



TSXV : TAO | OTCQX : TAOIF



# *“Developing Unconventional Carbonate Reservoirs”*

## *GPC Workshop*

### *Carbonate Reservoirs in Egypt*

#### *“Potentiality and Production Optimization”*

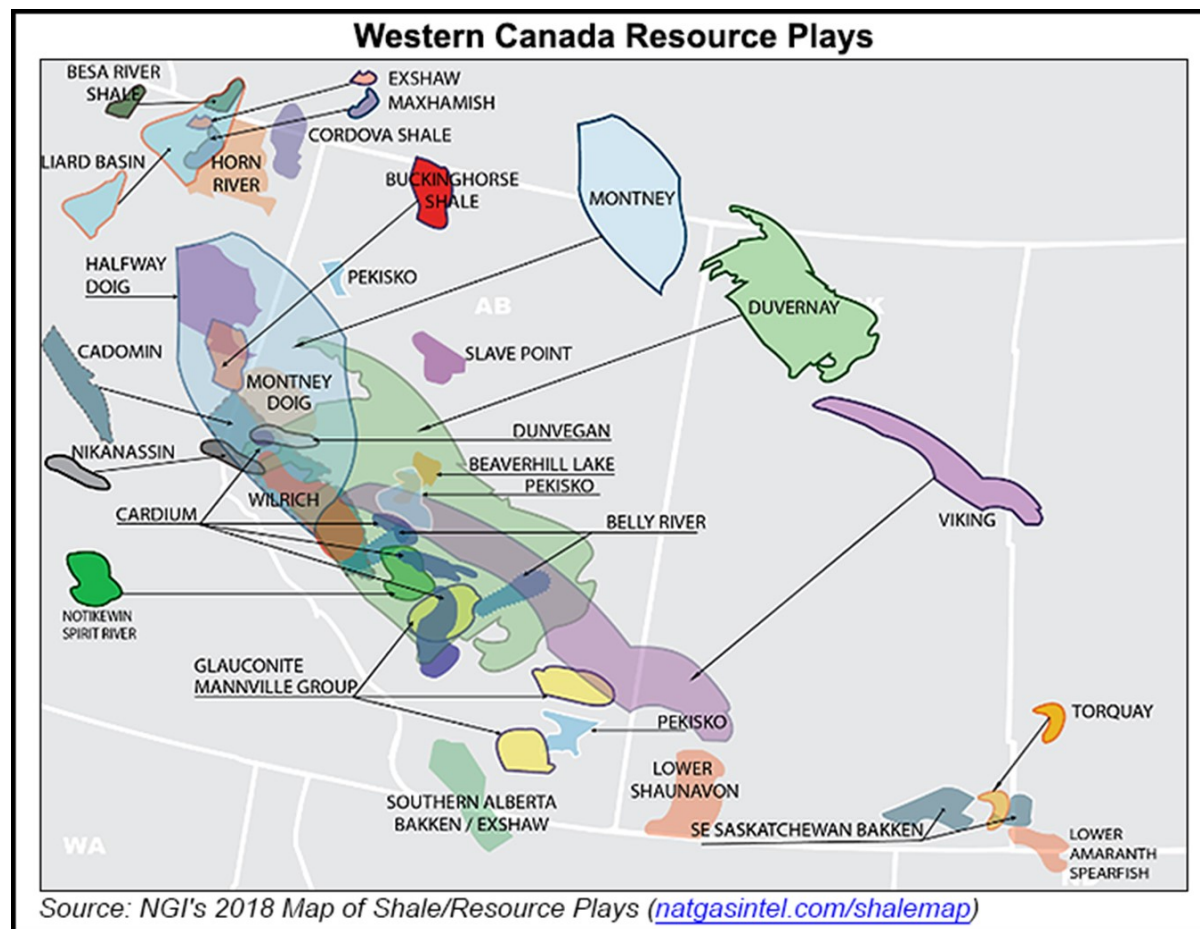
*November 24 - 26, 2021, Ras Gharib, Eastern Desert, EGYPT*

## Company Profile

- TAG Oil Ltd. is a Canadian publicly listed E&P Company (TSXV:TAO)
- Leadership team has a strong track record of leading and growing successful international energy companies and have targeted brown-field assets with significant upside potential in both conventional and unconventional reservoirs
  - **Expertise in new technologies to improve mobility and recovery of oil** using extensive Canadian and international experience, such as horizontal well re-development of brownfields, enhanced oil recovery (EOR) through water/polymer and gas/CO<sub>2</sub> floods and thermal applications (CSS)
  - **Access to investment capital**, management raised in excess of \$2.0 billion over the last 15 years to fund the development of several oil and gas fields in Canada, New Zealand, Egypt, Iraq and Albania
  - **Committed to ESG**, corporate governance and compliance, environment and community
- TAG specific case studies include:
  - **Bankers Petroleum from 2004 to 2016**: Implemented Horizontal Drilling and Polymer Flood development of the Patos Marinza Heavy Oil Field in Albania
  - **Rally Energy from 2005 to 2007**: Initiated a Cyclic Steam development in the Upper Dolomite of the Issaran Heavy Oil Field in Egypt
- Current strategy focused on MENA region with priority on Egypt, including:
  - Assessment of the potential in the unconventional Abu Roash “F” resource in the Western Desert of Egypt

## Canadian Experience – Multiple Oil & Gas Plays

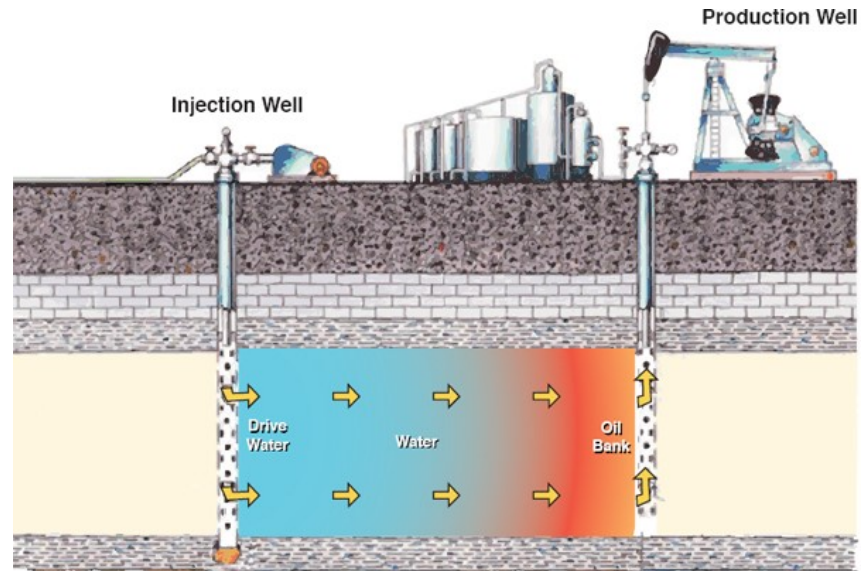
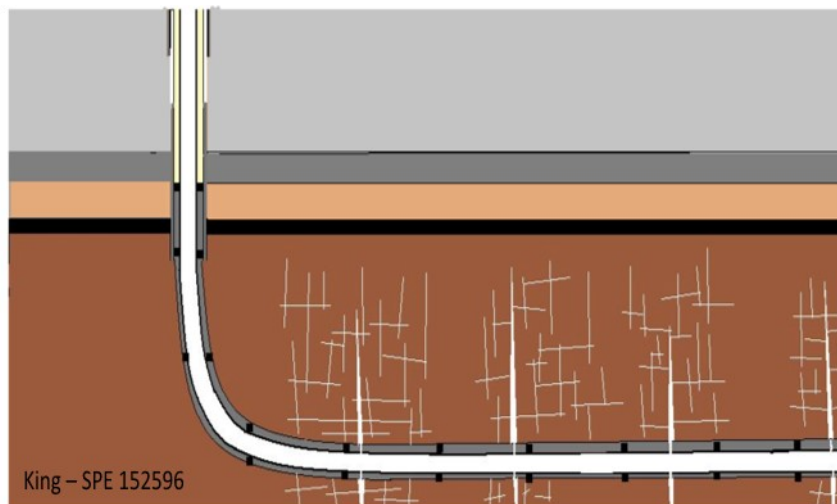
- Western Canada hosts a number of unique oil and gas plays (conventional & unconventional) including:
  - Oil sands – heavy oil, bitumen
  - Deep basin
  - Tight gas and oil
  - Shale gas and oil
  - Oil shales
  - Carbonate reefs
  
