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Scientific Presentation 91**

Qualitative assessment of petroleum and other resources, Pacific area of interest (AOI), offshore British Columbia

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1. **West Coast Vancouver Island First Nations Workshop on the Proposed Offshore Pacific Marine Protected Area**
Date presented: May 2, 2018

and

2. **Offshore Pacific Advisory Committee Meeting No. 3**
Date presented: May 3, 2018

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Qualitative Assessment of Petroleum and other Resources Offshore Pacific Area of Interest (AOI)

Presented by Renee Ferguson, on behalf of the Offshore Pacific MCT Project Team
Geological Survey of Canada
Lands and Minerals Sector
Natural Resources Canada

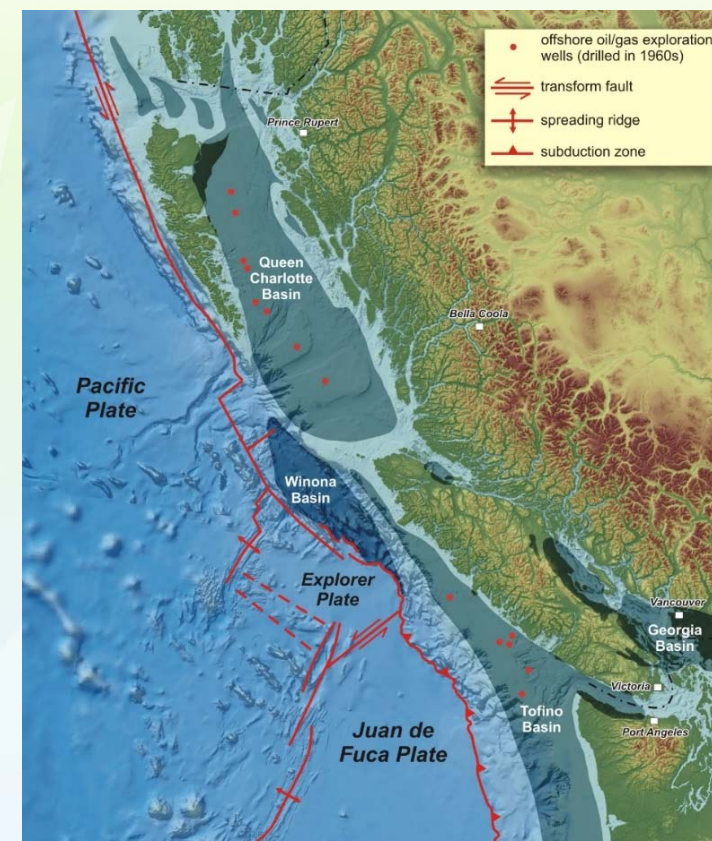
May 2, 2018



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Presentation Outline

- Introduction
- Purpose of the Resource Assessment
- Details of the Resource Assessment
 - Industry and Research Activity
 - Study Data
 - Methods
- Results
- Conclusions
- Feedback



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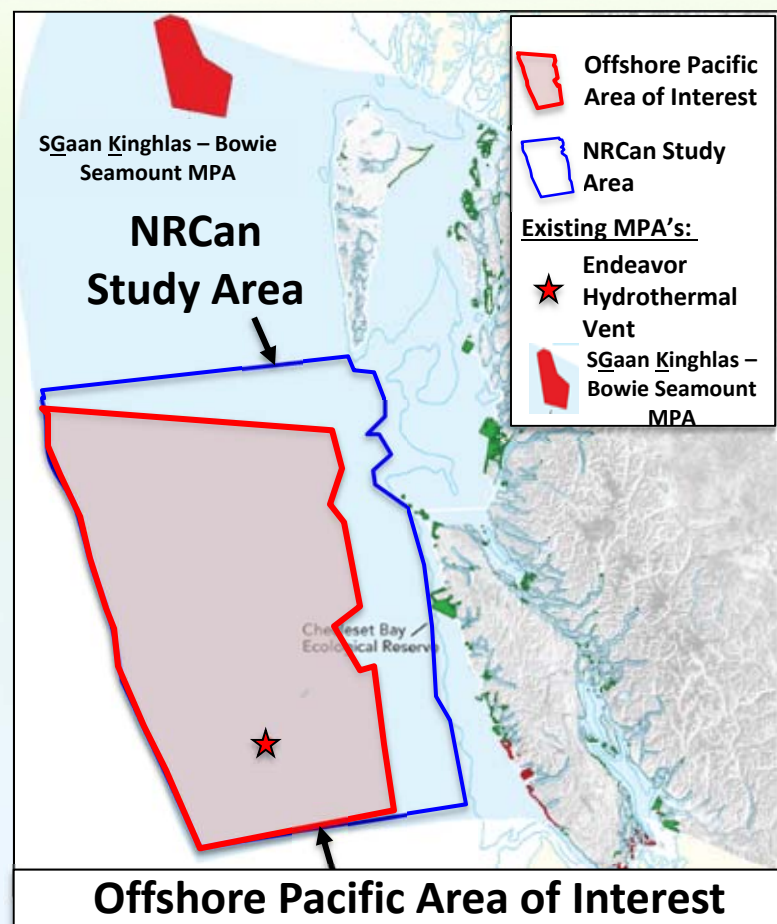


