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The Tuff Series in Cuba

by Dr. PIERRE BUTTICAZ, Geologist

Abstract

The considerable thickness of 26 000 feet attributed to the Tuff Series in the early reports had prevented any important drilling programs in Southern Cuba. In 1951 and 1952, geological and geophysical studies in the area corrected this original opinion and pointed to the fact that such thickness of 26 000 feet is probably three times the actual one. From a further study of source and reservoir rocks it was concluded that important oil accumulations may be found in the southern basins of Cuba, and as actually the thickness of the Tuff Series dœs no more seem too considerable, important drillings will start imminently.

A general description of the Tuff Series is given graphically in the enclosed plate and in the following text.

Introduction

No important economical results have been obtained by the explorations conducted up to the present, in spite of the numerous hydrocarbon seeps scattered all over the six provinces of Cuba, of the small production of the three Cuban Oil fields (Bacuranao, total production 150 000 barrels; Motembo, total production 1 000 000 barrels; Jarahueca, total production 800 000 barrels; situated in the serpentine and drilled near oil seeps) and after more than twenty years of sporadic and disconnected studies carried out by the major Oil Companies.

The main argument which has discouraged more intensive drilling operations in Cuba is the widespread occurrence of the igneous and pyroclastic rocks of the Tuff Series, which are encountered as well on the surface as in many drillings.

The extension of the Tuff Series is put in the limelight in the enclosed plate which contains a map of Cuba, one strike profile and seven cross profiles.

On the other hand, the following description of the wells drilled in Cuba, shows equally the importance of the Tuff Series. There are only three wells of little more than 10 000 feet: two of them in the heavily folded and faulted limestones of lower Cretaceous of the northern coast, the third one, which for the last 6 245 feet remained in the Tuff Series, did not penetrate this formation. Five wells are more than 5 000 feet deep: fifteen more than 3 000 feet; seven more than 2 000 feet and ten more than 1 000 feet, not to mention the shallow wells of Barucanao (over 60), Motembo (over 1050) and Jarahueca (over 450) oil fields. Below is a list of these wells, with the thicknesses of the Tuff Series pierced:

CUBAN WELLS

More than 10 000'	Total Depth	Formation
1. H 1 Shell	10 035'	3,790—10 035' in *the Tuff Series*
2. LV 2 Gulf	11 018'	all in dolomite.
3. C 2 Shell	10 563'	probably in lower Cretaceous.

More than 5 000'

1. PR 4 Standard N.J.	8 605'	Miocene-Paleocene
2. H 2 Shell	5 770'	Igneous (Diabase)
3. M 11 Gulf	5 045'	upper Miocene-lower Cretaceous
4. M 9 Atlantic	5 263'	3,875'—5 263' in *the Tuff Series*
5. M 8 Atlantic	6 070'	3 915'—6 070' in *the Tuff Series*

More than 3 000'

1. PR 1 Standard N.J.	3 147'	probably Igneous
2. PR 2 Standard N.J.	3 441'	2 600'—3 441' in *the Tuff Series*
3. PR 3 Standard N.J.	3 223'	2 800'—3 223' in *the Tuff Series*
4. PR 5 Standard N.J.	4 080'	Miocene-lower Oligocene
5. PR 7 Atlantic	3 500'	upper Cretaceous
6. PR 9 Rosario	4 015'	in *the Tuff Series*
7. PR 10 Rosario	3 161'	in *the Tuff Series*
8. H 3 Atlantic	3 288'	(1 280'—1 550' in *the Tuff Series* (1 550'—3 288' serpentine

	Total Depth	**Formation**
9. H. 8 Shell	3 685'	probably lower Cretaceous
10. M 6 Atlantic	4 104'	100'—4 104' in *the Tuff Series*
11. M 7 Atlantic	4 018'	tectonic intercalations of Aptychus limestone with the *Tuff Series*
12. M 10 Shell	4 018'	3 800'—4 000' in *the Tuff Series*
13. LV 1 Atlantic	4 034'	upper Cretaceous
14. C 3 Shell	4 277'	probably lower Cretaceous
15. C 5 Shell	4 646'	probably lower Cretaceous