- This variety has led to a deep pool of expertise when it comes to development and production of both conventional and unconventional resources



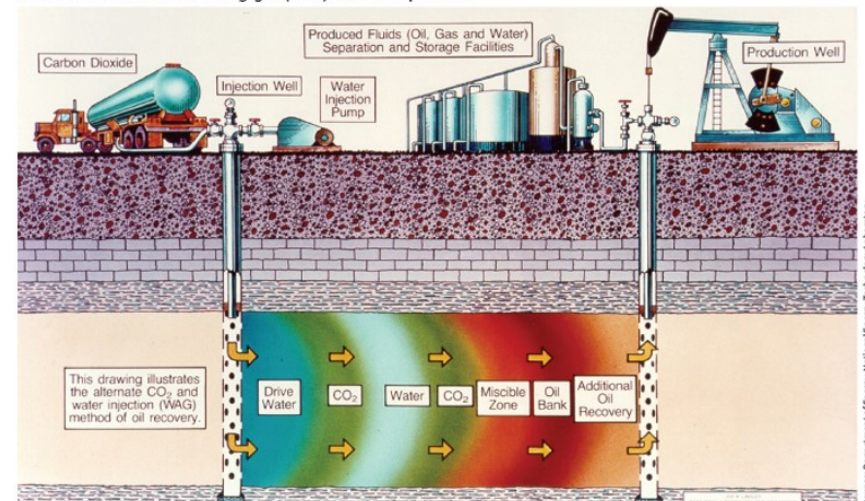
## Canadian Experience – Enhanced Recovery

- For improved recovery in unconventional reservoirs, several enhanced techniques are available and being further developed:
  - Enhanced oil flooding secondary recovery (water, polymer, surfactant-polymer, ASP)
  - Gas and solvent processes (CO<sub>2</sub>, VAPEX, cyclic solvent, hot solvent)
  - Reservoir stimulation (horizontal drilling, hydraulic fracturing, fish-bone development, etc.)
  - Primary and post-primary processes

**Schematic of Horizontal well with multi-stage fracture stimulation**

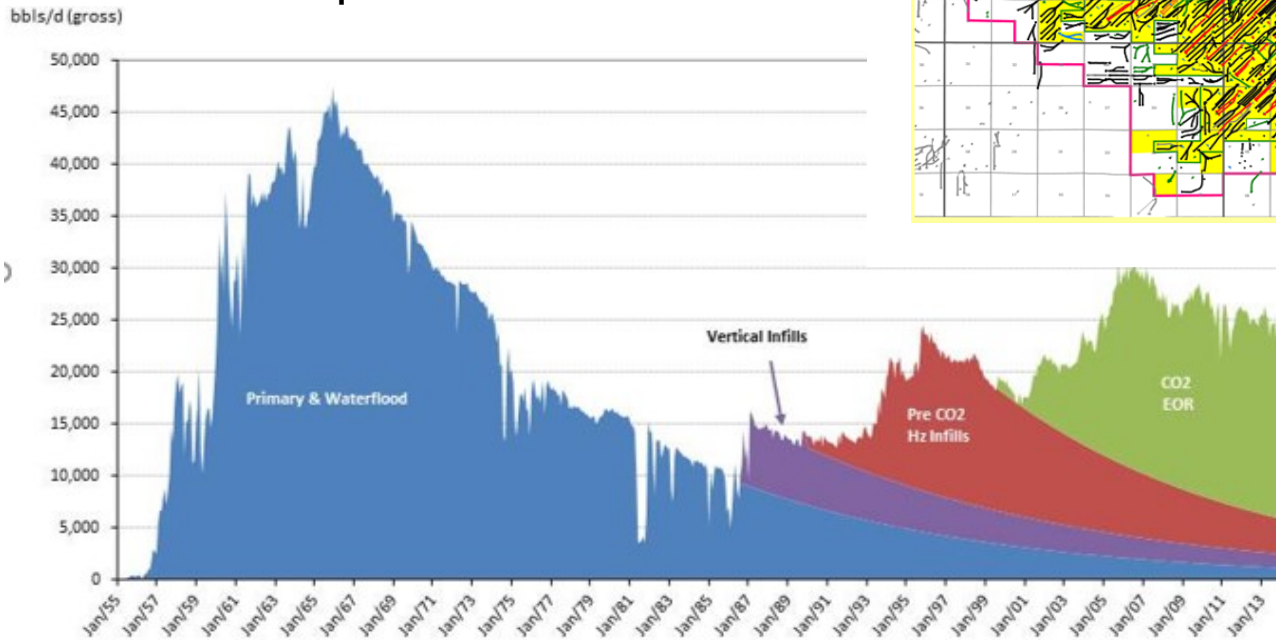
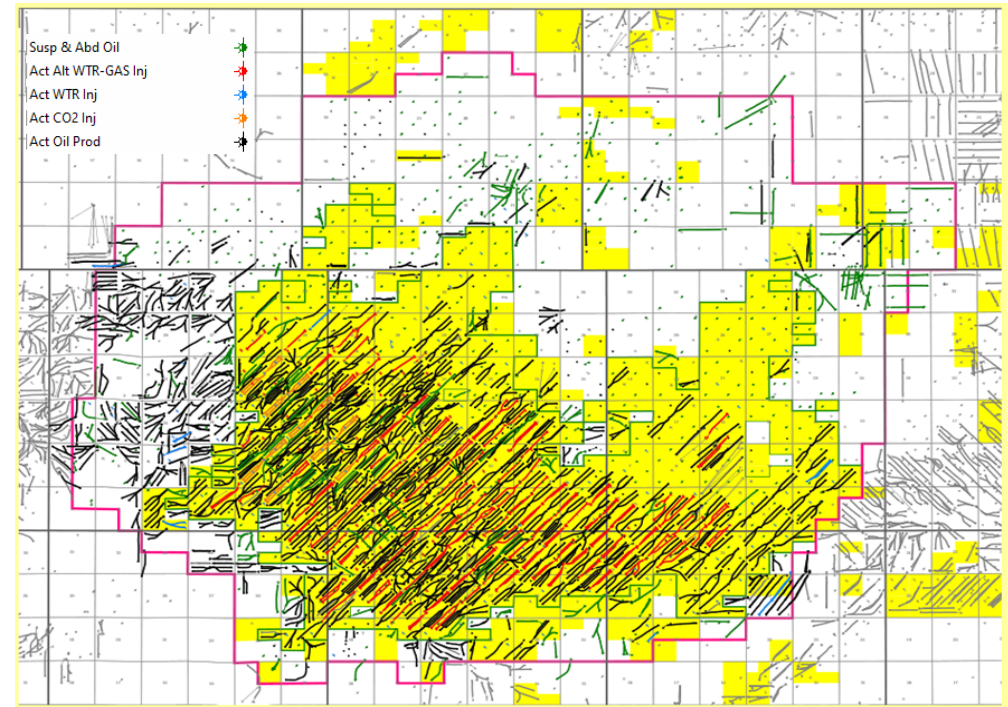


