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Origin, sequence stratigraphy and hydrocarbon potential of the Rayoso Formation (Aptian -Albian) in the central Neuquén Basin (Argentina)

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The Rayoso Formation (Herrero Ducloux 1946) (Late Albian – Middle Cenomanian) outcrops extensively in the western part of the Neuquén Basin. It is composed of clastic (and minor evaporitic) red beds up to 1,200 meters thick, which sharply overlie continental and marine-restricted deposits (Huitrín Formation) and are in turn unconformably covered by fluvial strata (Neuquén Group). The Rayoso Formation is also broadly distributed in the subsurface, extending over an area of about 20,000 km^2. The current understanding is mainly derived from the work of Uliana *et al.* (1975a; 1975b), Ramos (1981) and Legarreta (1985), amongst others. Although this unit is relatively well known toward the north, the southward extension remains less understood. In the south, its origin has been related to ephemeral fluvial streams (flash flood) in alluvial plain and playa-lake environments. In recent years, its petroleum potential has been enhanced with commercial production from this unit, especially in the embayment area.

In the subsurface, productive beds are cyclically-stacked, and truncated by the low angle Intersenonian unconformity (94 Myr). . Productive beds are relatively shallow (about 600 meters below surface), with good petrophysical characteristics (porosity and permeability). The development of these reservoirs requires a robust understanding of the origin, facies, geometries and sequence stratigraphy of the sandstone bodies. The last is critical to define correlation patterns between producing wells, and to propose new models and guidelines to predict reservoirs facies. Recent advances in clastic sedimentology provide new tools and perspectives for the analysis of lacustrine strata. Extensive field studies, supported by more than 6,000 meters of detailed stratigraphic sections, and complemented by an important volume of subsurface data (seismic, well logs and core analysis), support the review of the stratigraphy and depositional history of these strata. Three third-order depositional sequences can be recognized, with thickness and facies largely controlled by a variable subsidence and climatic changes. Broadly speaking, these sequences display internally two characteristic and repetitive intervals (each in the order of hundred meter- thick):

<u>Interval 1: Brackish lake with shallow lacustrine underflows.</u> It is characterized by m-thick fine to medium grained sandstones (dominant) and laminated mudstones. In marginal to central positions sandstone bodies display slightly lenticular shapes with clay chips, and are laid over erosive bases (Fig 1). Internally, these bodies show a complete suite of traction plus fallout structures, with evidences of fluctuating flow regimes. Amalgamation and internal erosional surfaces are also common. The lack of pure tractive structures and evidences of subaerial exposure suggest that these deposits could correspond to sustained (quasi-steady) hyperpycnal flows, mainly fed by sediment laden river currents that enter in a less dense standing body of water. Analysis of the surface texture of numerous sand grains reveals that these sandstones were probably eroded from mature aeolian systems.

<u>Interval 2: Restricted saline lake.</u> It is composed of cyclically stacked red mudstones and fine sandstones with minor levels of carbonate (stromatolites), anhydrite and halite, accumulated in a saline restricted lake with significant groundwater supply and intense evaporation. The episodic inflow of freshwater runoff locally controls the sedimentation, and constructs small deltaic bodies in marginal areas with associated buoyant plumes (overflows or interflows). The occurrence of stromatolites suggests water depths between 10-60 meters (Cohen & Thouin 1987).

With the exception of the first sequence, which is entirely composed of interval 2 type facies, the second and third sequences have a fining and thinning-upward tendency, and are composed by a basal interval 1 followed by an interval 2. Interval 2 probably represents periods of low lake levels during overall dry climatic conditions. These periods favored the growth of extensive aeolian dune fields (especially towards the east). During interval 1 an increase in precipitation, and consequent runoff, resulted in the fluvial erosion of most of the dune fields, and the delivery to the lacustrine basin of huge volumes of fine sand size sediments by fluvial currents. This fluvial influx also contributed to freshen the saline lake and to relatively raise the water level. Paleogeographic and sedimentological evidences suggest that individual fluvial related underflows traveled distances greater than 50 km, with very gently slopes (slope less than 0,5 degrees). The sandstone infill of these channels, sealed by lacustrine mudstones, could also be acted as effective carriers for migrating hydrocarbons to marginal positions. In these areas, the predominance of erosion results in a good hydraulic connectivity between different sand bodies (Fig 1).

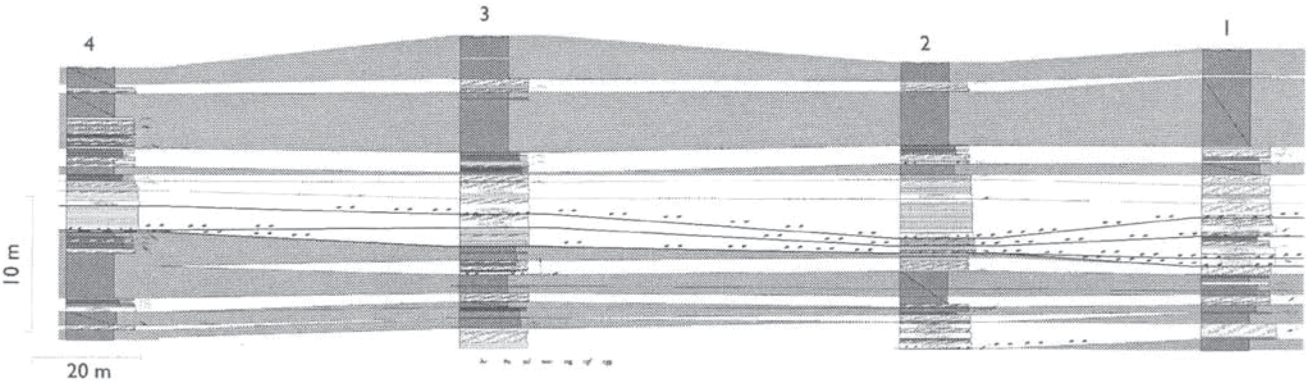

Fig 1: Detailed correlation of shallow lacustrine underflow deposits. This field example is considered analog of thesubsurface.

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