

Shell, Texaco and Occidental - Pioneers in the Exploration in Putumayo, Oriente and Marañón Basins*

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Abstract

The Putumayo-Oriente and Marañón Basins in Colombia, Ecuador and Peru are located in a foreland zone between the Andes to the west and the Guyana shield on the east. It covers about 320,000 km². Over 3 Billion barrels of oil (BBO) and 1,000 billion cubic feet of gas (BCFG) have been produced from the Putumayo-Oriente and Marañón Basins. Estimated undiscovered recoverable resources range from 1,000 to 7,000 BBO and 250 to 5,000 BCFG. The main hydrocarbon reservoirs in the Putumayo Basin in Colombia are the Cretaceous Caballos and Villeta and the Tertiary Pepino Formations. Oil is produced in the Oriente Basin of Ecuador mostly from sandstones of the Cretaceous Hollin and Napo Formations. In Peru's Marañon Basin, the reservoirs are sandstones of the Cretaceous Cushabatay, Agua Caliente, Chonta and Vivian Formations. Oil exploration in the Putumayo-Oriente and Marañón Basins started in 1921. The first discovery is Orito, in 1963, in the Putumayo by Texaco. The Oriente Basin has been intensively explored since the early 1930s. Shell first explored for oil in the Oriente Basin of Ecuador in the 40's mainly using field geology. Because of these efforts, three wells were drilled, Macuma, Pumbuiza and Tiputini, all three abandoned with only oil shows. Following the string of discoveries in the Putumayo Basin by Texaco in the 1960's, and interpreting the petroleum geology to continue down to the south into Ecuador and after negotiating with the government of Ecuador in the early 1960's for exploration acreage, Texaco undertook a large field geology campaign in the Oriente Basin of Ecuador, followed by 2D seismic. In April 1967, Texaco drilled the first exploration well, Lago Agrio # 1, a subtle structure in the foreland basin. The well TD into the top of the Pre-Cretaceous Chapiza Formation. The well tested 1,399 Bopd, 29.30 API from the Cretaceous Hollin Formation. This was the start of the modern oil industry in Ecuador. The Oriente basin of Ecuador contains the largest discovery to date in the Putumayo-Oriente-Marañon basins, the Shushufindi field, discovered by Texaco in 1970, with an estimated 3.5 BBO in place. The Marañón Basin of Peru was first explored for oil in the 1930s and 1950s. The first commercial discoveries in the basin were made by Occidental and PetroPeru in 1972.

Selected Reference

Mathalone, J.M.P., and M. Montoya, 1995, Petroleum geology of the Sub-Andean Basins of Peru: AAPG Memoir 62, p. 423-444.

Shell, Texaco and Occidental

Pioneers in the Exploration in Putumayo, Oriente and Marañón Basins



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History of Petroleum
Special Session



Agenda

- **How much oil**
- **Regional Geological Setting**
- **Exploration History**
- **Putumayo Basin**
- **Oriente (Ecuador) Basin**
- **Marañón Basin**
- **Summary**

Giant Oil Field County (in Ecuador)

More than 3 BBO and 1 TCFG produced to date from the Putumayo (Colombia), Oriente (Ecuador) and Marañon (Peru) basins. Ecuador is the sweet spot.

Estimated prospective resources (undiscovered recoverable resources) vary from *1,000 BBO to over 5,000 BBO and 200 to 4,000 BCFG*.