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Introduction



Offshore Pacific Area of Interest:

- Canada's Offshore Pacific Area of Interest (**red outline**) is located approximately 100 km west of Vancouver Island
- The Area of Interest covers ~139,700 km²

NRCAN Study Area:

- We assessed a larger area (**blue outline**) that covers ~200,000 km² to ensure that all areas with potential to contribute hydrocarbons to the Area of Interest were considered (Ferguson et al., 2018).

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Purpose

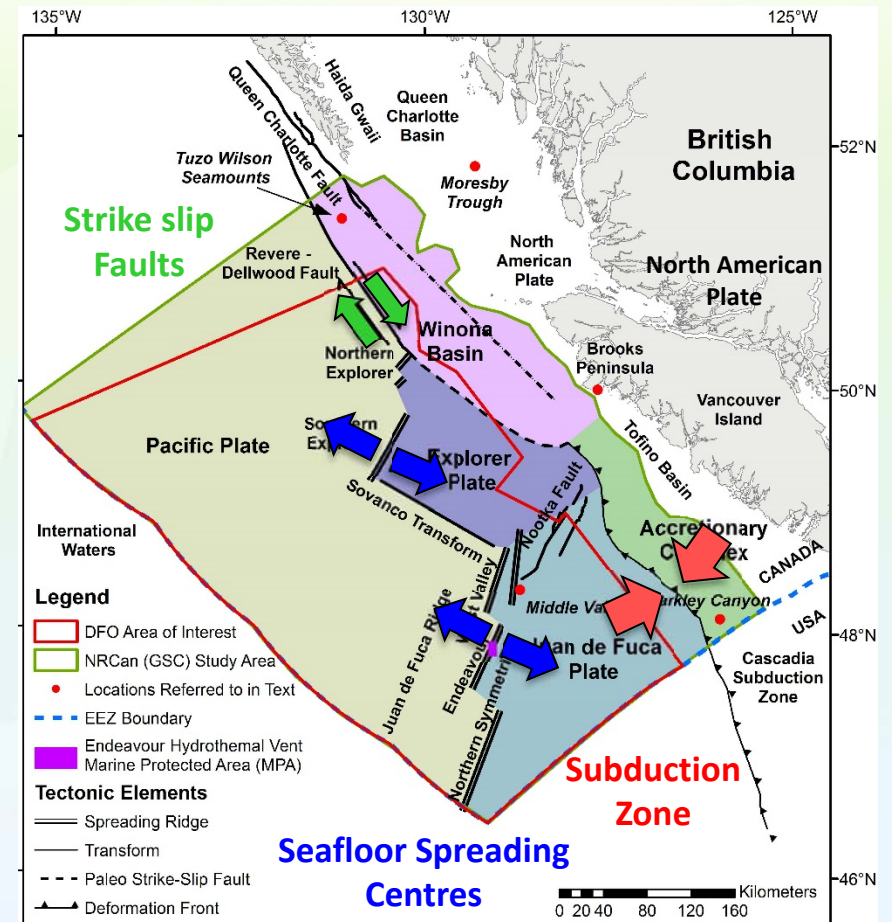
To assess the resource potential in an
Area of Interest identified by
Fisheries and Oceans Canada

Does the Area of Interest contain energy and
mineral resources?

What types and where?

What information did we use?

How did we get our results?



