A SILURIAN-DEVONIAN MUDDY PLATFORM-DELTA SYSTEM (RIO SECO DE LOS CASTAÑOS FM) IN THE SAN RAFAEL BLOCK (MENDOZA PROVINCE) ARGENTINA

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RESUMEN

Se presenta aquí un modelo depositacional integrado de la Formación Río Seco de los Castaños (asignada tentativamente al Silúrico-Devónico) con una nueva litofacies de secuencias progradantes y somerizantes pertenecientes a deltas dominados por olas. En la sección tipo que se encuentra en el Cañón del Atuel, entre Valle Grande y Dique Nihuil, se describe por primera vez, la presencia de un manto de material carbonoso vinculado a depósitos someros, costeros-lagunares y el registro de plantas fósiles actualmente en estudio. Esta unidad fue originalmente considerada dentro de la denominada “Serie de La Horqueta”. Otros perfiles se estudiaron también en Agua del Blanco, Lomitas Negras y Loma Rodeo de la Bordalesa. En el primero, la abundancia de trazas permitió caracterizar la icnofacies de *Cruziana* y señalar la presencia de estructuras sedimentarias mecánicas típicas de ambientes costeros de tipo submareal de moderada energía, el último perfil occidental, presenta icnofacies de *Nereites* que implican actividad de organismos que se alimentan en sectores batiales o abisales. Integrando a todas las secciones, se reconocen a las siguientes litofacies de plataforma fangosa-deltaica abierta hacia el oeste: facies de areniscas, pelitas, de areniscas finamente estratificadas con pelitas intercaladas, limolitas laminadas**,** areniscas estratificadas, capas con carbón vegetal y canales conglomerádicos. La procedencia sedimentaria de los vackes es de orógeno reciclado y bloque continental.

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INTRODUCTION

The Rio Seco de los Castaños Fm (Gonzalez Díaz, 1972; 1981) was originally assigned to the Pre-Carboniferous within the San Rafael Block (Fig. 1). The type section is located in the Atuel Creek, between the Valle Grande and the Nihuil area. Other outcropping areas are: Agua del Blanco, Lomitas Negras, Road 144 and Rodeo de la Bordalesa.

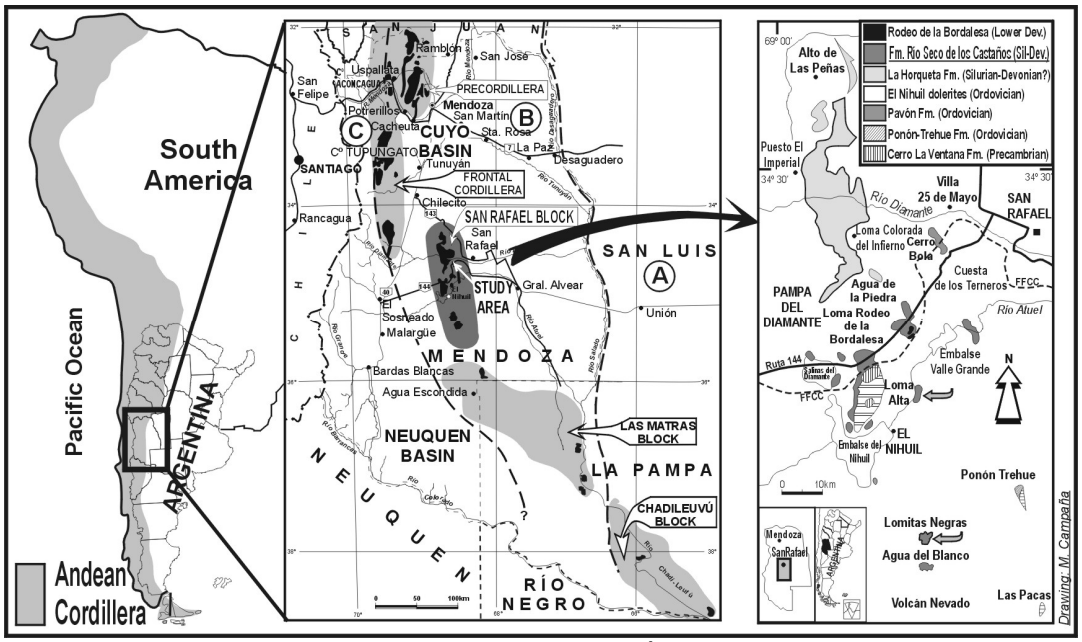

Figure 1: Geological map and studied sections of the Río Seco de los Castaños Fm.