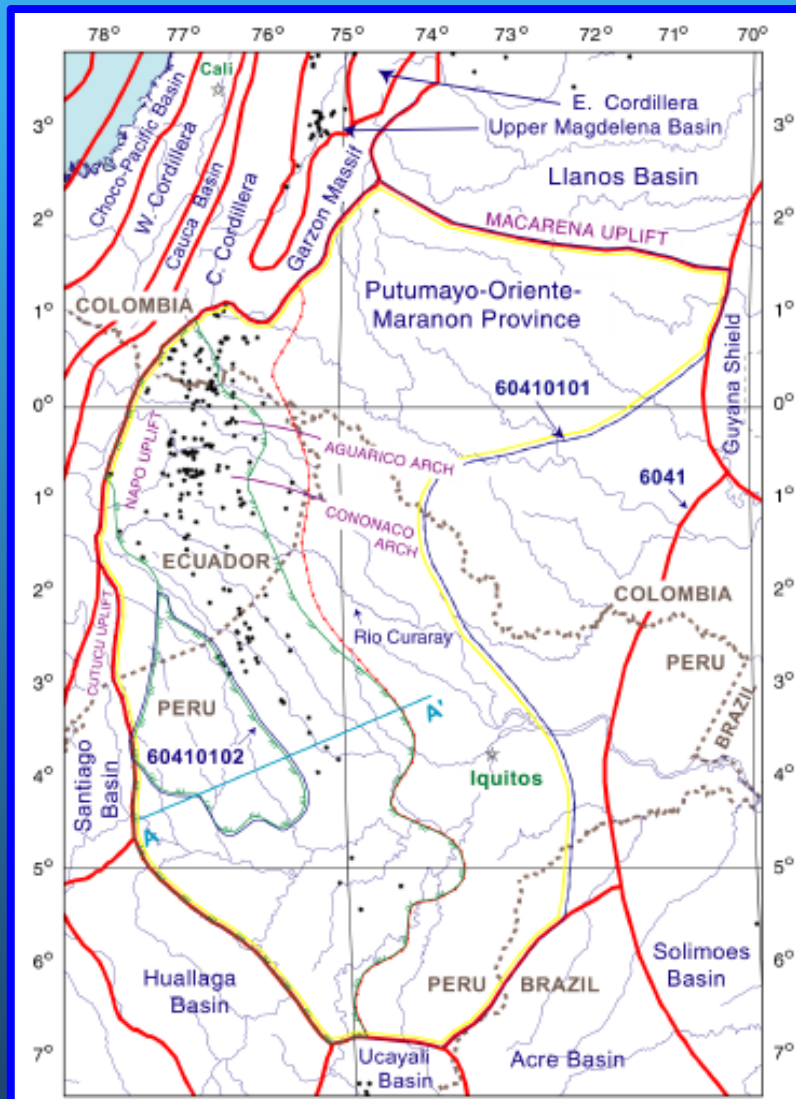
Major reservoirs.

Putumayo: Cretaceous Caballos and Villeta Formation and Lower Tertiary Pepino Formations.

Oriente: Cretaceous Hollin and Napo Formations.

Marañón: Cushabatay, Agua Caliente, Chonta, and Vivian Formations in the.

Regional Geological Setting, Basins Location, Strat Column



ERA	AGE	Putumayo Oriente Maranon		
		W → E		
CENOZOIC	TERTIARY	Pleistocene	Caiman	Chambira / Curaray
		Pliocene	Guamues	Arajuno / Curaray
			Ospina	Chalcana
		Miocene		
		Oligocene	Orito Gp.	Orteguaza
MESOZOIC	CRETACEOUS	Eocene	Rumiyaco	Tiyuyacu
		Paleocene		
			Nivel de Lutitas y Arenas	Tena
		Maastrichtian	Olini Gp.	
		Campanian		
		Santonian		
		Coniacian	"N" Ss	
		Turonian	Villeta	
		Cenomanian	"T" Ss	
		Albian	"U" Ss	
		Aptian	Caballos	
PALEOZOIC	JURASSIC			
PALEOZOIC	TRIASSIC			
PALEOZOIC	PERMIAN			
PALEOZOIC	CARBONIFEROUS			
PALEOZOIC	DEVONIAN			
PALEOZOIC	SILURIAN			
PALEOZOIC	ORDOVICIAN			
PALEOZOIC	CAMBRIAN			
PALEOZOIC	PRECAMBRIAN			

After USGS Digital Series Paper # 63 (Modified)