More than 2 000'

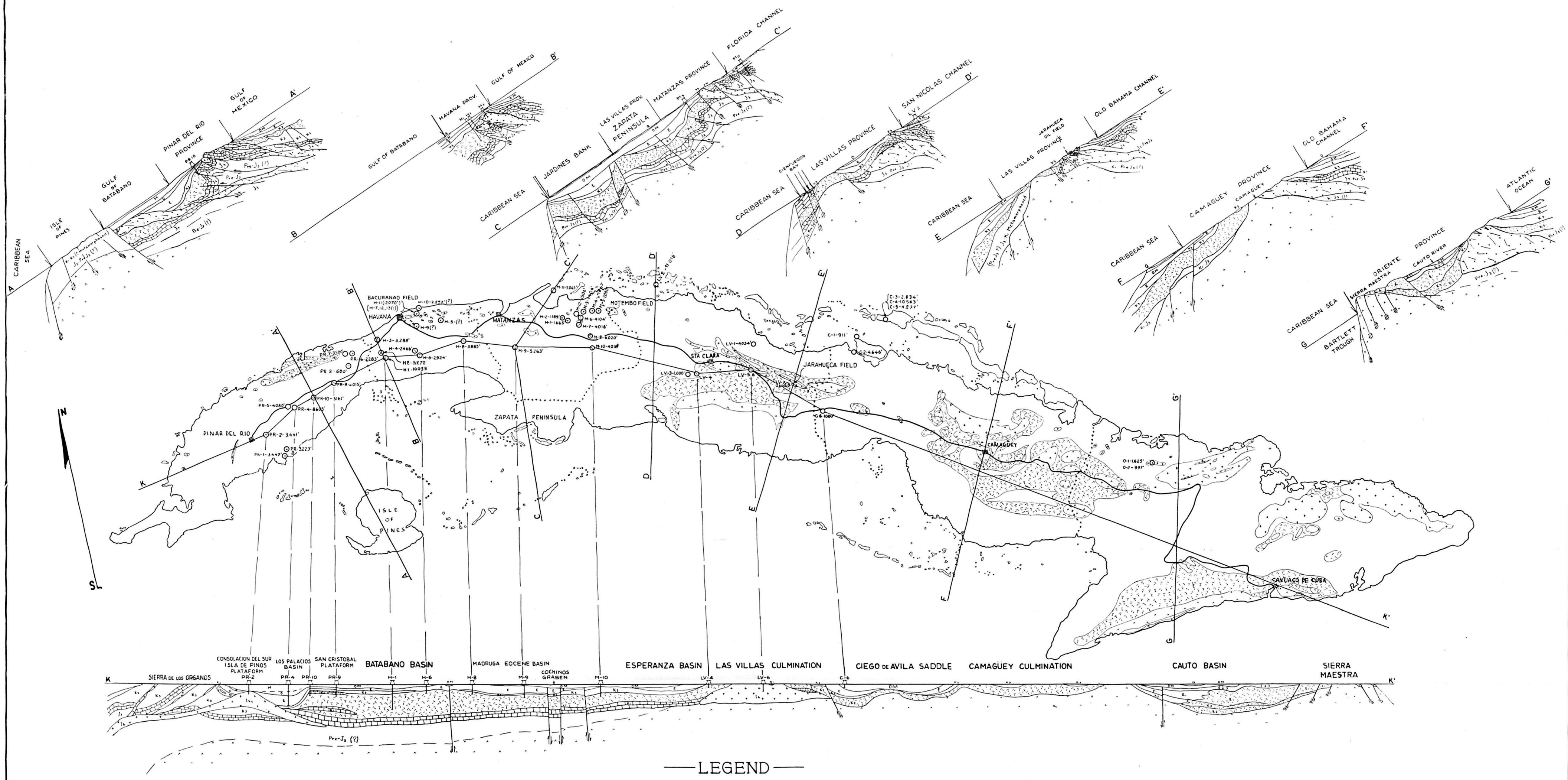
1. PR 6 Atlantic	2 283'	265'—2 283' Igneous
2. H 4 Shell	2 466'	1 540'—2 466 in *the Tuff Series*
3. H 6 Shell	2 964'	2 420—2 924' in *the Tuff Series*
4. H 10 T. Bess	2 257'	probably serpentine
5. M 5 Standard N.J.	2 080'	serpentine
6. C 1 Shell	2 834'	probably lower Cretaceous
7. LV 7 Private Group	2 600'	in *the Tuff Series*