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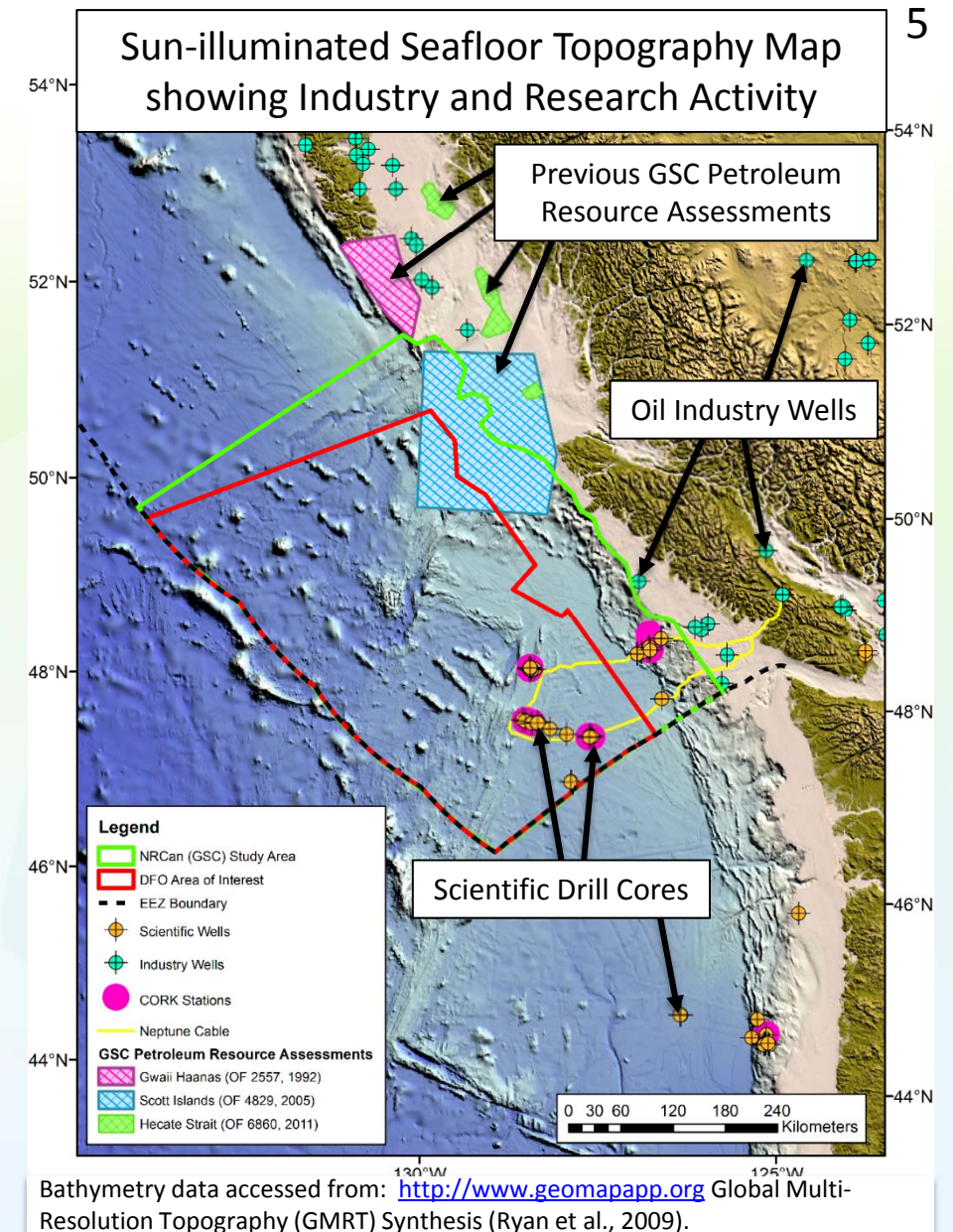
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Details of the Resource Assessment: Industry and Research Activity

- No oil industry wells in the area of interest and no previous petroleum assessments over the majority of the area of interest.
- Oil industry activity prior to 1972 moratorium focused on areas closer to the coast, where older rock formations with petroleum potential are present.
- Scientific drill cores and other data indicate these older rocks are not present in most of the Area of Interest.



