

## The Llanos Foreland Basin, an Underrepresented Reserves Distribution; Fact or Fiction

The Llanos foreland basin is among the largest South American foreland basins; yet, its field distribution shows the lowest average of proven and produced oil volumes in the region. Although the exploration history and ratio of wildcats to fields is similar to its regional counterparts, Llanos foreland basin field size distribution analysis indicates a significant under-representation of medium size fields (20-100 MMBO). Production began in the 1980's with heavy to light API oils distributed across the basin. The hydrocarbon is sourced from the Upper Cretaceous La Luna equivalent source rock and the majority of its production is derived from Tertiary clastic marine and non-marine reservoirs.

The Llanos foreland basin exploration history has been influenced by the economic contract terms combined with exploration reserve expectations and objectives of the operating companies. Large drilling campaigns in the 1980's resulted in the discovery of medium to large size oil fields. This early exploration success increased the Colombian government expectations for large field potential in the basin triggering modification in the contract terms. Moderate to low exploration success and global oil economics resulted in a decrease in exploration expenditure during the 1990's and early 2000's. Exploration enthusiasm was renewed with the formation of the *Agencia Nacional de Hidrocarburos* (ANH) in 2004 and the introduction in of a new contract model aiming to attract investment to explore for small to medium size prospects.

With the more favorable contract terms and the successful licensing efforts of the ANH, the Llanos basin is currently under technical review by new and old players alike. Recent regional evaluation studies underway by Ecopetrol and others are emerging through a number of technical papers outlining new ideas for the structural and stratigraphic development of the basin and the impact on reservoir distribution and hydrocarbon migration and entrapment. To capture these ideas, new exploration techniques are being applied in the basin.

While early explorers relied on gravity, magnetic and especially 2D seismic, the current exploration trend in the Llanos calls for the application of 3D seismic. Successful application of 2D and 3D resulted in the identification and discovery of ultimate recoverable reserves of up to 40 MMBO indicating the remaining exploration potential and the usefulness of the 3D seismic. Increased application of large 3D exploration programs focused on the lower Carbonera Formation reservoirs has increased the success rate in parts of the Llanos Basin. Lower success rates have been observed on 3D driven plays targeting the Mirador Formation.

Large 100 to 200 MMBO fields may be found in the Llanos basin by carefully combining the reviewed geological ideas, the favorable contract terms and the application of 3D seismic exploration. Additional structural plays can be expected to be identified and successfully drilled to fill in the lower field size distribution identified from the basin field distribution. The Llanos foreland basin exploration spans for over 50 years and prospecting efforts will continue focusing on finding and developing medium to large reserves in a well sourced and charged petroleum province.