**Schematic of water-alternating-gas (WAG) CO<sub>2</sub>-EOR operation**



# Canadian Example – Weyburn CO<sub>2</sub> Miscible EOR Project

- *Weyburn is the World's largest anthropogenic CO<sub>2</sub> storage project representing 42% of sequestered volumes in Canada over the past years*
- WhiteCap Resources is current operator, previously EnCana/PanCanadian and initially designed in 1990's.
- Mississippian Midale formation (carbonate reservoir with limestone, dolostone, evaporite facies and horizontal/vertical fracture network)
- 1.4 billion barrels of sour 25–34 API Crude, 1,450m Depth
- **104 million barrels incremental oil production**
- **1.8 million tonnes of CO<sub>2</sub> stored each year**
- **31 million tonnes sequestered since 2000**

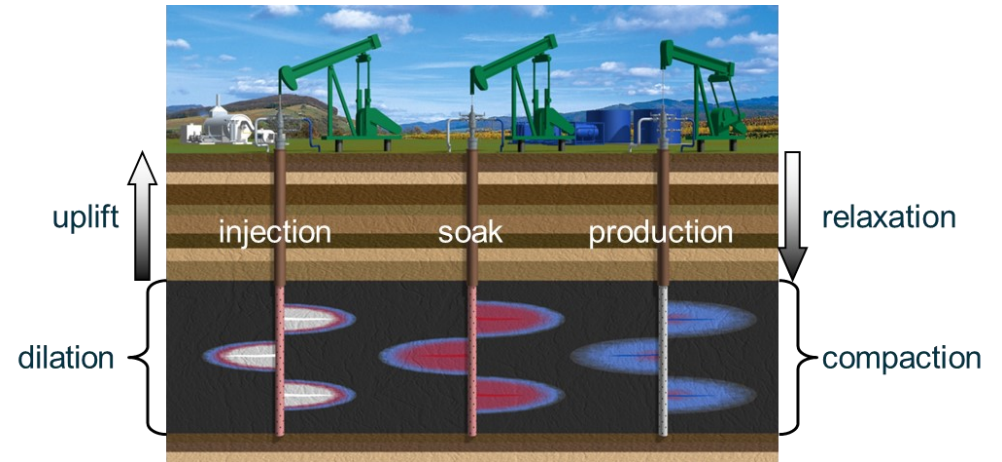


	2000	2019
Operator	EnCana Corp.	WhiteCap Resources
Production	20,560 bbl/d	23,400 boe/d

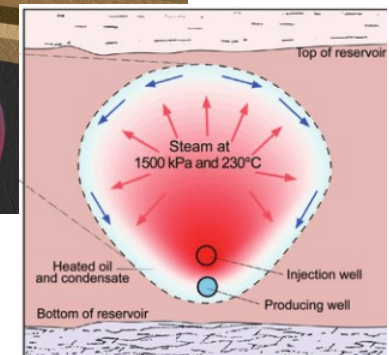
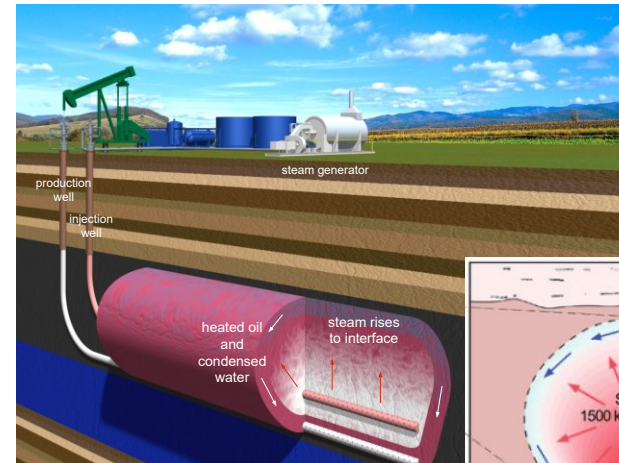
Source: WhiteCap Resources' website

# Canadian Experience in Thermal Recovery

- **Cyclic Steam Stimulation (CSS)**
  - Applicable to Clastic and Carbonate Reservoirs
  - during injection, the reservoir dilates and lifts the overburden
  - the relaxation provides main drive for production
  - mature CSS transforms into gravity drainage, similar to SAGD



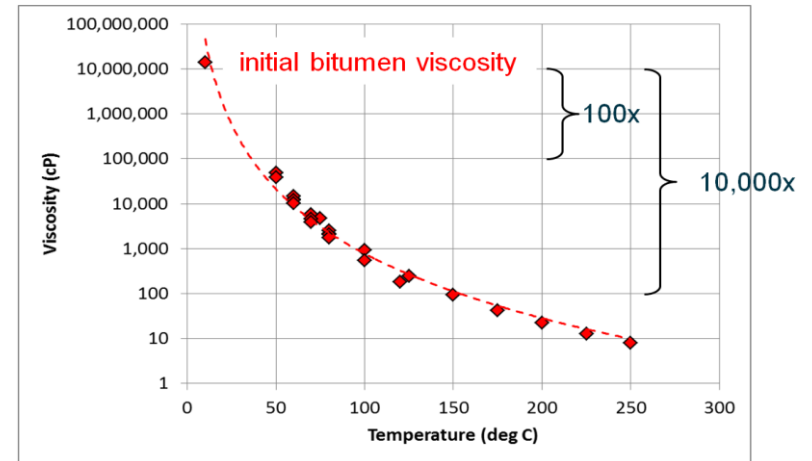
- **Steam Assisted Gravity Drainage (SAGD)**
  - Applicable to Clastic Reservoirs
  - steam and bitumen flow in the same regime
  - bitumen drains at steam chamber front
  - growth of steam chamber is linked to produced bitumen
  - maximum rate is linked to height of steam chamber



