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The Mio-Pliocene Turbidite System of The Valencia Trough

The Valencia trough is located in the Western Mediterranean sea, in front of the delta Ebro area, from 5 to 100 Km away the shoreline and covers more than 30000 km^2. Water depth is ranging from 10 m to more than 2000 m depth. A Mio-Pliocene depositional system has infilled this subbasin with thickness reaching more than 4000 m of siliciclastics sediments. Two different turbidite system has been identified, a not confined turbidite system characterized by flat long sheet sandstones for Pliocene sediments and a more conspicuous and restricted turbidite system for Middle Miocene age (Salou fm) which even has been proven to be gas-bearing.

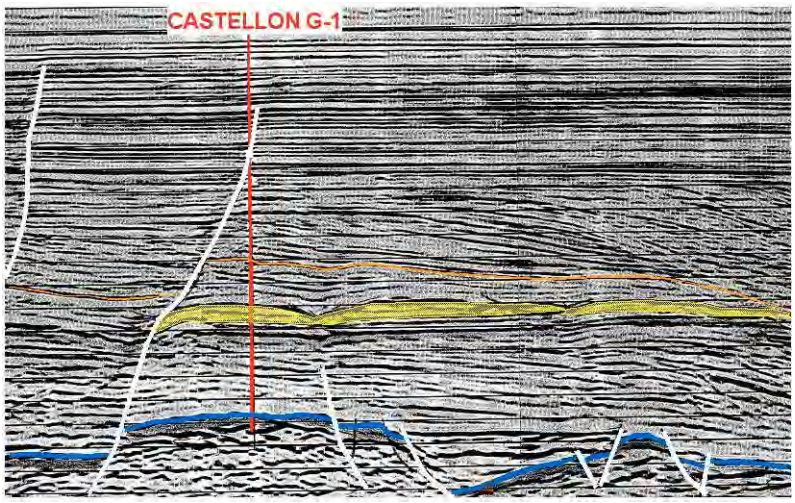
The Valencia trough has been the most prolific hydrocarbon basin in offshore Spain. More than 200 MMBO have been produce to present day, mainly in Casablanca, Tarraco and Amposta oilfields. The well-known petroleum system has been based in a Miocene source rock type II, fm Casablanca (Langhian), formed by dark limestones and marls that fossilizes an erosive and angular unconformity between the Lower Miocene and the high fluid-corroded Mesozoic. Generation and entrapment of oil is just constrained by the effective presence of the source rock in small depocenters. Migration is assumed to be form short to medium distance. Seal is provided by Lower Miocene marly and shaly formations (Casablanca fm and San Carlos fm). Traps are usually for 4way deep closure over faulted tilted blocks in the vicinity of this sub-basins. The reservoir is related to paleokarstic and corroed carbonate rocks and tertiary calciclastic deposition on flanks of paleohighs. This model has worked out well inside the basin but has become rather mature. As a consequence of the emerging Spanish gas market, the vision of the general exploration of the basin has opened to new opportunities for the gas searching. In this way, exploratory interest has swapped from deep objectives related to Mesozoic reservoirs to Mio-Pliocene stratigraphical features capable to have any hydrocarbon accumulation.

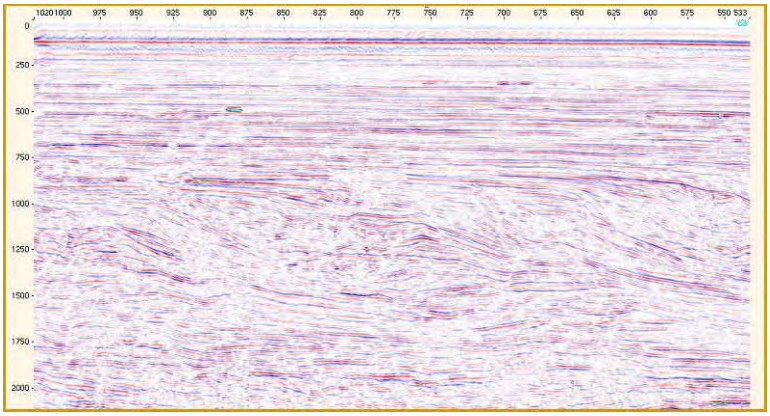
A seismic study has been conducted through more than 6000 km high quality 2d seismic shot from the lately eighties till nineties focusing in the searching for turbidite reservoirs. Well data base comprising this area are about 32 wells, 7 of them reported oil and shows, and 4 of them gas and shows, always for the Middle Miocene level.

Lower Miocene Casablanca fm has been deposited in deep marine facies. It is comprised by black shales with a high content of organic matter. Its deposition has been done in restricted areas close to the main depocenters. Seismically Casablanca fm appears where has been deposited as medium amplitude events onlapping against paleoreliefs. San Carlos group is aged Middle Miocene and comprises three different formations related to shallow to deep waters. Marls and limestones are the more commonly rocks found in this fm. No clear seismic features can be assigned to this fm.

Castellon Group comprises as well three different formations up to Upper Miocene. Salou sandstones represent the basal transgressive turbidites of the whole Castellon group sequence. Inside lowstand tracks basin floor fan can be recognized with difficulties, and it has been reported as the formation where first gas and oil shows commonly occurs, in fact, could be connected to the main source rock of the subbasin. No clear seismic features can be recognized for this level. It is overlying by Castellon shales that works out as very effective seal formed by open marine shales in a transgressive system. Castellon sandstones appear above these packages and is clearly recognized by high amplitude reflections. It is composed by interbedded shales and sands deposited during a HST.

