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Compilation of a geologic map of the Greater Antilles and Virgin Islands

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As part of an ongoing mineral resource assessment, we have compiled a digital database and geologic map of the Greater Antilles and Virgin Islands. The Greater Antilles include the islands of Cuba, Hispaniola (Haiti and Dominican Republic), Jamaica, Puerto Rico (and outlying islands), and the Cayman Islands. While geographically part of the Lesser Antilles, the Virgin Islands are included in this compilation because they share greater geologic affinity with the Greater Antilles than the rest of the Lesser Antilles. In undertaking this compilation, several issues have arisen not generally faced by geologic map compilers in North America. The primary issues are language and mapping style. The Cuban and Dominican Republic source materials are in Spanish, though the Cuban information is in Russian-influenced Spanish. The Haitian materials are in French and the materials for the remaining islands are in English. An initial step in the compilation was translation of source materials and interpretation of the various ways in which geologic features were described. For translation, we used Google Translate with assistance from language dictionaries and in the case of Spanish, checks by a native Spanish speaker. Interpretation of translated descriptions was commonly necessary as geologic terms often did not translate correctly (breccia translated as “gaps”) or the geologic terms used were at times different than those commonly used in North American. For example, the Cuban source (Pushcharovsky and others, 1988) used the terms “aleurolite” (siltstone), “silicite” (chert), or “granosyenite” (quartz syenite?).

Mapping style issues were more impactful. Map patterns appear to suggest thrust faulting is an important process, especially in Cuba, yet no thrust faults are indicated on the Pushcharovsky and others (1988) Cuban geologic map. In a field trip taken by some members of our project, the Cuban guides seemed to indicate that they did not map features seen by our project members as thrust faults. On many of the source maps, the nature of fault offset is not indicated, nor are cross-sections common.

On both the Haitian and Dominican Republic geologic maps (Toloczyki and Ramirez, 1991; Vila and others, 1985), though stratigraphic units are mentioned in some unit descriptions, the map units used are generalized and do not reflect specific stratigraphic units. We infer that other defined stratigraphic units may also be included in their map units. The mapping does not indicate the specific outcrop areas of any of the stratigraphic units mentioned. The map descriptions associated with these two maps as well as the spatial data indicate a clear break across the international border; logic dictates no such break exists. We have done our best to eliminate this break where the data allow. Igneous and especially intrusive map units tend to be lumped regardless of age; this is in part likely due to the very limited radiometric dating undertaken during or prior to mapping, especially in Cuba and on Hispaniola.

There is an extensive catalog of stratigraphic nomenclature in Jamaica and only in the last few years (Mitchell and others, 2016) has there been a concerted effort to revise and rationalize the nomenclature. Prior to this some variants of unit names were applied to different units and some units had multiple names.

The Puerto Rican part of the compilation is sourced from Krushensky and Schellekens (1999), a compilation completed as part of an earlier USGS mineral resource assessment. We are re-examining this compilation to incorporate in the larger effort and to reflect new information. We have also included outlying islands not originally part of the Puerto Rican compilation.

Data for the Virgin Island, both US and British, come from a series of Ph.D. dissertations done at Princeton in the late 1950s. These include Helsley (1960) for the British Virgin Islands, Whetten (1961) on St. Croix, Donnelly (1996) on St. Thomas and St. John, and Rankin (2002), also for St. John.

An important part of our compilation is the correlation of map units throughout the region. Unit descriptions upon which these correlations can be made are variable in detail and in some cases, correlations have been made using the spatial distributions of rock units.

We have compiled a database of radiometric age determinations to accompany the map database. A major problem in compiling this database is the common lack of good location descriptions for the samples. Where location maps are provided in the papers reporting age determinations, they commonly lack registration and location coordinates can only be determined approximately. In Haiti, a very large number of $^{40}Ar/^{39}Ar$ age determinations were made on units that define the Tertiary-Cretaceous boundary; strangely, none of the reports provide any location information. Additionally, analytical data is rarely available for some of the earlier determinations which were typically conventional K/Ar determinations for which decay constants were not reported. We had to make some assumptions to allow recalculation of the age determinations using modern decay constants (Steiger and Jager, 1977). Some of the earliest age determinations dated materials no longer considered acceptable or reported analytical errors greater than 10 percent. A few age determinations were made using the now discredited Pb-alpha technique. Recently, modern U/Pb age determinations are becoming more common.