## Canadian Experience - Thermal Solvent Processes

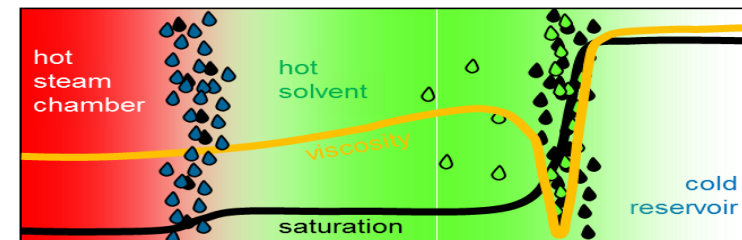
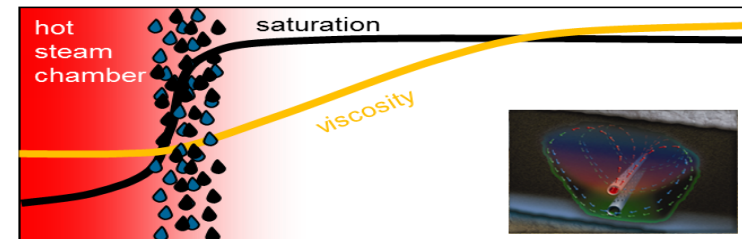
- Thermally Assisted Gas Oil Gravity Drainage (**TA-GOGD**)

- Applicable to carbonate reservoirs
- Suitable for medium heavy oil reservoir like Middle-Eastern heavy oil reservoir
- Continuous injection at top of reservoir and continuous production from bottom e.g. Qarn Alam in Oman.



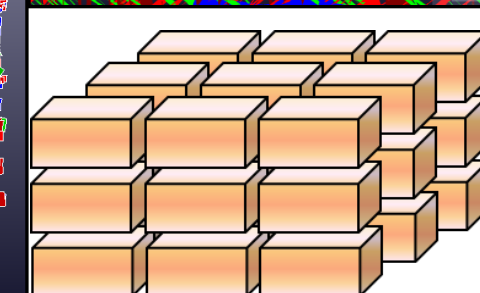
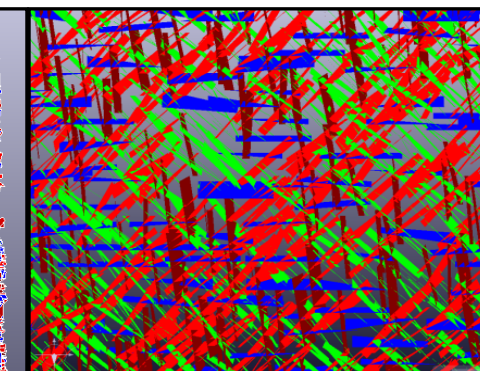
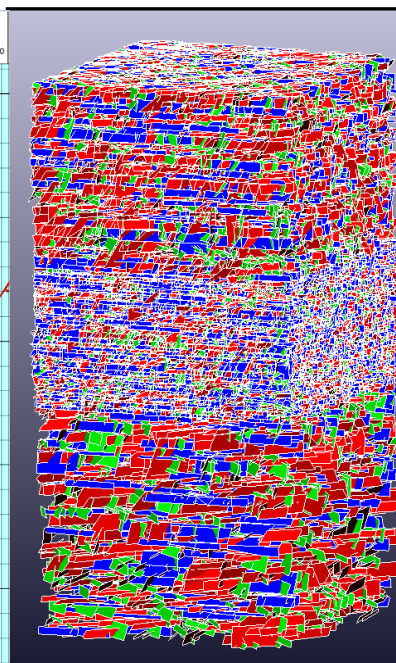
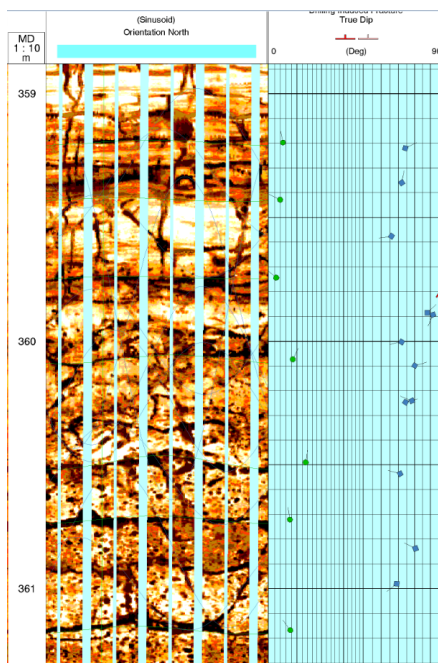
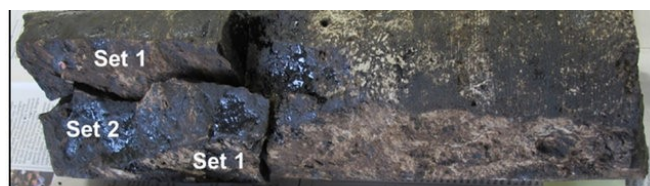
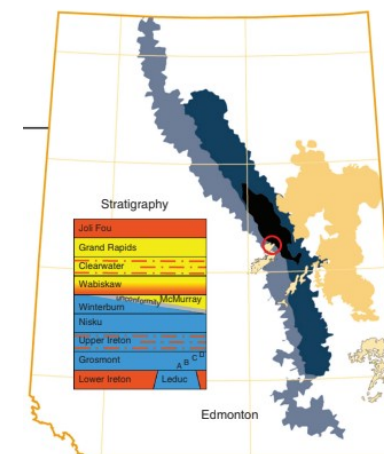
- Expanding Solvent – SAGD (**ES-SAGD**)

- Hydrocarbon additives co-injected with steam
- Improves viscosity reduction and SOR reduction
- Optimum solvent and concentration for each P and T
- At lower moderate temperatures like Middle-Eastern heavy oil reservoir solvent more beneficial



## Canadian Example – Grosmont (Upper Devonian Carbonate)

- Naturally Fractured Carbonate Reservoir (large unconventional heavy resource play located in Northern Alberta) - **Grosmont (400 billion bbl OOIP)**
  - Core studies, laboratory tests plus field pilots (conventional and thermal pilots) informed the larger development
  - Design/operation of SAGD and C-SAGD Saleski Pilot
  - Design and transition to commercial expansion employing TA-GOGD fundamental (similar to Oman's Qarn Alam reservoir).





## Patos Marinza Oil Field, Albania (Bankers Petroleum)

- Case Study of Horizontal Drilling and Polymer-flood EOR development in the Patos Marinza Heavy Oilfield in Albania – Bankers Petroleum Albania Ltd. (Bankers) from 2004 to 2016.
- Mr. Abby Badwi was President & CEO and Vice-Chairman of Bankers Petroleum Ltd., (2008 to 2016) and Mr. Suneel Gupta was Chief Operating Officer from 2010 to 2016 and President & CEO from 2017 to 2018.
- During that period, the Company re-activated over 600 vertical wells with new PC-pumping configuration replacing traditional Rod-pumping to pressure draw-down and increase fluid rate (10-fold oil production increase).
- Drilled first horizontal well in Albania in 2008 and subsequently advanced development significantly with **over 700 horizontal wells drilled in the asset.**
- Piloted and **expanded commercially Polymer-flood EOR in heavy oil to become one of the largest polymer floods in the world** (50% of production was coming from PF areas in 2016/2017).
- ***Increased production from 500 bopd to 22,000 bopd (2014 peak) through brownfield development strategies including vertical well re-activations for early revenue, horizontal drilling, polymer-flood EOR and thermal trials. Produced over 40 million bbls of oil from the asset during the 2004 to 2017 period.***
- ***Doubled recoverable reserves to over 200 million bbls through improved recovery from 5% URF under vertical primary development to 15% under horizontal wells and 30% under polymer-flooded areas.***

