Some Comments on the Geology of the Caribbean Region

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INTRODUCTION

The purpose of these comments is to encourage a dialogue by presenting some thoughts after reading the papers on the Caribbean in the Colloquium C5 "Geology of the Alpine chains born of the Thethys", 26th International Geological Congress, Paris, 1980. It is not a review, just a few ideas on selected subjects are written down. Therefore, the list of references is kept at a minimum and only a few publications will be mentioned. I refer to the articles submitted at the Colloquium for a complete bibliography.

SOUTHERN BOUNDARY OF CARIBBEAN PLATE

Molnar and Sykes (1969) show the southern boundary of the Caribbean plate in their Figure 1, by a solid line parallel to the right-lateral el Pilar Fault and its western extension. In central Falcón this solid line is interrupted, and a broken line swings towards the southwest across lake Maracaibo into Colombia. There is a triple junction in Colombia and from this junction a broken line connects with the triple junction in the Middle America arc near Panama. Molnar and Sykes (1969, p. 1642) remark:

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"The tectonic boundary of the Caribbean plate on the southwest in northwestern South America is not well defined".

However, the surface geology of Colombia and Venezuela has been studied intensively and the southern boundary of the Caribbean plate is well established: it follows the El Pilar Fault and its extension to the west, then connects with the Oca Fault and, northwest of the Sierra Nevada de Santa Marta, curves gently to join the triple junction of the Cocos, Nazca and Caribbean plates near Panama. In relation to the concept of rigid-plate motions (Molnar and Sykes, 1969), it is significant that the southern boundary of the Caribbean plate is more or less parallel to the northern one.

It should be emphasized here that Molnar and Sykes never showed on any illustration or suggested in the text that the southern boundary of the Caribbean Plate follows the Boconó Fault.

EMPLACEMENT OF ULTRAMAFIC ROCKS

Bird and Dewey (1970) summed up the current views on the origin and emplacement of the ophiolite suite by emphasizing "that the only viable mechanism is by plate generation at oceanic ridges. If this is so ophiolite emplacement in orogenic belts along consuming plate margins, is essentially cold and mechanical and at a considerable time after generation."

Several excellent descriptions of the mode of occurrence of Venezuelan ophiolites (see for instance Bellizzia and others, 1972) have been published. Notwithstanding that many years ago it was shown that the ultramafic rocks occurring in narrow shear zones so characteristic for deeply eroded orogenic belts were mechanically emplaced, some geologists still publish papers in which those ultramafic rocks are described as igneous intrusions.

A typical example is the Peridotite of Tinaquillo which recently was still referred to as a slab-like intrustion or a sill, at least 3000 m thick. This concept of a slab-like intrusion is based on a serious misrepresentation of the relationship in the field. In outcrop the ultramafic rocks are seen to be intensely fractured, mylonitized and separated by a network of slickensided shears into blocks of a few cubic metres to less than one cubic metre. To describe the Tinaquillo ultramafic rocks as "stratiforme" (Stephan and others, 1980, p.50) is highly misleading. The reported thickness of 3 km for this Tinaquillo ultramafic body is speculative.

ROTATION OF MINOR CRUSTAL BLOCKS OR FRAGMENTS OF CRUSTAL BLOCKS AND THRUST SHEETS (NAPPES).

The continental crustal fragments represented by the Greater Antilles and the non-volcanic Lesser Antilles, which are arranged in the form of garlands along the northern and southern boundary of the Caribbean Plate of

today suggest stone garlands produced by solifluction. Of course, the processes of formation and the scales are different. But as with the rock boulders of the stone garlands the crustal fragments of the Antilles were shoved away from the "pressure centre" in the central Caribbean and passively carried, in a rotating motion, into the shear zones bordering the Caribbean Plate to the north and south.

Since Carey's study (1958) it was obvious that the Greater Antilles, the fragments of continental crust in the shear zone along the northern margin of the Caribbean Plate, rotated anticlockwise, and that the smaller continental crustal fragments of the Lesser Antilles rotated clockwise. Based on this knowledge reconstructions were proposed by Carey (1958) and Rod (1967).