W

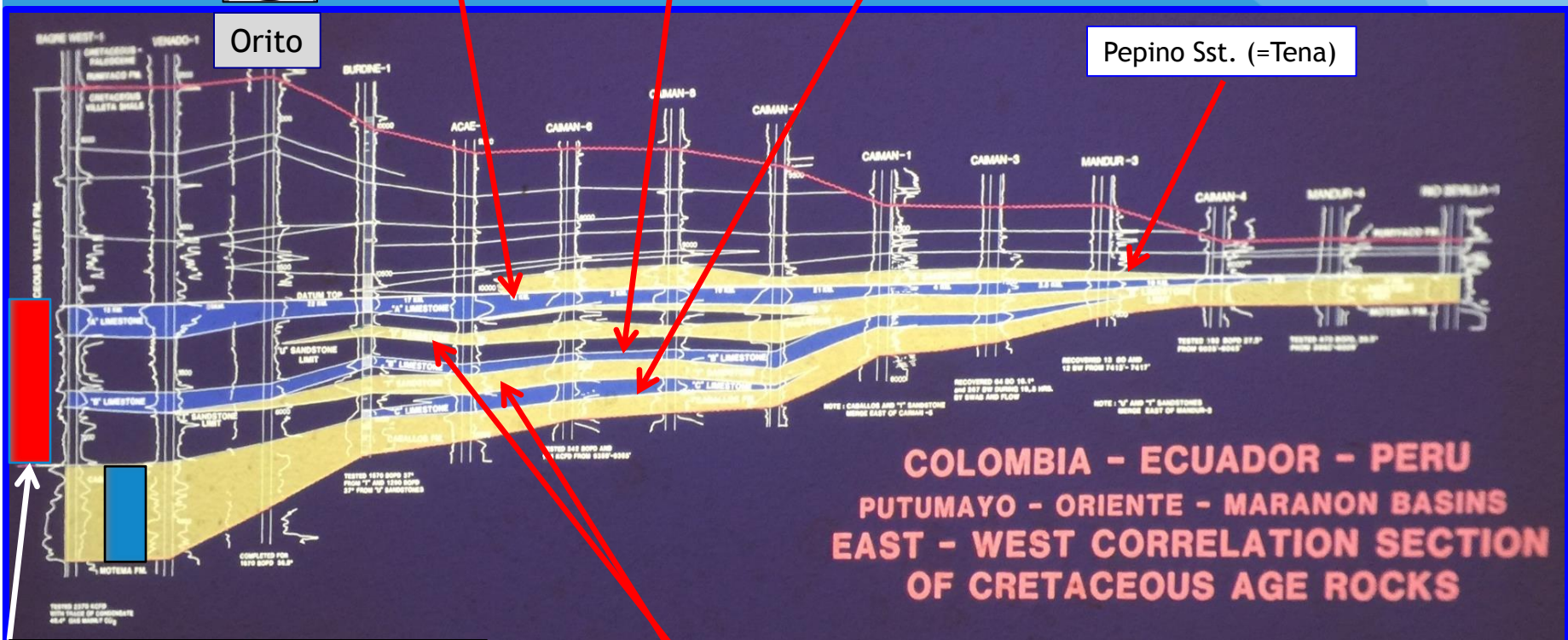


B Limestone

C Limestone

E

Pepino Sst. (=Tena)



Lower Villeta (Colombia)
= Napo (Ecuador)
= Chonta/Agua Caliente/Raya
(Peru)

Lo Villeta Sandstones In Colombia
U and T Sandstones in Ecuador
Chonta and Aguacaliente Sandstones (Peru)

PETROLEUM SYSTEM ELEMENTS 1.

Putumayo, Oriente, Marañón Basins

- Structural-stratigraphic accumulations, some *very* subtle.
- Main reservoirs are the fluvial/estuarine channel fills and nearshore marine environments of the Napo U and T in the Putumayo and Oriente and its counterpart, the Vivian sandstone in Marañón.
- Depths to the reservoirs ranges from 30 to 15,000 ft.
- Thickness: Napo-Villela varies with average of 300 meters and up to 900 meters. Porosity : average 17% with up to 25% and Permeability 500 MD with up to 6,000 MD.