# Bankers Petroleum in Albania (Patos-Marinza)

Key Contributor During 2004 to 2016, Bankers was one of the largest foreign direct investors in Albania

**Cumulative spending in Albania > US\$ 3.0 billion**

**Share of oil production and proven reserves in Albania** ~83% and 75%, respectively

**Total Employment** 1,700 people

Direct Employment  
(Albanian Nationals) 550 people

Indirect Employment  
(Albanian Nationals) 1,150 people

**Royalties & Taxes 2004 – 2016 > US\$ 500 million**

**Environmental Remediation** Cleaned more than 800 leases to date

**Investment in Lease Clean-ups** > US\$ 20 million

**Investment in Community Relation projects 2009 – 2017** > US\$ 6 million

**Local Taxes to Municipalities and Communes 2009 – 2016** > US\$ 11 million

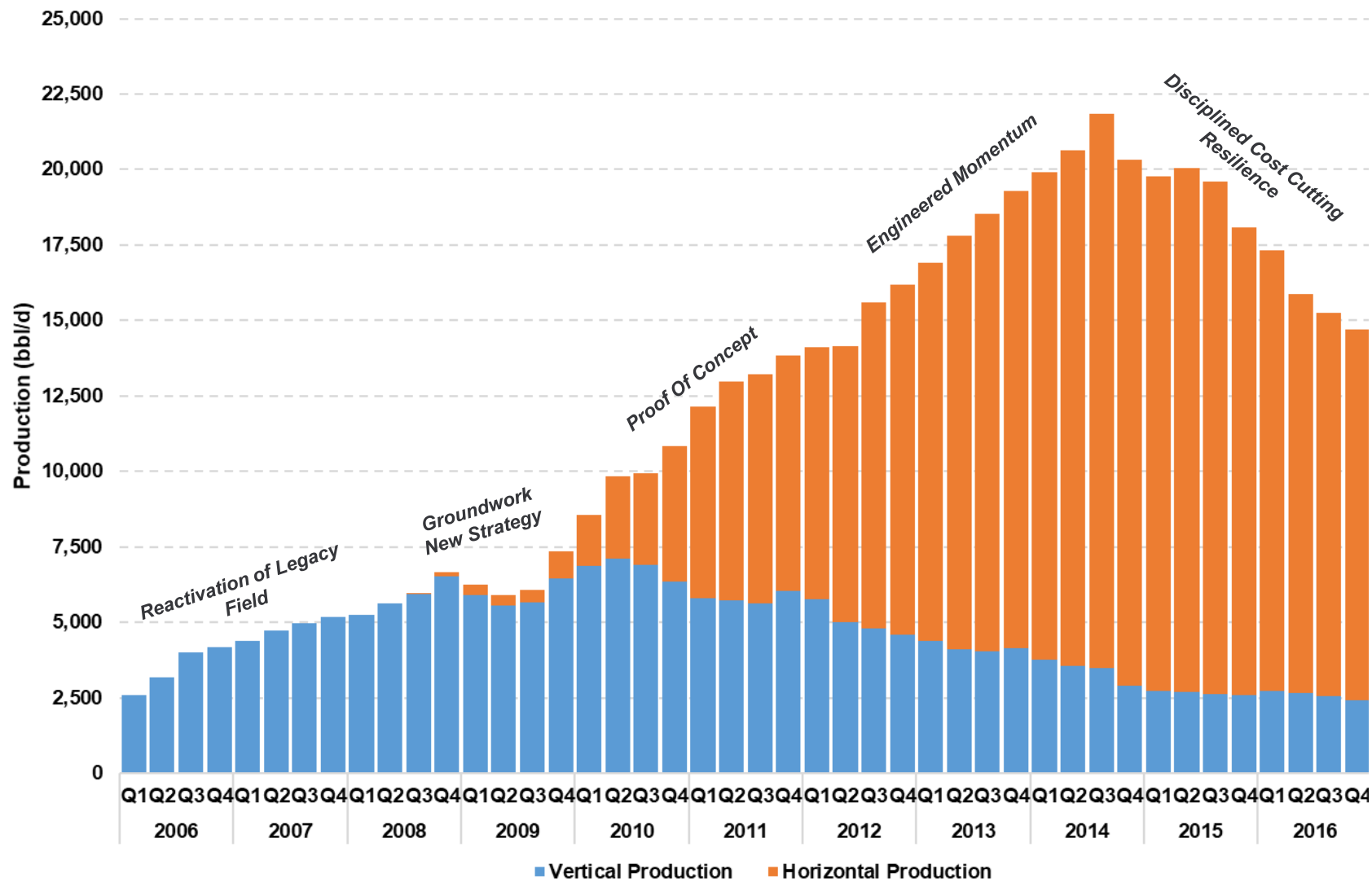
**Land Rentals** 800 land contracts in place supporting local families and business with > US\$ 9 million/year investment

Source: Bankers Petroleum Ltd. web-site 2016



- Patos-Marinza is Europe's largest onshore oilfield and core asset of Bankers Petroleum Ltd.
  - Revitalized with use of western Canadian heavy-oil technology
  - Following completion of corporate sale in September 2016, Bankers Petroleum was sold to private Chinese holdings.
- **Large reserves and production base:**
  - **2P reserves of > 200 million barrels of oil**

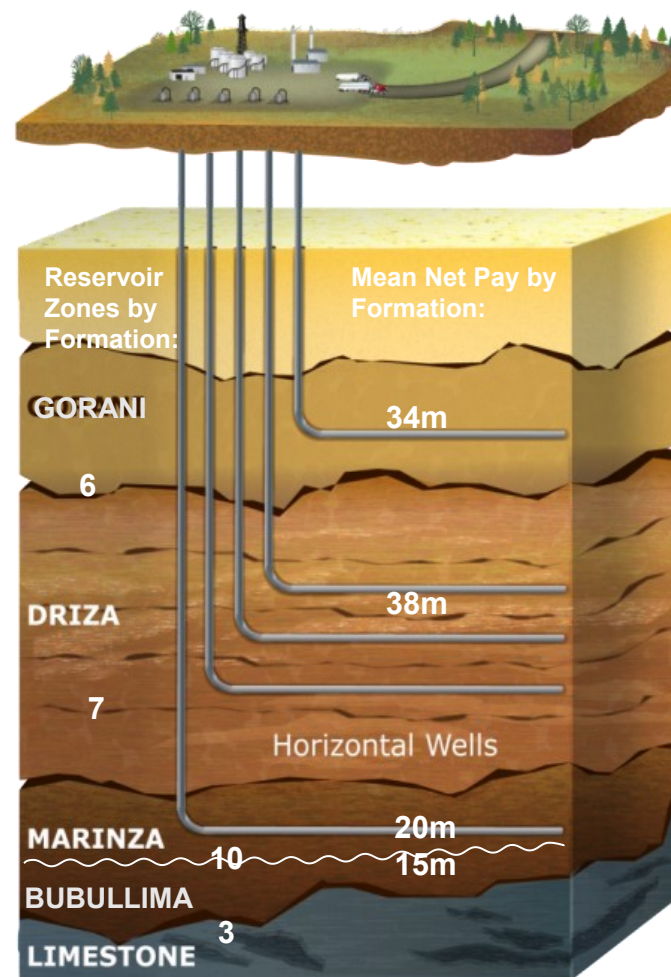
# Patos Marinza Production and Reserves Growth



