

GEOLOGICAL OBSERVATIONS ON ISLA DE LA PLATA, ECUADOR, SOUTH AMERICA.

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INTRODUCTION.

Isla de la Plata is situated in the Pacific Ocean, about fifteen miles from the mainland of Ecuador, and almost due west of the settlement of Callo. According to Wolf,¹ the island is five and one-half kilometres long and two kilometres broad at its widest part. Its area is probably about fourteen square kilometres.

Little has been written upon the general geologic and topographic features of the island though it is believed that it has been visited from time to time by various expeditions primarily interested either in natural history or in antiquarian research. During the hydrographic survey carried out by the British Admiralty in or about the year 1846 the island was correctly charted for navigation purposes. It must have been well known to mariners prior to this date, however, as here it was that Sir Francis Drake chased ashore the Spanish galleon *Cacafuega* during one of his piratical enterprises several hundred years ago.

For the most part the coastline of the island is rocky and precipitous and for this reason it is possible to make a landing at one point only, this being on the eastern side a few hundred yards to the south of the navigation light. The landing place itself is actually a small sandy beach (leading inland to a ravine) measuring not more than 100 yards in length. Between the mainland and Isla de la Plata the depth of the water exceeds twenty-two fathoms at but few points, yet near the western coast of the island the ocean deepens rapidly, as is the case at La Puntilla, the most westerly point of the mainland of Ecuador, directly to the south.

TOPOGRAPHY.

Two distinct topographic features can be recognized in the island, the highland area, dissected towards the east by deep gorges, and the elevated wave-cut benches which, as will be described later, were developed in post-Tertiary times.

¹ Wolf, T., *Geografia y Geologia del Ecuador*, 1892.

To the east of the principal divide of the island a series of short, deep valleys diverge and persist to the coastline. The curious truncated effect of these river gorges suggests that they are the remnants of much longer courses which existed in Quaternary times when the island itself probably formed part of the mainland of Ecuador. The eastern side of the island is the more precipitous and from the hill upon which the lighthouse is built the northern limit of the island can be observed as a steep cliff which descends sheer to the sea at a high angle. Towards the west, that is, immediately beyond the main divide, the topography is less rugged and shows evidence of marine erosion antedating the deposition of the raised beaches or "tablazos,"² seen also on the neighboring coast of the continent, which are of Quaternary age.

A remarkable topographic feature of the shore line is a wave-cut rock bench at about mean tide level. Several older wave-cut benches, emphasized by the presence of tablazo or beach deposits of marine origin, may be observed at higher levels in the interior of the island. In approaching the island from the east, one of these raised beaches is recognized as a distinct horizontal line along the cliffs at an elevation of about one hundred feet above sea level.

GEOLOGY.

The following formations have been identified upon Isla de la Plata:

Quaternary, three distinct tablazos (marine beaches) at elevations approximately 100, 500 and 740 feet above sea level.

Tertiary, represented only by indurated shale and rolled masses of chert.

Igneous (post Tertiary), dark grey, fine-grained volcanic rock.

Quaternary deposits. The Quaternary deposits, known as tablazos, are well developed on the island and at least three have been identified resting upon bevelled surfaces of the underlying volcanic rock (Fig. 1). Each tablazo, therefore,

² Bosworth, T. O., *The Geology and Paleontology of N. W. Peru*, 1922.

Sheppard, G., *Relation of Volcanic dikes to the Oil-bearing Formations of Southern Ecuador*, *Econ. Geol.*, 21, 70-80, 1926.

Sinclair, J. H., and Berkey, C. P., *Cherts and Igneous Rocks of the Santa Elena Oilfield, Ecuador*, *Trans. Am. Inst. Min. Eng.*, 69, 79, 1924.

represents a successive uplift of the land area, the oldest occurring on the highest elevation of the present island. These tablazos rarely exceed a thickness of more than fifteen feet though it is possible that, since their original deposition, a considerable amount has been removed by erosion. As a rule the raised beaches are composed of typical shore or shallow



Fig. 1. Generalized Section across Isla de la Plata, Ecuador, S. A.
A, B and C. Respective Tablazo Terraces. (Quaternary.)

bay material. In addition to the usual types of marine shells and similar littoral debris, large quantities of rolled basaltic pebbles are present, a fact in itself which indicates the past marine denudation of the land surface. It is of interest to note that even at the present time the same process of littoral deposition is in operation along the shores of the island with the result that tablazo formations of Recent age are being accumulated.

The most conspicuous tablazo terrace covers a considerable area of the western side of the island (Fig. 2) and extends as a low, flat plateau for a considerable distance from the lower slopes of the hills to the western coastline. Here the cliffs have an average altitude of a hundred feet, and the levelled surfaces of volcanic rock are covered by about ten feet of irregularly bedded tablazo deposits. This tablazo forms a marked feature in the topography as it can be followed around most of the island. As referred to above, it can be recognized as a thin, horizontal line on the cliffs to the east of the island. This line no doubt represents the raised beach "trace" which had been left after the regional denudation of the land between the present island and the mainland had been accomplished.

Two other tablazo levels can be observed, the first at 500 feet and the second at about 740 feet, the latter forming the highest point of the island (Fig. 3). In each case typical tablazo material occurs *in situ*, and the pre-tablazo erosion surfaces can be recognized as conspicuous tablelands.

