Quantifying Project Potential, Risk & Uncertainty in South America

Dr. Trey Meckel

Lic. Ricardo Piethé

28 February 2018

Framing Thoughts
[2017 USA House Foreign Affairs Committee]

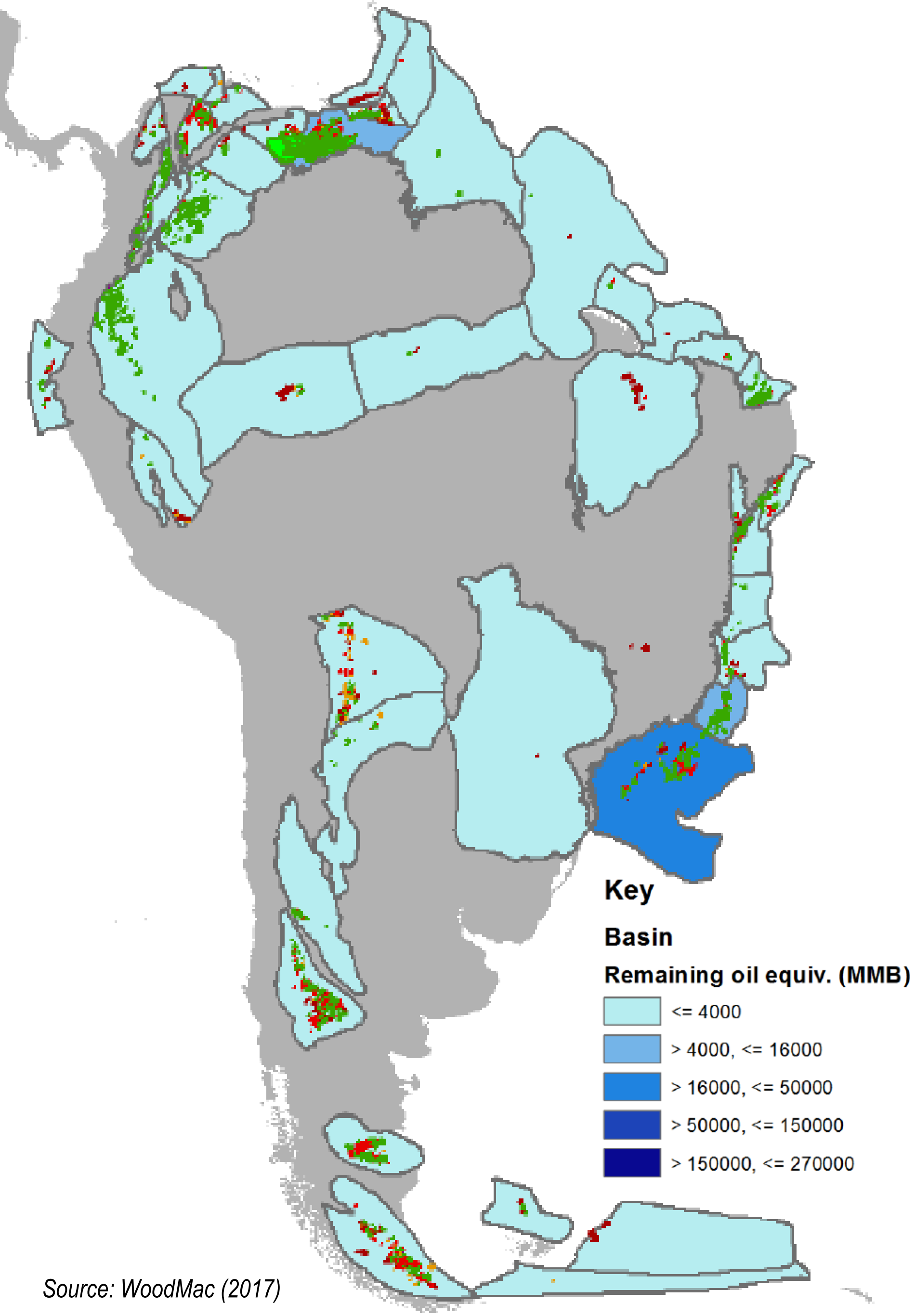
- "Abundant natural resources, growing markets, and increasingly favorable policy frameworks in many countries make South America **an increasingly important energy investment destination**."
- "The challenge is not the lack of oil and gas resources, but the **host countries' onerous contractual and fiscal terms and conditions, regulatory environment, and the lack of stability and continuity** that international oil companies need in order to invest and sustainably monetize and commercialize these resources."
- "A change appears to be under way, and **countries now are making reforms to advance free market-friendly energy policies and attract foreign investment**."

Roadmap

- What plays have been successful?
  - Historical perspective
- Selected plays that offer exploration potential (proven and frontier basins)
  - Deepwater
  - Onshore conventional
  - Unconventional (shale gas & tight oil)
- Risk & Uncertainty

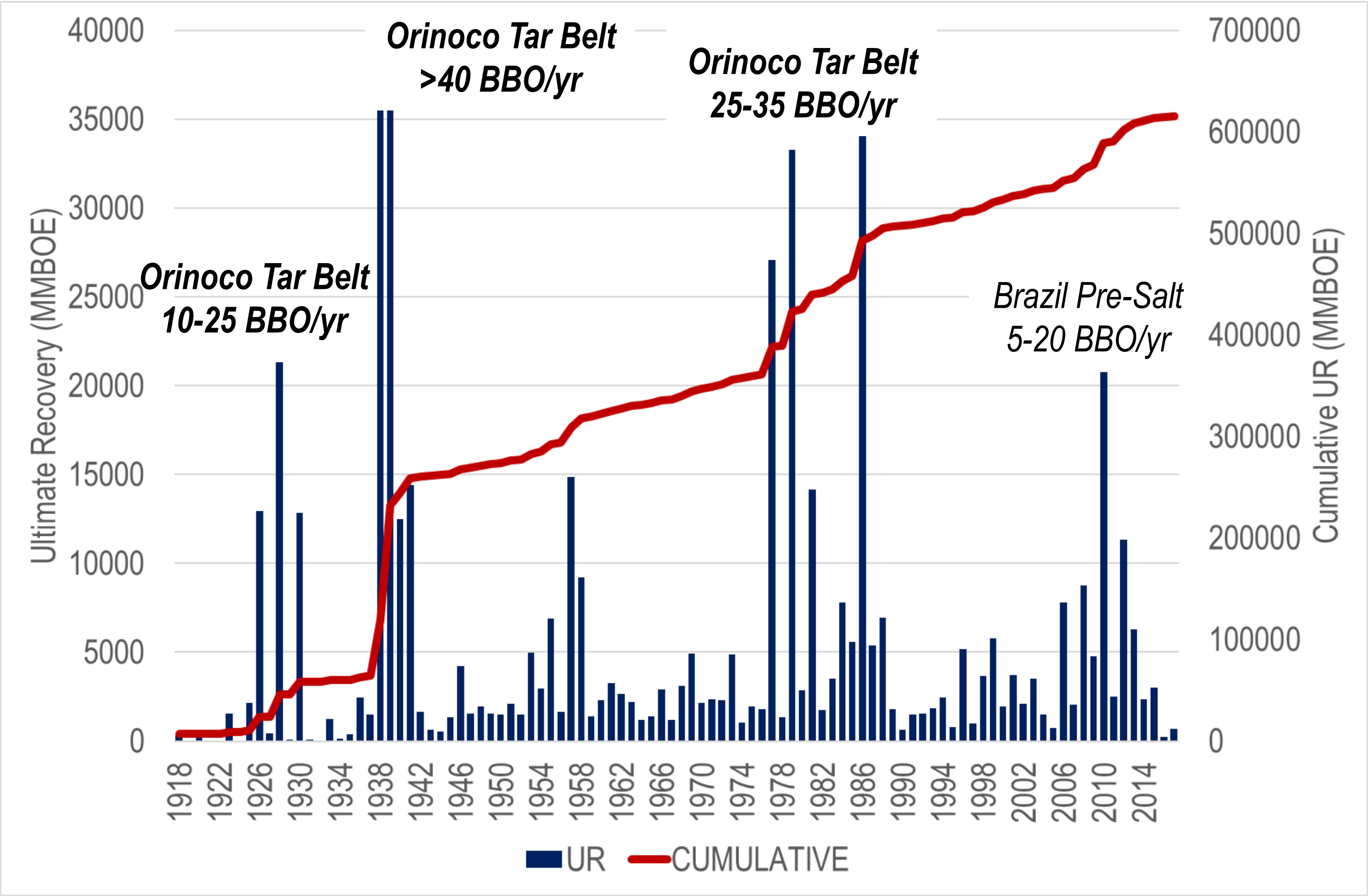
pluspetrol

A Century of Discovery

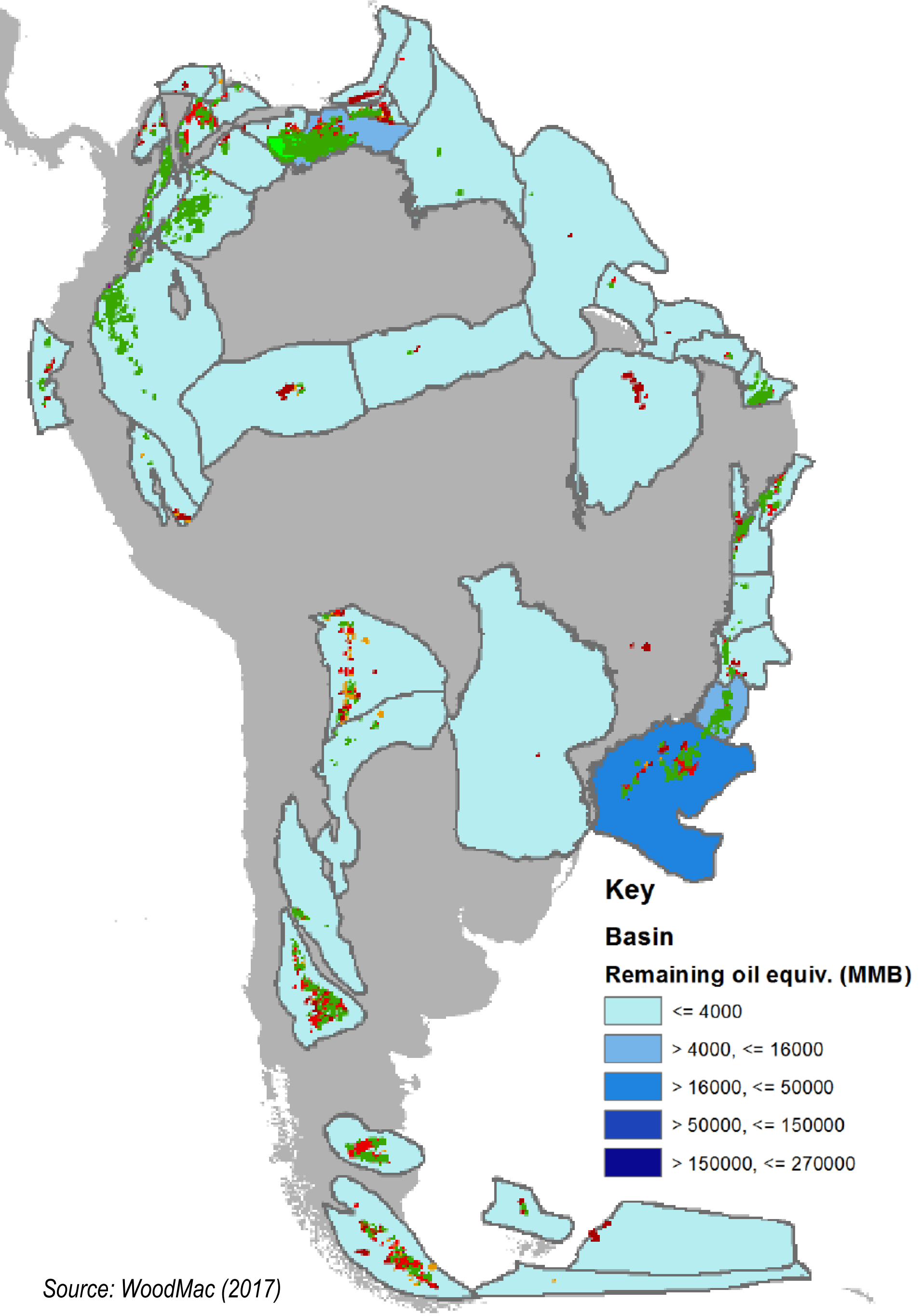


Source: WoodMac (2017)