Source: Bankers Petroleum Ltd. web-site 2016

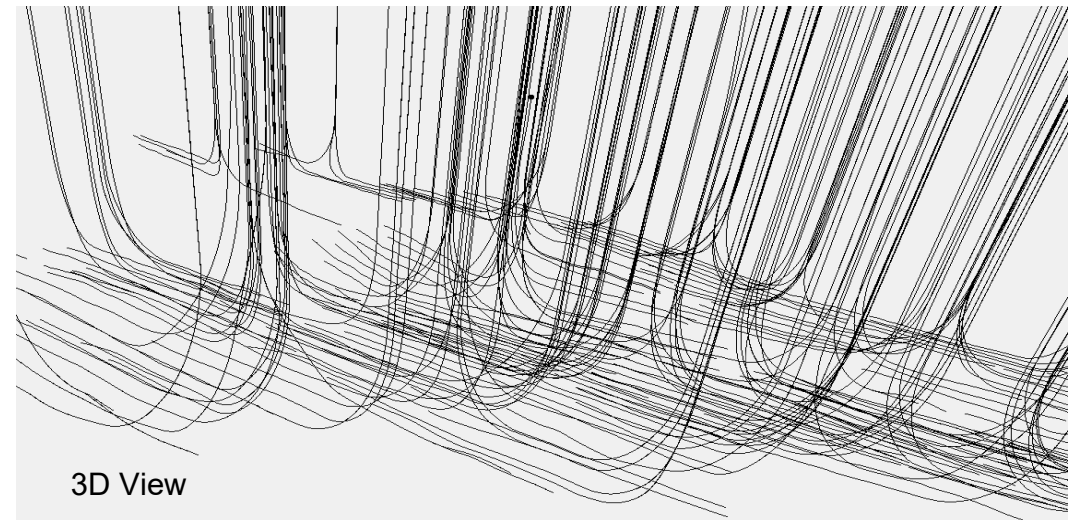
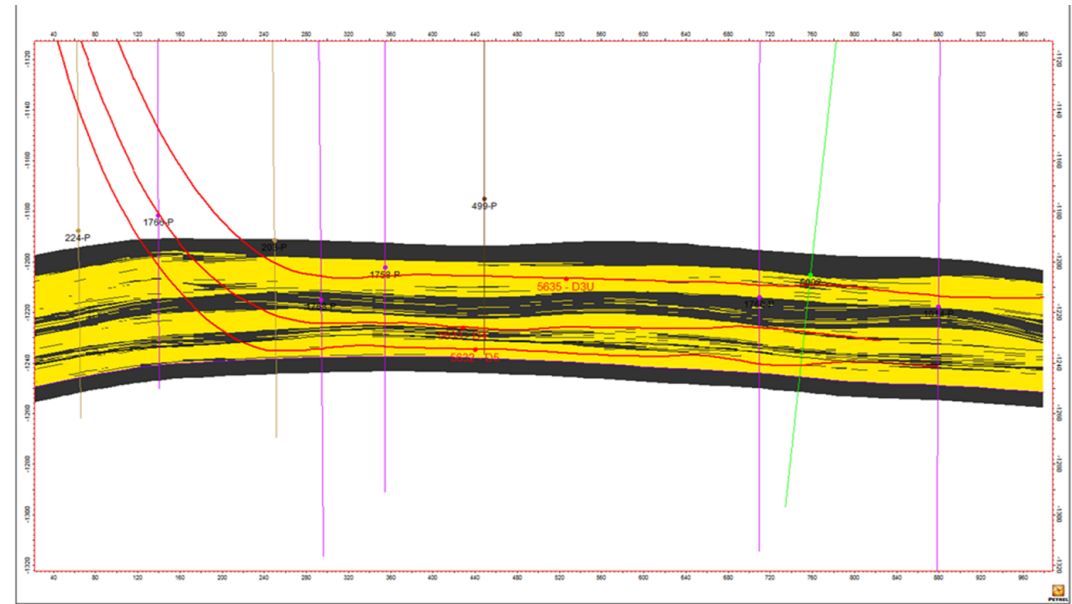
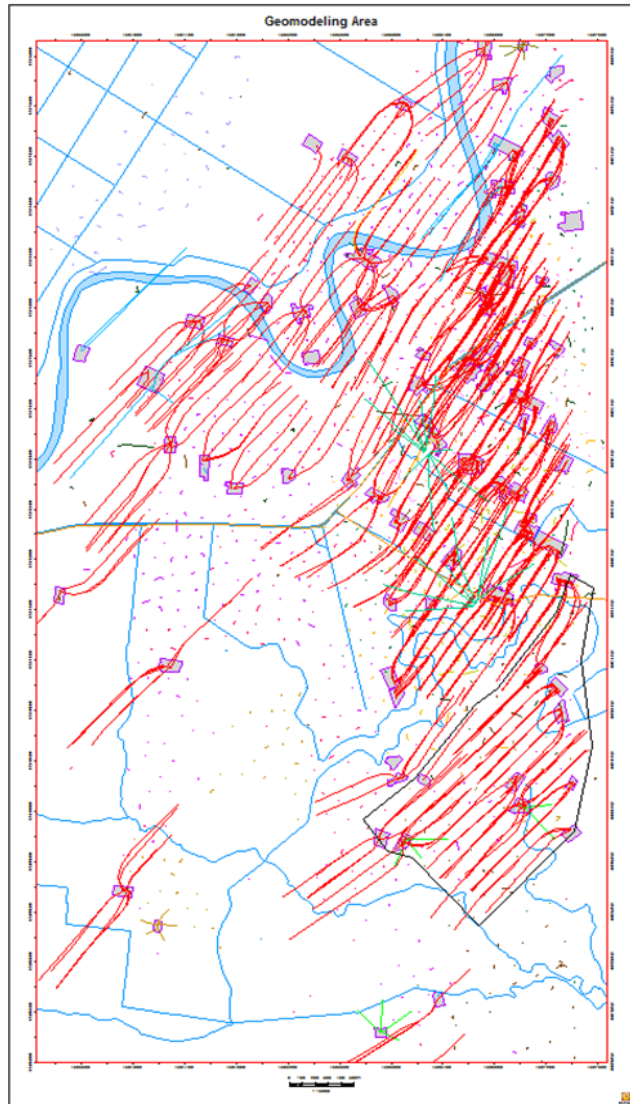
## Patos Marinza - Reservoir Development

- Multiple stacked pay reservoir of Upper Miocene (Messinian) age shallow marine deltas and bar with four main pay packages; the Marinza, Driza, Gorani, and Bubullima
  - More than 21 individual zones drilled and producing
- Field layers are steeply dipping causing a wide range of viscosities that require different development techniques
  - Deeper central and northern areas main focus for primary development due to lower viscosities and higher temperatures
  - Southern and more shallow areas target area for thermal technology
- Extensive in-field infrastructure - scalable treating facilities, flowline systems, storage and multiple off-take solutions
  - Use of pad drilling ensures access to different zones from the same geographic area
- Highly diversified and low risk production due to extensive number of wells