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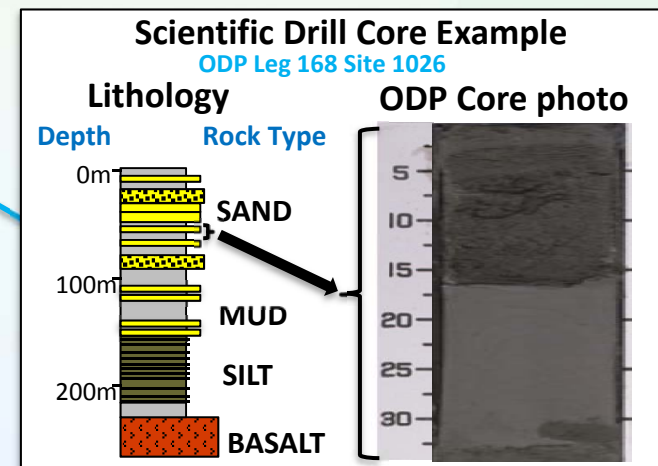
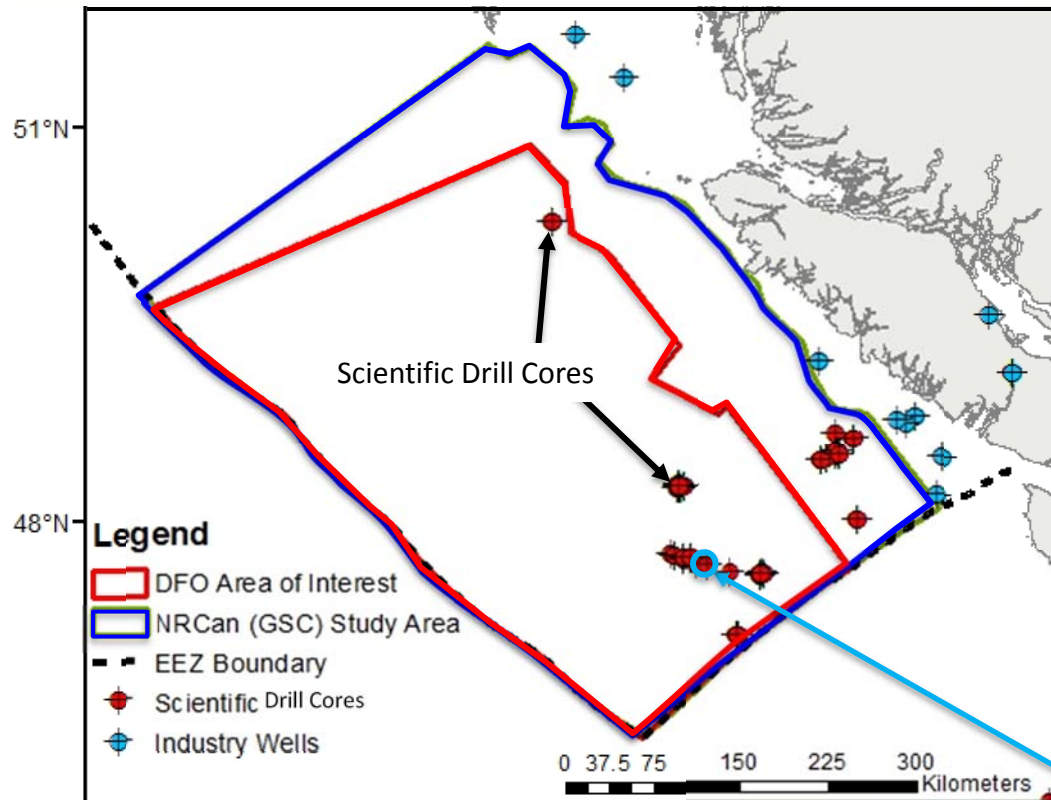
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Details of the Resource Assessment: Geological Data used in Study

- NRCan relied on existing geoscience data (mainly research data).
- Well data can tell us a lot at the well site:



- Rock type
- Age
- Temperature
- Chemical composition
- Grain size and much more