This unit was considered initially as a part of the La Horqueta low metamorphic Serie (Dessanti, 1956) and was differentiated later by its sedimentary features by González Díaz (1981) and assigned to the Devonian due to the finding of a coral (*Pleurodyctium)* by Di Persia (1972). Other contributions by Nuñez et al. (1976), Criado Roque and Ibañez (1979) have described many sedimentary features of this unit, a more recent contribution of Poiré et al. (2002), for example, recognized sedimentary and trace fossils associations in the Agua del Blanco locality that helped to interpret different sub-environments of deposition within a wide siliciclastic marine platform with gravity flow deposits developed in deeper sectors. This contribution is supported by grants provided by PICT 07-10829 de ANPCYT y PIP-CONICET.

GEOLOGICAL SETTING AND STRATIGRAPHY

The San Rafael or Sierra Pintada Block is located to the west of the Mendoza province and show diverse igneous, metamorphic and sedimentary units of Precambrian to Paleozoic age, known generally as “Pre-Carboniferous” due to their clear differentiation from the Carboniferous beds by regional unconformities (Nuñez, 1979; González Díaz; 1981).
The main study areas for the RSC are:
a- Road 144-Rodeo de la Bordalesa: restricted outcrops allow to study this unit, to the east of Rodeo de la Bordalesa area, Rubinstein (1997) found here microfossils and trace fossils like *Nereites* and also Cingolani et al. (2003) described an igneous intrusive tonalite body dated in 400 Ma (Lower Devonian).
b- Atuel Creek (Fig 2): the main outcrops are located to the north and south of this type locality, the unit comprises here 600 m of tabular, green sandstones and mudstones with sharp contacts. Here, we find the shallower lithofacies, interpreted as the top of transgressive wave dominated delta systems, with charcoal beds as abandonment facies (Theron and Lock, 1988). The beds are folded and sometimes have a 50 to 70 dip, trace fossils like *Nereites* have also been described here suggesting a Silurian age, but, following the scheme of Astini et al (2005), this sequence could also be interpreted as the top of the **Siluro-Devonian “Malvinokaffric” foreland basin stage**.
c- Nihuil area: comprise sedimentary rocks close to the basic intrusive of El Nihuil (Cingolani et al., 2003).
d- Lomitas Negras and Agua del Blanco areas: comprise the most southern sector of outcrops. Here Di Persia (1972) mentioned a coral of Devonian age.

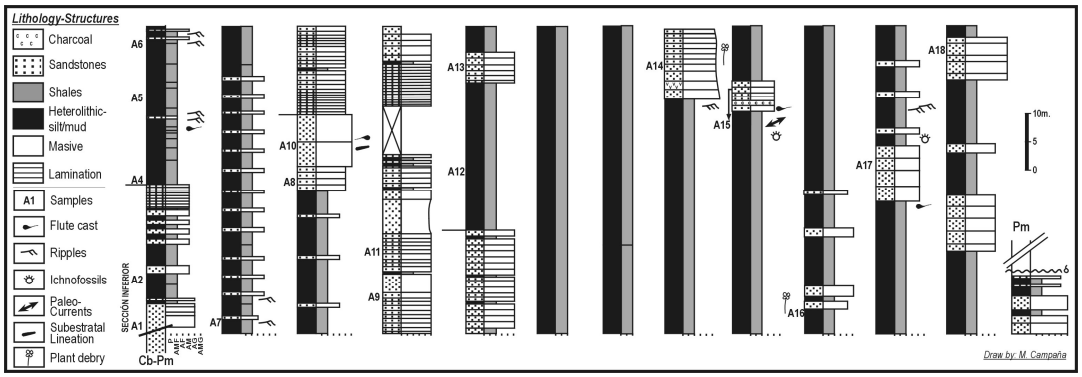

Figure 2: Río Atuel Section showing progradating wave dominated delta sequences with charcoal beds to the top.