Recent paleomagnetic studies have fully confirmed the postulated tectonic rotations of a few crustal blocks. New results and a succinct regional compilation map of reported paleomagnetic data from the Cretaceous and Paleocene rocks from the Caribbean area are presented by Skerlec and Hargraves (1980, Figure 11).

However, the reassembly of the continents in the interpretation of Rod (1967) is based on a Pangea A-type reconstruction, which has the main characteristics of Wegener's (1924) configuration but seems to be valid only for a relatively short time interval during the Early

Jurassic (Irving, 1977; Morel and Irving, 1981). Rod's (1967) interpretation for the close of the Carboniferous will have to be corrected and modified to fit Irving's Pangea B reconstruction (Irving, 1977; Morel and Irving, 1981).

During the Late Paleozoic and Early Mesozoic those fragments were a portion of a continuous orogenic belt, the southern continuation of the Appalachians, which connected with the Andes of Western Colombia, or, if Pangea B is accepted, the southeastern zone of the Appalachian orogenic belt. Carey (1958) called this belt the "Colombian-Appalachian Orogen".

Bird and Dewey (1970) also mention this extension of the Appalachian/Caledonian orogen. As the maximum expansion of the Appalachian Atlantic was during Early Ordovician time, and as the Ordovician deposits are well documented in Venezuela (Caparo and Mireles Formations), a study of the Colombian-Appalachian orogen beginning with Ordovician time is suggested.

When the separation of the North American Plate from the African Plate started in Middle Jurassic time, the opening of the Central Atlantic was accommodated by a wide shear zone along the southern boundary of the North American Plate in contact with the South American Plate. This shear zone consisted of a system of major left-lateral strike-slip faults incorporating several large wedges of

continental crust broken off from the southernmost part of the North American Plate.

Initially those fragments, which later became the Greater Antilles, Lesser Antilles and some of the thrust sheets in the Caribbean Mountains, or which were joined to the main mass of the South American Plate (Guajira, Paraguaná), were clustered, keeping their original relationship.

Any paleogeologic reconstruction of the Caribbean area which ignores the very considerable translations and rotations of the crustal fragments and thrust sheets in the Caribbean Mountains and shows those fragments and thrust sheets in more or less the same position through the ages, is therefore not valid.

Carey (1958) has discussed how the fragments of continental crust, now floating in the shear zones which border the Caribbean Plate, could be reassembled. Many additional clues on the original configuration of the orogenic belt which started to be dismembered when the Central Atlantic opened, are provided by the results of recent studies in stratigraphy and sedimentation. Dickey (1980) and Poole and Barker (1980) have shown that the bulk of the Eocene Scotland Formation of Barbados is characteristic for a near-shore depositional environment, of shallow water origin and a portion of the delta of a great river.

Dickey (1980) suggested that during the Eocene this huge

delta complex was located in the area of Lake Maracaibo of today. Further investigations on the source area of the rock components found in the conglomerates of Bonaire and Margarita Islands would certainly be of great help. According to Rod (1981, Figures 2 and 3) this huge Eocene delta was very likely the one of ancient Rio Orinoco.

LOCATION AND ORIENTATION OF POSTULATED SUBDUCTION ZONES

The interpretation of the Caribbean plate tectonics is dominated by the eastward motion of the Caribbean Plate relative to North and South America. However, as emphasized by Ladd (1980, 1981) the Caribbean Plate is under north-south compression by a slight convergence of North and South America. Thus, compression results in some minor underthrusting along the north and south boundaries of the Caribbean Plate. Ladd and others (1981) have studied the underthrusting of Hispaniola from the north and south. From this work it is clear that this rather small-scale underthrusting is a subordinate structural feature and has nothing to do with a subduction zone.

When going through the literature it is amazing how many subduction zones have been postulated by various authors along the northern and southern margins of the Caribbean Plate during its development. If paleogeologic reconstructions are attempted which take into account the considerable

rotations of the crustal blocks and thrust sheets, then it should be realized that during the long history of the Caribbean Plate subduction zones along its northern or southern margins never existed. The subduction zones which ever were active in the Caribbean region were trending north-south or northeast-southwest and were, exactly like the West Indies arc of today, dipping towards west.