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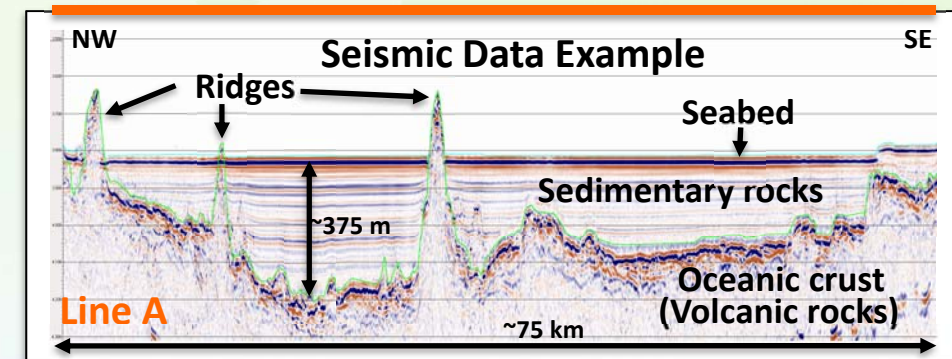
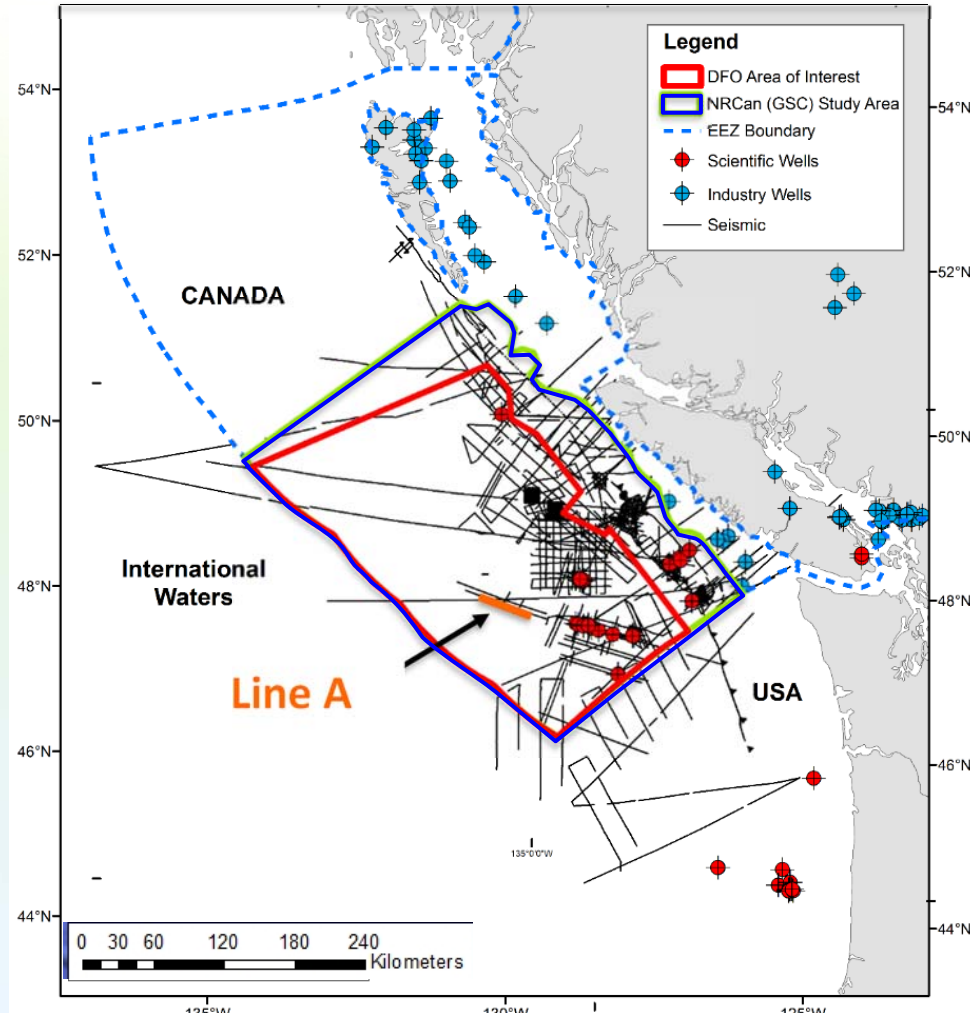
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Details of the Resource Assessment: Geophysical Data used in Study

- Geophysical data are collected over 10's to 100's of line km's.
- 30,000 line km geophysical data consulted



- These data can help us to:
 - map “basin fill” sediments that can host oil and gas deposits
 - estimate thickness of the basin fill
 - Detect and map possible hydrocarbon indicators, gas hydrates, faults and channels

