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New Insights on the Jurassic Rift Succession of the Mérida Andes, Venezuela: Implications for New Petroleum Systems in Northern South America

Along northern South America, vast oil and gas reserves are related with a Mesozoic to Cenozoic Wilson cyle, defined by a Triassic - Jurassic rift, a Cretaceous passive margin and a Tertiary foreland (Audemard and Serrano, 2001). This cycle contains several Cretaceous and Tertiary petroleum systems that provide important oil and gas reserves (**Figure 1,** Talukdar and Marcano 1994, Yoris and Ostos, 1997).

In this context, the existence of a rift - related petroleum system of Jurassic age has been considered only in recent years (Goodman et al. 1998, Audemard and Serrano 2001, Arminio et al., 2001)**.** The Jurassic succession in Venezuela is found either in rifts preserved under the Cretaceous passive margin or exposed in outcrops along the Perijá and Merida Andes **(Figure 5).** Additionally, Jurassic marine sediments have been described in Paraguaná and Siquisique as part of the Tertiary Caribbean nappes (Bartok, 1985). In the Mérida Andes and Perijá, most of the Jurassic succession is known as the La Quinta Formation. Thus far, the La Quinta has been generally described as red beds and subordinate volcanics with few references to organic rich sedimentary facies (**Figure 2),** and the same condition has also been extrapolated to the buried grabens. Therefore, the possibility of an effective Jurassic sourced petroleum system has been usually deemed remote.

In the central Mérida Andes, however, detailed field work and sedimentological analysis show that a more complete graben stratigraphy can be described in the context of a Mesozoic rift province. Case in point is the Jurassic depocenter exposed near the towns of Jají and San Juan near Mérida city, where “dark” La Quinta facies described by previous authors (e.g. Odreman and Ghosh, 1980) were studied in detail, particularly its stratigraphic, structural and geochemical relations (Hernandez, 2003).

The local structure is viewed as a half-graben that was reactivated, rotated and thrusted by the Mio-Pliocene uplift of the Serranía de La Culata (**Figure 3**).This half graben, in turn, is part of the Mesozoic rift system that was exhumed along today´s Mérida Andes (Bartok 1993, Lugo and Mann, 1995).

In the study area, the La Quinta is approximately 500m thick, with the lower 240m made of alluvial fan, fluvial channel and overbank red bed-type deposits followed by 200m of dark, organic-rich lacustrine shales and micrites that contain ostracods, stherids and pollen of Tithonian age. This lacustrine section is capped by 60m of shallow marine shales with bryozoans, also of Tithonian age (**Figure 4)**. This section is inferred to be in angular relation with the Cretaceous of the Maracaibo Basin. The lacustrine and marine shales showed good to very good and fair to good source rock quality, respectively. The whole succession, as well as the overlying Cretaceous, is in the gas preservation window (Hernandez, 2003). In a regional context, these organic – rich La Quinta facies compare with the Cuiza marine shales of the Colombian Guajira (Renz, 1959) and the Manari lacustrine shales of the Takutu graben (Crawford et al., 1985) **(Figure 5).**

The new evidence suggests that marine and lacustrine conditions may have extended into the continent along and around the Jurassic Espino, San Fernando - Mantecal and Urdaneta grabens in eastern and western Venezuela **(Figure 6)**, where pre-rift and syn - rift Paleozoic and Triassic – Jurassic sediments in variable thicknesses have been estimated by several authors (Feo Codecido et al., 1984 and Ríos et al., 2002) Therefore, exploration models in northern South America should consider source rocks of Jurassic age that may have formed effective petroleum systems additional to those already known in the Cretaceous and Paleogene successions.

