

NOTE ON THE GEOLOGY OF THE ISLES OF PROVIDENCIA AND SANTA CATALINA (Caribbean Sea, Colombia)

by

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RESUMEN.—Esta nota trata de las formaciones geológico-petrográficas de las islas volcánicas de Providencia y Santa Catalina. Se describen la facies fotogeológica y la constitución mineralógica de cada una de ellas y se discuten sus relaciones recíprocas.

ABSTRACT.—The geological formations of the volcanic islands of Providencia and Santa Catalina are briefly described. Their photogeological facies, mineralogical constitution and mutual relations are delineated.

RIASSUNTO.—Si descrivono brevemente le formazioni geologico-petrografiche delle isole vulcaniche di Providencia e Santa Catalina, indicandone facies fotogeologica, costituzione mineralogica e relazioni reciproche.

RESUME.—Nous donnons une description préliminaire de la constitution géologique et pétrographique des îles volcaniques de Providencia et Santa Catalina, en indiquant des différentes formations faciès photogéologique, composition minéralogique et relations mutuelles.

LOCATION

The island of Providencia is part of the Antillean Archipelago; like San Andrés, the other Colombian island, it is situated in front of the Nicaragua coast, about 250 Km from it. In respect to the Colombian territory, Providencia is located 740 Km from Cartagena, 750 from Barranquilla and 50 miles from San Andrés. It lies between the 13° 19' and 13° 24' North latitude and the 81° 21' and 81° 24' West longitude.

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Communications with Providencia are rather difficult. It is possible to reach San Andres by plane; in fact, being San Andres a free port, it has grown a considerable business town, and several air-lines with daily flights connect the island with the continent.

No regular service connects Providencia with San Andres. At the beginning of this year a private company organized a regular flight by means of a seaplane; two months later they discontinued the service, as the number of passengers wasn't sufficient to cover the expenses. The only means of conveyance are therefore the few boats which, occasionally and without any regularity, reach Providencia; when they do not happen to get lost and to be carried by streams towards the Nicaraguan coast; or they do not strand into the coral reefs, which are so abundant in that part of the Atlantic. It is also possible to arrange an express trip with the captain of some boat.

Ancient haunt of pirates, stronghold of captain Morgan, Providencia has a natural harbour (Bahia Catalina) with smooth waters and sheltered towards the north by the little island of Santa Catalina; from Santa Catalina captain Morgan's guns used to stop any hostile ship.

Providencia is about 15 square kilometers and from any point of it one can enjoy beautiful landscapes and unforgettable views of colours and lights.

The island is mountainous and very steep; only along the coast and close to it, mild slopes offer a ground where some kind of agriculture become possible.

The inhabitants are mainly the offspring of the ancient pirates. The negroes and the whites live together in a perfectly integrated community. The coloured people prevail in number over the white ones. They speak English, with a strong accent, and many of them Spanish. The English tradition is seen also in the architecture.

They live on fishing (abundant outside the coral reefs), agriculture and breeding; but most of them earn their living by working as sailors on ships of several countries.

They sincerely love their island and with sadness they tell the foreigner about the last hurricane which destroyed a great part of the orchards; in fact a very little has been left of the coco-nuts and mango-trees, sufficient anyway to give to the island its tropical geographical character.

Life on the island is very healthy, except for the presence of mosquitos, which fly in flocks when the wind is lacking. Water is abundant and the inhabitants can therefore breed cattle what they do with good results.

Most of the villages are localized near the coast and they are connected by means of a road which goes all around Providencia.

PREVIOUS WORKS

The literature on the geology of the island of Providencia is rather scarce; as far as we know the previous direct studies are those of A. SARMIENTO ALARCON and J. SANDOVAL (5) and E. HUBACH (2); all of them visited the island in different times.

R. QUINTERO published in 1960 a photogeological map (1:25,000) which had been worked out, we believe, on field data by SARMIENTO ALARCON and SANDOVAL and HUBACH. He cites a paper by MITCHELL (3) which we couldn't see directly. Anyhow we disagree with the interpretation and summary given by QUINTERO (4): "Los mismos movimientos tectónicos causaron en las Islas de Providencia y Santa Catalina la erupción de magmas de carácter predominantemente ácido. Según MITCHELL (1955; pp. 77-81) estas rocas se manifiestan actualmente como andesitas, basaltos, diabasas y essexitas (?). En ninguna de las islas se observan tobas volcánicas"; and farther: "Durante el post-Pleistoceno un nuevo levantamiento tuvo lugar y las plataformas pleistocénicas fueron convertidas en plataformas terrestres. Las rocas eruptivas de Providencia fueron intruídas por diques dioríticos de poco grosor y longitud"; and moreover, in the legend: "Rocas ígneas extrusivas... intruídas por diques post-Pleistocénicos en su mayoría verticales de rumbo general noroeste-sureste y de grosor y longitud aproximados de 0,90 m y 30 m respectivamente, compuestos de: diorita, cuarzo-diorita, cuarzo-diorita biotítica, cuarzo-diorita hornbléndica, cuarzo-diorita biotítico-hornbléndica".

