STRATIGRAPHY OF THE "CELICA-LANCONES BASIN" (SOUTHWESTERN ECUADOR- NORTHWESTERN PERU). TECTONIC IMPLICATIONS.

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RESUMEN : En la "Cuenca de Celica-Lancones", se distingue una serie sedimentaria occidental, que constituye la cobertura del Bloque Amotape-Tahuin, y una serie oriental en parte volcánica perteneciendo a la margen andina. Están separadas por una sutura tectónica, que involucra rocas maastrichtianas. Por lo tanto, la colisión del Bloque Amotape-Tahuin con la margen andina ocurrió despues del Maastrichtiano, probablemente en el Eoceno basal.

KEY-WORDS : Late Cretaceous, Paleogene, Andean margin, Terrane, Accretion.

INTRODUCTION

The Andes are classically divided into Central, liminal Andes without accretions nor ophiolites, and Northern and Southern Andes, which underwent obduction and/or accretion of oceanic and/or continental terranes. Moreover, the tectonic rotations are clockwise in the Northern Andes, whereas they are counter-clockwise in the Central Andes (Kissel et al. 1992). Therefore, the Peru-Ecuador border, that roughly coincides with the Northern to Central Andes transition (Mourier 1988), is a key area to understand the tectonic behaviour of the Andean margin and of the allochtonous terranes.

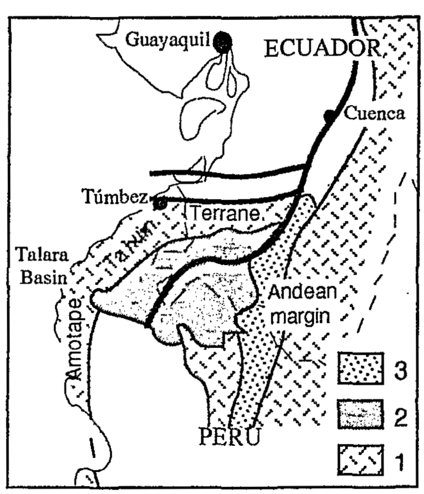

Fig. 1: Location sketch. 1: Paleozoic rocks; 2: Cretaceous "Celica-Lancones Basin"; 3: early Tertiary rocks of the Andean margin.

GEOLOGICAL SETTING

The Cretaceous series of the Celica (Southwestern Ecuador) and Lancones (Northern Peru) zones were interpreted as the infilling of a back-arc basin located on the suture of the Amotape-Tahuin Block (ATB), accreted to the Andean margin at the Jurassic-Cretaceous boundary (Mourier 1988, fig. 1). In these interpretations, western facies unconformably overly the Paleozoic rocks of the ATB, and laterally grade eastward into volcanic and volcaniclastic deposits, which are separated from the Andean margin by important faults (Kennerley 1973, Morris & Alemán 1975, Bristow & Hoffstetter 1977, Reyes & Caldas 1987, Mourier 1988). Paleomagnetic studies indicate that the ATB underwent a northward drift of hundreds of kilometers and a ≈110° clockwise rotation since the Paleozoic, whereas the Cretaceous rocks of the "Celica-Lancones Basin" recorded a ≈ 60° rotation, without significant migration (Mourier et al. 1988).

New stratigraphic, sedimentologic and structural field data, as well as partial geologic survey in the ecuadorian part of the "Celica-Lancones Basin" led to distinguish two tectonic units, separated by a major tectonic suture. The western series constitutes the stratigraphic cover of the ATB, whereas the eastern one represents the sedimentation of the Andean continental active margin.

STRATIGRAPHY

The Cretaceous-Paleogene sedimentary cover of the Amotape-Tahuin Block.

Disconformably overlying the Paleozoic rocks of the Eastern side of the ATB, is a thick, undated series of deltaic (?) shales and sandstones, overlain by mature, coarse-grained fluvial sandstones. They are correlative with the early Cretaceous Goyllarisquizga Gp of the West-peruvian margin (Benavides 1956, Gigantal Fm of Mourier 1988, Huayllapampa Gp of Myers 1980). A marine transgression then deposited shales, sandstones and limestones, correlative with the late Aptian-earliest Albian transgression of Peru (Inca and Pariahuanca Fms, Benavides 1956, Wilson 1963). They are overlain by black laminated, bituminous limestones, which yielded middle Albian ammonites (Bristow & Hoffstetter 1977), coeval with similar deposits of Peru (Chulec-Pariatambo and Pananga-Muerto Fms, Benavides 1956, Reyes & Caldas 1987).

These are overlain by a thick series of black shales and feldspathic sandstones, interpreted as low density turbidites representing the erosion of a continental cristalline basement with a noticeable volcanic contamination. These are known as the Copa Sombrero Gp in Northwestern Peru, and are dated as Cenomanian (Olsson 1934) to Campanian (Morris & Alemán 1975)(fig. 2). In Ecuador, they are capped by a 100 m-thick conglomerate correlative with the Campanian Tablones Fm of Peru (Reyes & Caldas 1987), and then by black shales, with thin-bedded turbidites intercalations and limestone nodules, dated as Maastrichtian in Peru (Pazul, Monte Grande Fms, Olsson 1934, Reyes & Caldas 1987)(fig. 2).