Mean Net Pay in Reserves Areas by Formation, as reported in RPS Reserves Report, 2016

# Patos Marinza - Horizontal Development Illustrative View



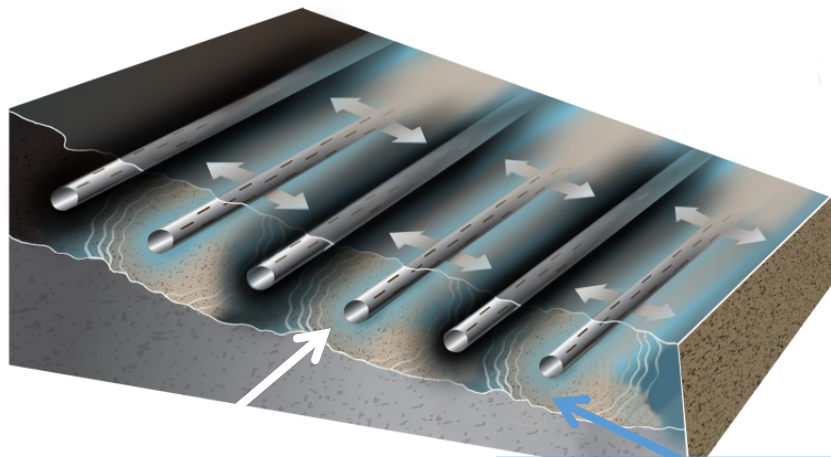
3D View

Source: Bankers Petroleum Ltd. web-site 2016

# Patos Marinza - Polymer-flood EOR Development

- Pilot polymer-flood projects began in 2013 and commercial expansion with over 100 polymer patterns in operation at end of 2016
- +30 MMbbl 2P reserves booked (16% of 2P) at end of 2016
- Approximately 50% of production comes from the polymer program
- **Reduced blended Finding & Development (F&D)<sup>(1)</sup> costs to < US\$10/bbl improving recovery and development economic returns significantly**
- Reduced decline rate from ~35% under primary to ~15% under effective polymer-flood support

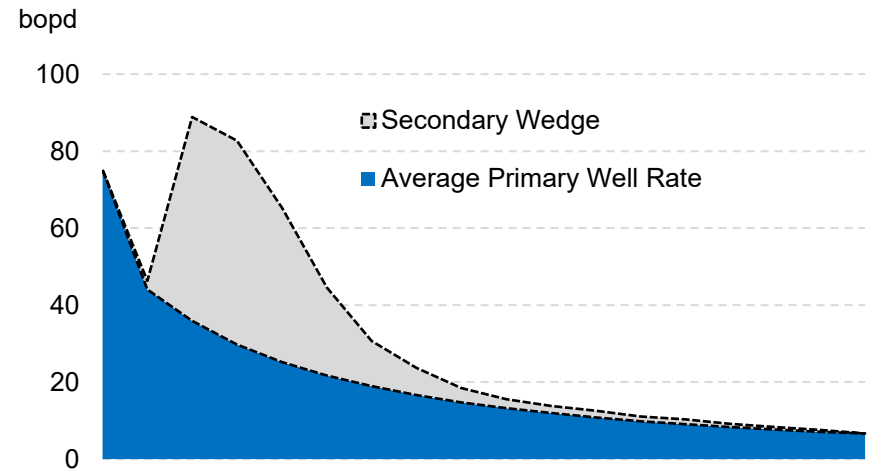
## Secondary oil recovery - illustration



The Water or Polymer flood sweeps or pushes the oil into the producing horizontal well

Water or Polymer flood is injected into a horizontal well

(1) Primary and polymer



- Graph indicates an average primary well profile and the corresponding average polymer response

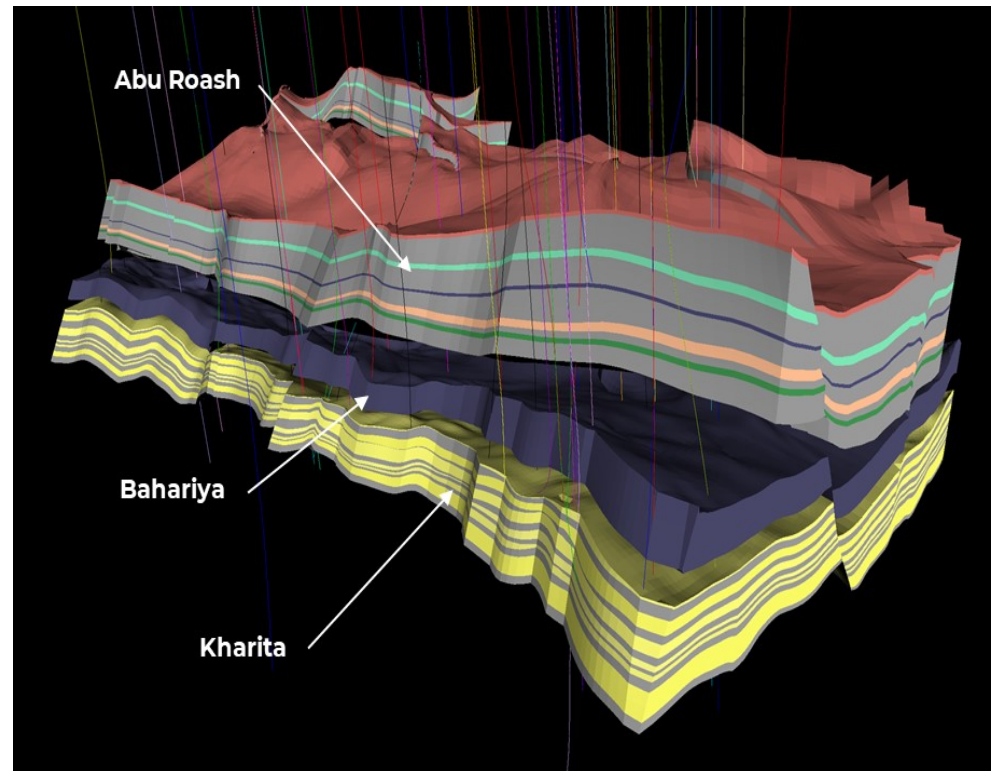
Source: Bankers Petroleum Ltd. web-site 2016

## Issaran Heavy Oil Field (Rally Energy 2005 – 2007)

- Mr. Abby Badwi was President and CEO of Rally Energy, parent company of Scimitar, from 2005 to 2007 and assembled a team of Canadian expertise to implement the thermal development of the low permeability, heavy oil Upper Dolomite Formation
- Drilled the first pilot horizontal well during this period
- Initiated Cyclic Steam Project in 2005 in a staged approach, starting with a pilot program followed by two phase commercial expansion
- Applied the first successful Cyclic Steam Stimulation (CSS) in a carbonate reservoir in Egypt and achieved first commercial production from a CSS in Egypt by drilling 40+ steam wells achieving 2,300 BOPD