South American Discoveries 1918-2017

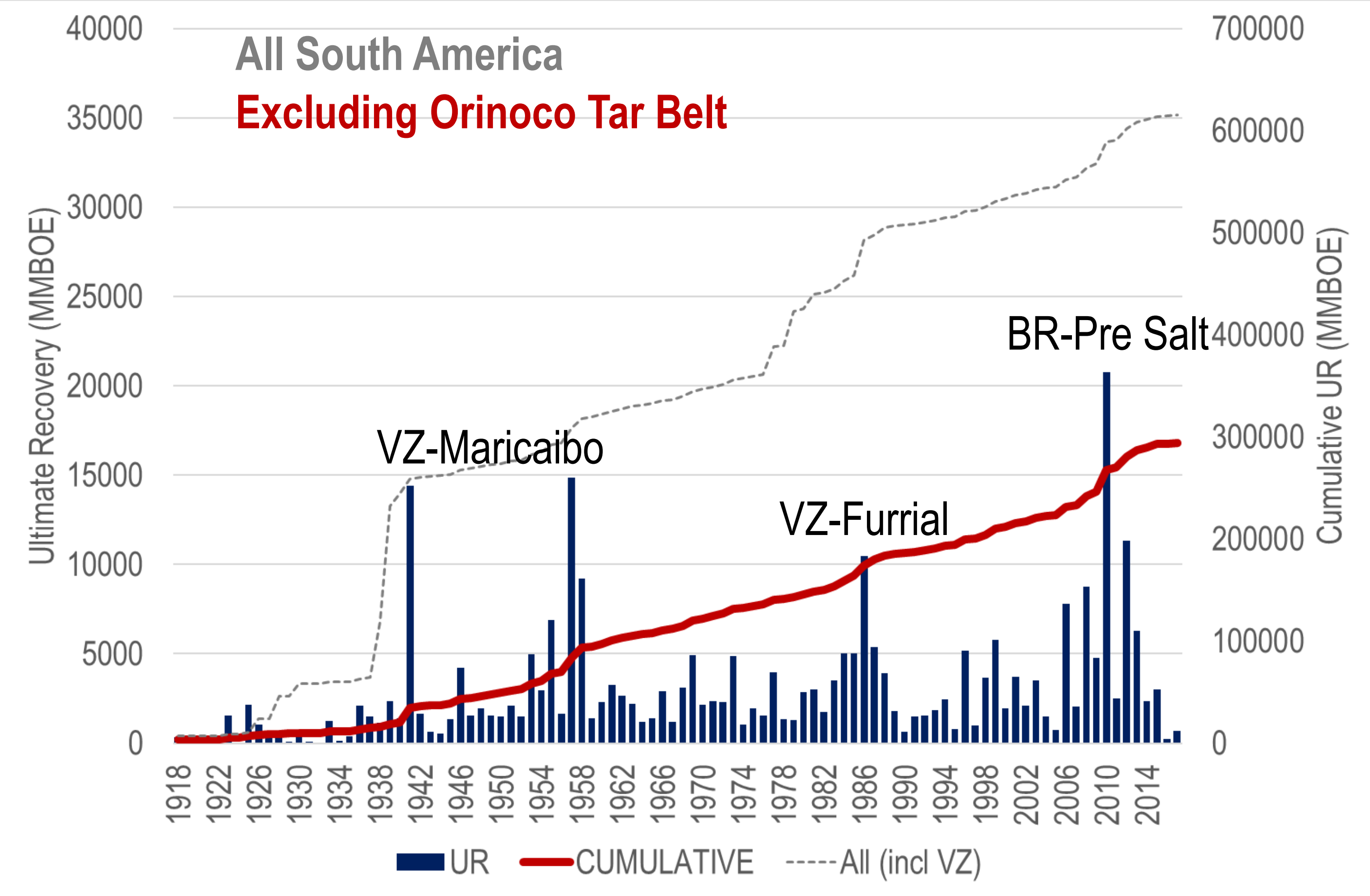


A Century of Discovery

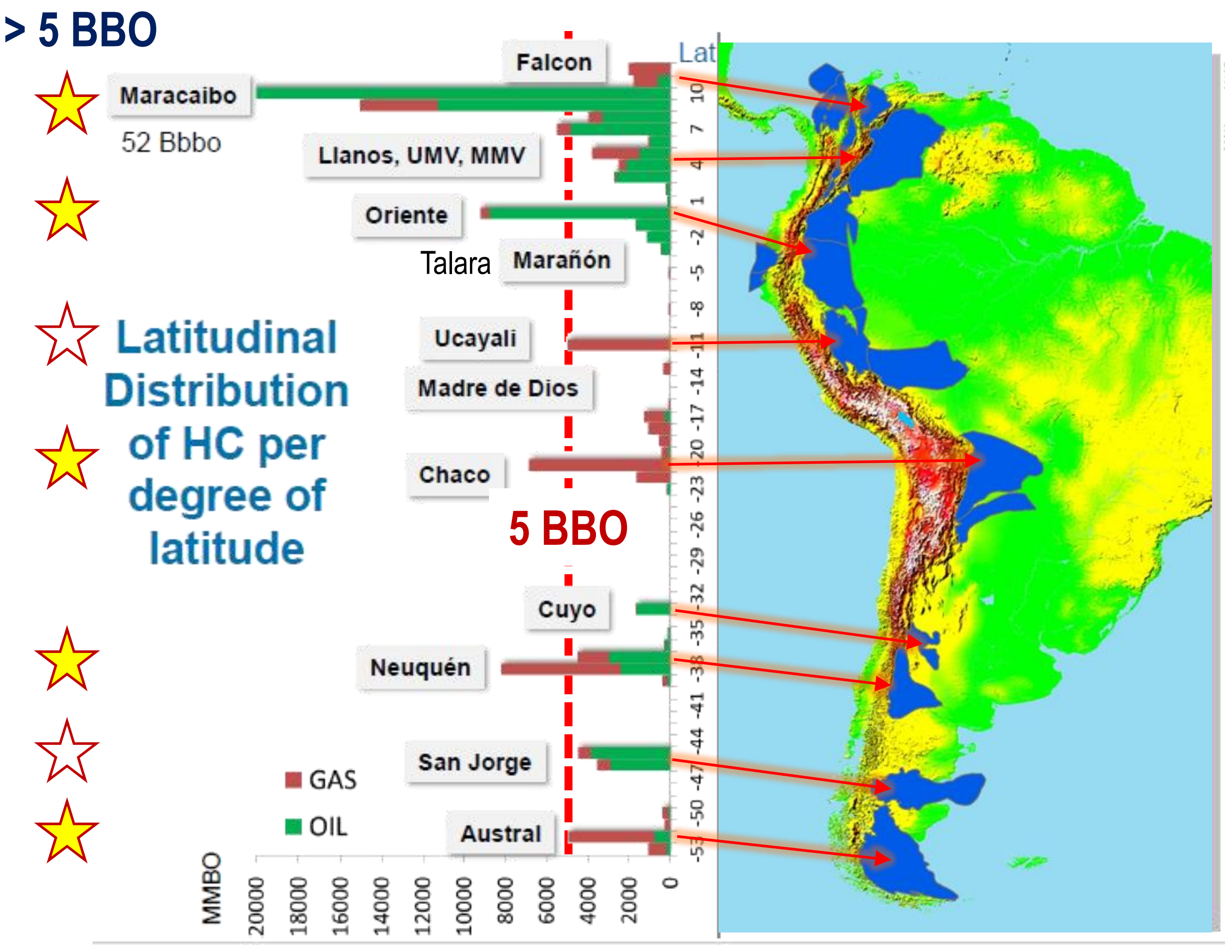


Source: WoodMac (2017)

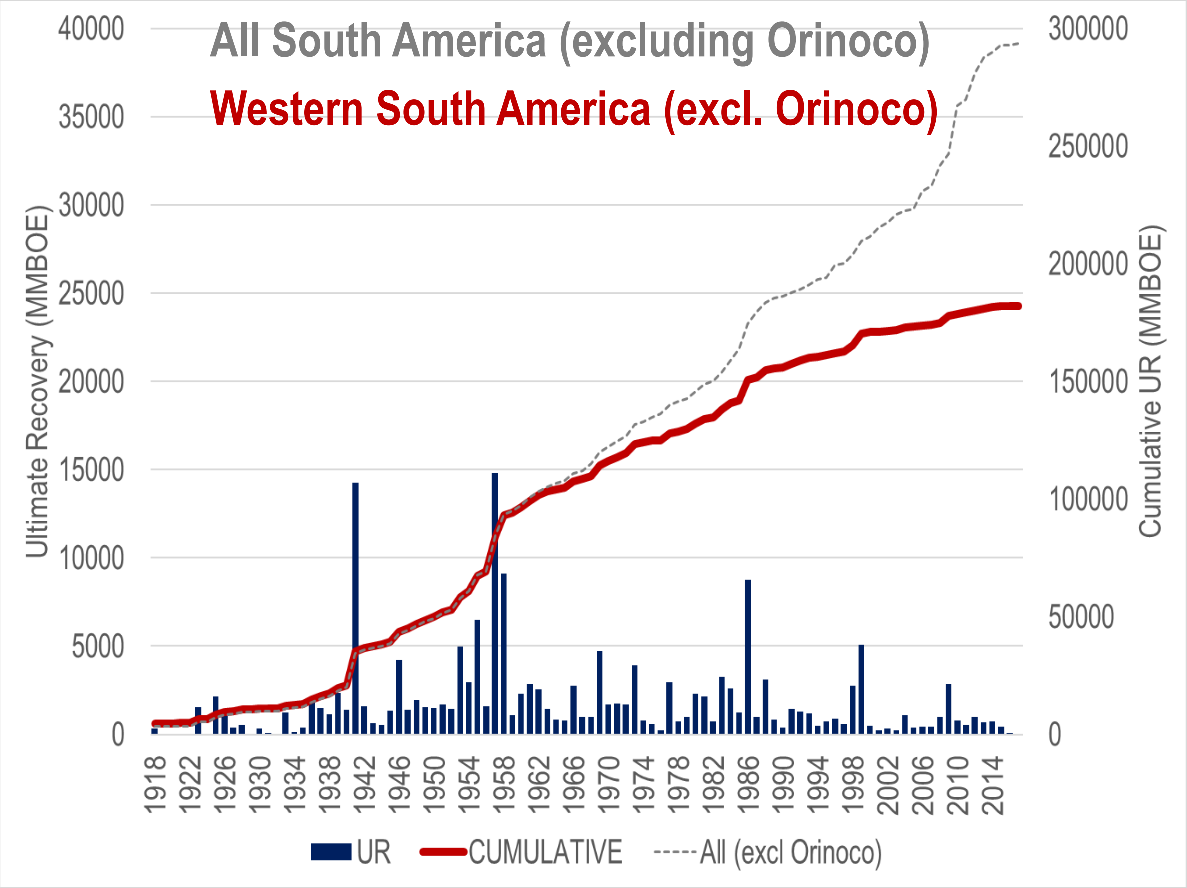
South American Discoveries 1918-2017



Western South America

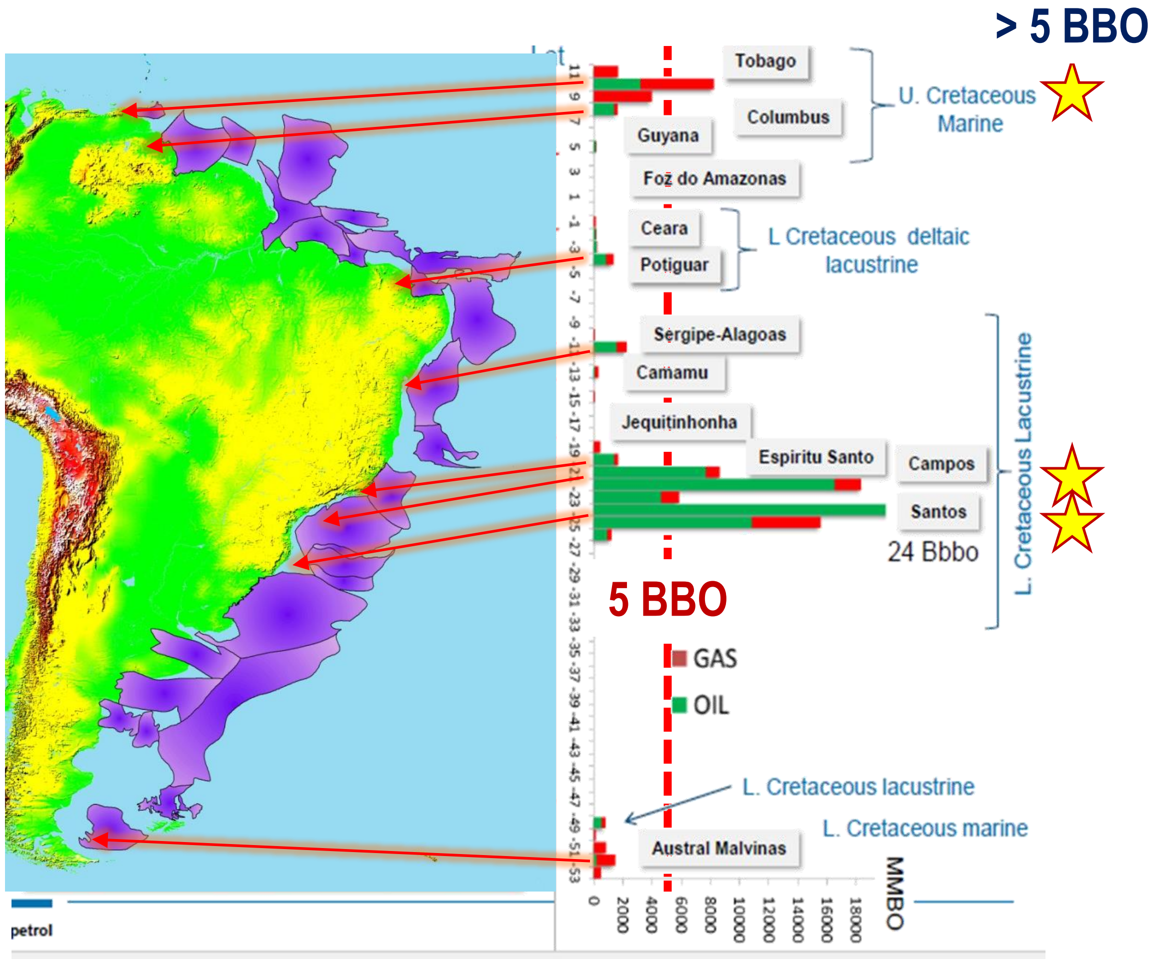


After Carlos Macellari (2017)

