JURASSIC-EARLY CRETACEOUS FACIES DISTRIBUTION IN THE WESTERN ALTIPLANO (18°-21° 30'S.L). IMPLICATIONS FOR HYDROCARBON EXPLORATION

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ABSTRACT: *Facies analyses of Jurassic-Early Cretaceous sequences suggest an extensive distribution of marine deposits toward the East. This paleogeographic model has implications for hydrocarbon exploration in the Altiplano, since it suggests that the Jurassic-Early Cretaceous backarc basin may be preserved in the subsurface of the western Altiplano.*

KEY WORDS: *Chile, Altiplano, Jurassic, facies, hydrocarbon.*

INTRODUCTION

A system of magmatic arc related backarc basins developed along the western margin of South America was covered by several marine advances during the Jurassic-Early Cretaceous period. Sediments deposited during these events are widely exposed along the Andes and preserved in the subsurface of subandean basin. Sedimentary Jurassic-Early Cretaceous units are of great economic importance as they provide the source and reservoirs for the largest accumulations of hydrocarbons of the western margin of the continent. This composite system of arc and backarc basin remained active until the middle Cretaceous, when a generalized tectonic event inverted of some of these backarc basins [1,5,11].

The remnants of the Jurassic-Early Cretaceous magmatic arc are well exposed for more than 1000 km along the present coastal line. However, the distribution of the backarc basin toward the east between 18° and 21°S latitude has not been studied in detail. In this paper we discuss the probability that, in this area, the backarc basin could have spread eastward and that it may be preserved in the western border of Altiplano. Based on published and unpublished information we discuss the stratigraphy and the paleogeography of the backarc basin along three profiles located at 18°, 20° and 21°30'S latitude (Figs 1,2).

GEOLOGICAL SETTING

In most of the studied sections, it is possible to identify three distinctive major intervals with different facies assemblages: (a) transgressive deposits (basal unit) that indicate the inception of the sea level rise; (b) widespread open marine deposits (middle unit) indicating a stable state of basin subsidence, and (c) regressive sequences that indicate a marine regression due to base level uplift.

18° South Latitude. Jurassic-Early Cretaceous sedimentary deposits are distributed between Arica, in the actual Coastal Range, and the Titicaca Lake in the south-eastern part of Peru. In the Coastal Range

of Arica, thick Pliensbachian to Oxfordian andesitic and basaltic-andesitic unitis are interbedded with detritic and calcareous marine deposits.

Inland from Arica, the Mesozoic sedimentary series begin in the Sinemurian and lie disconformably on an acidic tuff unit. In the upper Azapa Valley, a series of terrigenous clastic and carbonate sedimentary rocks with minor pyroclastic intercalations is exposed. This unit contains marine fauna of Lias to Lower Neocomian age[4].

Farther to the northeast, these facies are replaced by 1,200 m of a monotonously interbedded sandstones and shales, characterized by thinning-upward successions[6,10]. This facies association is interpreted as a turbiditic series.

A regional interpretation of these sequences indicates that in the upper Azapa Valley as well as in Arica the sedimentation took place on a shallow marine shelf. However, progressively deeper facies found to the east indicate that sedimentation took place through gravity flow deposits, suggesting that the deeper part of the Jurassic-Early Cretaceous back-arc basin was located in that direction.

19° South Latitude. In the Coastal Range of Iquique the sedimentation is characterized by shallow marine limestone and shales, interbedded with andesitic pillow lavas[9]. Similarly to the coast near Arica, these sequences represent the interaction of shallow marine conditions with a submerged portion of the volcanic arc.

To the East of Iquique, the Noasa Formation rests unconformably over Paleozoic metamorphic rocks. This formation includes basal conglomerates followed by shales and thin limestone intercalations, with diagnostic Sinemurian ammonites, that indicate the initial transgressive episode. Farther east these facies are replaced by a rhythmic interbedding of siltstones and sandstones that have been interpreted as a turbidite facies[2].

Post-Sinemurian - pre-Calovian sediments are dominated by clastic deposits that reflect the transition towards a fluvio-deltaic environment in this area. However, farther east the facies are correspond to distal deposits characterized by finer grained sediments than their western equvalents[2]. To the east no marine deposits of this age have been reported.

A regional analyses at 19° S latitude indicates that the marine facies are progressively deeper towards the East. However, eastern outcrops are incomplete and do not allow a clear definition of the facies changes during the Sinemurian-Calovian.

21° 30' South Latitude. The Coastal Range of this region was dominated by an almost continuous volcanic activity. The La Negra Formation is formed by up to 2,500 meters of andesitic lavas with at least two marine intercalations of calcareous sandstones and limestones with Sinemurian to Calovian-Oxfordian diagnostic ammonites[7]. To the east, this facies association gives way to exclusively by marine deposits.

To the East in the Cerro Jaspe area, the basal transgressive unit is followed by oolitic limestones and calcareous sandstones and siltstones. Farther east and north, in the Cerro Yocas-Guatacondo area, these calcareous facies associations were replaced during the Sinemurian-Aalenian by terrigenous clastic sequences. These facies associations can also be interpreted as turbidity currents deposits, which resulted from the retrogradation of a deep fan into the deeper part of the backarc basin in this area. Paleocurrent data show that sedimentation took place through flow deposits flushed northward and northeastward. The clastic influence decreases to the south where calcareous sequences dominate [3,8].