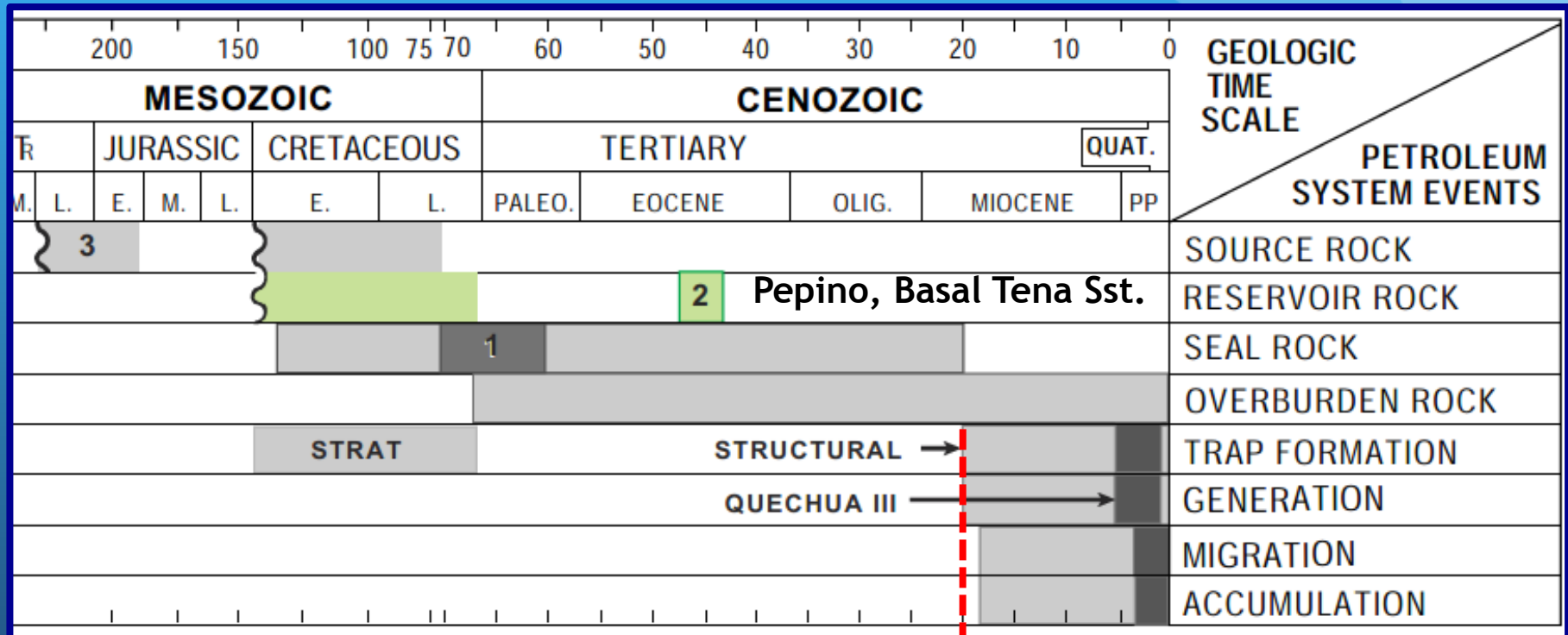


PETROLEUM SYSTEM ELEMENTS 2.

Putumayo, Oriente, Marañón Basins

- Source Rocks are the Cretaceous Villeta, Napo, Chonta Shales
- Seals are the Upper Cretaceous-Lower Tertiary Shale
- Thick sandstones of Caballos/Hollin/Cushabatay---major pathway of oil migration from downward expulsion from shallower rich source rocks.