Particulary interesting is the paper by A. SARMIENTO ALARCON and J. SANDOVAL (5) for their field observations: whereas the same paper is less valid where they give the petrographic description of the volcanic rocks that they had collected; A. SARMIENTO ALARCON and J. SANDOVAL have perfectly recognized the volcanic character of the island and their geologic map is also the first attempt to put on evidence the various stage of the volcanic process which originated it.

E. HUBACH (2) essentially agrees with A. SARMIENTO ALARCON and J. SANDOVAL and in his paper for the first time he points out the presence in the island of a main geological unit around which the others are arranged.

GEOMORPHOLOGY

Providencia has a roughly elliptical shape, with the main axis in the NNE-SSW direction.

As we will see farther, it is built by a ridge of massive lavas around which are arranged fluidal lavas and volcanic conglomerates. The massive lavas form steep, rugged mountains; the fluidal lavas and the conglomerates, on the other hand, build milder forms which gen-

ter slopes. Where no adventive cones are present, the area immediately near the shore is therefore relatively low, often developing swamps where the sea water penetrates during the light tide (e. g. the arc between Old Town and Free Town in the NW, or the Mar Bajo coast in the NE).

The isle of Santa Catalina was probably once linked to Providencia and later on, the block located where there is now the Bahia Catalina sank, and the two islands had therefore been separated; the sea water between the two islands is so shallow that it is possible during the low tide to cross the Aury channel (150 m wide) on horseback and that the cattle can be taken through without any difficulty.

Eastward a few volcanic reefs emerge over the sea level (e. g. Cayo Crab, Cayos Hermanos); and one mile outside the coast the main coral reef keeps the water inside the barrier very smooth; other isolated coral reefs exist between the main barrier and the island.

PHOTO GEOLOGY, PETROGRAPHY AND GEOLOGY

Schematically the geologic setting of the island of Providencia and of its naturale appendage, Santa Catalina, can be indicated as follows (from the inland towards the coast):

(1) Along the assial zone, with direction NNE-SSW, which forms the "backbone" of the island: massive lavas (andesitic-basalts and basalts).

(2) Outside (1), towards the south and the west: fluidal lavas, better developed on the western side.

(3) Conglomerates with volcanic elements and minor interbedded tuffs; especially on the north.

(4) Little adventive cones with andesitic lavas.

(5) Along the southern coast few coralline limestones.

(6) Beaches and bogs.

(7) Coral colonies settled on the volcanic platform (in the map they have been put together with the platform).

a) *Photogeology*

a-1) The massive lavas of zone (1) appear in the air photographs with sharp forms and symmetrical slopes; cone-shaped hills are also common. They are usually with abundant vegetation of low and medium-trunk.

a-2) The fluidal lavas appear in the air photographs with two characteristic photogeological facies: either they form mild hills, gently sloping towards the sea; or they show forms which are falt on

the top and are delimited along all or part of their perimeter by an escarpment (a typical case is the High South).

a-3) The conglomerates are easily recognizable in the air photographs because they form round reliefs and hills sloping on both sides and because of their lighter colour.

a-4) Those volcanic which we have called adventive under number (4), and whose geological meaning will be explained farther, can be recognized stereoscopically in the photographs because they show a high topographic relief and asymmetrical slopes; incidentally, only after the field work it is possible to realize that they are not vertical layered rocks as they seem to be in the photographs.

a-5) The coralline limestones cover a too small portion of the island to allow the definition of their photogeologic facies.

a-6) The coralline colonies are always easily recognizable in the air photographs as they have lighter colour than the sea-water and for the presence of sea-foam near them caused by the breaking of the waves on them. (Note that in the map enclosed in this paper, we have followed the delimitation of the coralline colonies as given

by R. QUINTERO (4) and H. C. RAASVELDT (2).

b) Petrography

b1)-The central lavas have dark colour and are always very compact. The most common lithologic type is a basalt containing andesine and with a porphyric structure due to the presence of phenocrysts of plagioclase (andesine), piroxene and amphibole (less abundant) in a groundmass essentially composed by microlites of plagioclase with little olivine usually chloritized. (The phenocrysts of plagioclase have albite or albite-Karlsbad twinning and are clearly zoned; the core is usually more basic than the outer zone and contains abundant impurities carried outwards as the crystal grew; the outer zone is clear. They have often been fractured and the parts displaced in the groundmass).