These formations represent the major depocentre during the Jurassic-Early Cretaceous in northern Chile. In this area up to 4,500 meters of different facies associations were deposited into the backarc basin. The deeper facies are located toward the east and there is no base to establish the eastern border of the backarc basin in Chilean territory.

CONCLUSIONS

A preliminary paleogeographic interpretation of the Jurassic-Early Cretaceous sequences exposed along the Coastal Range, Precordillera and the western border of Altiplano between 18° and 21° 30', shows a clear west-to-east sediment depth polarity. This polarity varies from shallow water calcareous deposits to the west, to deeper water terrigenous clastic deposits to the east. Pillow lavas interbedded with fossiliferous limestones are located in the present Coastal Range, give way to the east to calcareous marine sequences. Still farther east the facies equivalents are turbidite flow deposits.

The greatest thickness of Jurassic-Early Cretaceous sediments have been reported at 21° 30' south latitude (Cerro Yocas-Guatacondo areas) where up to 4,500 meters are exposed. In this region, the facies distribution suggests that the backarc basin had an extensive marine distribution toward the Altiplano.

This interpretation implies that the Jurassic-Early Cretaceous backarc basin may be preserved in the subsurface of the western Altiplano Basin (Fig.5). Consequently, this region could be considered as a hypothetic hidrocarbon exploration area.

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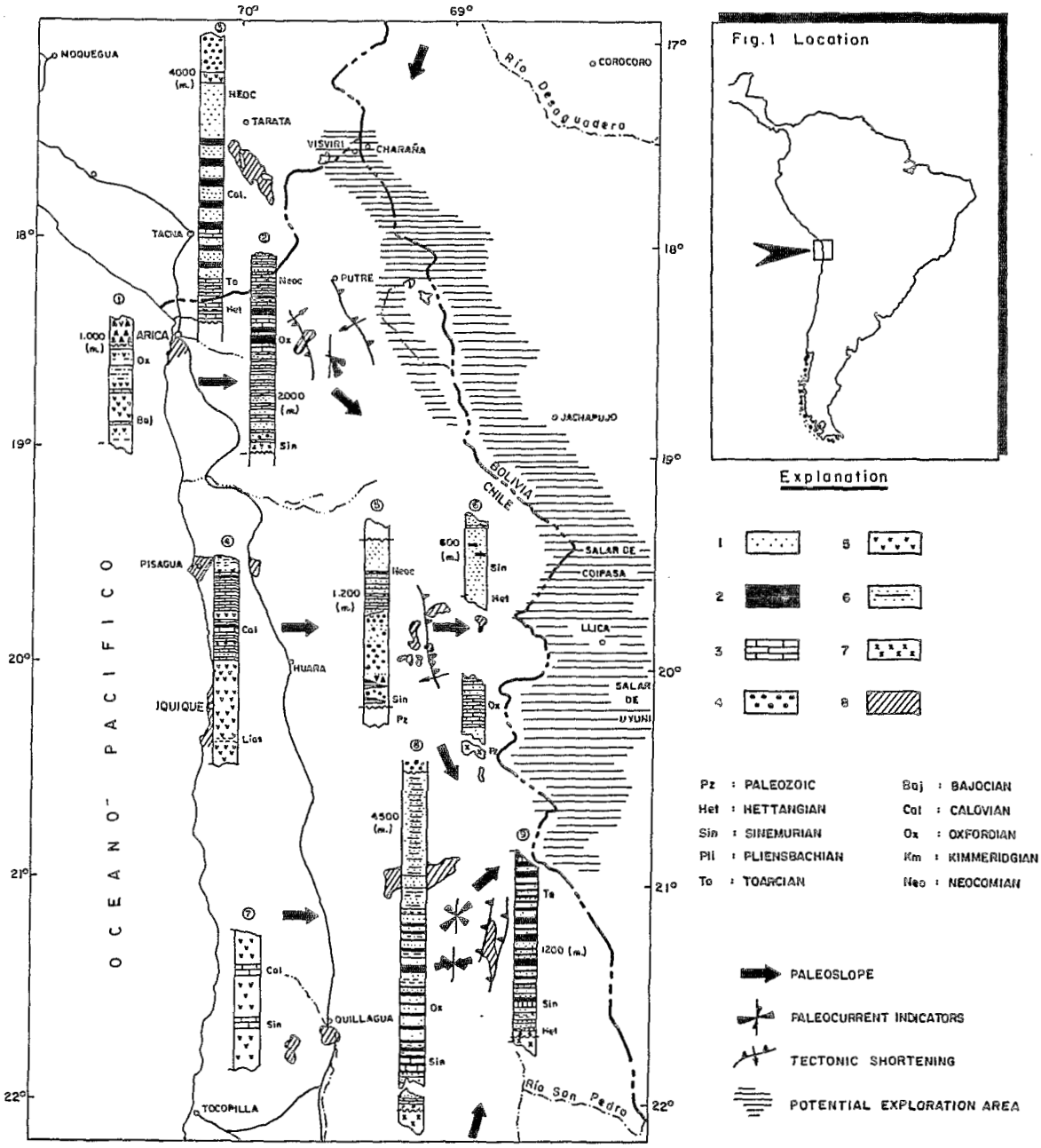

FIG.2 JURASSIC–LOWER CRETACEOUS STRATIGRAPHY. 1.-SANDSTONE ; 2.-BLACK SHALES ; 3.-LIMESTONE ; 4.-CONGLOMERATE 5.-LAVA ; 6.-SILTSTONE ; 7.-BASEMENT ; 8.-OUTCROP.—