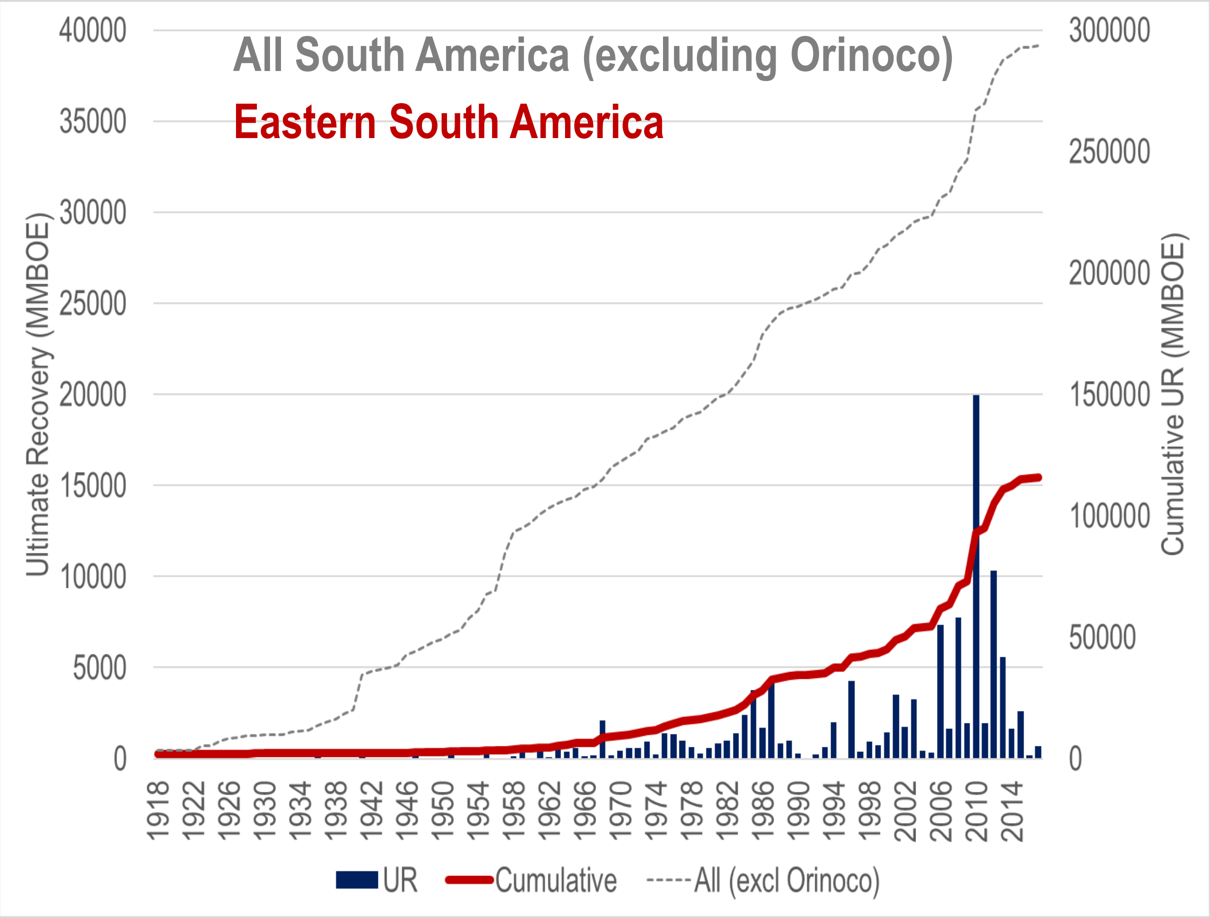


Maturing steadily. Not obviously creamed, but getting close…

Eastern South America

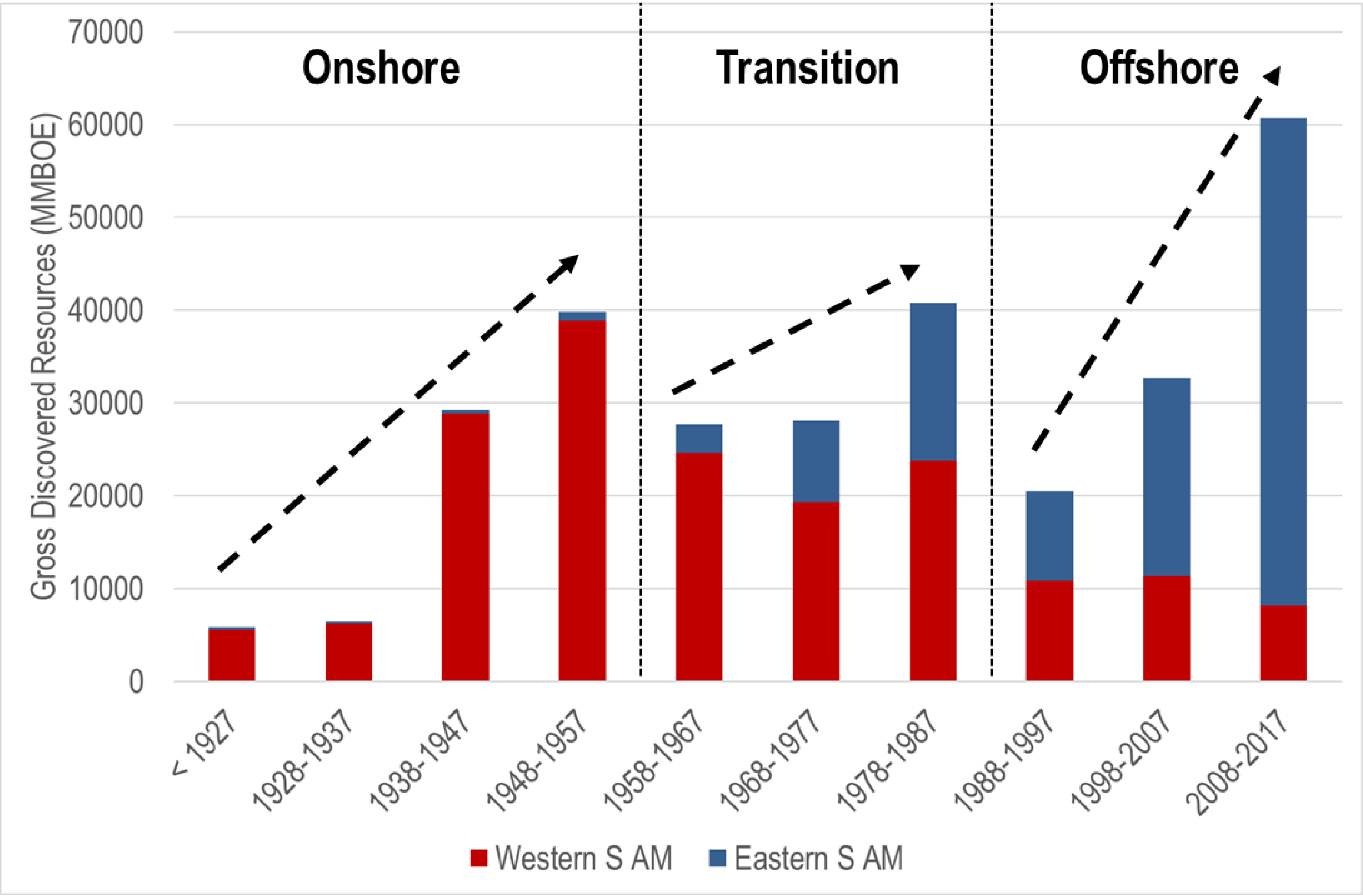


After Carlos Macellari (2017)



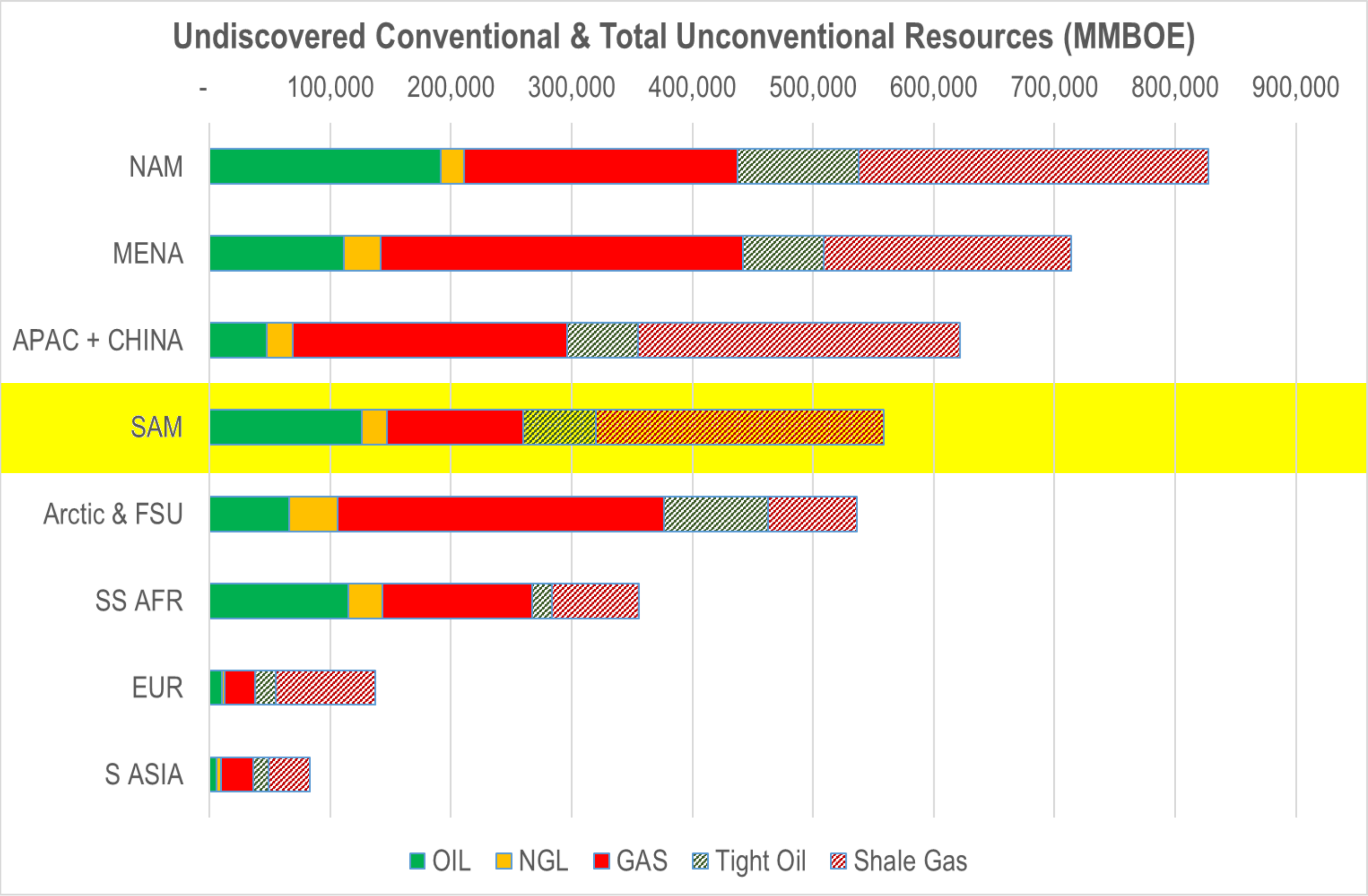
Recent slow-down, but probably still immature

Shift in Exploration Focus through Time



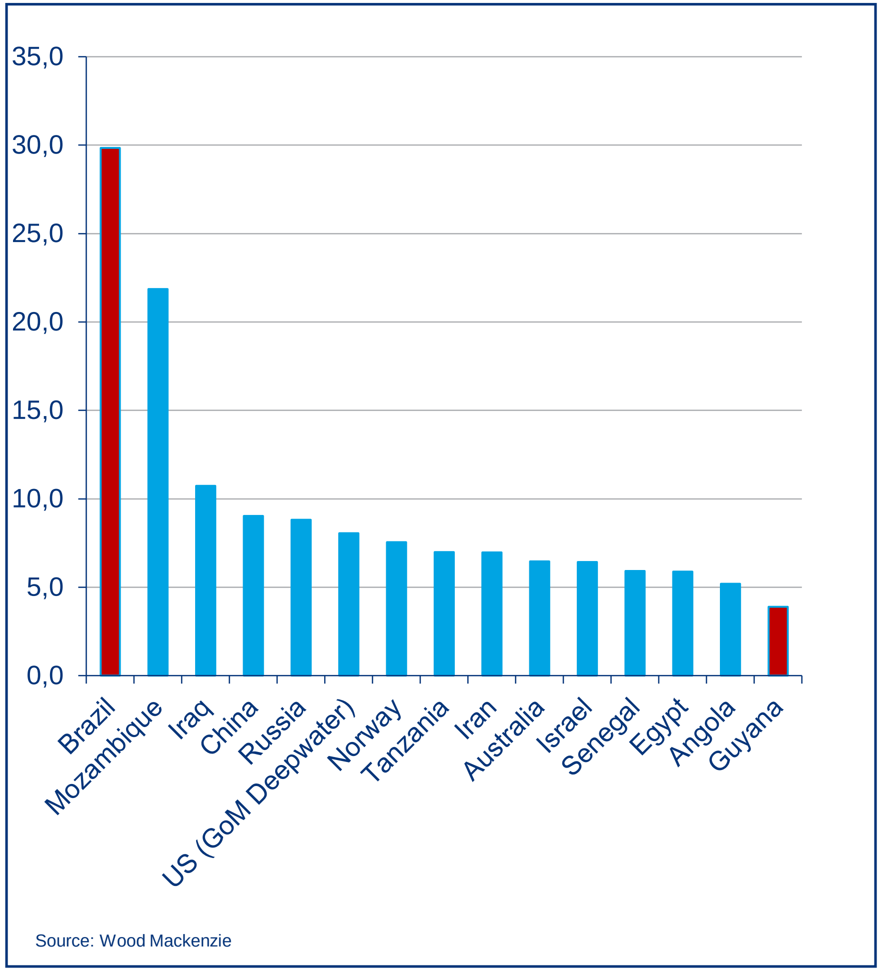
- Three periods of major reserves growth
- Change in focus from west (primarily onshore FFTB) to east (primarily offshore, especially since 1980s)

Exploration: Estimated Undiscovered Conventional Resources & Total Unconventional Resources



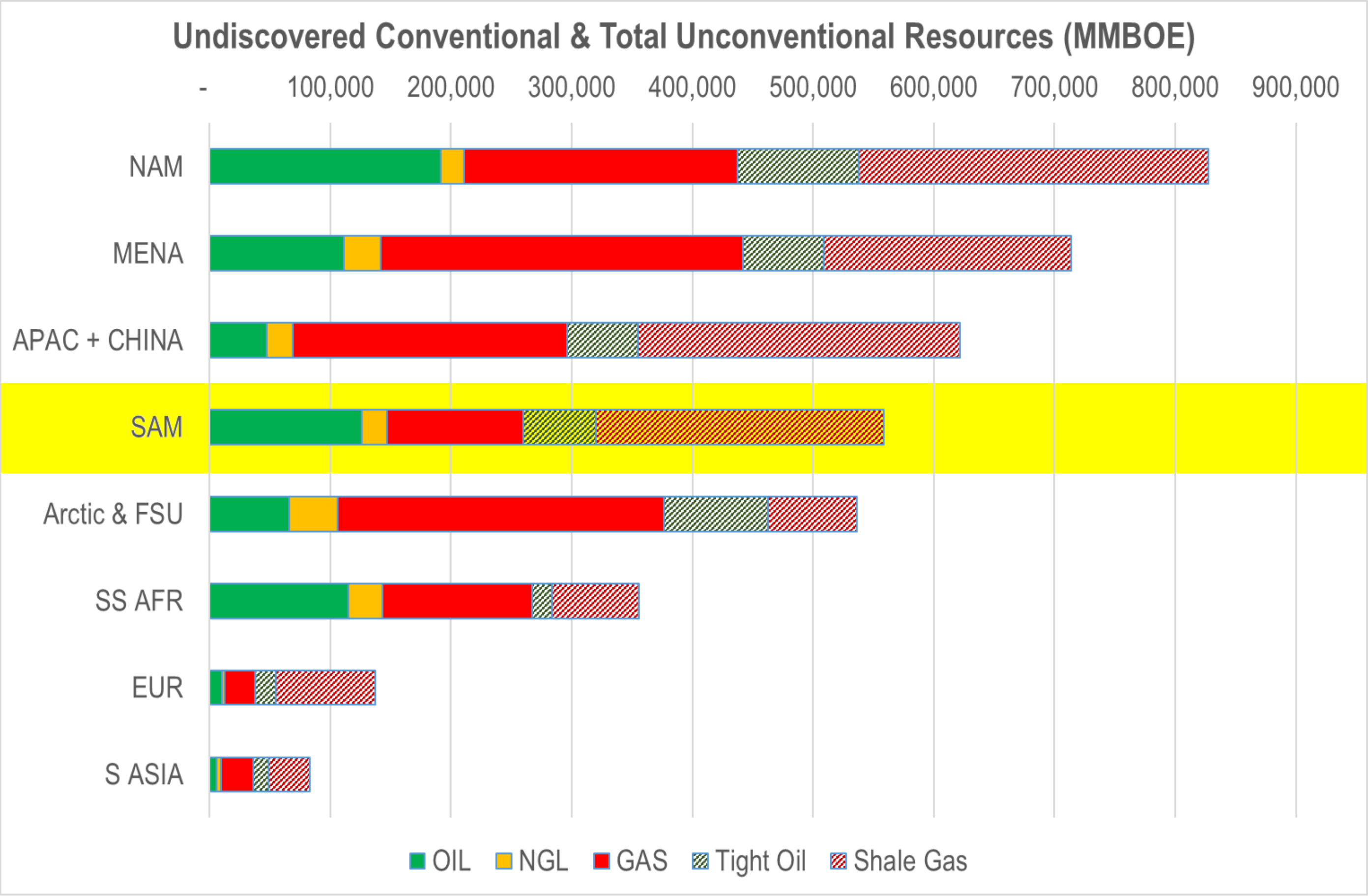
Data Sources: USGS & EIA

Discovered resources (BBOE) 2008-2018



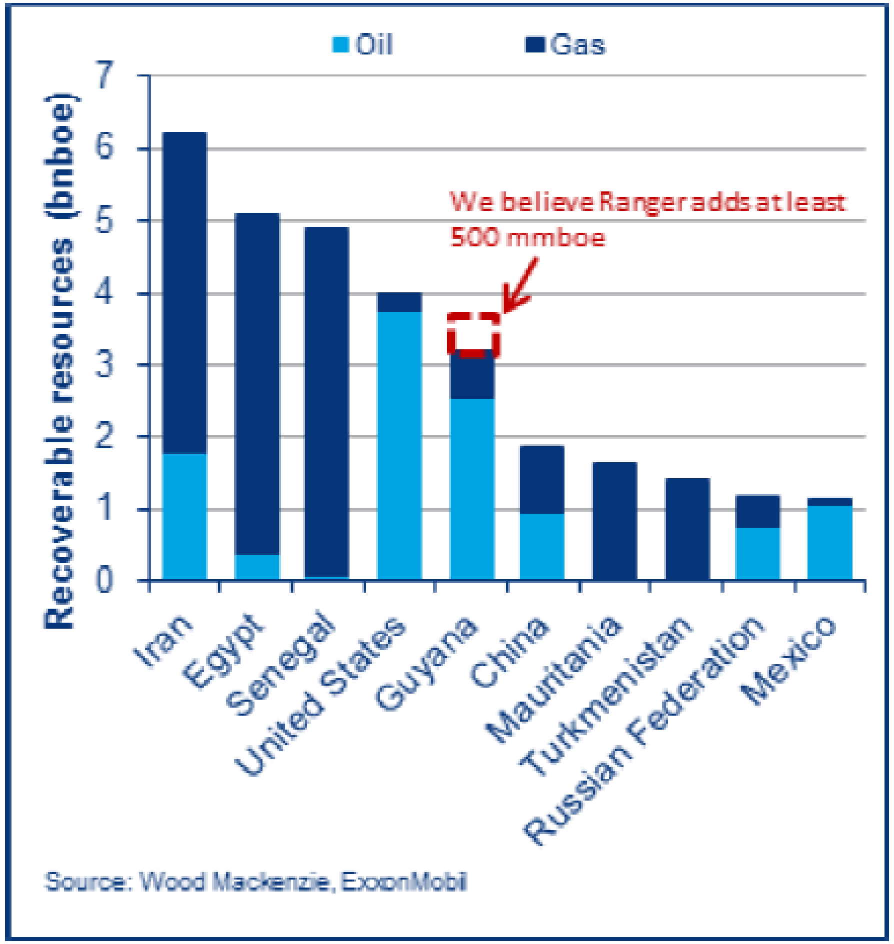
pluspetrol

Exploration: Estimated Undiscovered Conventional Resources & Total Unconventional Resources