Less common lithologic types are: basalts with hyalopilitic texture, with small grains of piroxene and amphibole on the groundmass (plagioclastic); and basalts with pilotaxitic texture due to the almost complete disappearance of the minerals of the first generation.

b-2) The fluidal lavas of the west and south coasts are light coloured, pinkish or whitish; the fluidal texture which can be seen macroscopically is due to an alternation of small layers and flames of different colours and compactness. Under the microscope they show a trachytic-pilotaxitic texture; in the vitreous groundmass, variable in quantity, only a thick felt of plagioclastic microlites and few elongated crystals of biotite are present.

They can be classified at least preliminarily as trachyandesites.

b-3) The volcanic conglomerates are made of fragments of rocks of the group (1) in a finer matrix, of volcanic nature as well, but

with lighter colour; they contain thin intercalations of whitish tuffs. The blocks are of different size: from almost one meter down to few centimeters (5-10) as maximum diameter. The largest blocks are more abundant toward the bottom of the formation.

b-4) The last stage of the volcanic activity originated andesitic rocks which are found to form little cones in the island of Providencia and practically the whole island of Santa Catalina.

The formation includes the following facies (all of them are clearly extrusive):

- Reddish lavas, more or less porphyric, practically holocrystalline
- Red and brown vesicular, slaggish lavas, often hematitic
- Vitreous stratified lavas, of various colours
- Columnar lavas

In the porphyric facies which are better crystallized, the phenocrysts (twinned, zoned plagioclases, andesinic on the average) stand out on the plagioclasic microlites of second generation; in these facies the association piroxene + amphibole, typical of the ridge basalts, has been substituted by the one amphibole + biotite, the former being found only as microlites and the latter often well developed.

c) *Geology*

According to our studies, the geological history of the island, that is essentially the history of the volcanism which created it, can be synthesized in the following chronological sequence:

c-1) Eruption of submarine lavas along a tectonic fissure, which produced a submarine ridge.

c-2) Tilting and lifting of the ridge, or (of part of it); the elevation caused a strong erosive activity with subsequent sedimentation of the volcanic conglomerates (which represent in fact submarine rock-slides), and accompanied by deposition of tuffs.

c-3) Extrusion of lavas, mainly above the sea level.

c-4) Resumption of the volcanic activity with birth of adventive cones and extrusion of lavas more acid than the earlier ones.

c-5) A new tectonic activity in the island, with vertical movements of blocks (lifting of the horst of El Pico; parting of Santa Catalina from Providencia).

c-6) Birth of the coralline colonies, around the island and on the volcanic platform nearby.

Discussion and conclusion

We do not have precise data on the geological age of the island. However we think that the current idea according to which the island originated during the Tertiary, is acceptable.

And we think that, as far as the structural history is concerned, the hypothesis of H. BUERGL (1) for the island of San Andrés could be accepted and applied to Providencia (see c-1, c-2, c-5); that is:

1st stage	preliocenic	c-1
2nd stage	prepleistocenic	c-2
3rd stage	postpleistocenic	c-5

With regard to the idea of E. HUBACH (2) on the possibility of a connection between the Andes Central Cordillera and the North-American Cordilleras through these islands, idea yet criticized by H. BUERGL (1), we think that the criticism is fully well founded.

