

The Canol Oil Shale Play Central Mackenzie Valley, Northwest Territories, Canada: Geoscience, Operations and Social License

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Introduction
Location and History
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NWT Oil and Gas
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Presentation

Acknowledgements

M.E. Enachescu
P. Price, F. Kierulf, M. Cooper,
A. Springer, MGM Energy Corp

Play Location

Arctic Circle, NWT

Devonian Canol Formation shale

**Source rock for the
Norman Wells oilfield**

Discovered in 1920

Depth top reef 320m

Oil Column > 300m

Canol Pipeline 1943-45

Developed in 1980's

320 MMbbls produced

Now ~12,000 bopd



Norman Wells

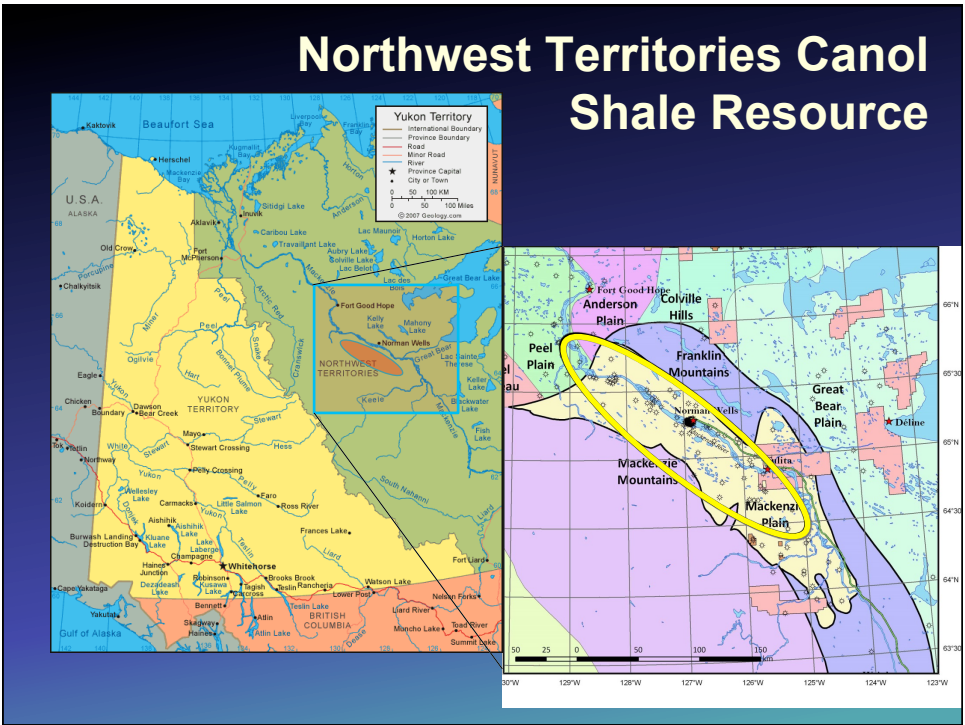
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Historic Petroleum Geology

- **Conventional exploration failed to find additional reserves in reefs or structural plays after Norman Wells discovery in 1920**
- **50+ wells over the course of 70 years looking for more conventional resources, with no new pools (*one Basin, one Discovery*)**
- **Since late 2000s focus on shale oil**
 - Industry
 - Geological Survey of Canada
 - Northwest Territories Geoscience Office
- **Stratigraphy is similar to lucrative Horn River play in NE British Columbia**

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Northwest Territories Canol Shale Resource