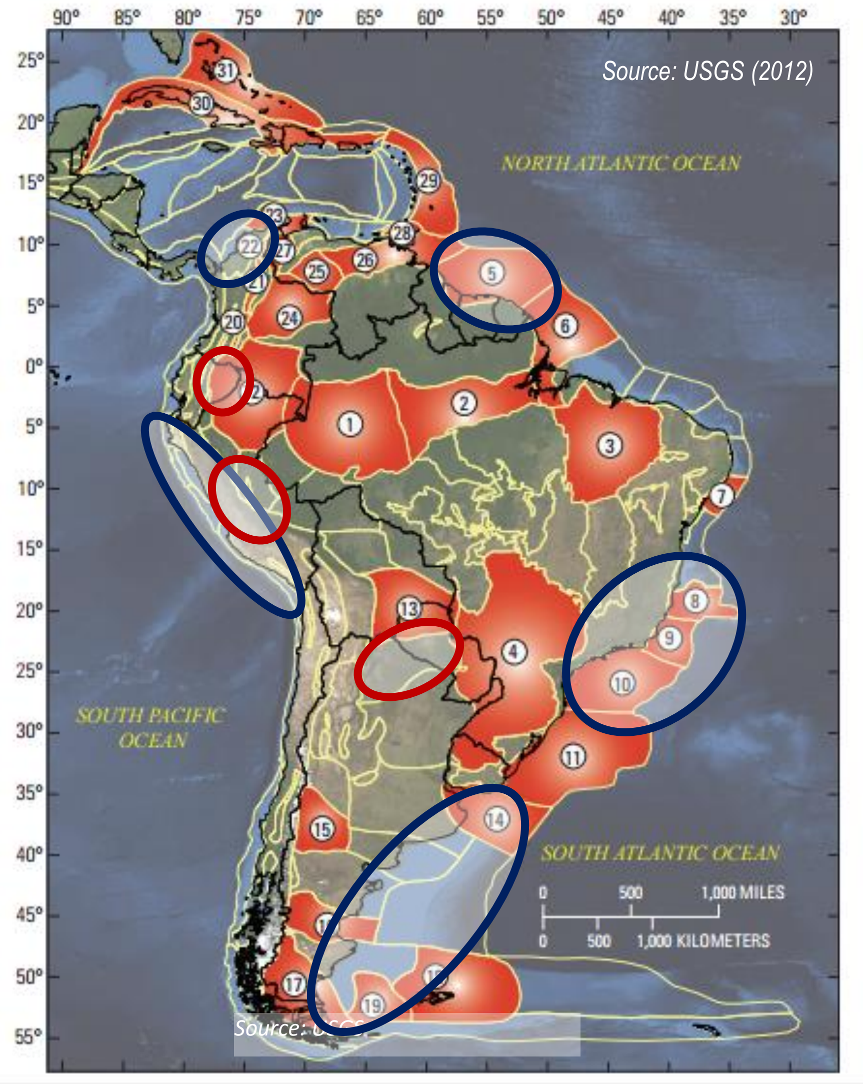


Data Sources: USGS & EIA

Conventional discoveries 2015 - 2018



Unlocking the Next Generation of Conventional Discoveries



Latin America is still a very attractive region to explore – but new ideas will be necessary to find future "sleeping giants"

Mean yet-to-find <u>conventional</u> oil and gas resources of South America and the Caribbean are estimated to be substantial (USGS, 2012)

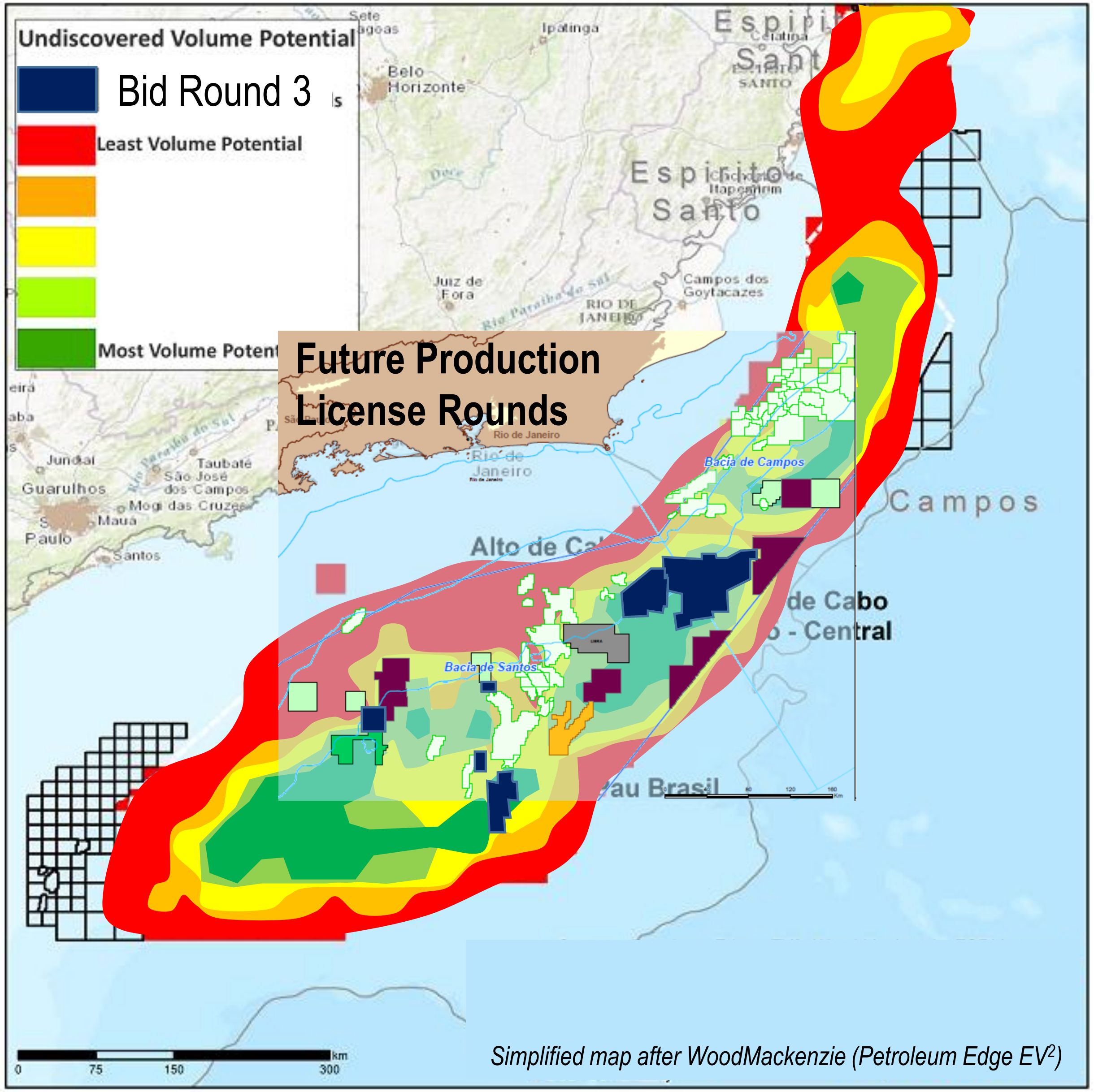
- 126 BBO (22% of global YTF)
  - Almost half in offshore (sub-salt) Brazil
- 21 Bn bbl NGL (13% of global YTF)
- 679 TCFG (12% of global YTF)

~40% of volumes discovered to date (90% excl. Orinoco)

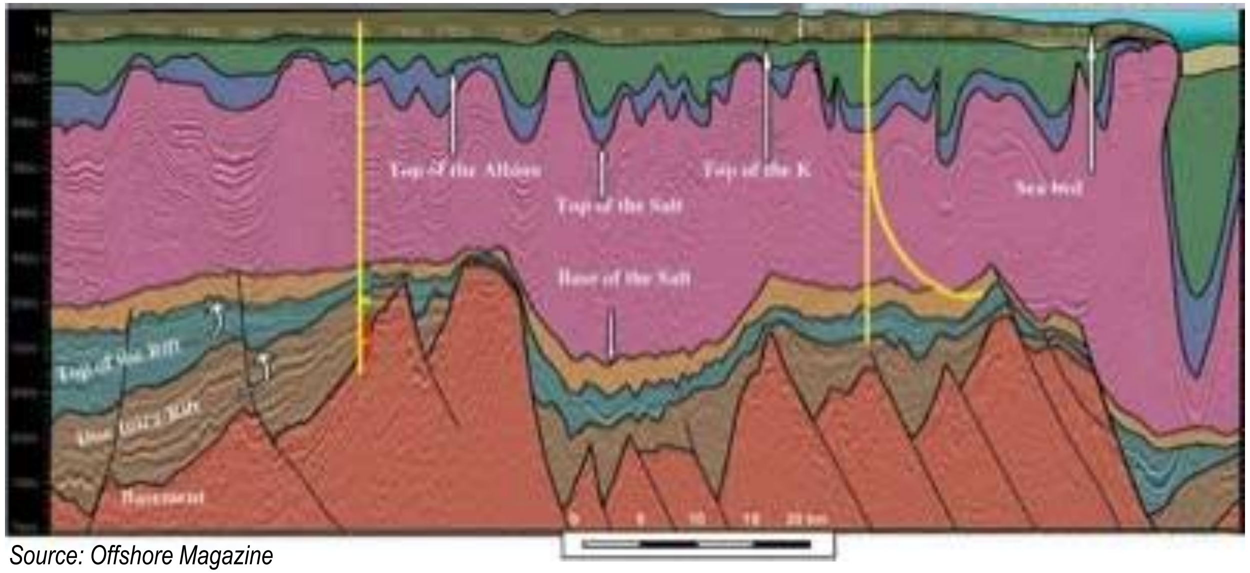
Numerous prospective basins not quantified (e.g., Chaco-Parana, Madre de Dios/Ucayali (Peru), offshore Colombia, equitorial Brazil, offshore Perú, offshore Argentina deepwater, …)

Necessarily speculative in terms of new/untested frontier exploration plays & undrilled stratigraphy in prolific basins

Brazil Pre-Salt



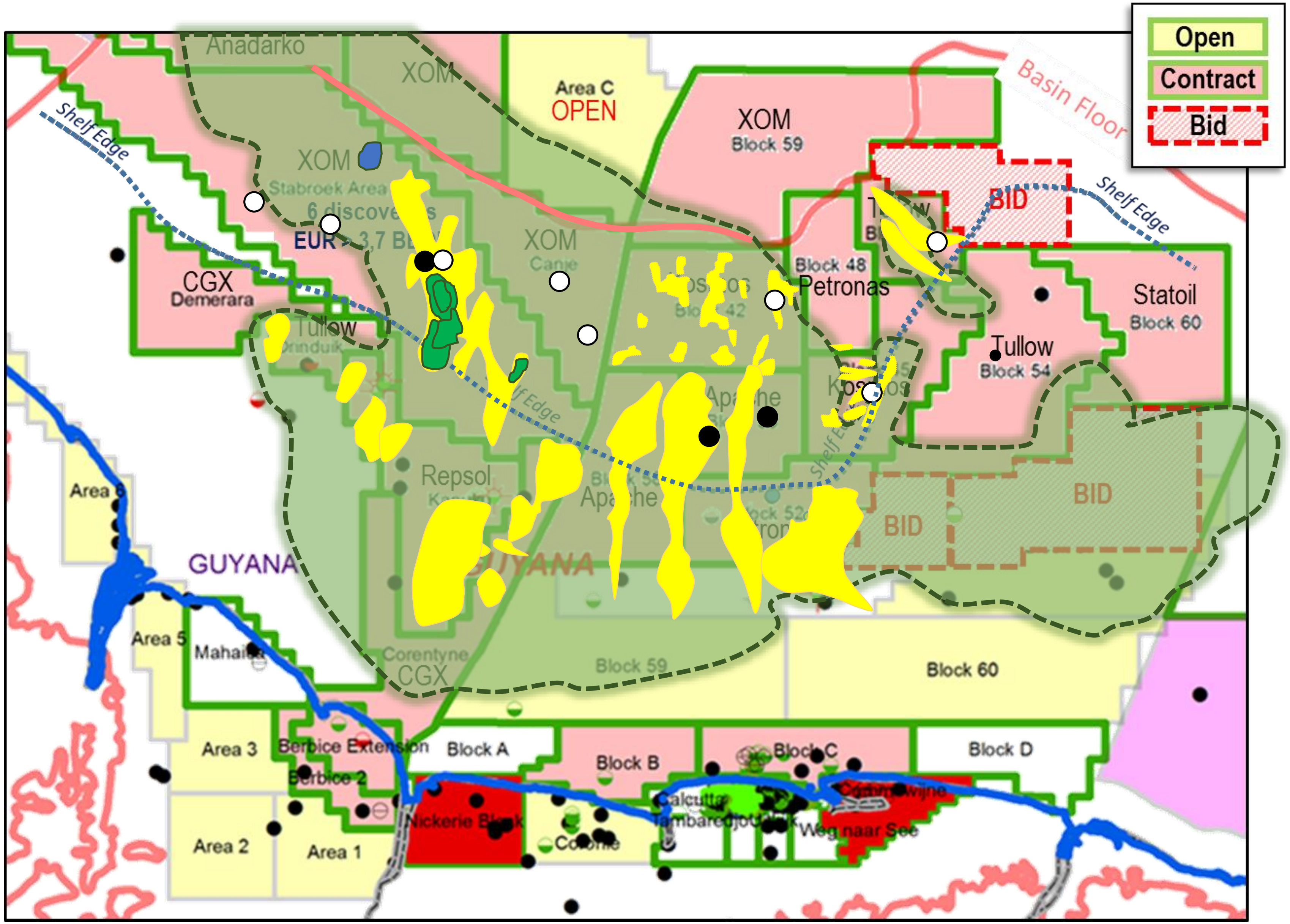
Simplified map after WoodMackenzie (Petroleum Edge EV[2])