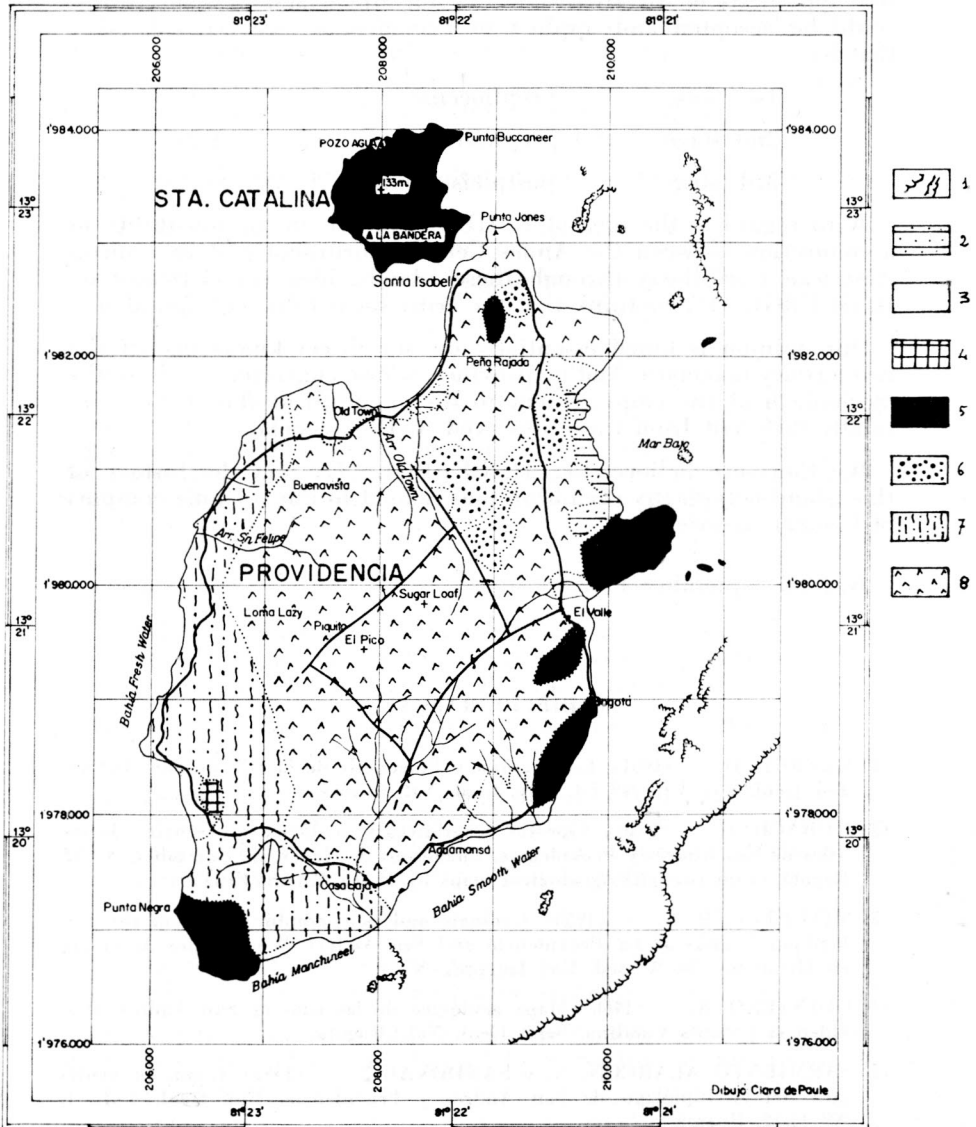
Our opinion is based essentially on our direct knowledge of the neo-tertiary magmatic Andine province, whose characteres—from the mechanism of the emplacement to the chemism of the rocks—are totally different from those observed in Providencia.

We therefore believe, like H. BUERGL (1), that the history of this island is typically caribbean and related to the volcanic complex of Central America.

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BIBLIOGRAPHY

- (1) BUERGL, H. — (1961) Estratigrafía y litogénesis de la Isla de San Andrés. Bol. Geol. Vol. VII, N° 1-3, Serv. Geol. Nal. Bogotá.
- (2) HUBACH, E. — (1956) Aspectos geográficos y geológicos y recursos de las islas de San Andrés y Providencia. Cuadernos de Geogr. de Colombia. N° 12 Bogotá (with two photogeological maps by H. C. RAASVELDT).
- (3) MITCHELL, R. C. — (1955) Geologic and petrographic notes on the Colombian Islands of La Providencia and San Andrés. West Indies. Geologie en Mijnbouw, N. W. sed. 17e, Jaargang N° 3.
- (4) QUINTERO, R. — (1960) Mapa geológico de las islas de San Andrés, Providencia y Santa Catalina. Serv. Geol. Nal., Bogotá.
- (5) SARMIENTO ALARCON, A. y SANDOVAL J. — (1953) Comisión geológica del Archipiélago de San Andrés y Providencia. Bol. Geol. Vol. 1, N° 11-12, Bogotá.



PHOTOGEOLOGICAL MAP OF ISLANDS OF PROVIDENCIA AND SANTA CATALINA (CARIBBEAN SEA, COLOMBIA).

1 - Coral colonies; 2 - Swamps; 3 - Beaches; 4 - Coralline limestone; 5 - Adventive cones with andesitic lavas; 6 - Volcanic conglomerates with interbedded tuffs; 7 - Fluidal lavas; 8 - Massive lavas (andesitic-basaltic and basaltic); Scale: 1:66,000.

(Elaborated by L. Radelli in the Servicio Geológico Nacional and published with their authorization).