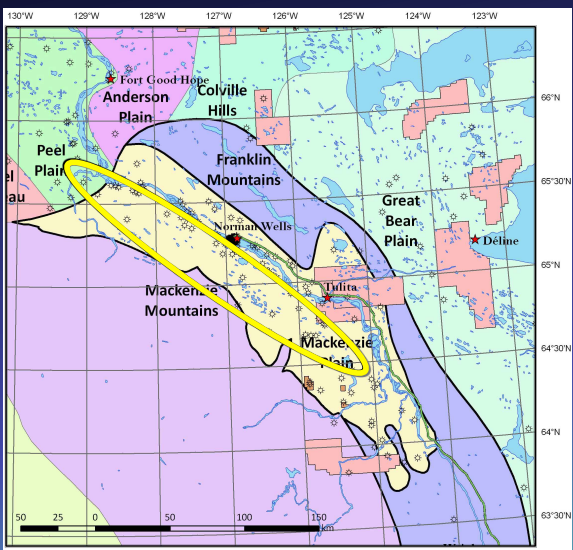
Central Mackenzie Valley

Area of Canol Shale potential is the Yellow highlighted area

Potential Area ~70 km wide by 200 km long

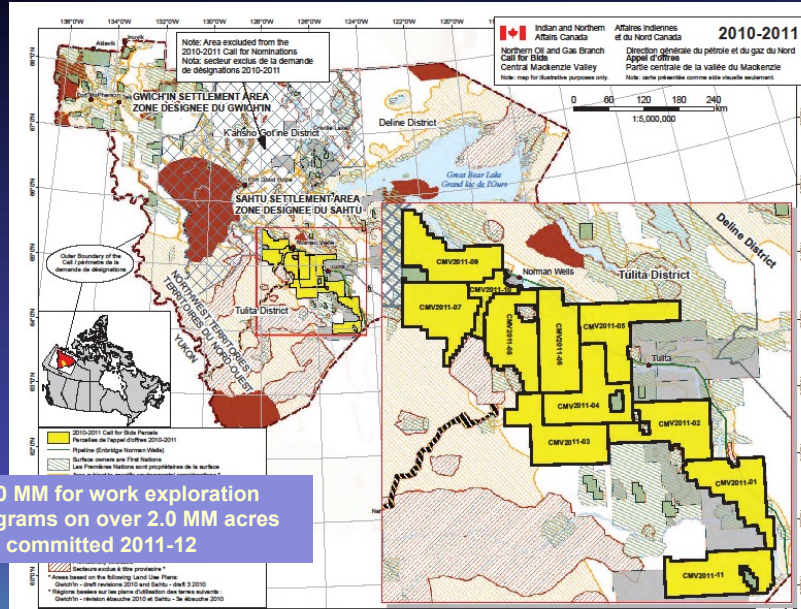
Shale exploration began in 2011

Data from forty-years of drilling through the zone was used in the shale resource assessment



http://www.nwtgeoscience.ca/petroleum/images/Mackenzie_Plain_large/mackplain_location.jpg 6

2011 AANDC Landsale – Call for Bids

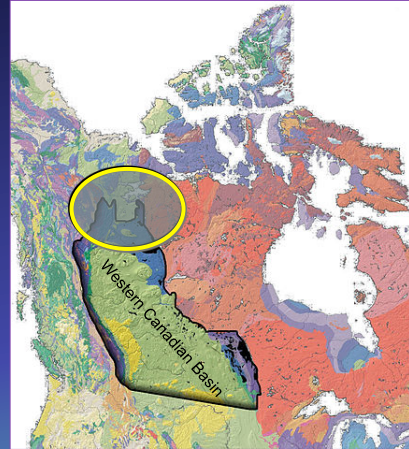


\$630 MM for work exploration programs on over 2.0 MM acres was committed 2011-12



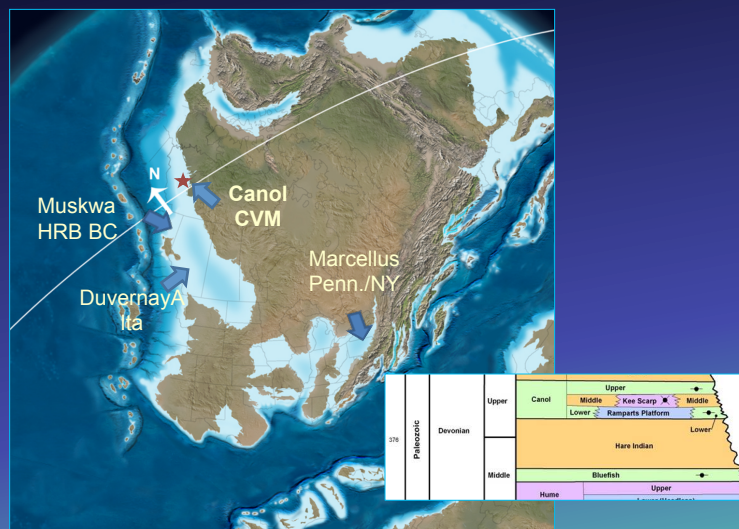
Central Mackenzie Valley (CMV) Regional Geological Setting

- Northern extension of the Western Canada Basin
- Paleozoic continental margin basin
 - Platform/Reefal carbonates
 - Evaporates
 - Marine Clastics
- Unconformably overlain by a Cretaceous foreland basin
 - Clastics and Coals
- Evolution includes repeated episodes of extension, trans-tension and compression