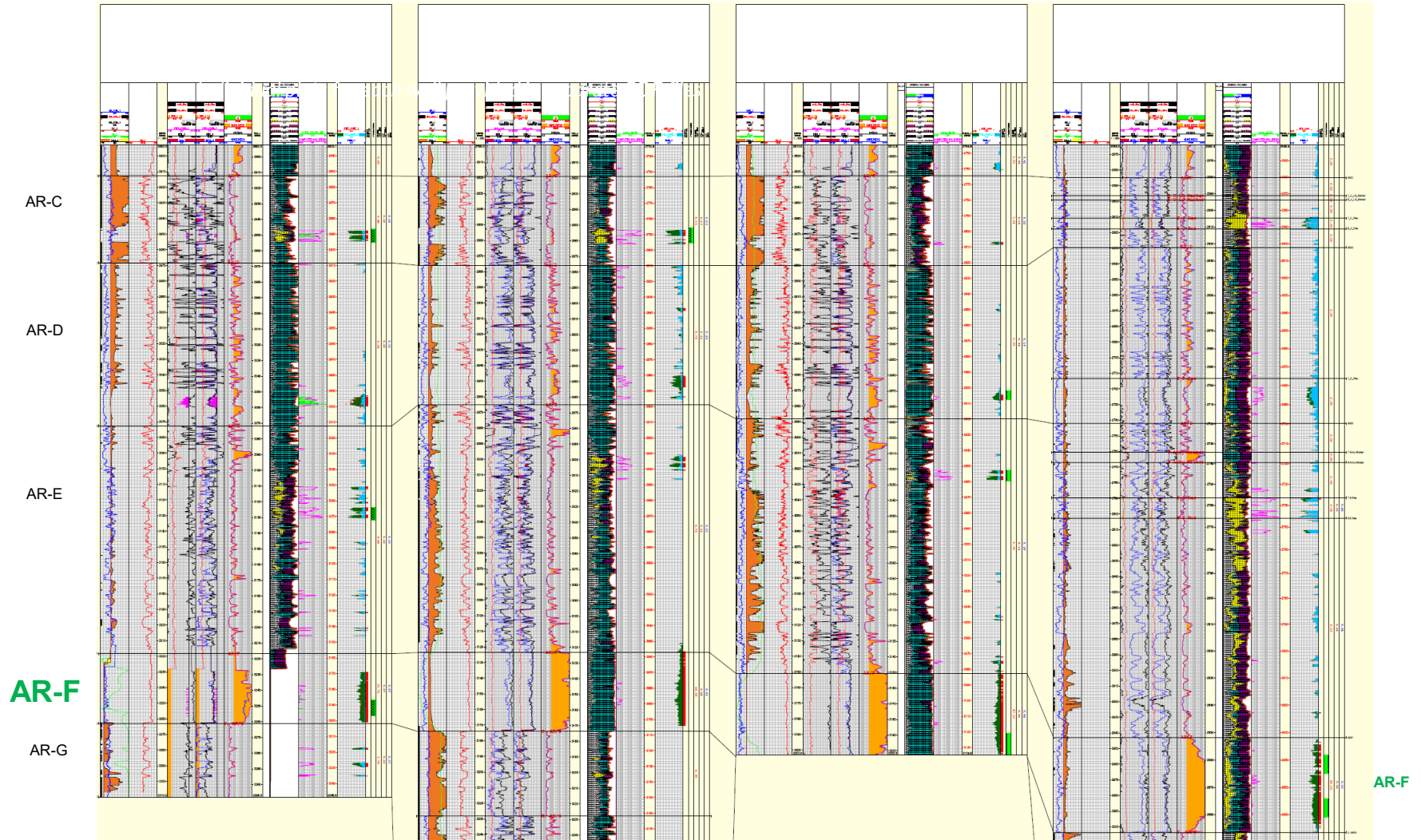
## Unconventional Abu-Roash “F” Resource, Western Desert, Egypt

- Several fields located in the prolific oil producing area of the Western Desert have produced significant volumes of light oil and gas from deeper horizons such as the Bahariya and Kharita Formations and have also encountered a thick section of heavy oil in the shallower unconventional Abu Roash “F” horizon (ARF)
- The ARF is well recognized as a source rock in the region rather than an oil producing reservoir
- The ARF is a thick low porosity and permeability zone carbonate rock with varied oil saturations and when tested it produced heavy oil at low uneconomical production rates in many cases





# Abu Roash Formation - Example Geologic Cross-section



## Development Approach of Abu Roash “F”

- The Abu Roash “F” ARF is a deep, tight, low porosity, low permeability carbonate reservoir and has varied fluid characteristics across the Western Desert and to our knowledge there has been no significant production from this heavy to medium oil-bearing zone in Egypt under conventional completion technology
- Significant analogies exist between the ARF and Canadian tight oil formations in the Montney of NW Alberta and B.C. as well as the Eagle Ford shale development in Texas USA
- Un-locking this resource play is challenging and will require an extended valuation Period to properly conduct the necessary studies to assess and model the ARF resource to determine best development method and must take into account all available wells in the area that have penetrated the ARF and existing seismic coverage in the area
- Acquisition of modern 3-D seismic data or re-processing existing 3D seismic with modern capabilities may be necessary, followed by planning and design of pilot vertical wells including coring programs, extensive logging and fluid and reservoir sampling

## Horizontal Drilling and Fracture Stimulation of Abu Roash “F”

- Based on detailed geological and geophysical modelling and rigorous reservoir simulation analysis, we can determine the appropriate horizontal drilling program to assess lateral length and fracture stimulation effectiveness
- Next step is to drill and fracture stimulate a pilot horizontal well with multi-stage fractures. Observe the well’s production performance over an extended period of time (1-2 years) prior to implementing a commercial development expansion
- If horizontal drilling does not achieve the economic results, we can explore different EOR methods and conduct additional technical studies to investigate the effectiveness of polymer-flood and or steam stimulation for improved oil recovery in the ARF formation.
- Several risks are associated with developing the deep high-pressure ARF that requires:
  - Extended piloting and evaluation prior to commercial expansion. Performance history and design improvements are critical for an optimal development.
  - High oil price, which is both an enabler and major risk factor.
  - Favourable economics and revenue/cost sharing fiscal terms to pursue commercially as unconventional deep & tight rock development is high capital intensity for drilling and fracture stimulation.

## CONCLUSION: Factors for Economic Success

Developing Unconventional Carbonate Reservoirs depends on a number of factors for success:

- 1) Detailed geological and geophysical technical studies, reservoir modelling and an extended initial phase piloting period approach prior to commercial expansion
- 2) Understanding and mitigating risk factors by utilizing the most suitable EOR technique
- 3) Favourable economic terms based on a Petroleum Services Agreement Model to pursue the high-cost capital requirements:
  - 1) Patos Marinha Fiscal Terms (100% Cost recovery, 10% Royalty and 50% Profit Tax)
  - 2) Issaran Fiscal Terms from 2005 to 2007 (Revenue Share Entitlement of Crude Oil Sales to enable Contractor to invest 100% of the capital and operating expenditures with higher share on a sliding scale up to 10,000 BOPD and decreasing at higher production volumes)
- 4) Favourable oil prices during the high capital development periods. Between 2005 and 2014 oil price was a critical factor.