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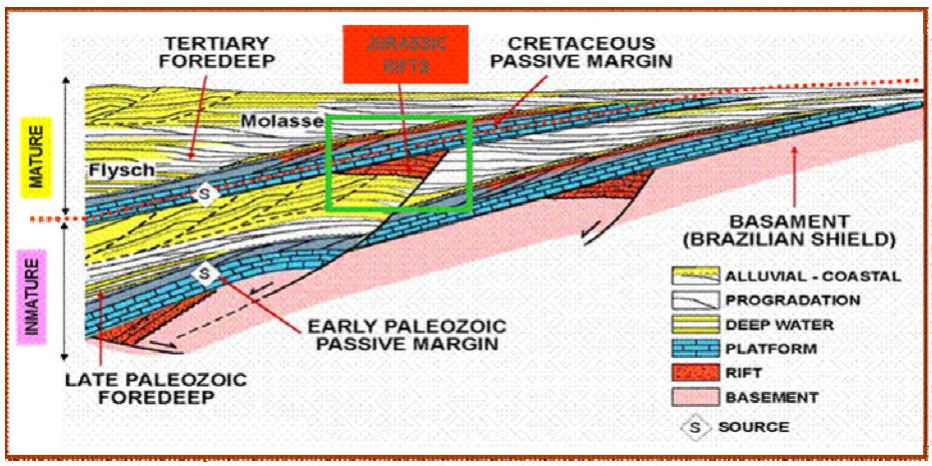

Figure 1. Tectonic style of northern South America, described in terms of two superimposed Wilson cycles. In Venezuela, oil and gas reserves have been found in the Tertiary foredeep (94%) and the Cretaceous passive margin (5%). The main source is the La Luna – Qurecual sequence that marks the top of the Cretaceous passive margin. Below this cycle, the Jurassic rift as well as the underlying Cambrian – Permian Wilson cycle remain essentially unexplored. Modified from Audemard and Serrano, 2001.

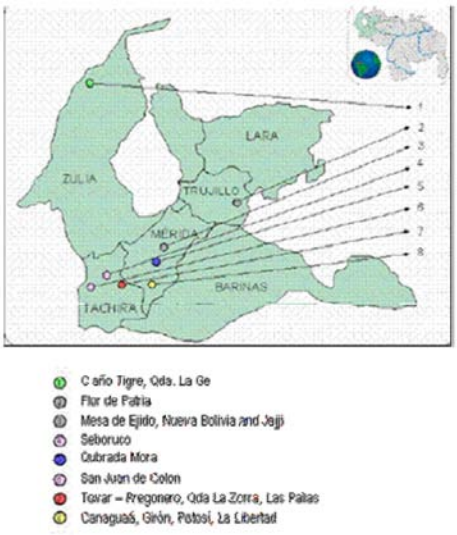

Figure 2. Published references of "dark" Jurassic La Quinta facies. Study area is reference number 3. Modified from Hernández, 2003.