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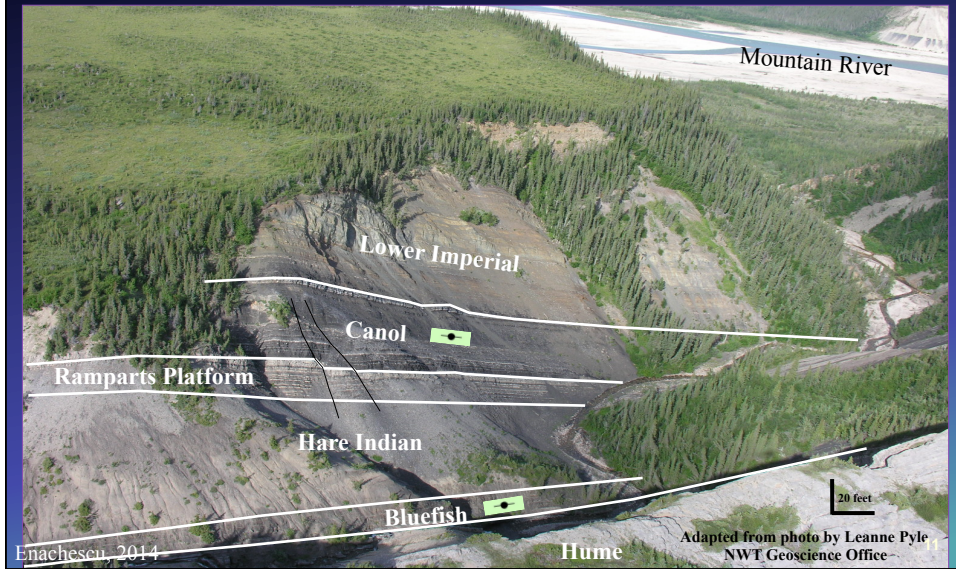
Paleogeographic Setting Middle Devonian Time (385 Ma)



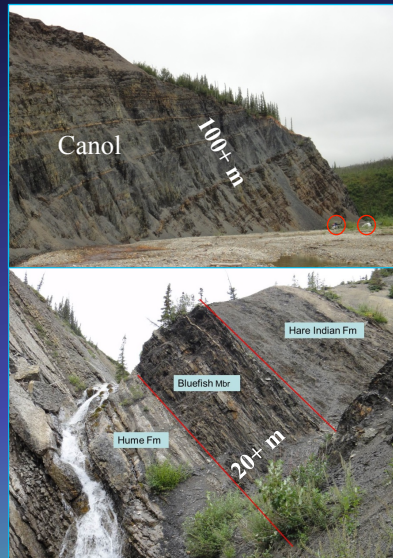
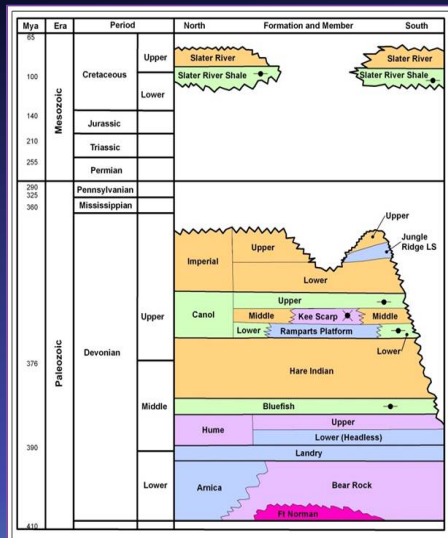
Map after Blakey, R.C. March 2011

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Middle to Late Devonian Geology of the Central Mackenzie Valley