Source: Offshore Magazine

- High prospectivity (multi-billion barrel potential)
- Large resource base and impressive well deliverability produce some of the most attractive development economics outside of tight oil
- PSC Bid Round 3 (2017)
  - First opportunity in 12 years to access pre-salt exploration acreage through licensing.
  - Considerable improvements to the PSC terms (including minimum bid levels) and to Brazil's upstream regulations (operatorship, local content) since the 1st PSC Round in 2013
  - 6 of 8 blocks awarded
  - Bids from eleven participating companies
  - US$1.9 billion in signature bonuses

Guyana-Suriname

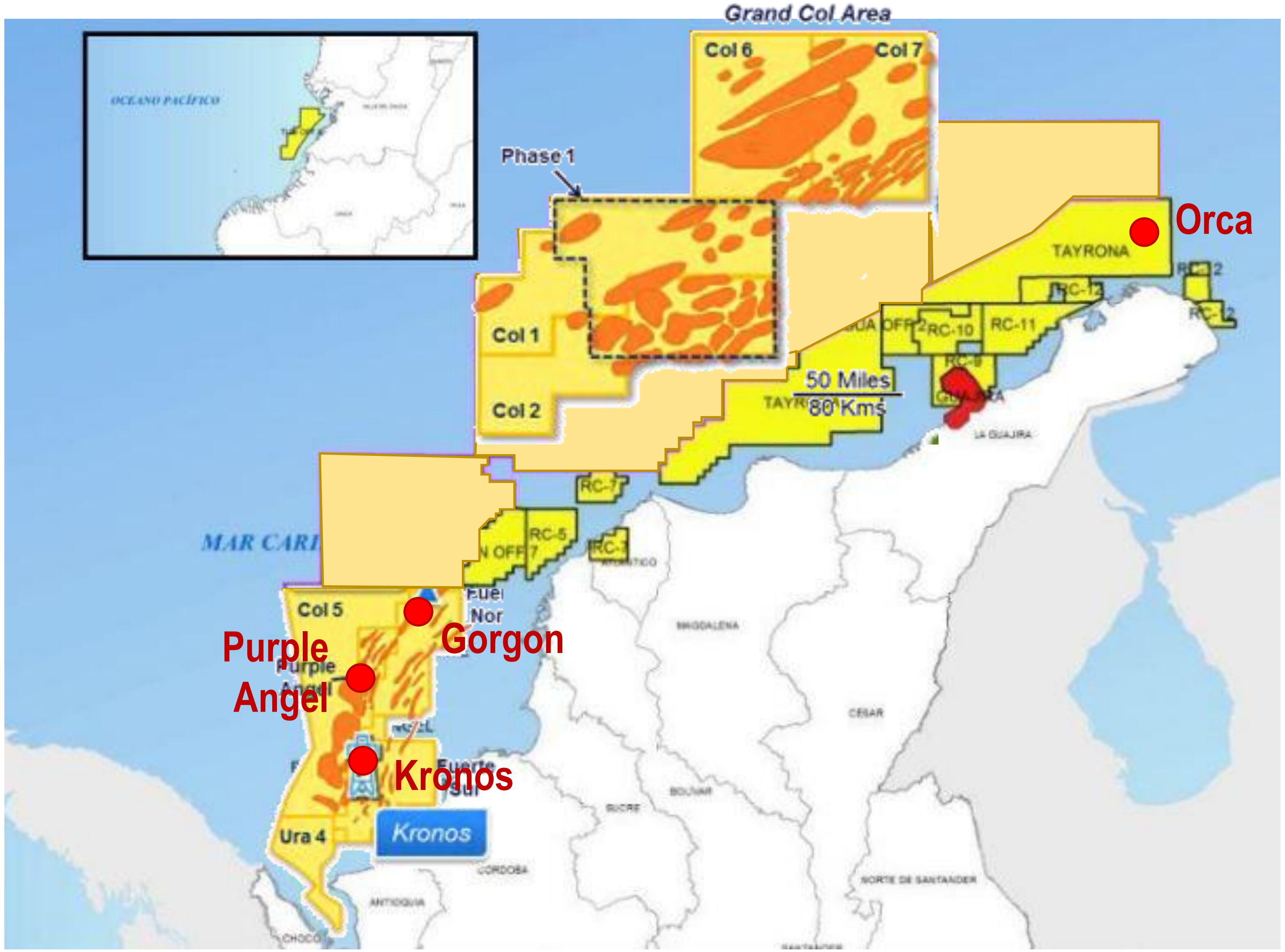
pluspetrol



- Multiple world-class light oil discoveries in Guyana by Exxon-led consortium has increased interest in basin.
  - 2 key plays: Onlapping Upper Cretaceous fans; Carbonate reefs
  - UR > 3.7 BBO
  - All elements of petroleum systems proven, de-risking plays
- Deepwater is still relatively underexplored
  - Only 9 exploration wells since 2015
  - 6 light oil discoveries to date
- Both plays remain largely untested to east in Suriname
  - Further Stabroek exploration
  - Kosmos to drill 2 wells in 2018
  - Other wells likely 2018-2019
- Almost all deepwater acreage held

Colombia Offshore

pluspetrol



- Colombia's Caribbean offshore has been highly active since 2014
  - Anadarko has dominant acreage position (65,000 km2)
- Multi-TCF gas potential
  - Petrobras
    - **Orca gas discovery** (2014): 0.4 TCF
  - Anadarko
    - **Kronos gas discovery** (2015): 1 TCF
    - **Gorgon gas discovery** (2017): 6 TCF
    - **Purple Angel gas discovery** (2017): 0.3 TCF
    - Numerous leads identified
  - Ecopetrol, Shell, Repsol, Statoil, and Exxon also hold significant exploration acreage

Source: Hart Energy E&P, Anadarko

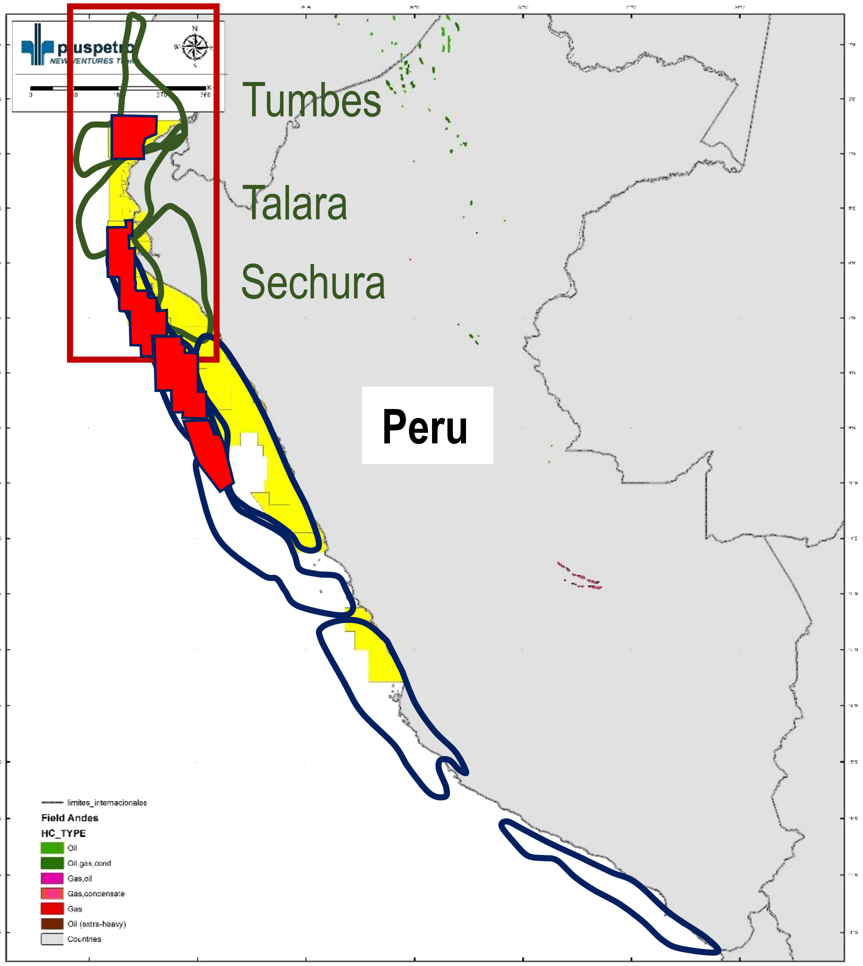
Perú Offshore

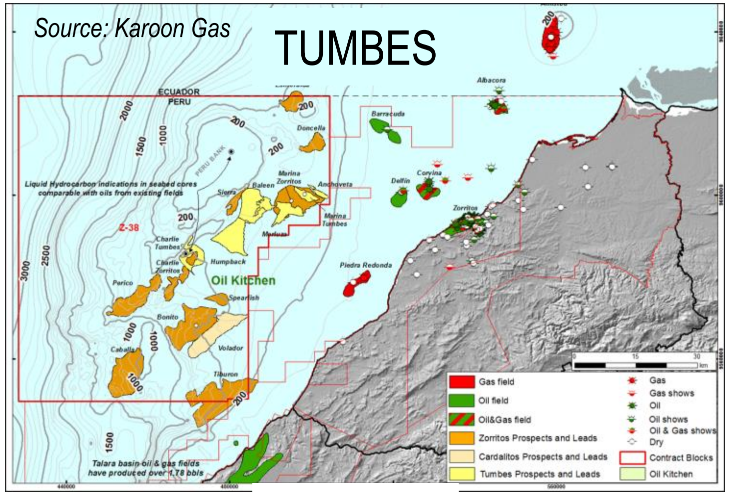
- 8 offshore basins
  - 3 basins have proven petroleum systems
    - Tumbes
    - Talara Basin: 1.6 BBO
    - Sechura
  - 5 basins remain underexplored
  - Oil slicks common
  - No wells drilled in water depth deeper than 115 m

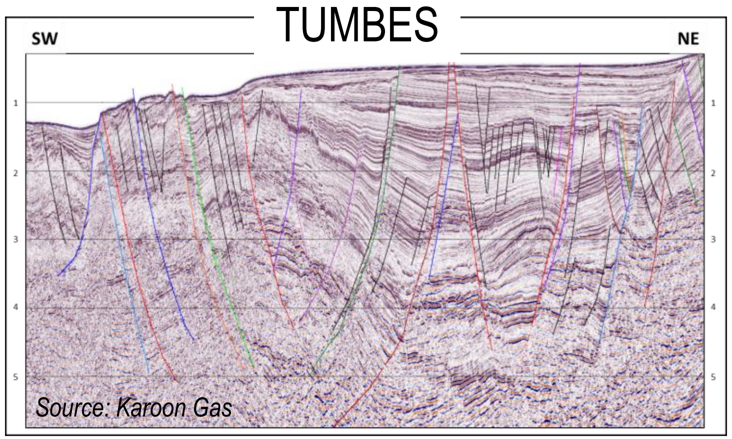
- Northern & central basins largely leased
- Explorers to watch (all acreage aquired in last 12 months)

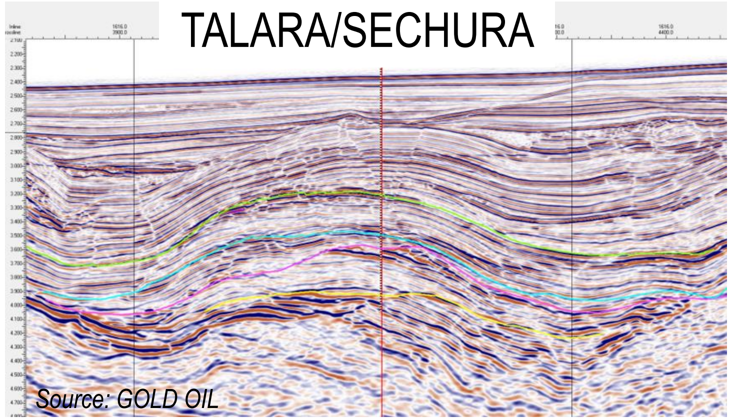
Tullow (28,000 km^2)

Anadarko (19,000 km^2)