More than 1 000'

1. M 3 Standard N.J.	1 404'	235'—404' in serpentine
2. M 4 Standard N.J.	1 867'	1 560'—2 100' in serpentine
3. M 2 Standard N.J.	1 389'	1 000'—1 389' in serpentine
4. M 1 Standard N.J.	1 665'	830'—1 665' in serpentine
5. M 12 Cuban Oil Co.	1 506'	Pleistocene-Eocene
6. LV 4 Cia. Federal S.A.	1 000'	Eocene
7. LV 4 Cia. Federal S.A.	1 000'	in *the Tuff Series*
8. LV Potrerillo	1 000'	in *the Tuff Series*
9. C 6 G.E.C.	1 000'	upper Oligocene-middle Oligocene
10. Private Group	1 625'	serpentine

TUFF FORMATION THROUGHOUT CUBA WITH RELATIONS TO SEDIMENTARY AND IGNEOUS ROCKS

By **Dr. Pierre Butticaz**



LEGEND

Q QUATERNARY	E EOCENE	CRETACEOUS TUFF	ACID IGNEOUS
M MIOCENE	EOCENE TUFF	J_3 UPPER JURASSIC	WELL WITH TUFF
O OLIGOCENE	K_3 UPPER CRETACEOUS	Pre J_3 PRE UPPER JURASSIC (?)	WELL WITH SERPENTINE
OM OLIGO MIOCENE	LOWER CRETACEOUS (APTICHI LIMESTONE)	BASIC IGNEOUS	WELL WITHOUT TUFF OR SERPENTINE

HOR. SCALE 0 50 100 150 200 km

VERT. SCALE 3 6 9 12 15 km

Description of the Tuff Series

The Tuffs vary from coarse, somewhat brecciated, with fragments of porphyrites and phenocrysts to finer grained crystal-tuff and glass tuffs. Due to changes of the volcanic activity as well as of the direction of the winds, the sedimentation of the products of volcanic origin shows considerable variations, ranging from real pyroclastic sediments to pure limestone, sandstones or shales, the last ones, intercalated with the pyroclastic rocks and sedimented during the periods of volcanic inactiv Between these two types of sediment all intermediary kinds of tuffaceous limestone, tuffaceous sandstone, and tuffaceous shale are observed.

Numerous lava flows have been deposited between the pyroclastic and sedimentary rocks, and at the same time they have been intruded by volcanic dikes.

The Tuff Series which comprises mostly green or greenish rocks, frequently alterated in a brownish color, is easily recognized in the field. It is often difficult to distinguish the pyroclastic from the igneous, if the decomposition has reached an advanced stage.

The fine tuffs are well bedded and resist weathering: they often carry abundant radiolaria which get silicified, thus grading towards chert. The coarse tuffs, which have little cement appear brecciated, with poor bedding; the feldpars undergo chloritization, zoisitization and sericitization; the pyroxenes undergo urolitization and chloritization; some calcification is generally present.

The limestone, shale and sandstone beds form lenses from a few feet to several thousand feet thick; fossils indicate a marine origin.

The igneous rocks consist of alterated andesite and diabase sills generally forming ridges; between these harder rocks occur low valleys consisting of tuffaceous shales and sandstones. The tuffaceous material is often intersected by aplitic dikes.