On the western side of the ATB (Talara Basin), a major transgressive unconformity (Sandino Fm) is overlain by Campanian to Paleocene marine shales (Redondo Fm, Mal Paso Gp, Gonzalez 1976). These are disconformably overlain by coarse-grained, continental, polygenic conglomerates (Mogollón Fm) grading westward into shallow-marine sandstones and shales of early Eocene age (Salina Gp, Gonzalez 1976, Séranne 1987).

The Cretaceous to Paleogene series of the Andean continental margin.

The lowermost unit is a thick series of massive, faulted and altered andesites, ascribed to the **Celica Fm**. Although it is crosscut by granites dated as Aptian (114-111 Ma K-Ar ages, Kennerley 1973), the Celica Fm is thought to correlate with the Albian volcanics of Western Peru (Casma Gp, Myers 1980, Soler 1991).

The Celica Fm is overlain by sandstones and greywackes (≈ 200 m), and then by thick-bedded, coarse-grained volcaniclastic high-density turbidites (≈ 1500-2000 m), with few thin intercalations of lavas and black laminated limestones. We propose to call this unit the **Alamor Group** (fig. 2). A poor microfauna locally indicates a post-Albian, probably Turonian age. Though the basal contact has not been observed, the lack of important deformation and alteration within this unit indicates that the Celica Fm was deformed before its deposition.

The **Naranjo Fm** (≈ 150-200 m) unconformably overlies either the Celica Fm or the Alamor Gp. It begins with transgressive pebbly marls containing Santonian ammonites, followed by coarsening-upward sequences of marls, fossiliferous limestones and grauwackes, of shallow-marine shelf to deltaic environment. Thee upper part of the unit yielded a late Campanian or early Maastrichtian microfauna (fig. 2).

The **Casanga Fm** (≈ 200-400 m) consists of shales, thin-bedded turbiditic grauwackes and nodular limestones of marine shelf environment. It differs from the underlying strata by the presence of coarse-grained conglomeratic lenses and beds, that reflect the progradation of coastal alluvial fans. The Casanga Fm contains a poor late Cretaceous microfauna, and would be mainly of Maastrichtian age (fig. 2).

Locally, it is unconformably overlain by undated, red-coloured, continental shales, siltstones and volcaniclastic beds, which seem to belong to the **Sacapalca Fm**, that crops out farther East. The latter is made up of thick subaerial andesitic flows with intercalations of fluvial red beds, crosscut by an early Eocene pluton (49 Ma, Kennerley 1973). It is thus probably coeval with the Llama and Porculla volcanics of Northern Peru (Reyes & Caldas 1987, Mourier 1988).

This volcanic series is overlain by the undated **Catamayo Fm.** It comprises regressive sedimentary sequences, grading from coastal-marine shales to fluvial coarse-grained conglomerates (fig. 2). The latter mainly contain clasts of metamorphic rocks, and thus contrast with the underlying, mainly volcaniclastic formations.

Southerly, the Sacapalca Fm is overlain by lacustrine black shales and turbiditic grauwackes, with abundant slumpings and olistolites belonging to the undated **Gonzanamá Fm.** Its relationship with the Catamayo Fm is unknown.

The latter formations are unconformably capped by the probably Oligocene volcanic flows of the Loma Blanca Fm.

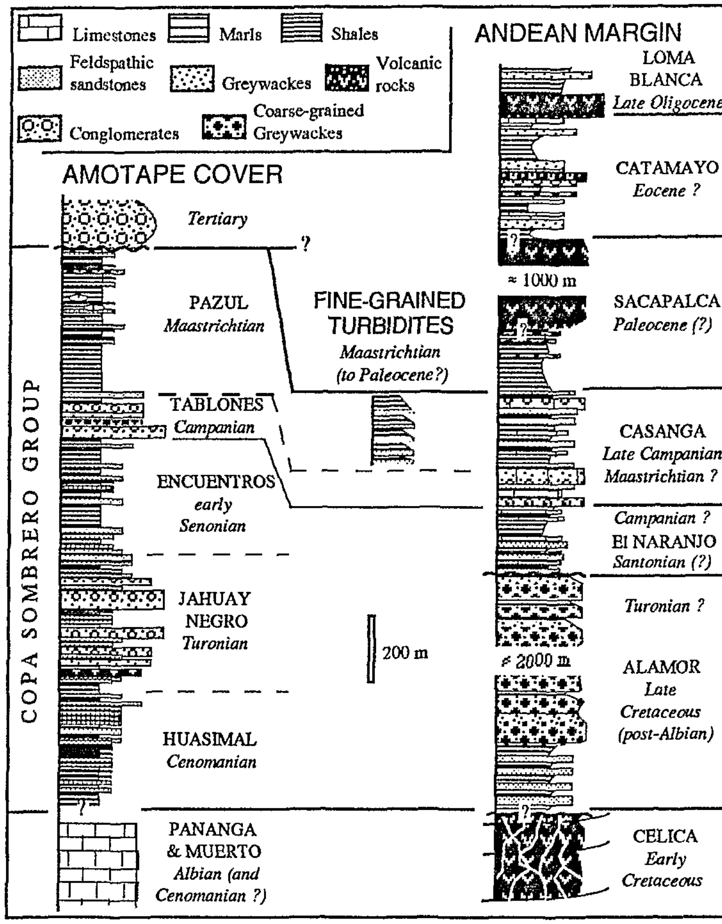

Fig. 2: Stratigraphic sketch of the Celica-Lancones series.