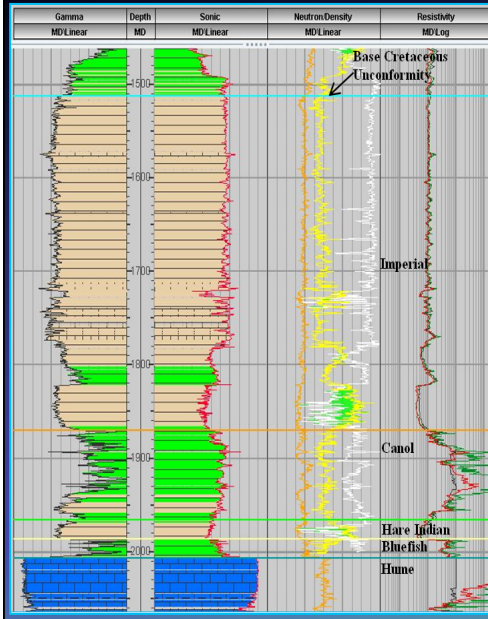
Reef and Basinal Stratigraphy



after Price et al., pers com

Photos: Paul R. Price

Representative Log – Key Characteristics



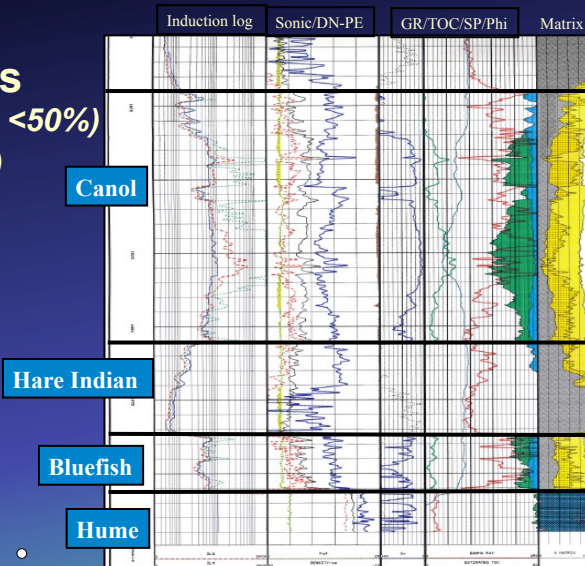
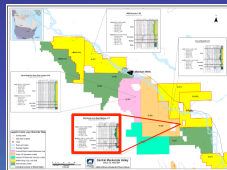
- Organic shale characterized by high gamma reading
- Hydrocarbon content indicated by high resistivity values
- Slightly higher seismic velocity and density due to increase silica content
- Average total porosity 13.9%
- Avg. TOC 4.9%
- TMax ~ 445

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Key Well - East Mackay I-77

Canol Parameters (Cutoffs $\Phi_T > 6\%$, $S_w < 50\%$) (1870.2 to 1965.5mMD)

- Thickness 95.3m
- Net Pay 59.3m
- Avg Φ_T 13.9%
- Avg S_w 20.9%
- Avg VSh 21.9%
- Avg TOC_{calc} 6.9%



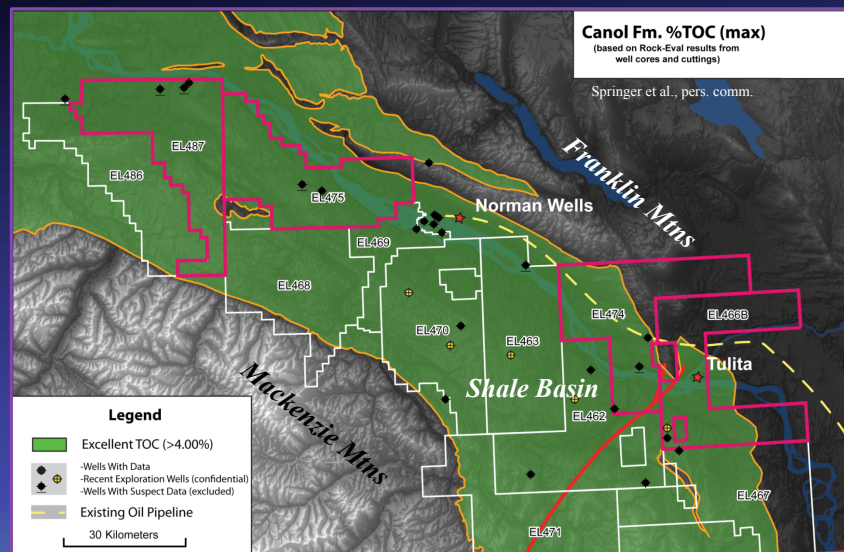
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Organic Geochemistry

- Performed work on outcrop samples, chips, well cores and cuttings
- Evaluation of source rock potential
 - Rock-Eval
 - Total Organic Carbon
 - Kerogen type
 - Thermal maturity
 - TAI
- Shale mineralogy/lithology (semi-quantitatively, using X-ray diffraction);
- Whole rock geochemistry