Age and Extent of Volcanism in Cuba

Insufficient field work and paleontological studies have resulted in a lack of definition of time boundaries and an improper dating of sediments. Without these necessary studies to ascertain wether or not a grouping should be in a vertical or horizontal time column, erroneous age and thickness have been assigned to the Tuff Series. Thus it was assumed in Cuba that volcanic activity extended through geologic time, ranging from Pre-Jurassic to Middle Eocene and it was referred to an immense thickness of 26 000 feet for the Tuff Series. Sections measured in different localities may have been added vertically whereas they were horizontally equivalent.

During three and a half years of field work in Cuba the writer had the opportunity to study the most typical localities of the Tuff Series in the six provinces. This series in several places is clearly lying unconformably above the Aptychus limestone of lower Cretaceous age; the Aptychus limestone dœs not contain tuffaceous material. The beginning of the volcanic activity could definitely be placed in the Cenomanian and tuffaceous material was extensively deposited through the Coniacian to the upper Campanian. The volcanic activity progressed eastward during the late Cretaceous and early Tertiary. Field observations have brought out that such volcanic activity died down in late Cretaceous in western Cuba, continued intermittently and feebly as high as lower Eocene in Central Cuba and reached its maximum in Oriente Province, where important tuffaceous sediments are still found in the Cobre Formation of lower Eocene age.

Careful observations of the best sections indicated that the Tuff Series has been subjected to strong deformations and igneous intrusions. Very tight folding, numerous fault and overthrusts have produced series of blocks, in which isoclinal beds generally present a strong dip. Repetitions of the same beds can be observed in several places, but as there are no characteristic leves and few fossils, it is very difficult to extend these observations and to calculate exactly the total thickness of this Series. As brought out in our field work the maximum thickness measured in the field is 7 500 feet.

Causes of Volcanism

To explain the volcanic activity in Cuba, it is necessary to have an over-all picture of the structural and anomalous gravity trends of the entire Caribbean area. A large gravity minimum, in excess of 150 milligals, extends along the whole northern coast of Cuba; to the east it extends to Santo Domingo, Puerto Rico, then south across the Barbuda Antigua to Trinidad and westward to Panama. These large negative anomalies represent areas in an active state of tectonics, corresponding to what is referred to as a tectogene; the downbuckling in this tectogene may be as deep as 60 km. As the downbuckling occurred, the sediments to either side were dragged into the downbuckle, the earth crust was intensively faulted and at the same time in Cuba the serpentinized Peridotite, which is observed all along northern Cuba, was intruded and also the oil which had accumulated during the lower Cretaceous time was allowed to escape through the fractures, producing the large amount of hydrocarbon seepages of Cuba.

According to one theory, it is assumed that the source of the volcanism accompanying this downbuckling is approyimately situated 100 miles away on the concave side of the arc. Since the axis of the tectogene passes through the northern part of the island, the axis of the volcanism would pass through the Isle of Pines and roughly be parallel to the axis of the tectogene.

It is interesting to note that in the East Indies it is there where the large negative belt terminates in a lesser negative area, that the large oil fields of West Java and Sumatra are located. The broad areas generally characterized by open faulting and in many cases by great thicknesses of sediments occur in the geosynclinal areas adjacent to the axis of the tectogene. This theory puts southern Cuba and its islandshelf in a most favourable position fort the possible accumulation ob oil, but also in an area where the Tuff formation extends broadly.

The Tuff Series and actual oil prospects in Cuba

Geological exploration work indicates that important source, reservoir and cap rocks may be found in the southern basins of Cuba. Geophysical data obtained by gravimeter and magnetometer indicate that all types of anomalies associated with oil production in other areas of the Gulf coast exist in southern Cuba. It is believed that sufficient geological and geophysical information is available to warrant test holes to confirm the geology and the geophysics in this sector.

The scarecrow which until now delayed the undertaking of important drilling programs in the southern basins of Cuba was the opinion that any drilling would have to cross an immense thickness of the Tuff Series.

During 1951 and 1952, new geological studies corroborated by new geophysical results indicated that the general conditions for oil accumulation are favourable and that the thickness of the Tuff Series is far less important than was believed previously; consequently oil companies are ready to start new important drilling programs.

The next logical step in the development of these areas is to drill the most favourable geophysical anomalies. The first drilling location is actually already chosen and operations will start imminently.