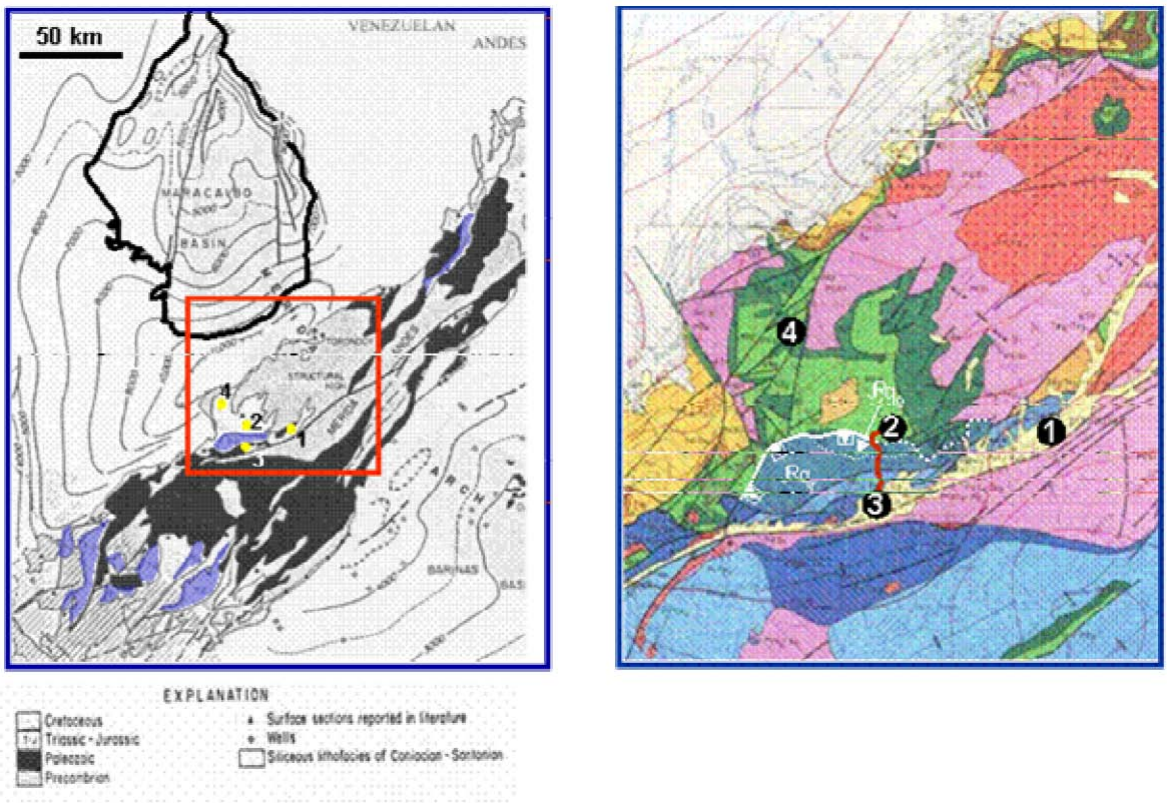

Figure 3. The Jurassic depocenter exposed along the road from from Jají (2) to San Juan (3) in the Central Mérida Andes contains typical La Quinta Formation red beds (JRqr) capped by "dark" facies (JRqo), detailed in Figure 4. Blue hues: metamorphic Paleozoic. Green: cretaceous. Yellow: Paleogene. Pale yellow: Neogene. Pink: crystalline basement. White squares and triangles: inferred inverted normal fault. 1, Merida. 4, La Azulita. Window width: 50 km. Modified from Ministerio de Minas e Hidrocarburos (1976, right) and Salvador (1986, *in* Audemard and Lugo 1994)