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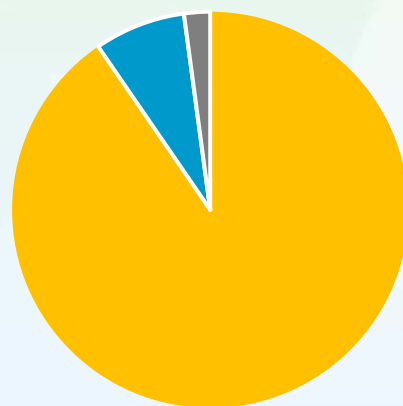
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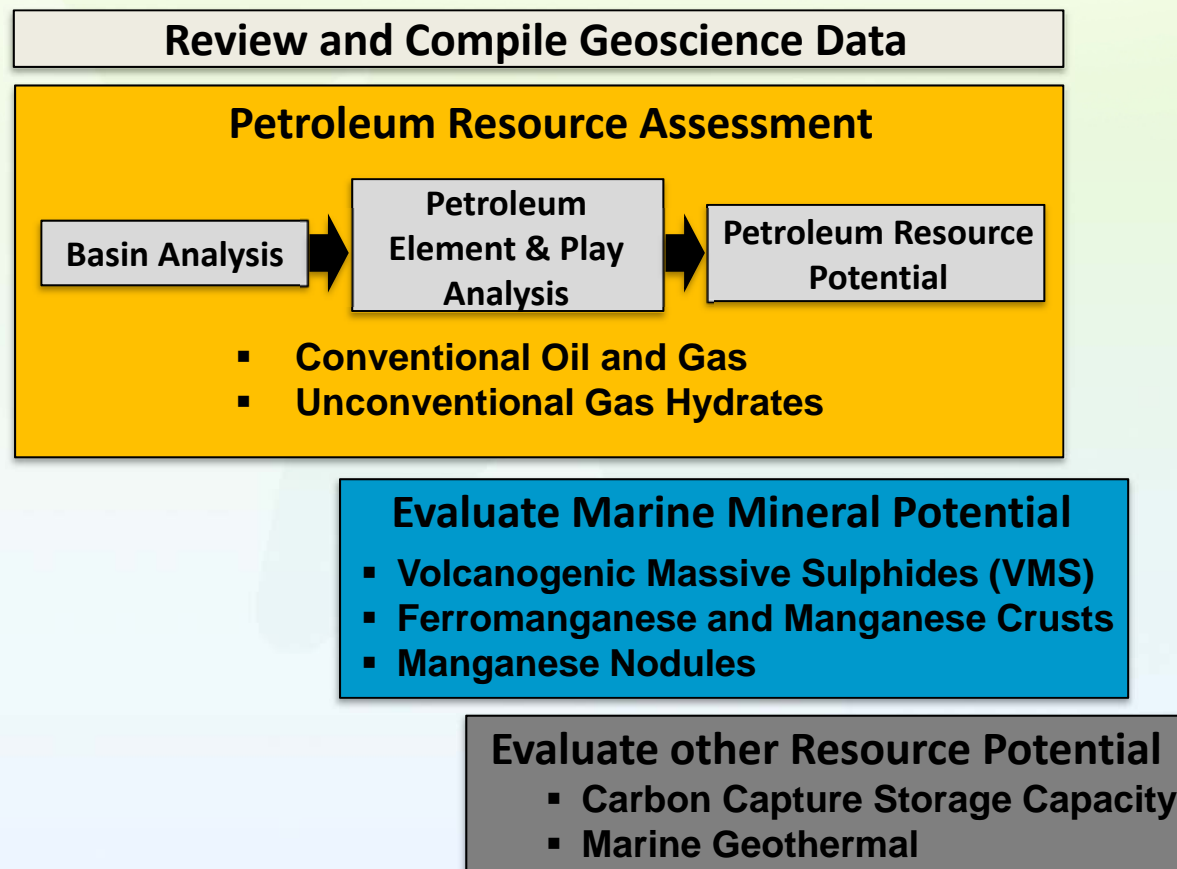
Details of the Resource Assessment: Methods: Study Approach

- Study focused on petroleum resources
- Marine mineral resources also evaluated
- Other emerging resources were considered