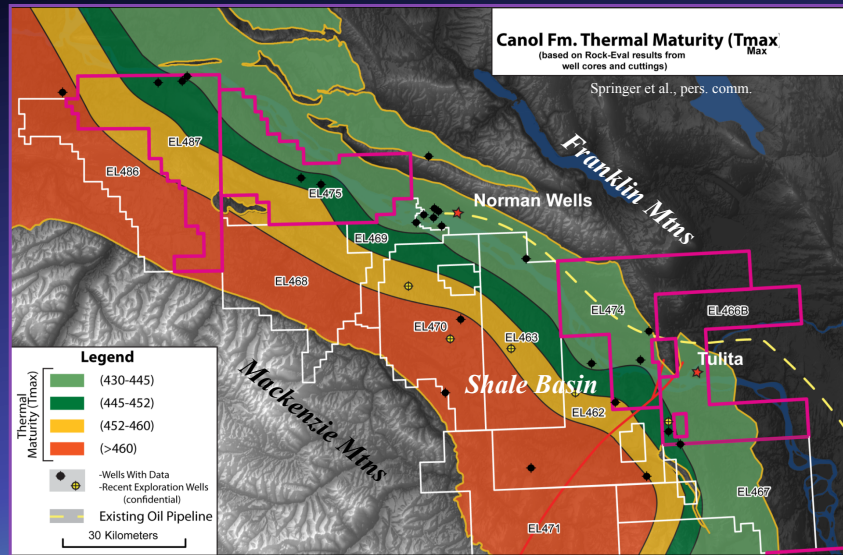
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Organic Geochemistry



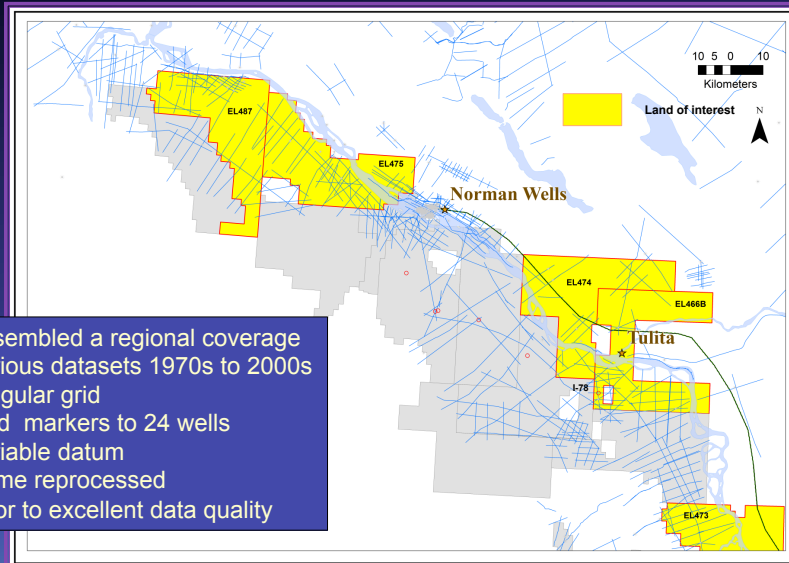
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Organic Geochemistry