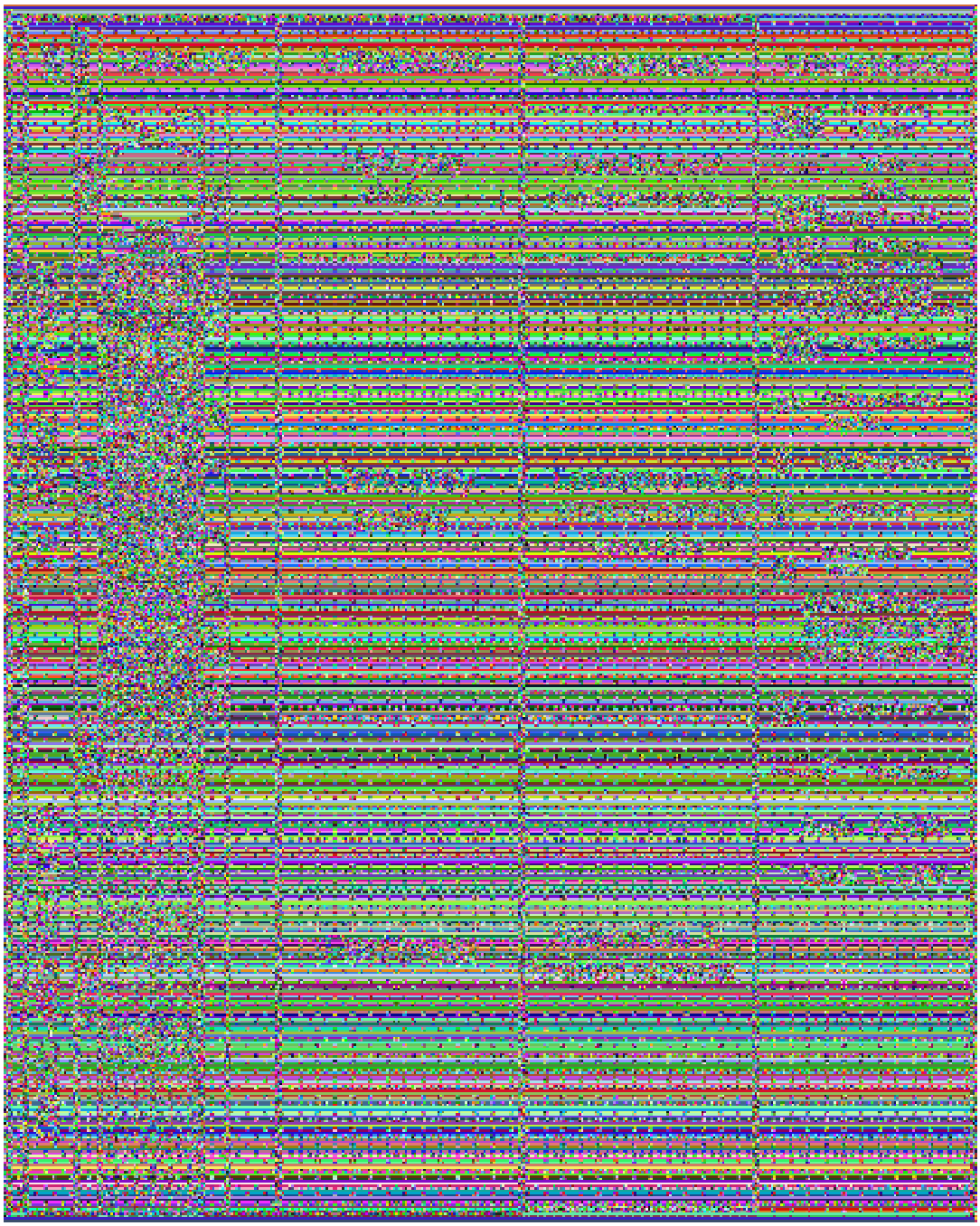

Figure 4. Synthetic stratigraphy of the La Quinta Formation in the Jají – San Juan area, Central Mérida Andes, Venezuela. This Jurassic succession belongs to a system of inverted and exhumed Mesozoic grabens located along the Mérida and Perijá Andes. The column was composed with field and laboratory data obtained in 17 outcrops located along and near the road from Jají to San Juan. Modified from Hernandez, 2003.