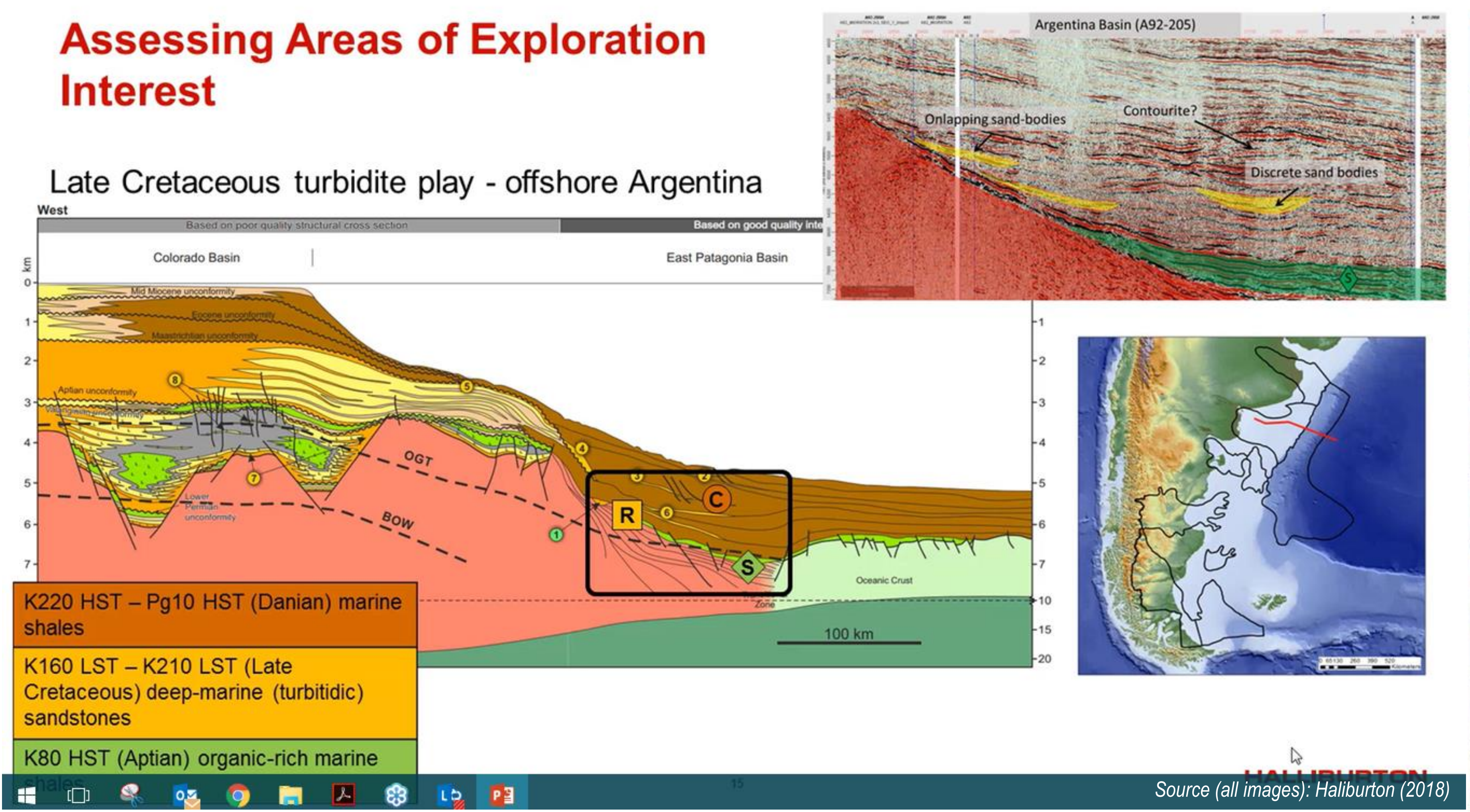


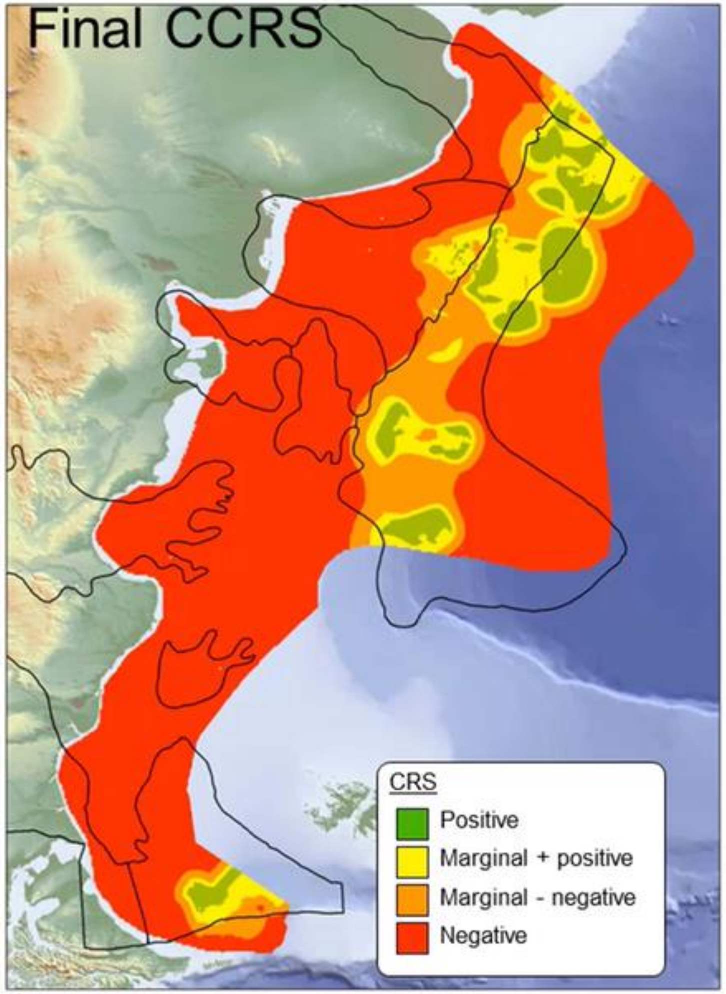






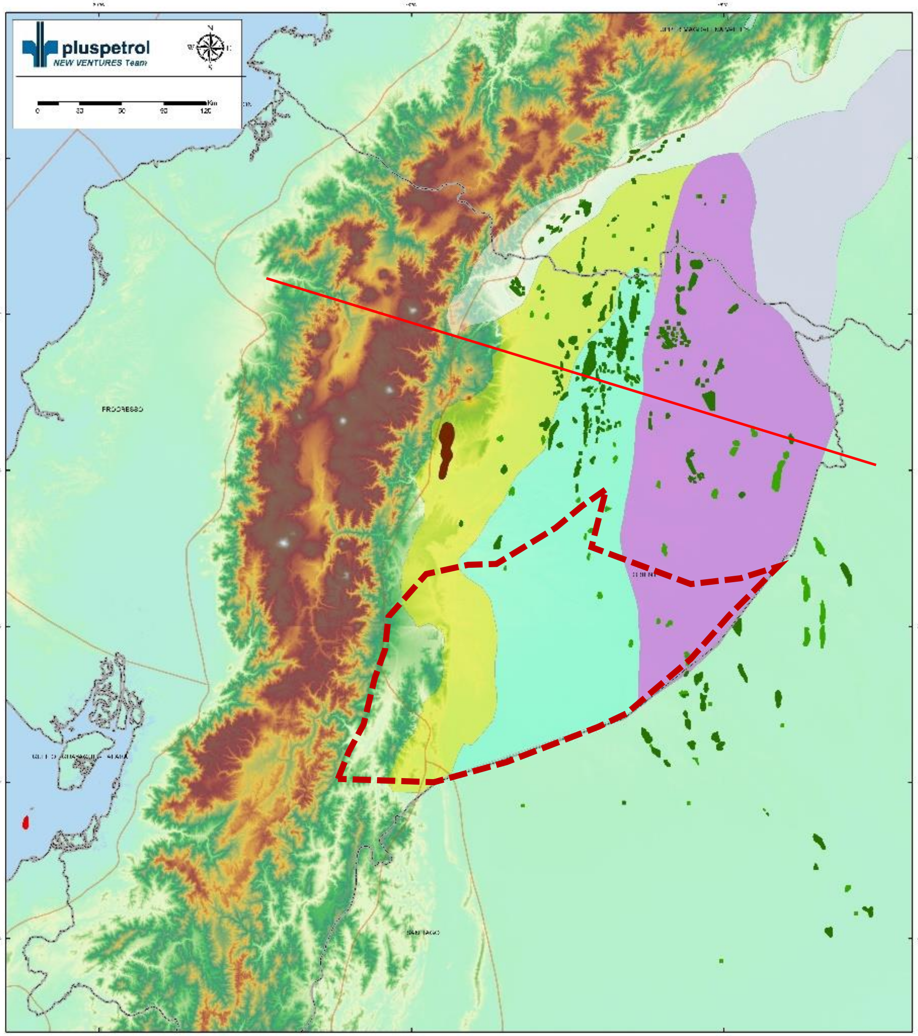
Argentina & Uruguay Offshore



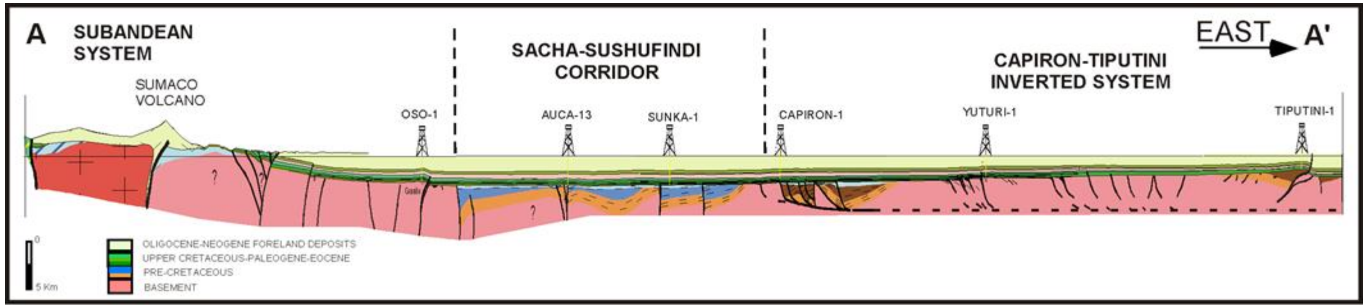


Source (all images): Haliburton (2018)

Ecuador Onshore

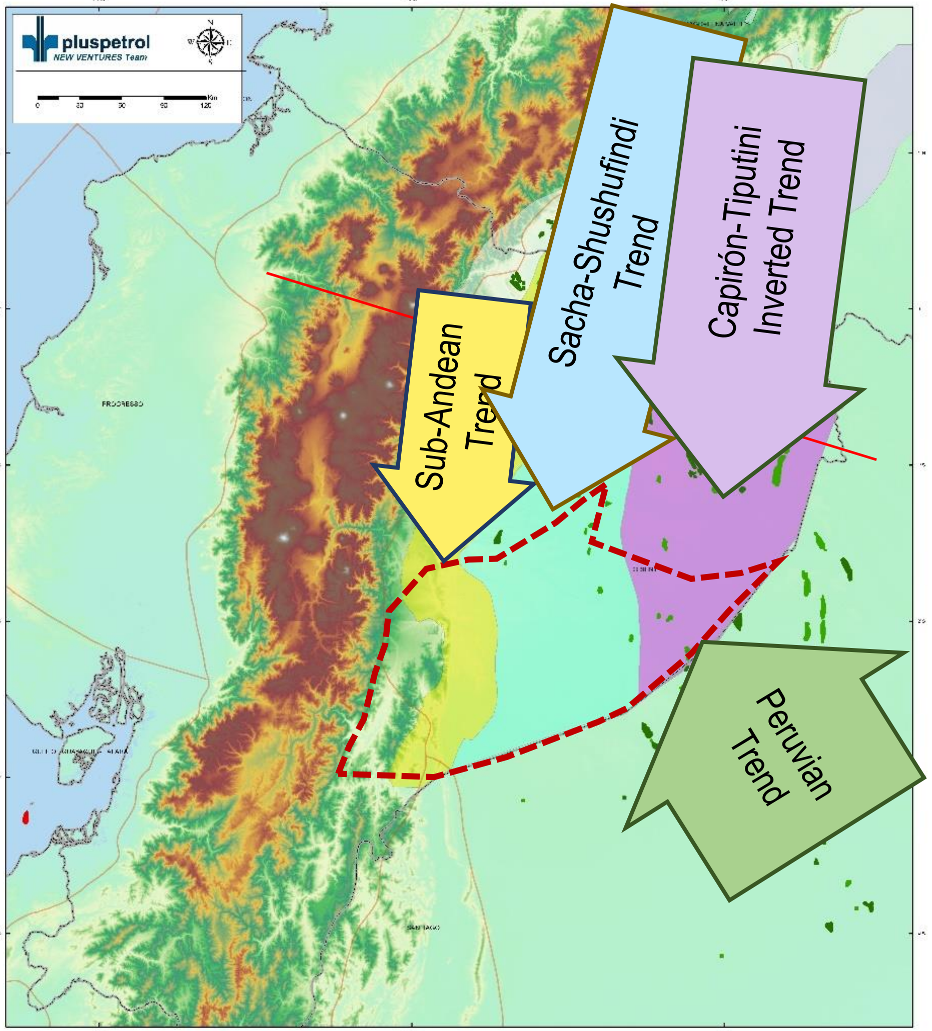


- Numerous fields/discoveries in Southern Colombia (2.5 BBO), northern Ecuador (36.5 BBO) and northern Peru (8.4 BBO)
- Southern Ecuador is highly underexplored in comparison.

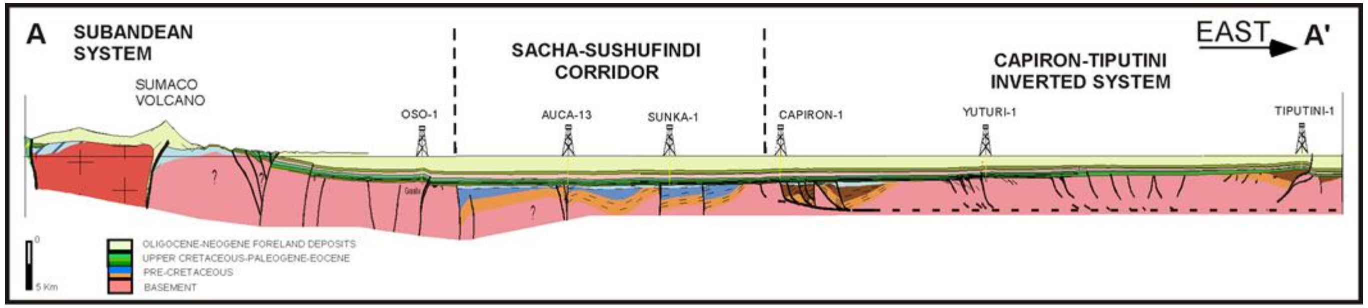


- On-trend potential?
  - Stratigraphic traps (> structural traps)
  - Sensitive community relations

Ecuador Onshore

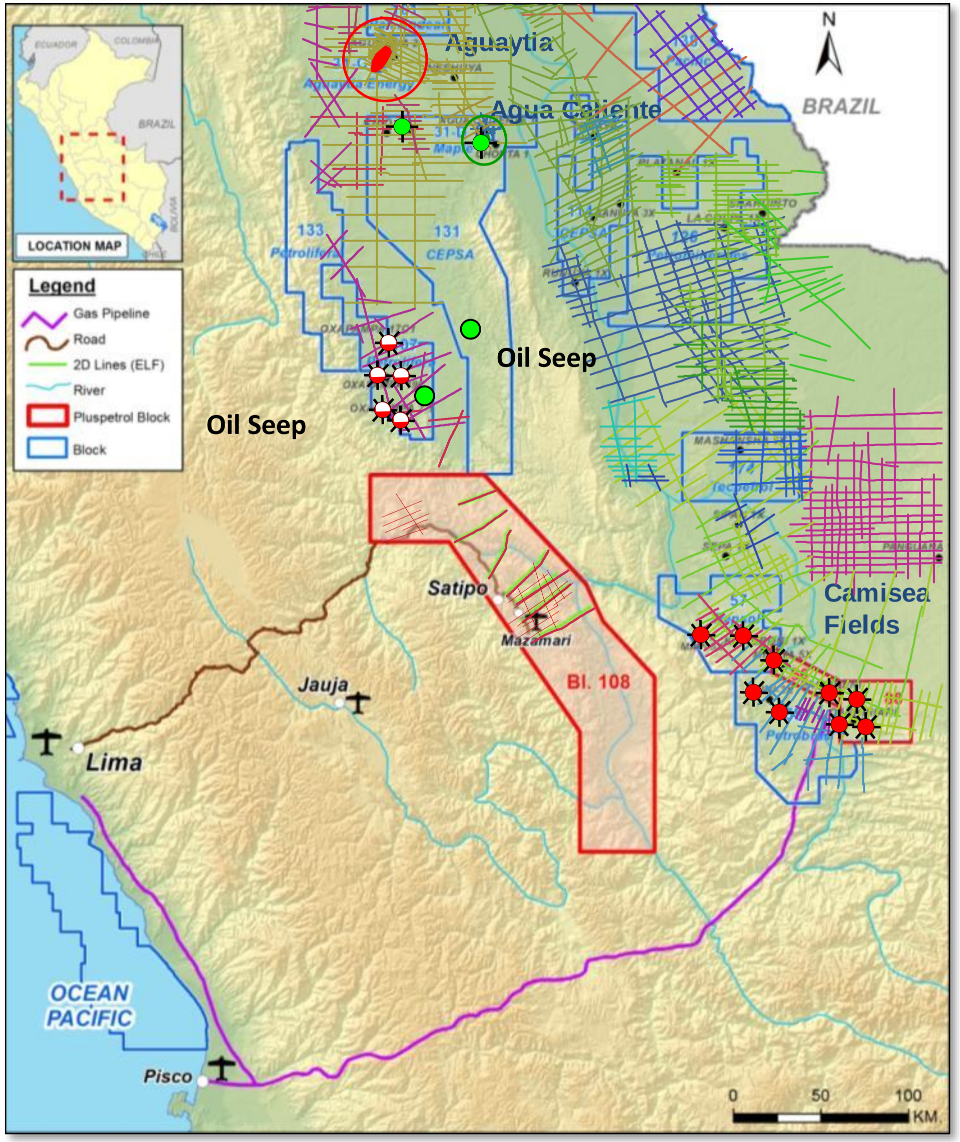


- Numerous fields/discoveries in Southern Colombia (2.5 BBO), northern Ecuador (36.5 BBO) and northern Peru (8.4 BBO)
- Southern Ecuador is highly underexplored in comparison.