INTEGRATED LITHOFACIES ANALYSIS

The main components of marine fine-grained siliciclastic platforms are sandstones and mudstones, the conglomerates, as in this case, are restricted to channel fills in some areas of the basin (Manassero et al., 2005). Six facies with subfacies have been recognized in this system. In the following sections they will be described and compared with other facies scheme in order to attribute them to one ore more processes of deposition (Aguirrezabala et al., 1994, Martino et al. 1990, Miller and Heller, 1994; Melvin, 1986).

a- **Mudstones,** comprises several 50 to 90 % of the fine beds, with greenish colors (Hue 5GY 372) usually with lamination and slightly bioturbated that commonly display repetitive sequences. The changes in colors are frequent but they are not related to textural gradding. Some mudstones of this lithofacies are massive. Interpretation: the fine-grained sediments are product of suspension and fall out from low density turbidity currents (Stow

and Piper, 1984) deposited in low energy conditions. The lack of tractive structures imply transport of bed load in distal areas of the platform. The lack of fauna and dark colors suggests anoxing conditions in low energy environments.

b-**Thin bedded sandstones and interbedded mudstones,** with good lateral continuity with tabular-planar beds of few centimeters and green colors (HUE 5GY 5/2), with sandstone/mudstone ratios of 1/2 to 1/4, is very common and it is characterized by alternating bed of gray fine to very fine sandstones and laminated mudstones. The sandstones could show wavy bedding structures or be massive. They exhibit sharp contacts and in many cases wave and current ripple structures (sharp ripple tops) and also climbing ripples (Reading, 1996). The current wave index is 13- 16 (wave ripples have index: 3-4 and the symmetry index is smaller than 2,2). The dominant internal structure is normal gradding. Also, this lithofacies show frequent bioturbation, Poiré et al. (2002) have recognized *Arenicolites, Bergaueria, Cochlichnus, Cruziana, Gordia, Mammlichnis, Paleophycus, Phycodes, Rusophycus and Teichichnus*. Interpretation: this facies are well oxigenated and interpreted as a proximal or shallow marine platform, with dominance of a subtidal environment. They are developed over a soft substrate with moderate energy. The coarse sediments are carried out by storms to the upper wave base level area, the finer sediments settle down periodically due to wave and storm action.

c- **Laminated siltstones**, comprises bedded siltstones that range in thickness from several tens of centimeters to 1 meter. They may be intercalated with fine-grained sandstones. They contain laminae and thin beds with sharp contacts. Some coarser grained beds show small-scale ripple cross-lamination. Interpretation: the sediments represent fine sediments deposited out of suspension in low energy environments. Also, may be associated to low density gravity flows.

d-**Medium bedded sandstones,** comprises tabular beds of fine to medium grained gray and green sandstones (HUE 5GY 5/2) that occurs in beds of 10 to 50 cm thick, sometimes separated by very thin (1-2 cm) dark gray mudstones. Trace fossils like *Cruziana* are also found. The sandstones are massive, have sharp contacts and display also current and wave ripple marks (wave index 12-20) to the top of the beds suggesting paleodepths of 20 m (Komar 1974). There are deformational structures like contorted beds, dish structures and also some flute marks. Erosive structures like hummock and swaleys can be found in this facies suggesting storm action on the platform. The continental source was near due to the presence of plant remains (Lychophytes). Interpretation: the massive beds are interpreted as proximal platform deposits, under wave and storm action, also may be, in cases, product of high density gravity flows, the erosive base of some beds suggests high sedimentation rate. No cross stratification, indicative o tractive currents, was observed within this facies, and their association with thinner-beds sequences suggest both more dense gravity flows in the platform.

e- **Channeled Conglomerates**, composed by channels (2 to 3 m wide and 1 m depth in Fig 3) of clast supported conglomerates with erosive bases only present in the Lomitas Negras Section. The beds are normally lenticular and laterally discontinuous. They show poor sorting and contain medium to coarse sandy matrix, usually are not graded. Sandstone and limestone clasts range from 2 to 10 cm long and show chaotic internally without stratification. The limestones clasts bear ordovician fossils (Nuñez, 1976, Criado Roque e Ibañez, 1979). In cases, they may show normal gradding, resulting from rapid settling of gravel in high density gravity flows. At the base of each sequence, the channels tend to be more restricted, and show better sorting, to the top, they could reach several meters wide and two or three meters thick. They tend to have a subvertical position, due to the regional folding of the sequence, and as they are harder than the associated fine to medium sedimentary rocks, they result into a strong geomorphological control, being probably the main reason for the name “Lomitas” or the “small hills” typical of the area where these channeled deposits are restricted. Interpretation: This facies is interpreted as channels developed perpendicular to the coast, the continental areas were located to the east and the deeper areas of the platform, to the west, they transport an important bed load removed by

wave and storm action. The important thickness of sandstones and mudstones associated to this facies suggest continental source areas, close to the coast, high energy and a relatively inestability of the coast-line. This platform was developed over wide areas with a very small paleoslope, probably without any slope brakes.