Modified from Search and Discovery Article #10559; Enachescu et al., (2013) 17

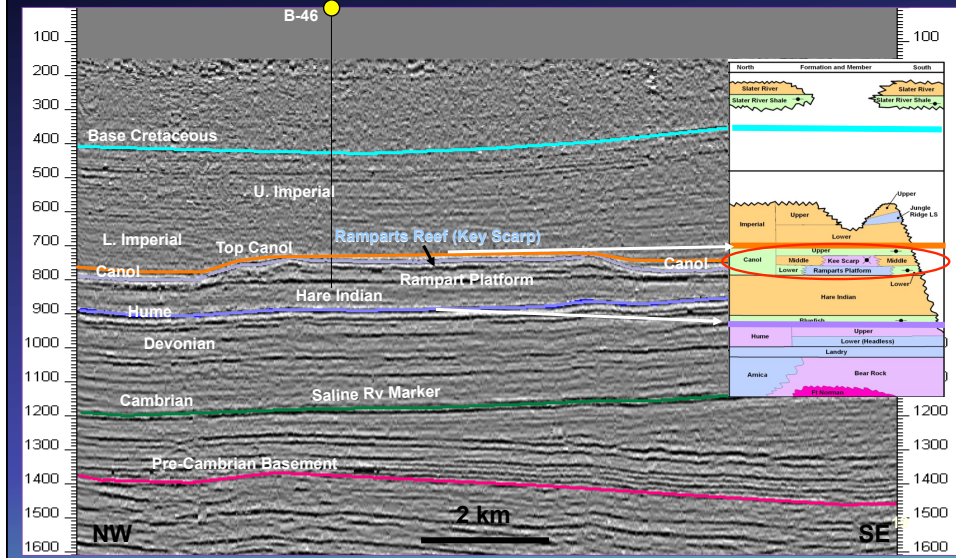
Geophysics: Seismic Coverage



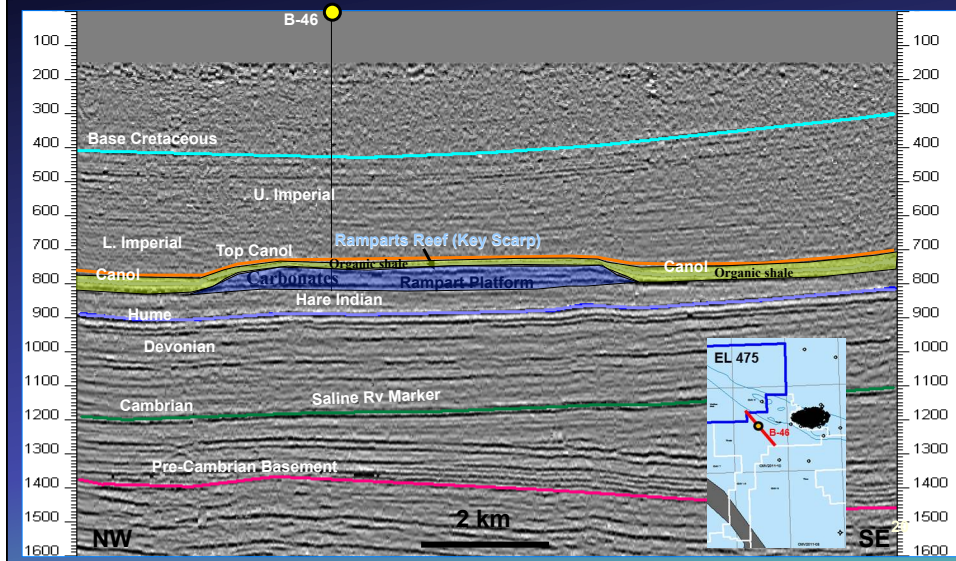
Assembled a regional coverage
 Various datasets 1970s to 2000s
 Irregular grid
 Tied markers to 24 wells
 Variable datum
 Some reprocessed
 Poor to excellent data quality

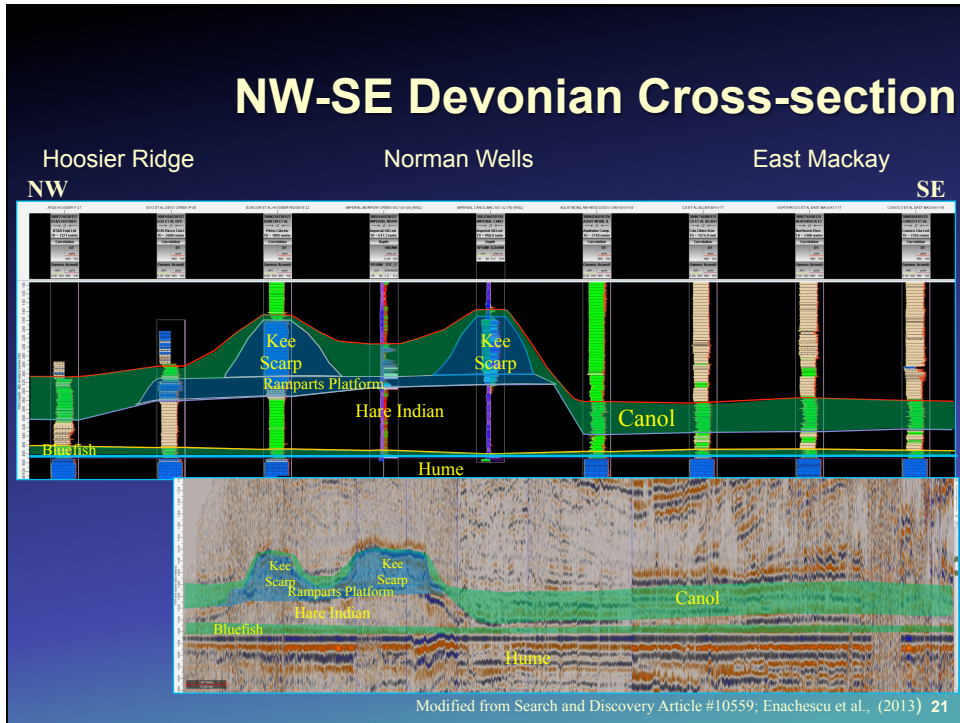
Modified from Search and Discovery Article #10559; Enachescu et al., (2013) 18

Regional Geophysics Ramparts Reef and Shale Basin



Regional Geophysics Ramparts Reef and Shale Basin





Drilling: East MacKay I-78

Why Drill I-78?