From its initial stage, the dominant structural features along the northern and southern boundaries of the Caribbean Plate were strike-slip fault zones (for a good review of the strike-slip faults of Northern Venezuela, see Schubert (1979) and additional references in bibliography).

"GEOTOME", "OBDUCTION", AND "TRANSVERSALE"

Many years ago a geologist wrote in a footnote of a paper that, just by calling a spade a "geotome", the spade is not made a better tool. There are several terms in the jargon of some geologists which are regarded as very learned but which are meaningless and often used to cover up ignorance of certain geodynamic processes, or which just replace a good English term.

"OBDUCTION"

One of these terms is "obduction", introduced by Coleman (1971) for the overthrusting of parts of the oceanic crust and upper mantle onto thin continental edges.

interpretation of the emplacement of the Papuan Ultramafic Belt and the ultramafic rocks of New Caledonia current at this time. However, the fact that the slab-like nature of the ultramafic rock body was never established and is the least likely interpretation (Rod, 1974) based on an unrealistic mechanism of implacement, was never mentioned.

This idea of a slab-like portion of oceanic crust and upper mantle, which has to be pushed across a trench up an incline along a slip zone dipping away from the continent, up and onto the continent, is still very much in vogue. How this pushing was done is usually not further analyzed. As pointed out by Elliott (1976): " 'Obduction' is not substantially different from any other kind of thrusting; the material being moved is different, but the physical processes appear similar".

Coleman (1971) correctly emphasized that those ultramafic belts were mechanically emplaced along narrow geosutures. The processes involved are subduction of the oceanic crust and upper mantle to a certain depth, vertical uplift of up to 20 km of a wide belt, and thrusting by gravity spreading. The term "obduction" refers to exactly what is understood by thrusting and is therefore superfluous.

"TRANSVERSALE"

In the paper of Stephan and others (1980), the "Transversale de Barquisimeto" is frequently mentioned. This

geologic feature seems to be the westernmost margin of an overlapping complex of thrust sheets. It is an erosional contact where those thrust sheets are exposed and a hypothetical margin where the thrust sheets are supposed to lie under a pile of Cenozoic sediments in the Falcón area. Moreover, on illustrations and in the text of the contributions to Colloque C5, several other transversales are mentioned. Among them is the "Transversale du Guatemala" and the "Transversale de Huancabamba". The Transversale du Guatemala coincides with the Motagua Fault Zone and the Transversale de Huancabamba was described (Ham and Herrera, 1963; Gansser, 1973) as the Huancabamba Deflection, and also seems to be a shear zone of a major strike-slip fault.

I do not know who introduced the term "transversale" or the whereabouts of its original definition. However, it seems that "transversale" is a catch-all for different unrelated geologic features and is unnecessary. It is much better to mention the strike-slip faults by the name they are known in the literature and to describe the edge of an overlapping thrust complex as such.

A PLEA FOR BETTER ILLUSTRATIONS

A geologic paper is not expected to present illustrations merely for embellishment. A good illustration in a geologic paper should replace several pages of text. Rabassó-Vidal (1975) in his "Guia para preparar informes

proverb "un dibujo vale por mil palabras".

Stephan and others (1980) show in their Figure 3, a series of six more or less north-south sections through the Caribbean Mountains. No scales whatsoever accompany these sections. The line of section "A" goes through Barquisimeto and Siquisique, and the line of section "F" through Tobago. The horizontal scale of those six sections (calculated from Figure 2) varies from 1: 4 470 000 (A) to 1:1 653 000 (F). The vertical exaggeration is at least ten times. It seems that the editor, or more likely one of the authors, did not feel too happy about this Figure 3. A remark is added in a footnote on page 42, that the "horizontal and vertical scales are different and vary from one section to the other".

On this Figure 3, the lines which purport to indicate the suggested correlation of the shear planes of the nappes, are drawn as if the surface of the paper would be a map and the sections would form the west side of a series of block diagrams. Such a block diagram would be very instructive if properly constructed. But here, in this Figure 3, the mix up of profile sections and map symbols is only confusing.

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