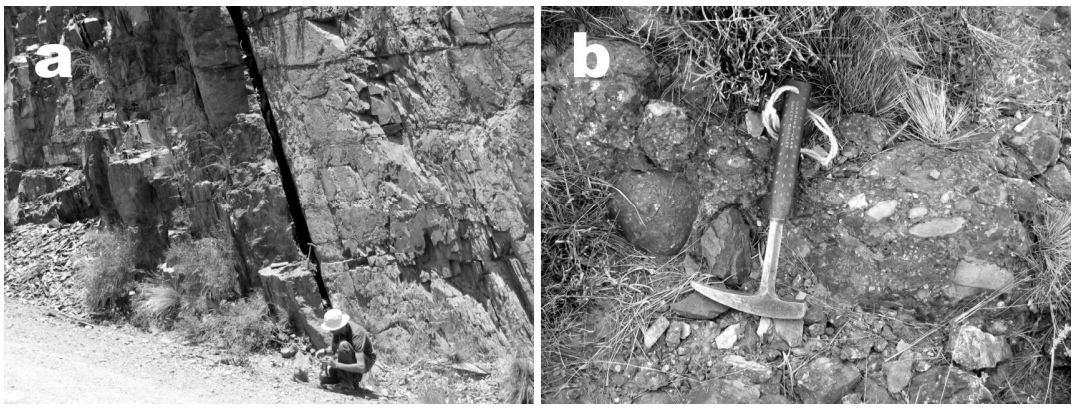

Figure 3: a) Charcoal bed intercalated in wave dominated delta facies to the top of the Río Atuel Section. b) Base of a conglomerate channel with rounded and angular clasts at the Las Lomitas Negras Section.

f –**Charcoal bed,** restricted to the Atuel Section, and is associated to beds bearing small plant debris. Transgressive sequences have been documented widely in the sedimentary record (Reading, 1996). Wave dominated deltas have facies sequences that coarsens upwards from shelf muds through silty sand to wave and storm influenced sands, capped with lagoonal or strand plains where these peat beds developed. This seems to be the case for the Atuel section, (Fig. 3), where several prograding sequences with intense wave action have been described.

DISCUSSION AND CONCLUSIONS

The relatively scarce diversity of environments, dominance of fine to medium sedimentary grain sizes, lack of tractive sedimentary structures, and the important thickness of the beds associated also to gravity flow processes are typical of a distal (below wave base) to proximal silty-siliciclastic marine platform-deltaic system.

In our case, the sedimentary input was continuos, due to the absence of internal discontinuities, the basin was extense, and the paleo-slope was very small (less than 1%). The dominant processes acting on the environment, were wave and storm action, prevailing the settling of fines over the tractive processes. The source areas were located to the east, close to the study area.

The presence of plant debris in the Atuel and Lomitas Negras section suggests closer vegetated areas. The hydraulic regimes were moderate and the sea level changes in this sequence have generated very few sedimentary unconformities, but widespread lateral bed continuity .The trace fossil data (Poiré et al., 2002) with shallower *Cruziana* ichnofacies to the east and *Nereites* to the west is coherent with the lithofacies interpretation of deeper sectors of the basin located to the west.

Similar siliciclastic environment interpreted as overfeed sedimentary system with great thickness (high sedimentary rates) and low textural maturity (Los Espejos Fm, Villavicencio Fm, Talacasto Fm and Punta Negra Fm) have been described by other authors (Cingolani et al., 2003; Astini, 1991; Astini et al., 2005) for the Precordillera Terrane. Here, two new

lithofacies: **conglomerate channels** and an **organic matter rich bed** are described as new relevant sedimentological characteristics.

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