the Tres Pueblos sinkhole which is 400 feet deep by 650 feet across, at the bottom of which flows the River Camuy.

In 1971 Gurnee returned with Flag No. 179 with intent to conduct the first traverse of Rio Tamana which goes underground five times over thirteen miles. The beautiful and highly visited Cueva de Arco is located along this river.
Dominican Republic

Dominican karst is limited to a small and remote area in the northeast within the Los Haitises National Park. The word ‘Haitis’ (singular) translates to ‘Highland’ in the language of the pre-Colombian Taino Indians. The park runs along the mangrove-covered south shore of Samana Bay. This is the wettest area of the country and thus is inducive to the development of karst landscape.

The karst covers some 50 miles along Samana Bay and extends 15 miles inland. Conical hills and cones rise to almost 1,000 feet above sea level with some forming small islets similar to the larger karst pinnacles in Halong Bay, Vietnam. Sinkholes are common between the cones, and caverns are plentiful. The park was created in 1976 as an ecotourism site and forest preserve and is mainly accessible by watercraft.

Haiti

Haitian karst landscapes are mostly of minor size and accordingly are termed ‘karren.’ The area along the south coast and directly south of Port-au-Prince shows karst development in the form of small fluted pinnacles similar to stone forest or stone city features, which have been named Karst Dan (broken teeth) in Creole by the locals.

This karstic area of Eocene age is within the area of La Visite National Park near the town of Marche. Apparently very little data is available on Haitian karst.

Jamaica

This former Colonial government and the University of the West Indies have published studies on Jamaican karst, especially on the cockpit country of northwest Jamaica. The abundant cockpits or hollows and sinkholes of Eocene age are separated by conical hills or cones (some exceed 650 feet in height) developed in a limestone plateau. Apparently caves are not too common. Because the area is Jamaica’s largest remaining rainforest, application was made in 1994 to UNESCO for World Heritage Site status, but has yet to be approved.
The geology of Cuba is extremely complicated in both stratigraphy and structure. The island is the least mountainous of all the Greater Antilles and yet it holds a record elevation of 6,476 feet at Pico Turquino in the Sierra.
Maestre Mountains of eastern Cuba. Most of the island is flat to rolling hills. The major mountains are concentrated in several groups with many outcrops termed Basement Complex composed of volcanic/igneous and metamorphic rocks (transformed by heat and pressure) with few limestones. An exception are the mountains in western Pinar del Rio Province which include the Vinales Valley area with abundant karst limestones.

The expedition commenced at Baracoa on the eastern tip of Cuba which was founded by the Spanish in 1512 as the oldest town on the island. Since no significant limestones were found, the expedition continued west to the Holguin karst. See Map No.2 above.

**CUBAN KARST AREAS**

**Holguin Karst**

This area on the northeast coast of Cuba, between the city of Holguin and the Guardalavaca beach tourist zone has extensive karst limestone outcrops in the form of butte-type landforms not usually found in Cuba, rising from a savanna type arid plain. These impressive features are known as the Cerros Maniabon, of Cretaceous age. These karst features were eroded during an earlier geologic time with a wet climate, while today the Holguin area has the least rainfall in all of Cuba. Outcrops of Basement Complex rocks (including Serpentines) were also noted in the area. The pre-Colombian Taino Indians lived in this vicinity and occupied karst caves for shelter.

Guardalavaca beach exhibits coral limestones with some Diente de Perro surface. This limestone is thought to be very young, probably Pleistocene in age.
The Sierra Cubitas is a low northwest-southeast elongate mountain range lying 8 to 10 miles inland from the north coast of Camaguey Province. These karst mountains reach a maximum elevation 1,082 feet at Cerro Tuabaguey (Loma Limones on recent maps).
The Cubitas is famous for the Hoyo de Bonet, Cuba’s largest karst depression some 295 feet deep. It was named after the pirate Bonet who used it as a hideout. Another notable site is along the Rio Maximo called the Paso de los Paredones, a water-cut, steep-sided karst ravine some 325 feet deep and over one-half mile long. Much of the Cubitas surface is rough and jagged Diente de Perro ‘karren’ type karst with underlying caverns, some with Taino Indian wall paintings. My friend and EC member Rudy Mola kindly provided information on these Cubitas caves. Rudy spent his boyhood in the area and has suggested a possible EC expedition to revisit the caves.

In the same area are found the Cangilones (potholes) of the Rio Maximo. These features extend along the river for several hundred feet and are lined with what appears to be hard, white marble (metamorphic limestone). For years these Cangilones have been a swimming and recreational destination for local people.

To reach this site we traveled in a 1955 Chevy Bel Air, typical of the classic cars we used for transportation across the island.
Jaruco Karst

The Jaruco area is the nearest major karst zone to Havana. Location is in eastern Havana province some 18 miles southeast of Havana Bay in a geologically uplifted area termed the Alturas (heights) de Havana-Matanzas. The Jaruco karst is a series of eroded limestone terraces known as the Escaleras (stairs) of Jaruco which reach an elevation of some 900 feet.