The Maastrichtian slices. The above-described series are separated by a major fault, whithin which are pinched discontinuous slices of black-coloured, thin-bedded turbidites and cherts, which have been locally dated as Maastrichtian (Bristow & Hoffstetter 1977)(fig. 2). These are ususally affected by tight folds associated with well-developped axial plane cleavage.

TECTONIC INTERPRETATIONS

The eastern, Andean series differs from the western, ATB cover, through : (1) the presence of an early Cretaceous volcanic "basement", (2) the dominant volcanic nature of the detritism throughout late Cretaceous and Paleocene (?) times and (3) the presence of a mixed carbonate-detritic shelf during Senonian times. These major differences indicate that they belonged to quite different paleogeographic domains, and that they cannot have deposited in a same "Celica-Lancones Basin" of Cretaceous and Paleocene age.

In spite of still poor stratigraphic data, the eastern series recorded all the major early Andean geodynamic events (Jaillard 1993, fig. 3). The thick andesitic Celica Fm probably represents the products of the Albian subduction-related volcanic arc, which is well known along the Peruvian margin (Casma Gp, Quilmana Fm, Soler 1991). Its deformation before the deposition of the Alamor Gp woulde result from the late Albian-early Cenomanian Mochica compressive phase of Peru (Mégard 1984). The subsequent accumulation of thick, coarse-grained deposits (Alamor Gp) indicates the creation of a subsident trough (fig. 3), possibly related to dextral wrench movements (e.g. Soler 1991). The Coniacian (?) unconformity below the Naranjo Fm is correlative with the early Peruvian phase, defined in Southwestern Peru (Jaillard 1993). The appearance of conglomerates in the Casanga Fm seems to be coeval with the late Campanian major Peruvian phase. The late Maastrichtian or Paleocene regression, the intense volcanic activity of probable Paleocene age (Sacapalca

Fm), and the marine transgression of possible Eocene age (Catamayo Fm) still need stratigraphic confirmations, before to attempt correlations with Andean events known elsewhere. Whichever the case, the Celica series is one of the quite scarce examples of a complete sedimentary series deposited in a forearc setting throughout the whole central Andes.

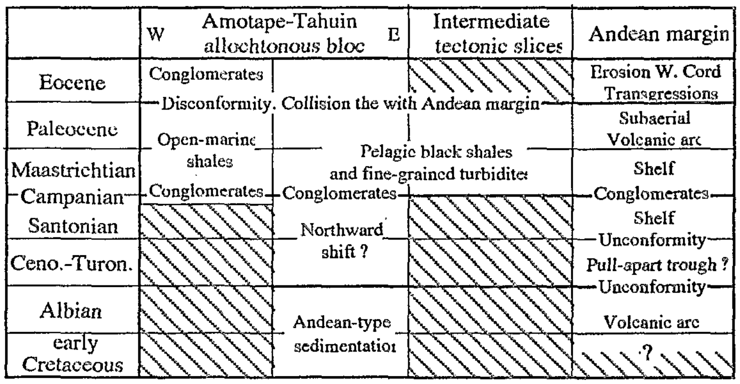

Fig. 3: Tectonic interpretations of the late Cretaceous-Paleogene evolution of the Amotape and Andean series.

The early Cretaceous to Albian facies of the ATB cover are comparable with those of the West- Peruvian margin, and it probably belonged to this latter at this time (fig. 3). Since Cenomanian times onwards, the turbiditic sedimentation on the ATB differs totally from that of the Andean margin. This drastic change could be interpreted as the beginning of the northward migration of the ATB. As a matter of fact, late Cretaceous times are a period of very oblique, northward convergence, which would have induced dextral wrenching along the Andean margin. This could also account for the coeval creation of the Alamor, possibly pull-apart basin (fig. 3).

The presence of Maastrichtian rocks in the suture between the two units demonstrates that these cannot have been emplaced in their present-day location before Maastrichtian times. Therefore, the hypothesis of the latest Jurassic to earliest Cretaceous collision of the ATB must be left out. The age of the accretion of the ATB could be indicated by the irruption of the early Eocene coarse-grained deposits (Mogollón Fm) in the Western side of the ATB (Talara Basin).

CONCLUSIONS

The Celica-Lancones area comprises two distinct late Cretaceous-Paleogene sedimentary series and can no longer be considered as a "Basin" of that age. The western unit represents the cover of the Amotape-Tahuin Block, whereas the eastern one is a well-preserved example of an Andean series in a arc to fore-arc setting. The presence of deformed Maastrichtian slices between both units indicates that the accretion of the Amotape-Tahuin terrane occurred after Maastrichtian times, probably near the Paleocene-Eocene boundary.

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