- First flow test in the basin
- Vertical well approved
- Deeper and thick Canol within fault bounded syncline
- Offset East MacKay I-77
- Intersection of seismic lines
- Good seismic data quality
- Coring and logging will allow further research of seismic, geo-mechanical and reservoir properties of Devonian shales

Map from Enachescu et al., (2013) 22



Regulatory Process in NWT

- It takes 9-12 months to secure approval to drill in the NWT, through a Project Description, PD, that is submitted to the Sahtu Land and Water Board, SLWB
- Multiple stakeholder consultation
- Review of the PD by 20+ GNWT and Federal Agencies
- Review of the PD by local Sahtu Boards, towns and hamlets
- Coordination of the PD is done by the SLWB
- Well design and HSE is the purview of the GNWT and NEB

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Community and Public Consultations

- Before submitting Project Description
 - Consultation with Communities
 - Consultation with NGO's
 - Consultation with Federal and Territorial Government Departments
 - Modify Project Description after receiving comments
- During the Project
 - Communities, Government and NGO's visits to lease
- After the completion of the project
 - Post drill consultation with Communities, Government and NGO's

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Environmental Program

- Before submitting Project Description
 - Extensive Flora, Fauna and Surface Water Assessment of the area
 - Consultation for Traditional Knowledge, Archeological, First Nations special places
- During Drilling/Fracture Stimulation
 - Ongoing assessment of Wildlife and Environmental conditions by onsite wildlife monitors
 - Monitor groundwater wells
- After Leaving the Lease/Staging Area
 - Reporting on Flora & Fauna
 - Ongoing Monitoring of Groundwater wells
 - Additional testing of all surface waters
 - Lease and Staging Area post-drill inspection/reclamation
 - *All reporting is part of the public record*

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The Project

- Negotiate Access and Benefits Agreements with SLWB
- Acquire Land Use Permit and Water License
- Barge equipment/fuel to the staging area
- Goods and Services contracts for road and lease construction
- Build winter road and lease, construction begins Nov. 2012
- File Technical Applications are with the Regulator, NEB
- Drill three ~150m ground water wells on the lease
- Drill, core and evaluate by March the vertical shale oil exploration well
- Fracture Stimulate and flow test the well
- Off the land by March 31st



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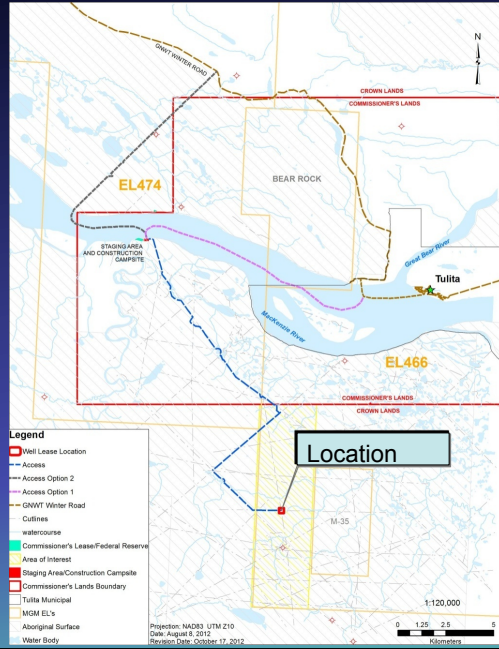
Planning, Staging and Construction



East MacKay Project

Project Activities:

- Staging
- Road/Lease Construction
 - Included 23 km of onshore road and
 - 13 km of ice road on the Mackenzie River
 - Lease construction was a 150x200 m exploration lease
 - Constructing a 100+ camp at the staging area
- Ground Water Wells (3)
- Vertical Exploration Well
 - Drilling to ~2000 m
 - Coring the Canol/Bluefish
 - Vertical Fracture Stimulation the Canol and Bluefish shales



Staging using Mackenzie River



Road Construction

- Ice Road Construction
 - Flood all roads with 15-20 cm of water
 - Grade and Continue to maintain through the Project
- All roads were existing seismic lines
- Water used was from the Mackenzie River ~ 40,000 m³
 - 80% was used for roads
 - 15% lease/staging area
 - 5% Camp