Assessment Activities



- Petroleum Assessment
- Marine Mineral
- Other Resources



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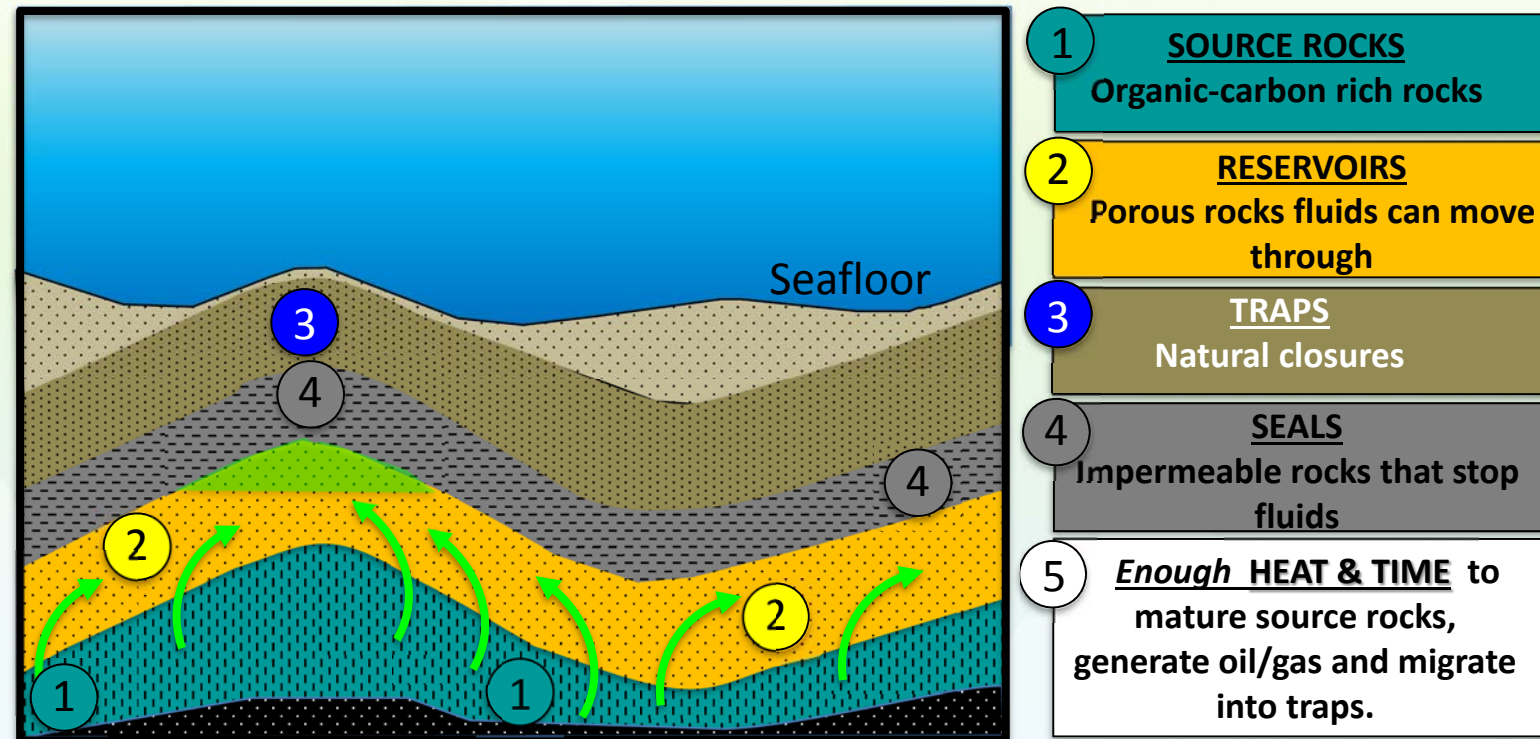
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Details of the Resource Assessment: Methods: Petroleum Assessment

A working petroleum system requires “basin fill” sediments and all petroleum system elements (1 2 3 4 5), to be present and timing of events must be in the right order.



Modified from <http://energy-alaska.wikidot.com/natural-gas-as-a-resource>

Play = set of potential petroleum accumulations from certain combinations of trap, reservoir, seal and source

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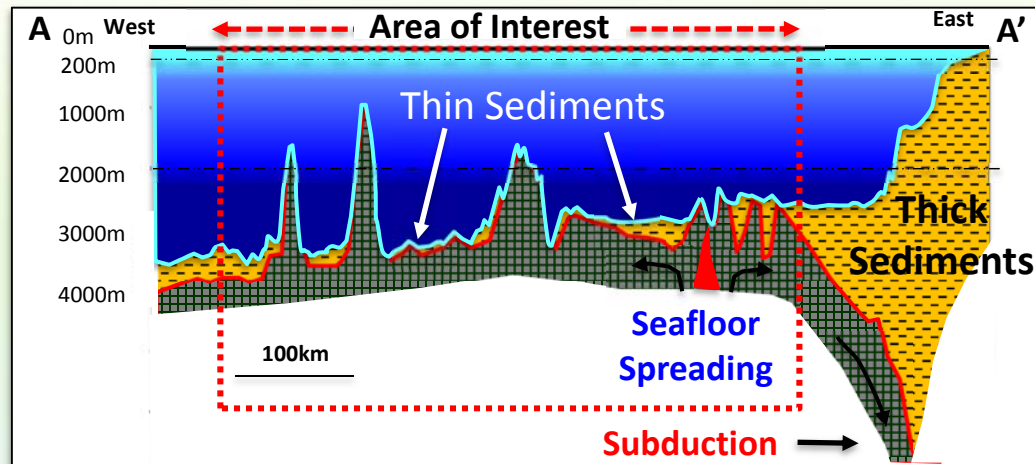
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Petroleum Resource Assessment Results: Conventional Petroleum Potential