Messinian unconformity is an erosive surface related to relative major sea-fall. It is clearly recognized on seismic at





Mio-Pliocene boundary and erodes and truncates the underlying Castellon sandstones formation creating a paleorelief of broad ridges and canyons. It is assumed till now that no hydrocarbon objectives can be found shallower than Messinian unconformity. Nevertheless a biogenic gas system could be present in overlying sediments.

Ebro Group is aged Pliocene and lithologically is formed by two sequences, the Ebro clays that underlying the Ebro sandstones. From a depositional point of view this is not an adecuate division due to the fact of the main rich sandstones deposits belong chronostratigraphically to the Ebro clays. This group can reach more than 3000 m depth being the thicker section deposisted over the subbasin. A set of different sequences can be defined inside the Ebro Group. Correlation of these sequences are extremely difficult to correlate throughout the subbasin due to the strong erosional unconformities that can erode more than 1000 m and have affected these formations denoting a set of rapid eustatic changes in Pliocene times. All these sequences show a strong progradational character over the shelf edge and slope and exhibit small but frequent synsedimentary growth faults affecting the whole depositional system. The break of the slope is moving towards offshore from the beginning of the Pliocene time involving the infilling and the subsidence of the subbasin. Agradattional sequences facies are characterized by sandstones of shallow marine coastal plain and near shore origin . This is considered as an early highstand track. Down to the basin, deep marine depositional features as turbidite sheets mainly and low relief mounds appears overlying different condensed sections. Maximum flooding surface can also be inferred from seismic.

The Pliocene turbidite system present in the area corresponds to a not confined type scarcely affected by tectonics. In addition, as the slope of the shelf is not dip enough to generate huge turbidite mounds, turbidites appears mainly imaged as basin floor fan deposited in thin sheets reaching up to 250 m as a maximun thickness. Only one well, Castellón G-1, has penetrated a Pliocene BFF. Net to gross ratio is in the range of 40% and the porosities found can

reach up to 20%. It appears as a fining upwards stacked sandstones. These sheet turbidites are characterized by stacked strong amplitudes with hummockies reflections. Onlaps on top BFF and downlaps into the base reafirmed the existence of these deposits. Mounds are defined by strong amplitudes reflections downlapping

Tectonics affecting these layers are clearly recognized as synsedimentary features, representing by subtle growth faults. These faults are related to the pulses that have affecting the basin looking for accommodation space for the provenance of sediments.

Conditions for formation and entrapment of biogenic gas in the Western Valencia trough are favourable. A high TOC content is present in the basin, Miocene layers can reached up to 20% in Casablanca fm. A clear relationship can be established in between high TOC content with a volcanic activity. Volcanic supplied a large amount of nutrients that favors plankton and algal booms. Volcanic events have taken place mainly in the Miocene age. The sedimentation rate is quite high in this basin, in fact, in the deeper part of the basin, the thickness can reach about 4000 m of Plio-Miocene sediments and commonly around 3000 m of these sediments are present all over the area. In spite of the production of organic matter could have been uniform, the accumulation has been controlled by the high subsidence and restricted water circulation, tectonically controlled. The thermal gradient present in the basin is pretty cool having a average about 45-50 º degrees/km computes from bottom holes temperatures.

There are a huge catalogue of anomalies amplitude inside the subbasin. Basically can be divide into three categories depending on its nature: Isolated amplitude anomalies on isolated turbidites sheets, at depth around 1.5 s, in the aggraddational supersequence, that could be inferred as a sharp change of facies not easily explained or to the presence of biogenic gas, shallower small anomalies amplitudes revealing gas pocket at depth not deeper than 1 s and amplitude anomalies affecting to layers bounded by faults deeper than 1 s. Gas chimneys coming from Ebro group have also been detected in some seismic lines. No any other DHI as flat spot or change of phase have been found. Anyway, flat spots would be very difficult to find them and would be hampered taking into account the flat geometry present in the turbidite reservoirs.

Under these considerations a new play concept could be introduced taking into account the following issues:

- A Mio-Pliocene depositional system that is capable of infilling the basin up to 4000 m thickness. This depositional system comprises platform, slope and deep marine facies clearly recognized by mean of seismic in the basin. So several BFF and mounds have been detected revealing as possible reservoirs.
- Structural traps have been scarcely recognized. Nevertheless, three way deep closure have been found all over the basin. Stratigraphic closure is needed (pinchout of sandstones)
- Wells drilled with deeper objectives have penetrated occasionally some BFF recognized on seismic. Reservoir characterictics are good reaching up to 20 % porosity.
- Some anomalies amplitudes have been detected inside the Ebro Group encouraging the possibility of an active gas basin within Mio-Pliocene sediments.
- High content of TOC sediment, supplied in connection with volcanics events that took place along Miocene times can assure an effective biogenic source.
- The rate of sedimentation, about 200m/MM years and the thermal gradient, around 40 º/km is comparable to other basins (i.e. Po Basin with up to 4000 m thickness and thermal gradient 25 º/ km) where an gas biogenic system has reached up to 19 TCF of recoverable reserves.