- On-trend potential?
  - Stratigraphic traps (> structural traps)
  - Sensitive community relations

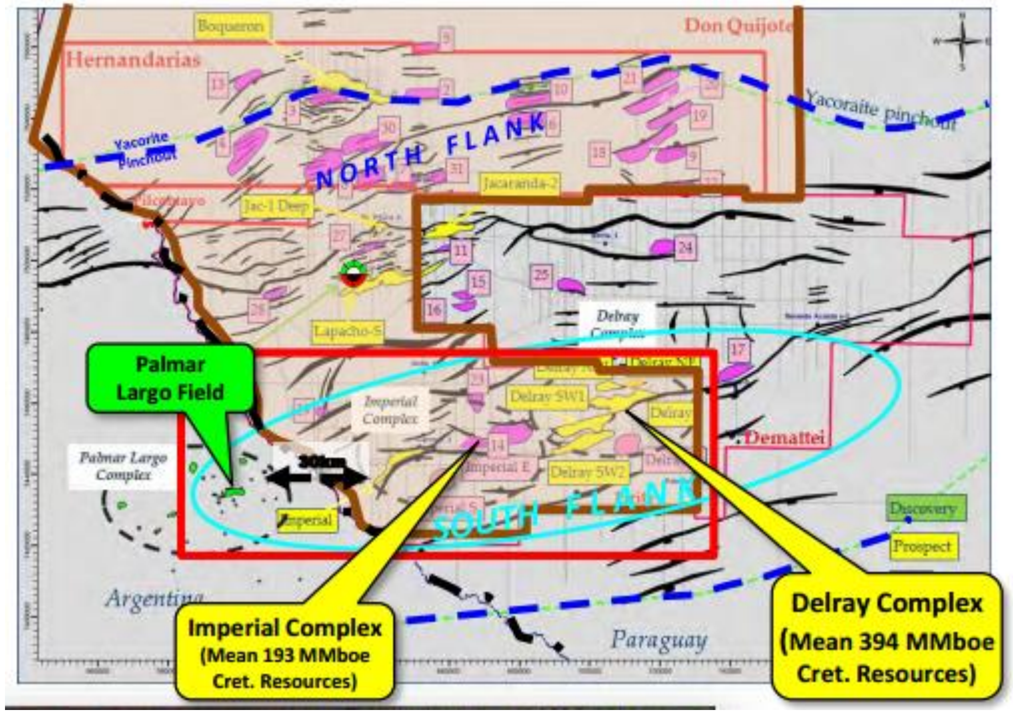
Perú Onshore

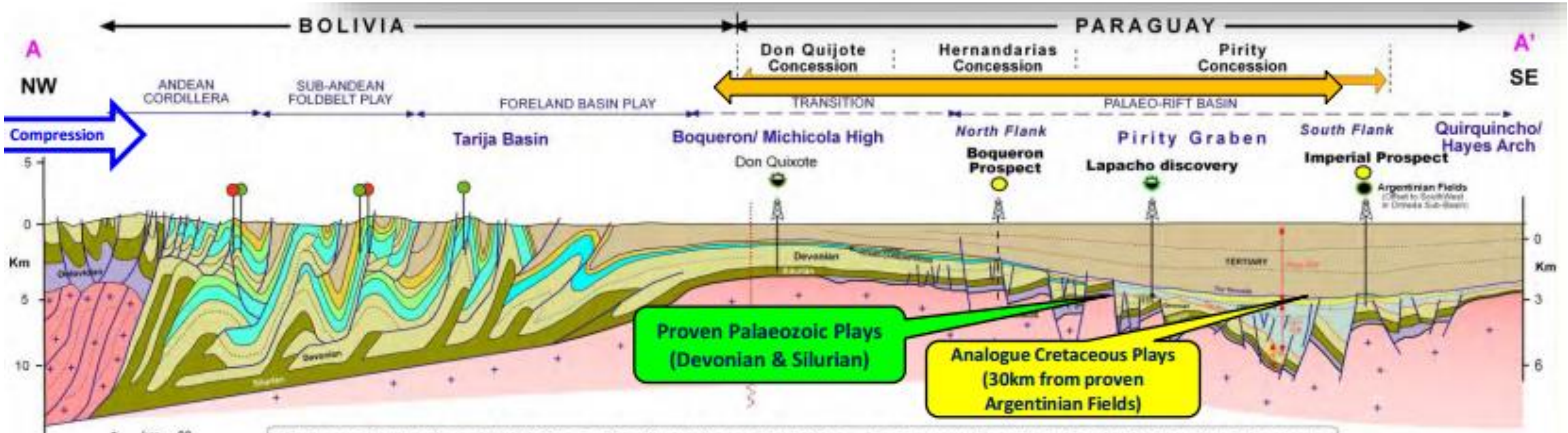


- Ene Basin: no wells to date
- Nearest fields:
  - Camisea (18 TCF; 1,000 MMBNGL)
  - Los Angeles (30 MMBO)
  - Agua Caliente (EUR: 19 MMBO)
  - Aguaytia (388 BCF)
- Big area with little seismic (only 754 km 2D)
- Several potential petroleum systems
  - More than 8,000 m of sediments from Devonian to Early Tertiary in depocenter
  - Presence of source rock and oil seeps
  - Good reservoirs
  - Large untested structural traps
  - Multiple large leads: resources of >> 2,500 MMBO in place
- Pluspetrol/Woodside JV will drill the first exploratory well in 2018

Paraguay Onshore

- 34,000 km² area captures entire prospective area of underexplored and highly prospective Pirity Basin
  - Larger than play fairways of Viking Graben (North Sea) and Albertine Graben (Uganda)
- Multiple drill-ready prospects on trend from producing analogues in Argentina
- Multi-TCFG and multi-hundred MMBO resource potential at Cretaceous and Paleozoic reservoir levels



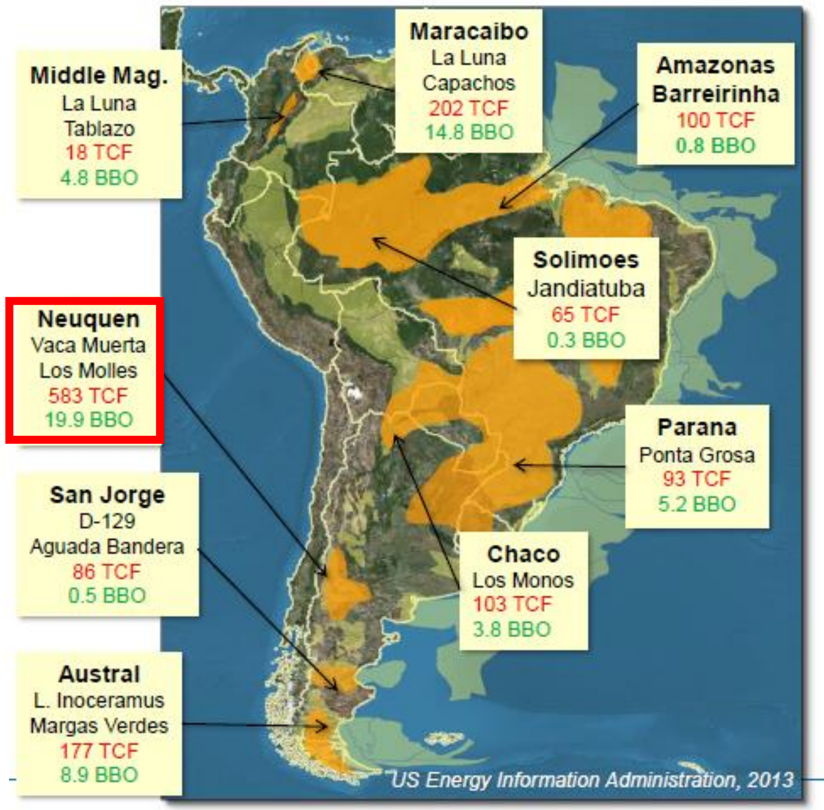


Schematic Regional E-W Cross Section Through Boliva - Paraguay Showing Basin & Play Architecture

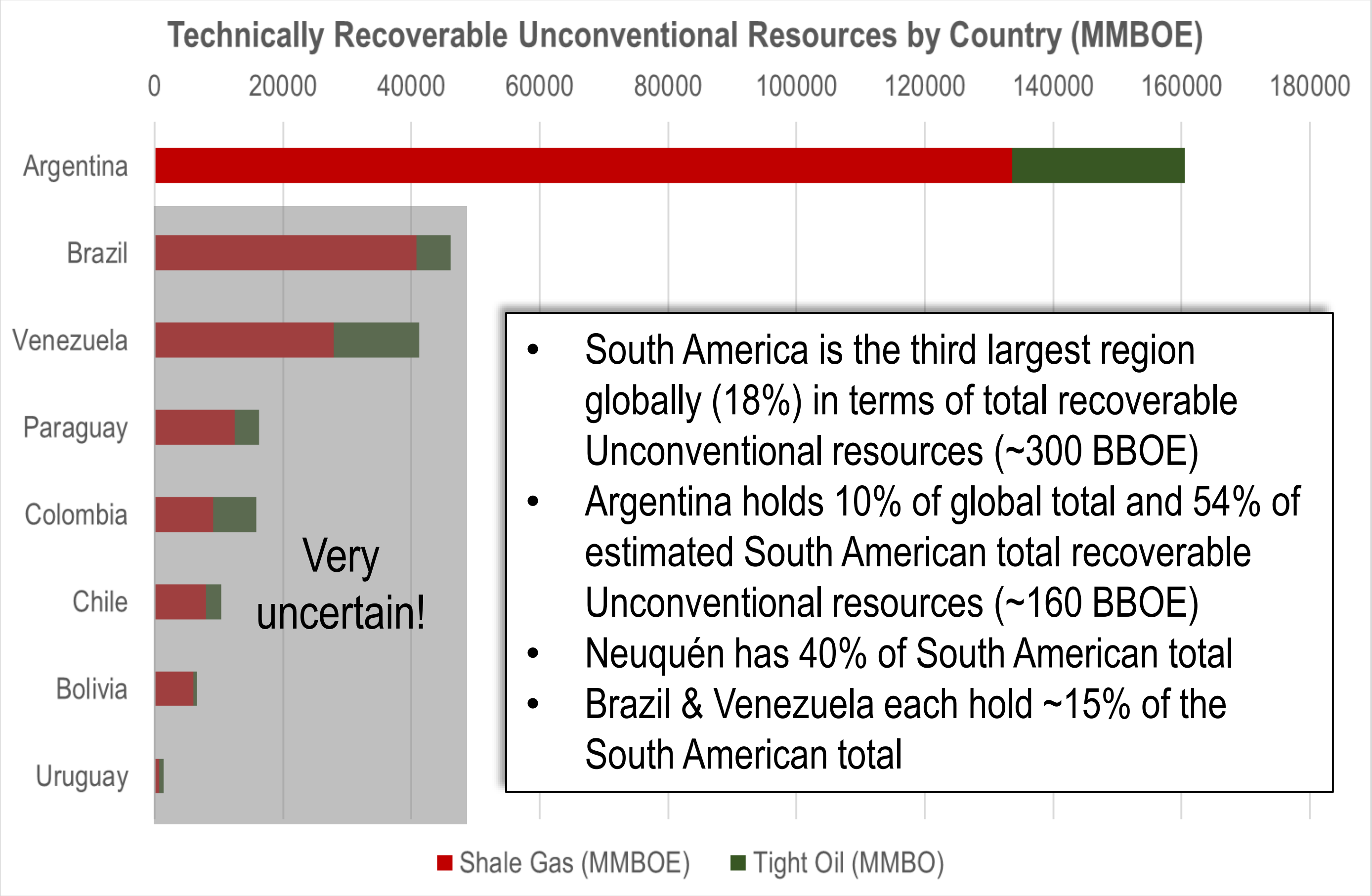
Source: President Energy & Envoi

An Unconventional Future

Unconventional Potential Latin America



Source: Macellari (2017)



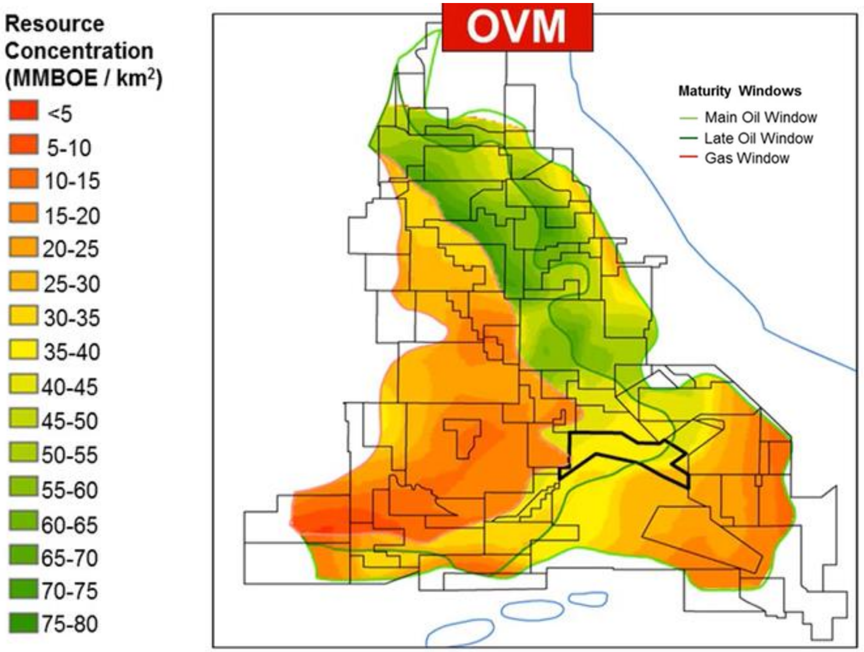
- South America is the third largest region globally (18%) in terms of total recoverable Unconventional resources (~300 BBOE)
- Argentina holds 10% of global total and 54% of estimated South American total recoverable Unconventional resources (~160 BBOE)
- Neuquén has 40% of South American total
- Brazil & Venezuela each hold ~15% of the South American total

Data Source: EIA

Neuquén Basin

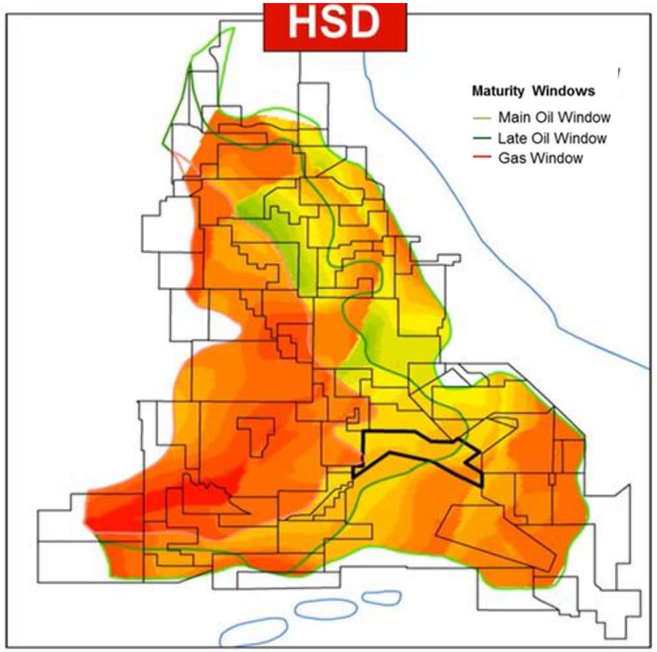
- IHS considers the Neuquén Basin among the world's "Super Basins", with at least 31 stacked conventional and unconventional plays.
- In additional to unconventionals (shale gas), tight, conventional resources that were bypassed previously could yield great upside.
- Recoverable resource estimates are on the order of 15-20+ BBOE
  - Remaining conventional 2P technically recoverable oil and gas: 5.1 BBOE
  - Vaca Muerta/Los Molles recoverable resources: 8.8 BBOE