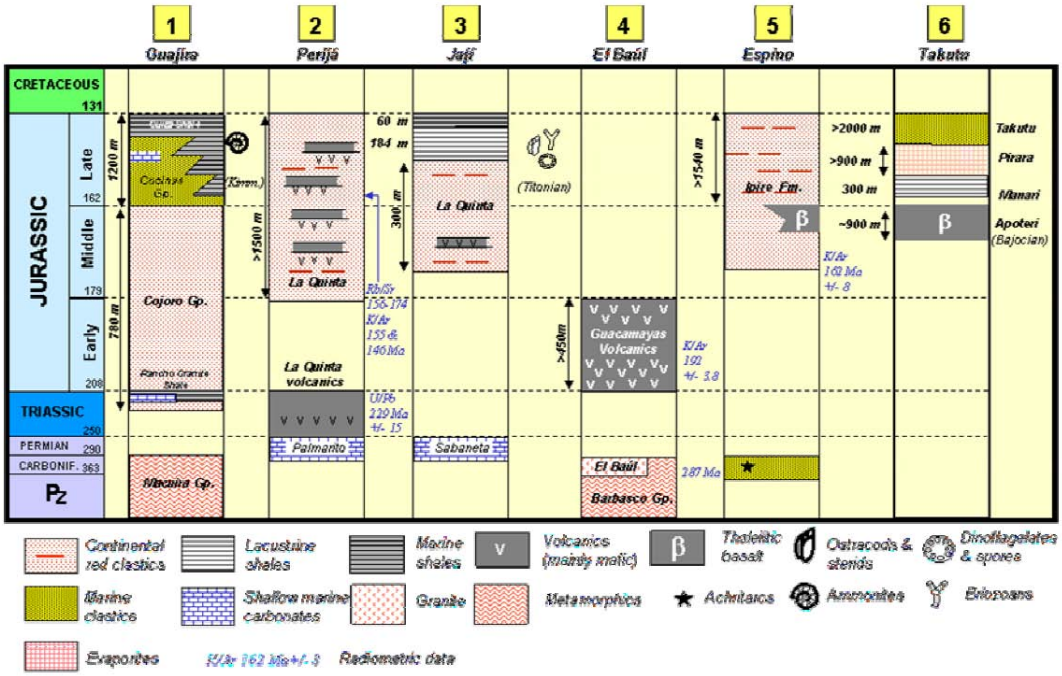

Figure 5. Schematic correlation of the Jurassic from in Northern South America. Numbers in yellow squares correspond with numbers in the map. Selected references: Renz (1959), Feo Codecido et al. (1984), Motiscka (1985), Crawford et al., (1985), Petrobras (1994), Yoris and Ostos (1997) and Hernández (2003).

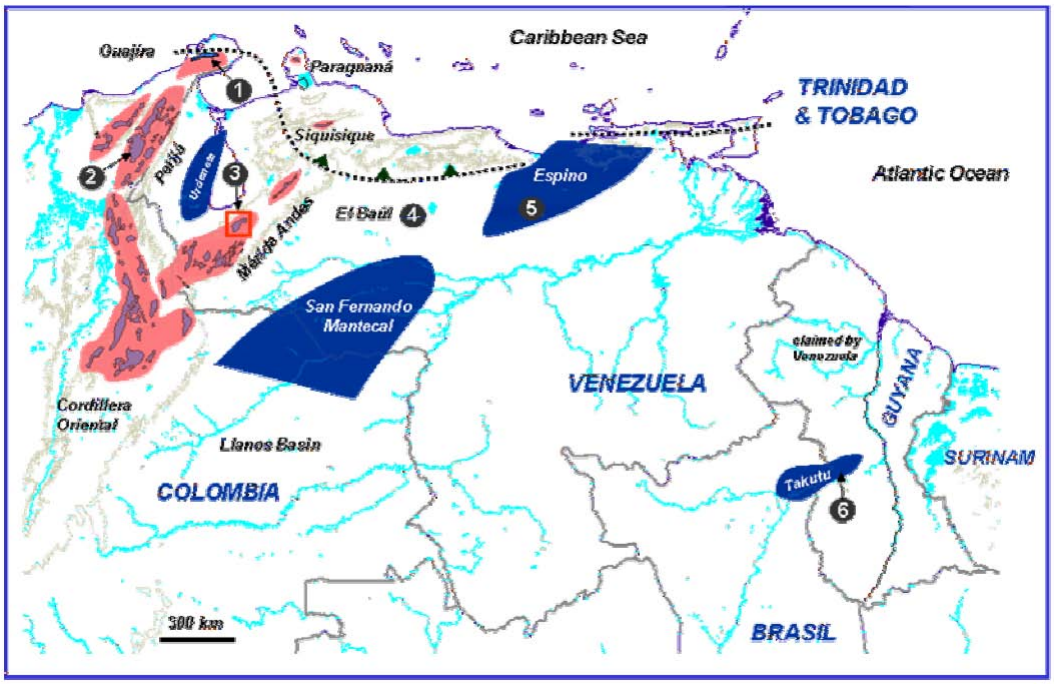

Figure 6. Schematic map of the Jurassic in Northern South América, showing the regional location of the study area (red square) as well as the numbered locations described in Figure 5. Outcrops highlighted in pink, buried grabens of the Mesozoic rift province in dark blue. Caribbean allochton in stippled line.