Petroleum Systems Event Table, Putumayo, Oriente, Marañón Basins

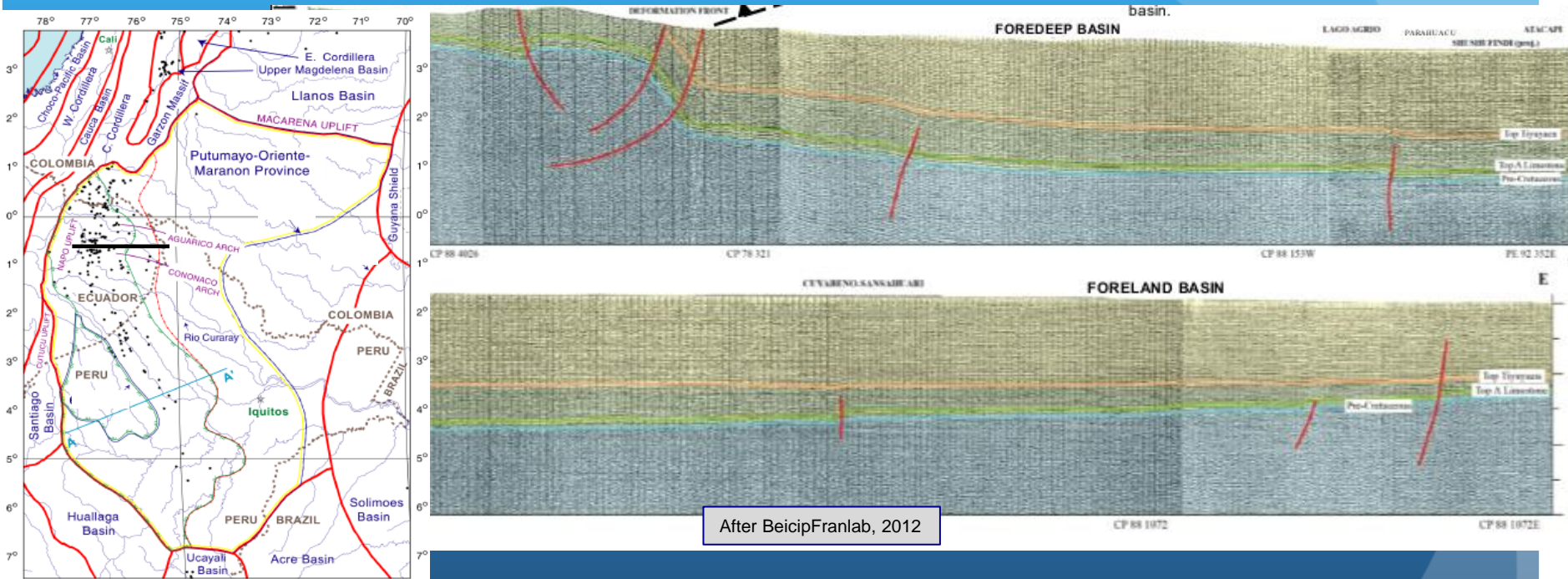


Critical Moment

Exploration History, Putumayo, Oriente, Marañón Basins

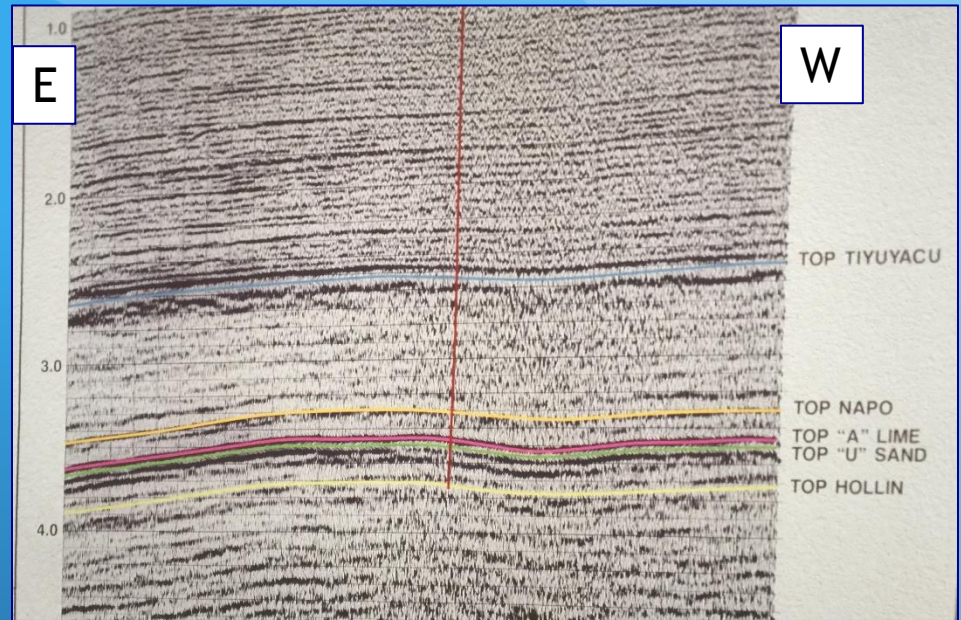
- Exploration in the Putumayo Basin was initiated in the late 1950s. First listed discovery was by Texaco in Orito (1963).
- Exploration in the Oriente Basin began with Shell's pioneering work. All Shell office stranded in Ecuador in WWII, had no where to go, performed extensive outcrop and drainage analysis studies, built a town, airport, road.
- The first discovery in the Oriente Basin by Texaco was Lago Agrio in 1967. Giant field, with hydrodynamics (tilted water contact, common in this megabasin)
- In the Marañón, exploration started in the late 1960s (Texaco, Mobil). First economic discovery was by Occidental in the 1970s---cluster. Union discovered 3 fields in adjacent acreage, sub-economic without Oxy's cluster. Dropped acreage, Oxy produced the heavy oil, co-mingled with their lighter crude.

Exploration History, Putumayo, Oriente, Marañón Basins



The first discovery in the Oriente Basin by Texaco was Lago Agrio in 1967. This was followed by a string of discoveries by Texaco, including, Shushufindi-Aguarico, the largest field in 1969, with 3.5 BBO in-place, followed by Sacha and Auca.