Tertiary. Very little evidence of undoubted Tertiary is found on the island and although Tertiary formations must have been present originally, surrounding the main igneous mass which now forms the island proper, they have since been



Fig. 2. West coast of Island showing tablazo level.

removed by erosion. Loose and denuded material, however, in the form of indurated shales and siliceous cherts are common, the latter being satisfactory evidence of the existence of Tertiary strata which, at the end of Quaternary time, formed part of the island. These cherts and indurated shales are associated with post-Tertiary dikes on the mainland and hence it can be assumed that they probably formed part of



Fig. 3. Highest level of Isla de la Plata showing small peneplane due to Quaternary tablazo.

the same series of Tertiary deposits. Owing to their lithologic nature they have been preserved as the only remnants of the once widespread Tertiary sediments.

Igneous rocks. The greater part of the island consists of a dark grey, fine-grained volcanic rock having the general appearance of a basalt or an andesite. For the most part the rock is altered, thus giving rise to chloritic and allied decomposition products. The whole mass, however, is characterized by the presence of small, irregularly shaped fragments of hard, unaltered vitreous rock. From the general appearance of the intrusion, and from the comparative study of similar phenomena in the same geologic area, on the mainland to the east, it may be assumed that after the initial intrusion differential movement occurred prior to final consolidation. Megascopically this rock is similar to that occurring at Punta San Lorenzo, twenty miles or so to the northeast of Isla de la Plata.

GEOLOGICAL HISTORY.

The geologic history of La Plata as an island dates from near the close of the Quaternary. During Quaternary time at least three tablazos were formed, and while these phases of sedimentation were in progress the island formed an integral part, I believe, of the mainland of Ecuador. The subsequent separation which took place, therefore, must have occurred within comparatively recent times. The close of the Tertiary period was marked by a gradual tectonic uplift which involved the littoral, or coast-belt, of both Ecuador and Peru, this probably being the consequence of a major movement initiated from the axis of the main Andean upthrust. The coastal region of Ecuador had no doubt a much greater westerly extension than obtains at the present time; it must have persisted beyond the present Isla de la Plata and probably included the area now known as the Gulf of Guayaquil. Hence it formed a northerly continuation of the Peruvian littoral.

During the Quaternary period the Tertiary coast belt began to be slowly uplifted and this manifested itself in at least three successive stages which are indicated at the present time by the respective tablazos. The oldest, and as a consequence, the present highest tablazo was probably laid down at the beginning of the Quaternary, and the lowest, namely that occurring along the cliffs at a height of about one hundred feet above

sea level; represents the final stage of sedimentation of the same period.

The tectonic instability of the coast belt is still a feature of western Ecuador as, from the evidence afforded by the recent raised beaches, and the additional presence of truncated valleys, it is certain that this part of the country is still being uplifted. Contemporaneous and equivalent tablazo terraces have been investigated on the adjacent mainland and occur chiefly in the northern part of the province of Manabi and in the neighborhood of the Santa Elena peninsula.

Finally, it is of interest to consider by what geological processes the separation of the island from the mainland has been accomplished since the close of Quaternary times. In the first place the greater part of the island consists of a hard volcanic rock, this, in itself, being almost sufficient to account for its preservation at the present time. In this connection it may be noted that the more prominent headlands of southern Ecuador owe their existence to the fact that they are invariably composed of volcanic rock with indurated sedimentaries very similar to the type occurring on La Plata. Punta San Lorenzo, Punta Callo and Punta Santa Elena are cases in point where the more easily eroded Tertiaries have been removed by marine erosion, thus leaving the above-mentioned promontories as outstanding features of the coastal topography.

It has been observed further that the Tertiary strata of coastal Ecuador have been considerably dislocated by a series of earth movements which were initiated at the end of the Tertiary period, continued through the Quaternary, and are possibly in operation at the present time. The Tertiary formations are thus disposed in irregular faulted masses which are undoubtedly the result of crustal oscillation. It is reasonable to assume, therefore, that a zone of dislocation may have occurred between the Isla de la Plata and the mainland and thus may have been the medium for the separation in the first instance.

The deep river gorges or truncated valleys which characterize the topography of the island have considerable significance and give some idea regarding the enormous amount of sub-aerial denudation, with the consequent initiation of large river systems, which was undoubtedly accomplished after the close of the Quaternary period. The valley remnants of the island

represent the only evidence at the present time of a large and widely distributed river system which probably flowed over the area now submerged between La Plata and the mainland, and drained an enormous territory. The larger gorges occurring on the island head to the east and have been eroded out of hard volcanic rock to a depth from 300 to 500 feet. In order to account for the presence of these valleys it must be assumed that they drained a much greater area (probably a westward extension of the present island), and, in addition, the climate must have been excessively humid at this period. On the mainland the principal valleys present identical features to those described above, and hence it is possible that the original rivers of these gorges formed the westerly flowing tributaries of the main stream, being complementary to those of the La Plata region.

Whatever factors, however, have been concerned in the history of this chapter in the geology of Ecuador, it is noteworthy that the greater part of the interesting geomorphological development of the island has taken place since the close of the Quaternary period.

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