Present plans are to issue our initial compilation as a USGS Open-file Report and subsequently release an enhanced compilation as an USGS Scientific Investigation Map (SIM) using more detailed sources. Note this map database is structured identically to the recently released Geologic map of Alaska, including using many of the same related tables.

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Compilation of a Geologic Map of the Greater Antilles and the Virgin Islands

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Introduction

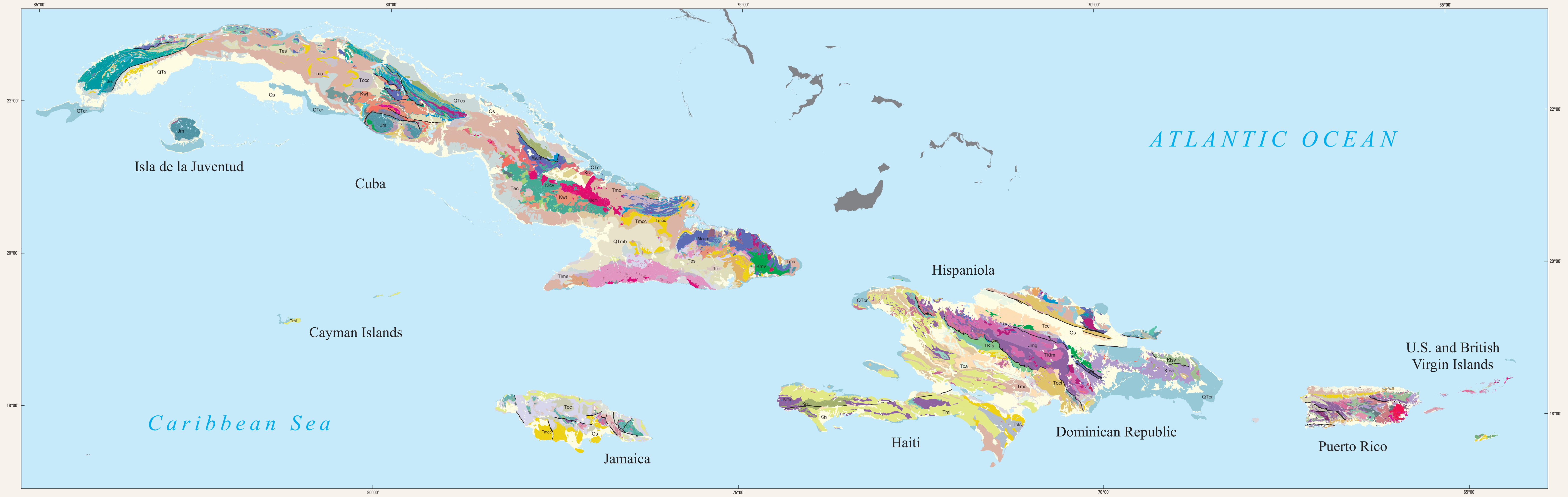
This geologic map of the Greater Antilles is a compilation of information from the literature, integrated to provide a seamless map of the region. The map represents output from a database of geologic data assembled as part of and to facilitate an ongoing mineral resource assessment. The geologic map shown here covers Cuba, Hispaniola (Haiti and the Dominican Republic), Jamaica, Cayman Islands, Puerto Rico, and the U.S. and British Virgin Islands. The product will also include a second sheet showing the geology of Puerto Rico and the Virgin Islands in greater detail.

