

Petroleum Systems Chart (Pucará source rock – south half of Block)

GEOLOGIC TIME SCALE	CENOZOIC										MESOZOIC					PALEOZOIC						
	TERTIARY					CRETACEOUS					JURASSIC	TRIASSIC	PERM	CARB	DEV	SIL	ORD	CAMB				
	NEOGENE			PALEOGENE																		
	Pliocene	Miocene	Oligoc	Eocene	Paleoc	Late	Early															
	10	15	20	25	30	35	40	45	50	55	60	65	100	150	200	245	250	300	350	400	450	500
GEOLOGIC EVENTS																						
SOURCE ROCK											CHONTA											
RESERVOIR ROCK																						
SEAL ROCK																						
TRAP FORMATION	ANDEAN OROGENY																					
GENERATION/MIGRATION																						
REMIGRATION	QUECHUA																					

Prospects and Leads

PROSPECTS AND LEADS				10,840 Km ²						
	Name	Description & Status	Area Km ²	Petroleum System			PTD m. A.C.	Porosity	Cum Res Thickness m.	Net Pay m.
				Source Rock	Seal	Reservoir				
1	VALENCIA STYLED LEAD 1	Area 1. NE of Valencia	60	Pucara/Chonta	Chonta & Lower Tertiary	Chonta Sand	2,950	17-18%	20	10
2	FLAT AREA LEADS	Area 1. Potential subtle structures		Pucara/Chonta	Chonta & Lower Tertiary	Chonta Sand/Vivian	3,100	17-18%	120	20
3	VALENCIA STYLED LEAD 2	Area 2. Between Shiviayacu, San Jacinto and Bartra		Chonta	Chonta & Lower Tertiary	Chonta Sand	2,900	17-18%	20	10
4	TUCUNARE REEF PROSPECT	Area 3	7	Chonta	Chonta	Chonta reef	4,000	12%	?	?
5	TUCUNARE PUCARA PROSPECT	Area 3	3	Pucara	Pucara	Pucara	NA	12%	250+	30+
6	AMPLITUDE LEAD	Area 4	100+	Chonta	Chonta	Chonta	2,900	17%	?	?
7	ARABELA SOUTH NOSE LEAD	Area 5. Combination Strat/ Struct/ hydrodynamic trap		Pucara?/Chonta	Chonta & Lower Tertiary	Low Chonta Sands/Vivian	2,100	17-18%	150	25

Block Overview

Block F-04 measures 10,840 km² in size and is located adjacent to and south of the prolific producing Block 1-AB. Additionally, the Block surrounds two of the Block 8 production Blocks: the Pavayacu Field (60+ MMBO recoverable) and the much smaller Valencia/Nueva Esperanza Fields (<10 MMBO recoverable). The oil pipeline connecting the Valencia/Nueva Esperanza Fields to Corrientes in the south runs centrally through the Block. As the Block lies within the major production fairway and encompasses a large portion of the previous Petroperu Block 8 and the later Pluspetrol Block 8 exploration license, a large quantity of seismic has been acquired through various seismic campaigns spanning a period of nearly thirty years. Only the seismic data available in SEG Y format was utilized for the interpretation discussed in this summary. Included with this were three 3D seismic surveys: Tucunare in the westernmost corner of the Block, and Valencia/Esperanza and Pavayacu over the two producing fields in the southern half of the Block

Despite being such a large Block within the principal Marañon Basin production fairway only 7 wells have been drilled on it; Bolognesi (Petroperu, 1976), Martha (Oxy, 1983), Tuncheplaya (Petroperu, 1983), Maynas (Oxy, 1987), Margarita (Oxy, 1987), Tigre (a sub-commercial oil discovery - Petroperu, 1993), and Tucunare (Oxy, 1998).

Most of the Block lies just east of the lower Mesozoic Basin which includes sediments of the Sarayaquillo (Jurassic) and the Pucará (Jurassic to Triassic) Formations. In the western part of the Block near Tucunare and to the SW of the Tuncheplaya well, the Cretaceous overlies this sedimentary package unconformably. However, throughout most of the Block the Cretaceous rests directly on basement. In a number of areas, basement is punctuated by a series of minor half grabens containing sediments of unknown age although they are believed most likely to be of Paleozoic age. These half grabens are bounded by normal faults that can form minor drape structures on the footwall side within the overlying Cretaceous sediments. Occasionally these normal faults have been reactivated in a reverse sense forming gentle rollover structures, which typifies the structures on the Block. The exception to this is the Pavayacu/Capirona structural complex, which is primarily a young NW trending Andean aged structure with significant vertical displacement. The other example is a very prominent SW plunging structural nose in the northeast region of the Block.

The source rocks for the Block are the Chonta Formation in the northern half and the Pucará Formation in the south. All fields north of Pavayacu in the Marañon Basin have been sourced from the Chonta whereas those to its south have been sourced from the Pucará. The Pavayacu Field has oils of both affinities. The fact that this Block has access to both Marañon Basin petroleum systems helps contribute to its prospectiveness.