Shale Gas: Organic-Rich Vaca Muerta

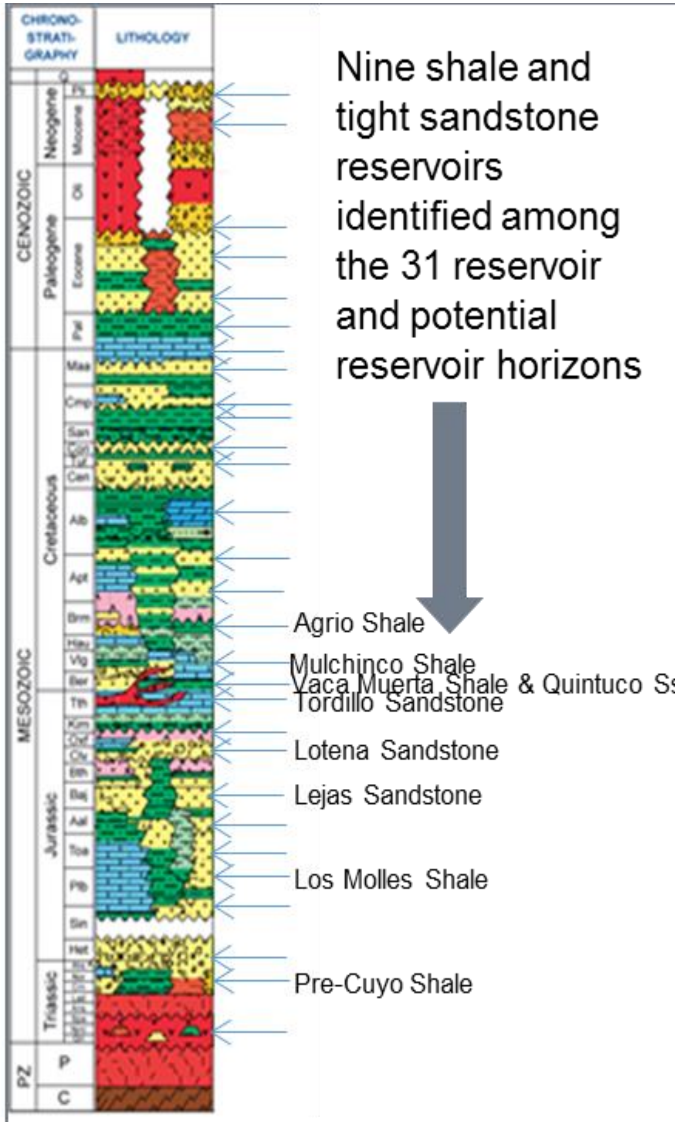


Source: Haliburton (2018)

Tight Oil: High-Graded Stratigraphic Domains



Source: Haliburton (2018)

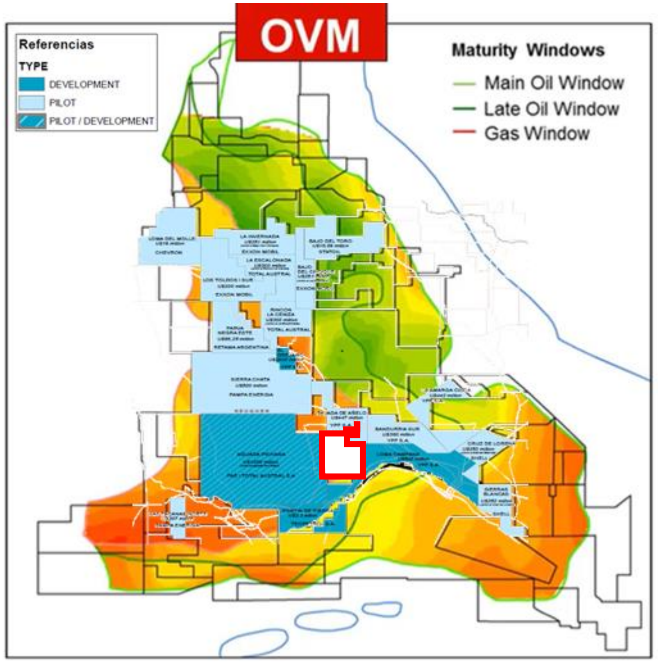


Nine shale and tight sandstone reservoirs identified among the 31 reservoir and potential reservoir horizons

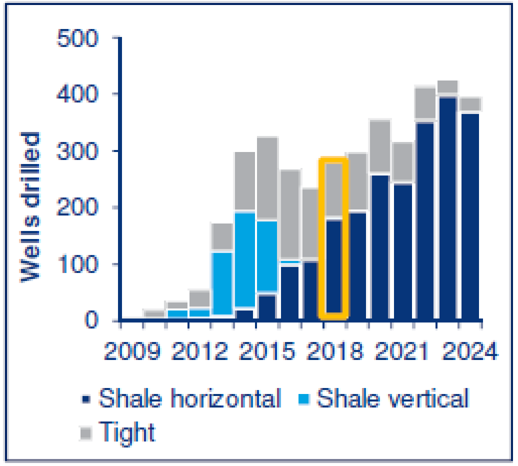
Source: IHS Energy

pluspetrol

Substantial Investment & Activity



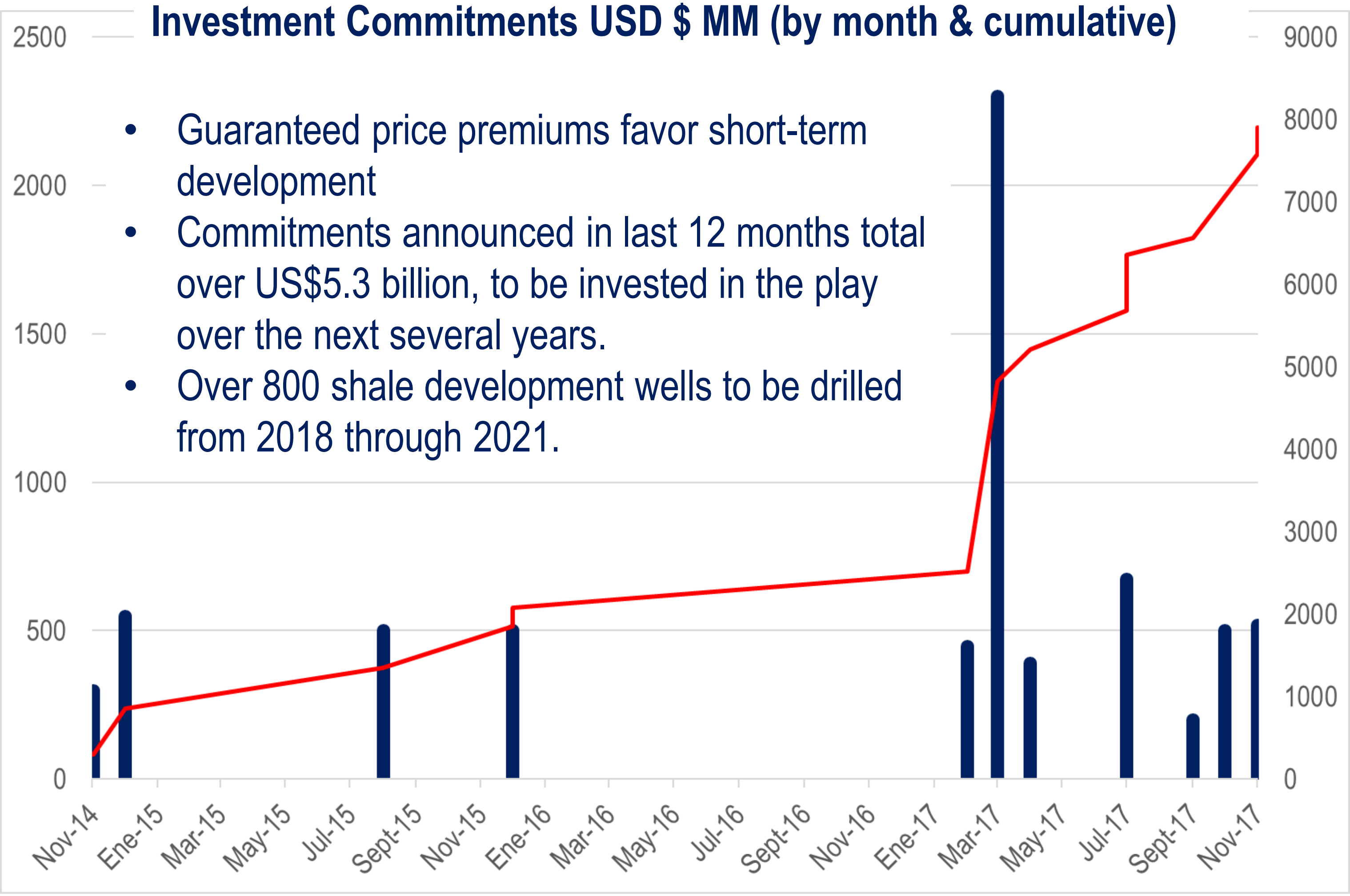
Neuquén unconventional drilling



Source: WoodMac (2018)

Investment Commitments USD $ MM (by month & cumulative)

- Guaranteed price premiums favor short-term development
- Commitments announced in last 12 months total over US$5.3 billion, to be invested in the play over the next several years.
- Over 800 shale development wells to be drilled from 2018 through 2021.



Conclusions: Risk & Uncertainty

- Most proven basins appear to be mature – new play concepts and/or safe access to some areas will be required to revitalize exploration
  - Onshore: Colombia, Ecuador, Peru, Argentina, Bolivia, Brazil, Paraguay
  - Offshore: Trinidad & Tobago, Brazil post-salt
- Difficult to enter regions with largest confirmed liquid potential
  - Venezuela: Fiscal risk
  - Brazil pre-salt: High capital commitments have so far restricted playing field to Petrobras, selected supermajors/IOCs, & NOCs (China, Qatar)
  - Guyana-Suriname deepwater: Almost all offshore acreage held by consortia of IOCs
- Other emerging and frontier offshore basins could offer attractive possibilities for players comfortable with deepwater risks and economics
  - Colombia: Gas commercialization strategy?
  - Peru: Fluid phase? MEFS?
  - NE Brazil: MEFS?
  - Argentina/Uruguay: Working petroleum system(s)?
- Argentina unconventionals: Acreage in sweet spots is highly competitive; economics of projects yet to be confirmed

Balancing a Portfolio

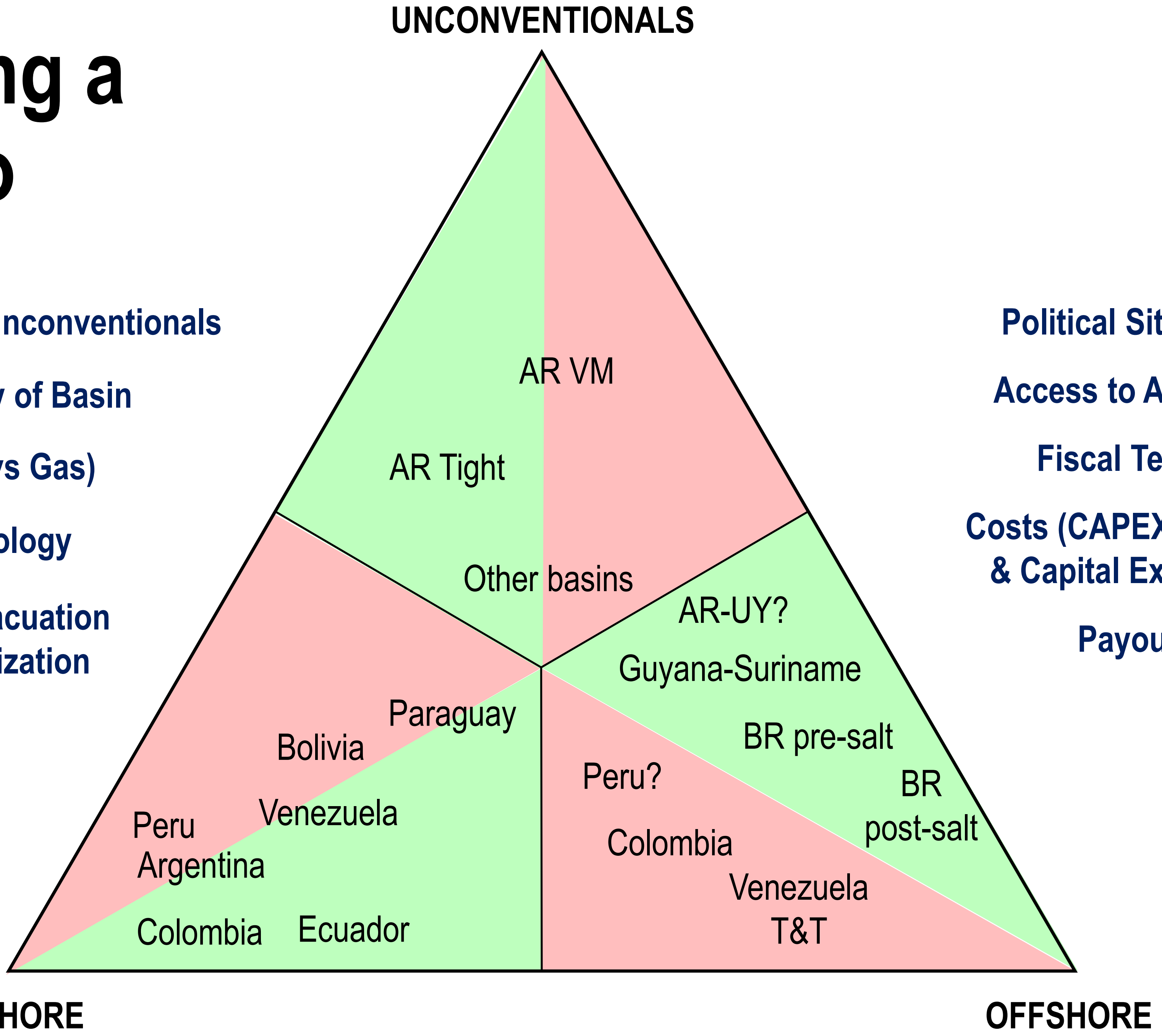
Onshore vs Offshore vs Unconventionals

Exploration Maturity of Basin

Fluid Phase (Oil vs Gas)

Subsurface/Geology

Infrastructure: Evacuation Strategy & Monetization



Political Situation

Access to Acreage

Fiscal Terms

Costs (CAPEX, OPEX) & Capital Exposure

Payout

Acknowledgements

- Marcelo Arteaga
- Alfredo di Salvo
- Fernando Martinez
- María Silvia Castro
- Federico Seminario
- Juan Chung
- Miles Biggins (President Energy)
- Julie Wilson (WoodMac)