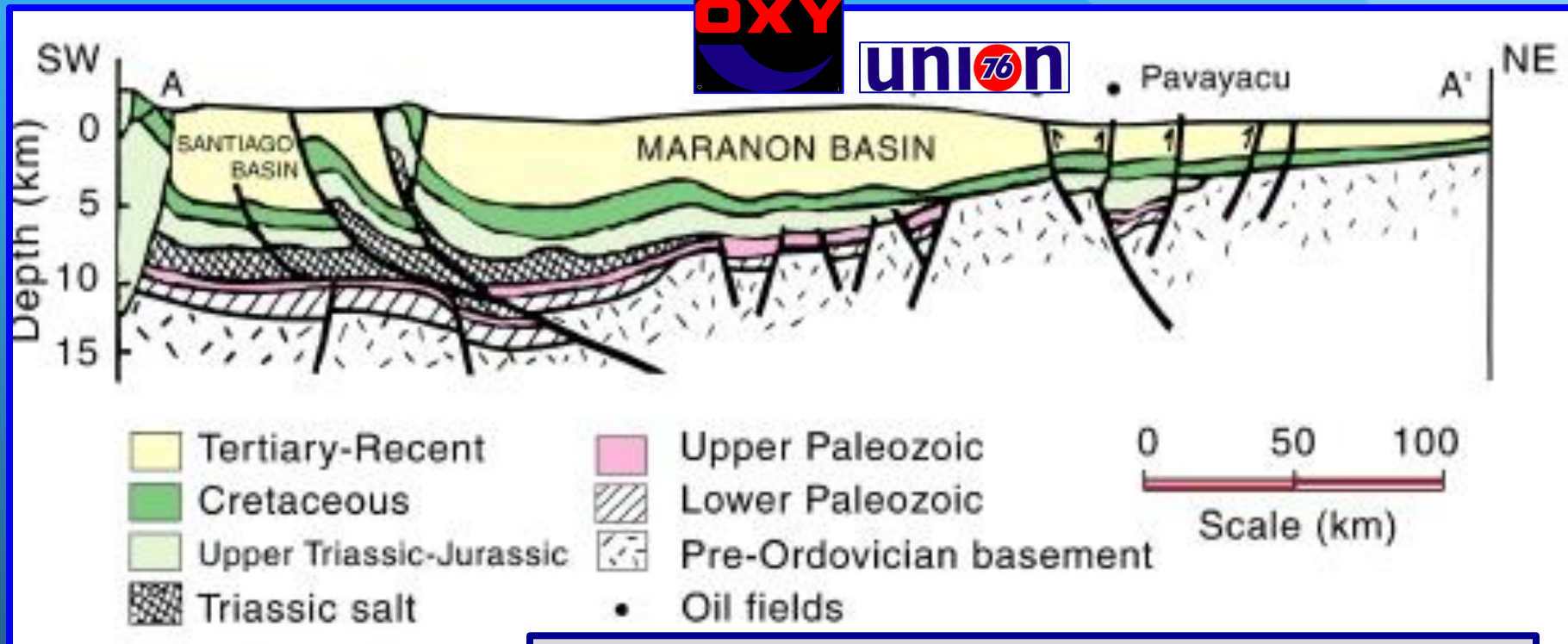
Seismic Acquisition, Oriente Basin



Oriente Basin, Well Lago Agrio # 1, Texaco, Completed 04-08-1967

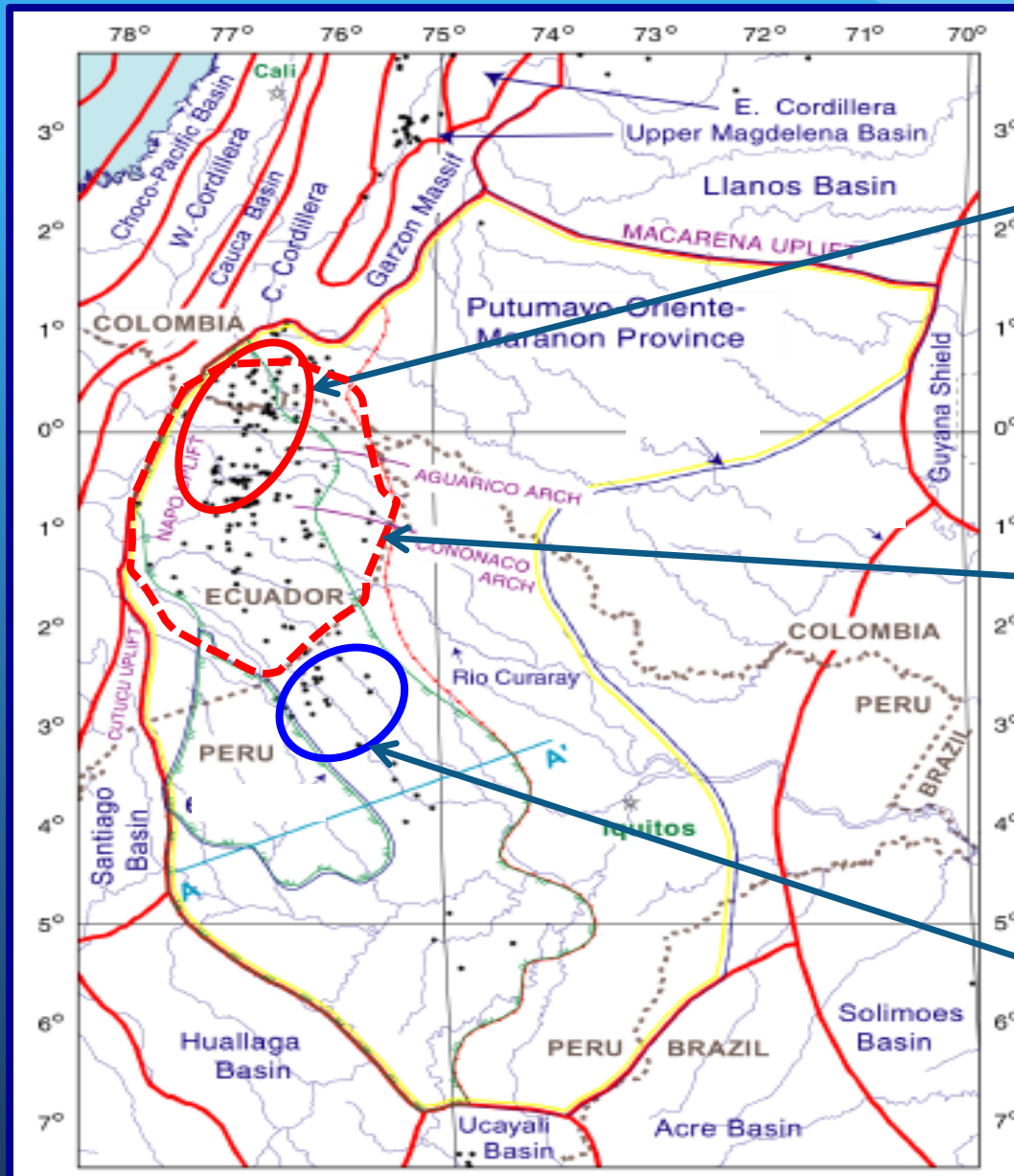


Northern Marañon Basin



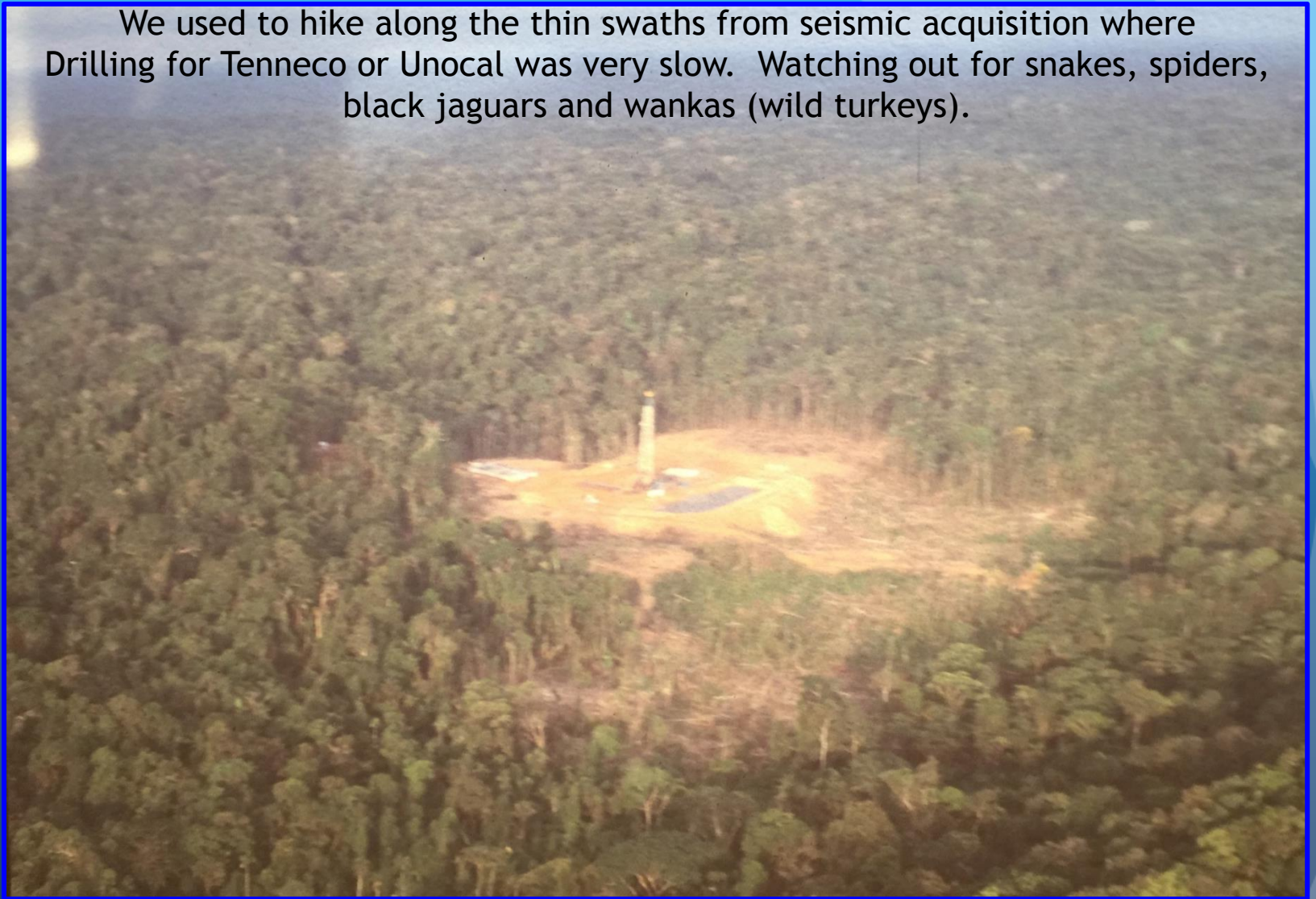
1. Oxy/Union Blocks acquired based on regional gravity data & drainage
2. Oxy's geoscience team came from experienced Texaco geoscientists, lawsuit ensued
3. Built pipeline, first significant oil in Marañon, boost to Peru's economy

Pathfinding Exploration Companies



Typical Rainforest: Tenneco Danta-1 Oil Discovery