To understand the prospectiveness of the Block, the Pavayacu and Valencia/Nueva Esperanza oil fields need first to be reviewed. 3D seismic surveys cover both of these areas. Pavayacu, as mentioned previously, is the largest structure on the Block. What makes it significant is that despite it being primarily a young structure, it is filled to, or near to, spill point in the mid-Cretaceous reservoirs. With this, it becomes apparent that both young and old structures have the potential to be productive in this area. Although Valencia and Nueva Esperanza are minor fields, they are nonetheless interesting because they display unusual characteristics that could be utilized in the exploration of other larger, subtle accumulations.

Looking at the time structure maps for the fields in sequence from oldest (Chonta Limestone) to youngest (Pozo), it can readily be seen that the Valencia structure is an old feature that was formed by what appears to be extensional faulting closely contemporaneous with the deposition of the Lower Cretaceous. Nueva Esperanza, however, is only subtly defined as such. By Chonta Marker time (middle of the Chonta Fm), the Valencia structure remains a very prominent feature (paleo-structure) as seen on a Chonta Marker to Chonta Limestone isochron and the Pozo to Chonta Limestone indicates that this structure remained intact at least until the end of Pozo deposition. In terms of present day structure, however, the Chonta Marker level has only a very weak indication of an underlying structure as the effects of the older structure become overridden by the more dominant effects of regional tectonics. By Vivian time the Valencia field has actually become a low and the Nueva Esperanza emerges as the prominent structural feature as a minor closure on a very prominent almost east-west trending high. This effect however has more to do with stratigraphic thickness variations within the Vivian section than with tectonic structuring. By Pozo time there is virtually no remaining evidence of a deeper underlying structure in the vicinity of the Valencia field.

The implications of these relationships are interesting in that they represent a trap type currently undocumented in the Basin. The Valencia Field produces primarily from a Chonta (Lower Cético) sand reservoir on a drape structure and no structuring that postdates Pozo deposition can be seen affecting this field. The influence of the depositional thicks and thins within the Vivian has more influence on the 'closure' of the Vivian than does tectonic

structuring. Where this is most pronounced is within the Nueva Esperanza field. In conclusion, the Valencia/Nueva Esperanza fields are a combination, and interaction, of early normal faulting creating very subtle horst blocks, and structure created by depositional thinning and thickening.

Northeast of Valencia some 15 km is a northwest trending Valencia-styled lead that is over 60 km² in size. The updip trap is set up by down to the NE normal faulting that has little expression in the uppermost Cretaceous and has had no later reactivation. The target Lower Cretaceous reservoir is on the footwall side with closure being provided by drape structure and fault closure. Other such leads exist in the northern portion of the Block between Shiviayacu and Barta Fields but there is insufficient seismic data to further detail these features.

Presumably, there are also Nueva Esperanza-styled, plays associated with Vivian 'build-ups', on the Block. Another example of such a trap is at Carmen in Block 1-AB where Vivian thicks create structural closures that are not seen at deeper levels. The most attractive area to explore for traps such as this would be within the identified structurally 'flat area' just northwest of Pavayacu and northeast of Valencia where regional dips into the Basin are minimal.

In the northwestern portion of the Block, a continuation of the Tambo "reefs" trend from Block 1-AB can be found. This is a play type that has yet to be tested in the Basin. The "reefs" appear to be rooted on the Chonta Limestone and situated distal enough from the shoreline to be unaffected by siliciclastic contamination. The Chonta interval in this region is typically argillaceous with abundant limestone stringers. The "reefs" generally have an oval shape with the long axis orientated NW-SE. Although not a perfect correlation, the "reefs" appear to be focused on paleo-highs that are reflected by the Chonta Limestone to Pucará isochron. This relief is somewhat subtle but it does appear to have influenced the localization of these "reefs". The largest of these features is located just south of the Tucunare well on Block F-04. This anomaly is found over a paleo-high defined by the Chonta Limestone to Pucará isochron. At this location the Cretaceous is found structurally along a south plunging nose while at Pucará level, a fourway dip structure can be mapped.

The PX8 amplitude anomaly provides an example of how better quality seismic data can be used to look for possible stratigraphic traps in the Marañon Basin. The anomaly is located in the northern central area of Block F-04 which is covered by a relatively tight grid of seismic that was acquired in 1998. The survey was shot to define a structural closure located centrally within the survey area (not shown). The structure did demonstrate four-way dip closure but was not drilled, probably due to its small size.

The amplitude anomaly is mapped as a large feature some 8 km by 18 km in size. The event mapped is within the upper Chonta section, approximately 75 msec beneath the Vivian. As a note, much of the seismic data in the Basin with its current state of processing would be unusable for such an evaluation due to the poorer quality of data. This is a readily mappable amplitude anomaly on the Block that demonstrates the possibilities of identifying stratigraphic traps when better quality seismic is available.

Another lead on the Block is in the northeastern region of the Block where little SEG-Y seismic data was available. A very prominent southwest plunging nose can be mapped in this zone that has been designated the 'Arabela South' nose. Of particular interest are a series of discontinuous amplitude anomalies within the Cretaceous section that terminate over, or on, the flanks of this structure. With additional seismic it may be possible to define very large combination stratigraphic/structural traps that are associated with the nose.