Pre-Construction



Post-Construction



Ground Water Wells



Water Well Completion Test



Water Well Water Results

- All of the results from our three water wells public
- Results show that the fresh water around our location at ~ 80-100 metres below the surface and is naturally a little high in Fluoride, Copper and Zinc
- There is no trace of hydrocarbons, before, during or after our drilling or stimulation operations

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Exploration Drilling



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Data Acquisition

- Coring of Canol and Bluefish
- Full suite of conventional logs over the surface hole and spectral gamma
- Main hole had a full suite of logs plus additional logging runs for pressure data
- One third of the drilling costs were for evaluation, cores and logs

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Fracture Stimulation Operations



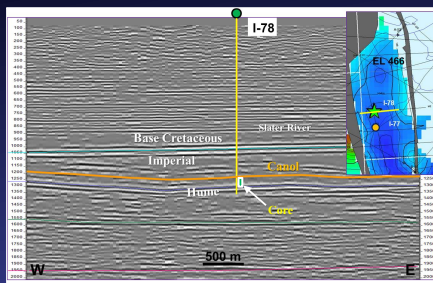
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Fracture Stimulation

- Fracture stimulated four zones:
 - One in the Bluefish
 - Three in the Canol
- Comingled the Canol production, very short timeframe to complete the task
- Objectives were to flow hydrocarbons in order to obtain a Significant Discovery License, not to determine commerciality
- All of the objectives were achieved

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Drilling Results: East Mackay I-78



Drilled to total depth 2001 m
 Seismically tops came in ± 5 m
 Cored Canol & Blue Fish
 Full suite of wire line logs
 including Dipole Sonic
 Fracture Stimulation of Canol
 and Bluefish using a clear
 mineral oil
 Confirmed presence of free
 hydrocarbons
 Shut-in for pressure build-up
 and re-tested
 A Significant Discovery
 Licence was awarded to
 partner companies by NEB

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Social License



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What is a Social License

- **Industry, Government, Communities, First Nations (when applicable) and the Public** working with a common goal of understanding past, future and ongoing projects
- For the Industry, this involves consultation, communication and *full public disclosure* of work programs
- For the Government, a Social License is to be an active participant in the Region *before* licenses are granted
- For the Communities a Social License is to work with Government and Industry on their Concerns over the project

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Government Responsibility for Social License

- **It is the duty of Government to ensure that baseline data is collected in exploration areas *before* exploration licenses are awarded**
- **This includes:**
 - Surface and Groundwater studies
 - Community potable well data
 - Regional Seismicity data
 - Regional planning for increased activity on rural infrastructure
- **Consultation with the affected Communities, Stakeholders and NGO's which includes discussion on what exploration and development will bring to the Region**
- **Actively listen and modify future land postings for specific concerns**

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Industry Responsibility for Social License

- **Once land is obtained by a company they must meet with both Government and Communities to discuss future programs, timelines and opportunities**
- **To actively listen to concerns of the Communities and Public and address areas of concern**
- **To report to the public and government on a timely basis**
- **To fully disclose environmental information to the public including all fracture stimulation fluids, chemicals and volumes, drilling mud chemicals and ensure a groundwater and surface monitoring program**

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Communities Responsibility for Social License

- To make themselves aware of the activity and an acknowledgement that the Oil and Gas Resource extracting is an Industrial activity
- To understand that the Technical aspects of the program are being monitored by Professional Engineers, Geoscientists, Biologists and Hydrologists within the Government, who awarded the lands to the Industry
- Recognize that the Industry and Government are committed to full disclosure of baseline and ongoing studies to the public before, during and after completion of the projects

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What does the Industry need from Government for Resource Plays?

- **Clear regulatory path forward**
 - Know the rules before proceeding with exploration
 - Development planning will take years, the regulatory process can't change in the middle of planning
- **Communication with Stakeholders**
 - Communities need to know that with success there will be a need for pipelines for oil, gas and natural gas liquids to markets and additional roads and infrastructure improvements
 - Good quality environmental baseline data is acquired before exploration

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Summary

- The Canol shale is and example of a frontier basin play with little local infrastructure
- The Canol shale, like in many frontier basins plays, are Projects, not single wells, they require significant Project Management
- Social License is “best practice”
- Industry, Government and the Public need to be involved in planning the projects
- Industry must see a clear path forward from Exploration through Development



Thanks

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