Compilation exposed several issues that are not generally faced by geologic map compilers in North America. The primary issues were language and mapping style. Cuban and Dominican Republic source materials are in Spanish, though the Cuban information is in Russian-influenced Spanish. Haitian materials were in French and materials for the remaining parts of the map area in English. An initial step was translation of source materials and interpretation of the differing descriptions of geologic features. For translation, we used Google Translate with assistance from language dictionaries and in the case of Spanish, a few checks by a native Spanish speaker. Interpretation of translated descriptions was commonly necessary as geologic terms often did not translate correctly (breccia translated as "gaps") or the geologic terms used were at times different than those commonly used in North America. For example, the Cuban source (Pushcharovsky and others, 1988) used the terms "aleurolite" (siltstone), "silicite" (chert), and "granosyenite" (quartz syenite?). Mapping style issues were also impactful. For example, map patterns appear to suggest thrust faulting is an important process, especially in Cuba, yet no thrust faults are indicated on the Cuban geologic map. During a field trip taken by some members of the project, the Cuban guides seemed to indicate that they did not map features seen by our project members as thrust faults. On many of the source maps, the nature of fault offset is not indicated, nor are cross-sections commonly presented.

At first glance, the Greater Antilles may appear to reflect the character of a magmatic arc; but represents multiple distinct features. Only in Cuba are there rocks of unquestioned Jurassic age, and perhaps older, rocks present. Ophiolite assemblages that may include rocks of Jurassic age are present in Cuba, Hispaniola, and Puerto Rico. Metamorphic assemblages on Hispaniola and Puerto Rico, contain rocks that may be of Jurassic age. Metamorphic rocks that have Cretaceous protoliths are more widespread, present in Cuba, Hispaniola, and the U.S. and British Virgin Islands. Cretaceous plutonic rocks are present in Cuba, Puerto Rico, and Dominican Republic. Gabbro and trondhjemite of inferred Early Cretaceous age are present in U.S. Virgin Islands. Cretaceous volcanic rocks are widespread in Cuba, Hispaniola, Puerto Rico, and Virgin Islands; they are of variable age and do not appear to reflect a single arc system; Cretaceous volcanic rocks are found in Jamaica in inliers on the eastern part of the island. Eocene volcanic rocks are prominent in southern Cuba, Haiti, eastern Jamaica, Puerto Rico, and Virgin Islands. Volcanic rocks possibly as young as early Miocene are present in southern Dominican Republic; the youngest volcanic rocks of the region are the Low Layton Lavas of Jamaica of late Miocene age and alkali basalt of Quaternary age on Hispaniola.

Carbonate rocks are an important component of the sedimentary section in the Greater Antilles, as old as Jurassic in Cuba and as young as Holocene in many areas. Early Cretaceous sedimentary rocks in Cuba tend to be dominantly limestone; volcanic clasts and debris are not present until the Late Cretaceous in Cuba, Jamaica, and Puerto Rico. In contrast, Early Cretaceous volcaniclastic sedimentary rocks are common in the Virgin Islands. Olistostrome deposits are commonly described in latest Cretaceous and Eocene rocks; in Paleocene and early Eocene these are commonly associated with tectonic mélange units. Volcanic debris and tuff are common in sedimentary rocks of Paleocene and Eocene age, often associated with carbonate rocks. Post Eocene sedimentary rocks are dominantly carbonate rocks or mixed clastic and carbonate rocks where the clastic component reflects erosion of earlier units, including older carbonate rocks. Rocks containing lignite are only present in Cuba and on Hispaniola and are generally of Miocene age.

The source maps tend to focus on sedimentary, and to a lesser extent, volcanic rock units. Few report radiometric ages on igneous rocks and particularly plutonic rock units. We compiled available radiometric age determinations and have tried to evaluate their quality and applicability to determining the age of rock units. We recalculated virtually all K/Ar ages to modern decay constants (Steiger and Jager, 1977). Many of the sources of radiometric data do not provide information on the decay constants used and we had to infer these, depending on the source. The few U/Pb dates are relatively modern and we assume they use modern and consistent constants. An additional and serious problem is that the sources frequently do not provide detailed sample descriptions or even rudimentary location information for the radiometric dates. Typically, the only location information is from a small non-registered graphic image. We have located sample sites as best as we can, but in some cases, these may only be within a few kilometers of the actual sample collection site. Analytically, several age determinations are suspect, due to exceedingly large analytical errors or use of inappropriate materials, for example, whole rock dates of coarse-grained plutonic rocks.



List of Map Units

Map Unit Database Structure