We used to hike along the thin swaths from seismic acquisition where Drilling for Tenneco or Unocal was very slow. Watching out for snakes, spiders, black jaguars and wankas (wild turkeys).

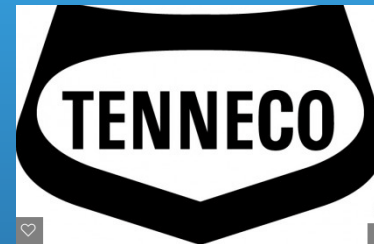


Second Tier Companies Which Discovered Oil in Order of BBO

Economic Resources total
> 150 BBO EUR



Subeconomic Resources total
< 150 BBO EUR



Operator



Conclusions 1

Pathfinding explorers: Shell

Foothills discoveries by Texaco, Shell, Burmah and others discovered based on excellent field work and regional geology

Peruvian and Colombian parts of this mega basin appear quite maturely explored

Ecuador: first company into the basin, Shell, did not find the giant oil fields

Conclusions 1

Paleozoic plays have been tested (Lago Agrio Deep Test-1) and a few other wells, but reservoirs were tight.

Robust hydrocarbon charge system: very rich source rocks, good to excellent reservoirs.

Considerable potential exists within Ecuador.

Following the Path of the Oil Finders is not only fun, but important to any initial regional evaluation of a basin.

Acknowledgements

In honor of deceased explorers who influenced us a great deal:
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