From the rugged summit of the Escaleras, the beautiful north Cuban coastal plain along the Straits of Florida can be seen. These hills are laced with caves of various sizes and have been explored over the years. In 1995 EC Flag No. 61 (the first EC flag to Cuba per the club's archival records) was carried by member Cato Holder and hosted by the Cuban Speleological Society. His Flag Report states that seven caves were visited in adjacent Matanzas Province into which the Alturas extend.

In 1960 I visited Cuba's famous Cuevas Bellamar (discovered 1861) in Matanzas, just east of the Jaruco karst. These highly decorated caves exhibit interesting stalactites and stalagmites along with the magical Gothic Temple with a 65ft ceiling. It is interesting to note that the nearest (to Bellamar) dry and walkable US cave is located over 550 miles away near the Florida-Georgia line and Tallahassee and is known as the Florida Caverns. The majority of caves in Florida are water-filled vs. dry in Cuba.
The city of Havana has few karst features except El Morro (a rocky karst cliff under Morro Castle) and unfortunately an excess of sharp foot-cutting Diente de Perro along the waterfront. The only good sand beaches are in Havana del Este some miles east of downtown. It is interesting to note that the original thirty-foot high Havana city walls (construction started in 1694) are built with limestone blocks quarried from nearby karstlands.
Vinales Karst

The world-class Vinales Valley karst area is located about 100 miles west of Havana in Pinar del Rio Province in the Cordillera de Guaniguanico mountain chain, which reaches its highest elevation at 2,293 feet on the sugarloaf-shaped Pan de Guajaibon near the north coast. These mountains are divided into the Sierra de Rosario in the east and Sierra de los Organos in the west. These karst limestone outcrops are Jurassic age (earlier maps show a Cretaceous age) and the oldest in Cuba. The relative nearness to Havana (population over 2.2 million) makes it a destination for Cubans as well as for foreign tourists.

The area has several environmentally significant areas including the Vinales Valley UNESCO World Heritage site, La Guira National Park, and the UNESCO Sierra Rosario Biosphere Reserve. These karstlands have many caves including Santo Tomas, a sixteen mile system of passages and thus the longest in Cuba. Cueva de Indio is very touristic and offers a subterranean motorboat ride. Many of these caves were inhabited by pre-Colombian Indians, while another inhabitant is the non-poisonous Pygmy Boa, the only locality in Cuba where this snake is said to be found.
The main attractions in Vinales Valley are the limestone tower karst landforms called Mogotes (ragged) which dot the valley. Between these features which often rise to 1,300 feet above the valley floor are Hoyos (small depressions) filled with rich red soil perfect for growing tobacco. The Vinales Valley lies within the Sierra Organos, the name deriving from the church-organ shaped karst mountains. The small town of Vinales is very pleasant and lies near the center of the valley, completely surrounded by the dramatic Mogotes, making this the most spectacular natural scenery in all of Cuba.
CONCLUSIONS AND ACCOMPLISHMENTS

This expedition carried the second EC Flag ever planted in Cuba. Surface karst landforms were documented for the first time for the EC archives. After conducting comparative studies on the other Greater Antillean karst areas, it has been concluded that Cuban karst ranks number one in these islands and is also world-class.

Should Cuba eventually open up to become a major tourist and cruise ship destination particularly for Americans, Vinales Valley day tours could become a premier shore excursion, being only a two hour drive from Havana. Hopefully, advanced, strategic, and visionary planning by the Cuban government will protect the environment and beauty of this area for future generations.

Tom and Natalie Ambrose in Vinales Valley, Cuba
TEAM BIOS

Thomas Ambrose MN’10 (Expedition Leader and report author) holds BS and MS degrees in Geology and has lived and worked as an international exploration and natural resource geologist for many years in Cuba, Puerto Rico, Trinidad, Colombia, Ecuador, Indonesia, and Singapore. In 2011 he carried EC Flag No.99 to the Geodetic Center of South America in Brazil. Ambrose is a member of the Southern Florida Chapter of the Explorers Club and resides in Ocean Ridge, Florida. He can be reached at (t) 561-737-3601 and realthora@yahoo.com.

Natalie Ambrose, Expedition Assistant, has an MBA in International Business and works in trends research and strategic planning. She believes that Cuba’s future attraction will be from the continued preservation of both its natural and built environments, currently little changed from the 1950’s. Natalie resides in Washington, DC and can be reached at ambrose.natalie@gmail.com.
MAP OF CUBA
SHOWING
MAJOR KARST AREA IN YELLOW
ROUTE OF EC FLAG 99 EXPEDITION IN GREEN
(COVERING ALMOST 2000 MILES)
NOVEMBER 2013

MAP 2