The Origin and Evolution of Virgin Gorda

By Tracy H. Allen, PhD, Department of Geography and Environmental Sciences, SUNY College at Oneonta, Oneonta, NY 13820. Email: Tracy.Allen@oneonta.edu

Introduction and Purpose

Virgin Gorda is an island born of fire. Its abrupt and violent birth has yielded to the steadfast sculpting of water, wind, and time. Steep mountain slopes, rolling hills, deep valleys, level plains, rugged beaches, and crescent bays pattern a landscape of stunning contrasts. The geographic profile of Virgin Gorda rising out of the sea is so varied and dramatic that it loosely resembles a large female reclining on her side. Be it feminine curves or geomorphologic diversity, Christopher Columbus was inspired to name the island Virgin Gorda - the "Fat Virgin". The purpose of this research is to determine the origin and evolution of Virgin Gorda Island. There are no comprehensive scholarly studies on the Island's geomorphology, despite its unique shape, distinctive house-sized boulders, and dynamic natural setting.

Three Geomorphic Regions of Virgin Gorda

Central Landmass is the body of Virgin Gorda. Steep hills rise straight out of the water to form Virgin Gorda Mountain and culminate in Gorda Peak, the highest point on the Island (1416 m). Belying its rich geologic history, Gorda Peak is the erosional remnant of tectonic upheaval. The elevations of this region are high enough to generate an orographic effect as moist air is forced to lift. The mountain is steep-sided, generating a radial drainage pattern. While the streams are ephemeral, they are high gradient and produce considerable erosion during rainfall events.

South Peninsula

South Peninsula (The Valley) is a wide, flat, fairly homogeneous plain marked with slight hills. The highest elevation is Cow Hill (136 m). Due to The Valley's generally flat conditions, erosion by surface runoff, outside of urban environments (Spanish Town) and hills, is minor. Arrows represent direction of relative plate motion.

Virgin Gorda was situated on the tectonic boundary between the Caribbean and North American plates. Subduction-related volcanism is no longer - erosional processes ensue.

Virgin Gorda is granodiorite rock. The British Virgin Islands, the United States Virgin Islands, and Puerto Rico were part of a single landmass. Submerged below the surface of the Caribbean Sea, the islands are joined by the Puerto Rico-Virgin Island Platform. In places, the Platform rises above sea level, forming islands that are collectively part of the Puerto Rico Bank. Like the other islands in the Bank, Virgin Gorda is the exposed topographic high of a larger underwater formation. A drop in sea level, equivalent to the most recent glacial advance when more water was stored in glaciers, would reestablish a land bridge between the Virgin Islands and Puerto Rico (Rankin 2002).

Puerto Rico-Virgin Island Platform

The Platform forms a microplate in the Greater Antilles between the southern boundary of the North American plate and the northern boundary of the Caribbean plate.

56 km to mainland

Virgin Gorda

Rocks: The origin of all rocks on Virgin Gorda is magma that was either volcanically extruded or intrusively formed below the surface. Older extruded basaltic and andesitic rocks have been largely metamorphosed, leaving intrusive rocks to dominate. Granodiorite dominates the South and East Peninsulas. The second most abundant rock is tonalite. It covers most of the Central Landmass. Granodiorite is a gradation between granite and andesite. Add quartz and potassium feldspar to diorite to make granodiorite. Diorite with less quartz than granodiorite is tonalite.

Origin

Virgin Gorda is situated on the northeastern margin of the complex fault zone that forms the boundary between the Caribbean and North American tectonic plates (see Figure 1). The small plate separate originated in the Pacific Ocean and began to drift eastward with the separation of North and South America approximately 170 million years ago (Pindell and Barrett 1990). Over millions of years of continuous eastward drifting, the Caribbean plate moved into the Atlantic and essentially filled the gap in the two larger plates of North and South America. When two plates of different densities collide, the denser plate will be forced to sink (subduction). The Caribbean plate began to override the North American plate beginning approximately 120 million years ago (Pindell and Barrett, 1990). A consequence of subduction is volcanism. As the North American plate was forced under the Caribbean plate, it was subjected to greater and greater pressures with increasing depth. The pressure melted the oceanic crust and lithosphere and formed magma beneath the overriding plate (see Figure II). The magma ascended into an arc of oceanic volcanoes parallel to the subduction zone, forming the Puerto Rico-Virgin Island Platform. The Platform emerged from the Caribbean Sea as a result of undersea mountain building, followed by periods of uplift and explosive volcanism. Virgin Gorda was born.

Evolution

The batholith that lies below Virgin Gorda formed as an intrusive igneous or plutonic reservoir of molten rock that cooled beneath the surface. Batholiths are large aggregations of plutons. The Virgin Gorda Batholith (VGB) owes its origin to the collision between the Caribbean plate and the Bahamas Bank 30 to 40 million years ago. After uplift and extensive erosion, only 14 square miles of the VGB is exposed at the surface, while at least 80 square miles remain submerged (Kesler and Sutter, 1979). Much of the original batholiths and volcanic pyroclastics (rocks fragments ejected from a volcano during a violent eruption) have been changed due to the intense heat and pressure of the VGB. The batholiths on Virgin Gorda are made of granodiorite. Worldwide, the Batholiths are exceptional. Most granodiorite boulders are underized by comparison, and are spread over a smaller area, in fewer numbers. The boulders were not thrown to their present location by volcanism, rather, they were exposed by faulting, tectonic uplift, and erosion. The Batholiths were exposed some 15 to 25 million years ago (Island Resources Foundation, 2012). The individual boulders were formed as the batholith cooled, shrunk, and cracked. With the passing of millions of years, the rocks have weathered, becoming smaller, more broken, and rounded. Rainwater is weakly acidic. Slowly, the acid chemically erodes minerals, producing pitting and fluting (long shallow grooves) in the granodiorite. With differential erosion, due to the presence of harder and softer mineral compositions, the Baths take on spectacular shapes.

Conclusion

Virgin Gorda is rich in geomorphologic diversity due to its violent and fiery origins and its slow and steady denudation. Steep mountain slopes, rolling hills, deep valleys, level plains, rugged beaches, and crescent bays pattern a landscape of contrasts. It is a land of superlatives defined by a unique geologic history. One hundred and twenty million years ago, Virgin Gorda began to take form, as the Caribbean plate overrode the North American plate. Collectively, the Virgin Islands are geographically classed as part of the Lesser Antilles. This is a misnomer. Geomorphic history reveals that all of the Virgin Islands, including Virgin Gorda, are a part of the Puerto Rico-Virgin Island Platform, which is a microplate within the eastern Greater Antilles. Tectonic-related subduction followed by plutonic intrusion and uplift, shaped the major construction periods of the Island. The origin of all rocks on the Island is magma that was either volcanically extruded or intrusively formed in the Virgin Gorda Batholith below the surface. Older extruded basaltic and andesitic rocks have been largely metamorphosed, leaving intrusive granodiorite and tonalite to dominate. Recent motion of the Puerto Rico-Virgin Island Platform on the Caribbean plate is transitional, from subduction to a transform boundary or strike-slip faulting. Continued uplift, denudation, faulting, earthquakes, and tsunamis will primarily shape Virgin Gorda's geomorphology in the near geologic future.