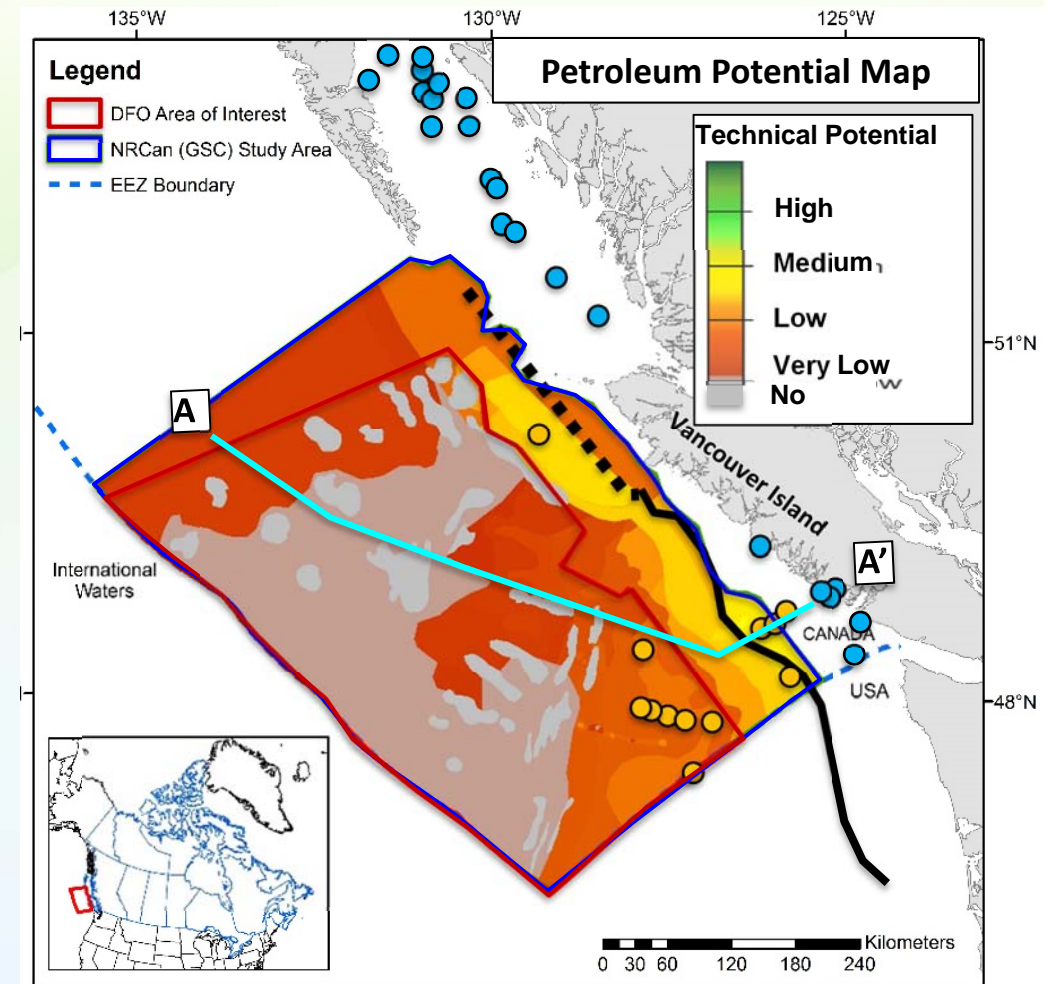
Conclusions (based on existing data):

Area of Interest:

- No areas with high or moderate potential.
- Very Low or No petroleum potential over most of the Area of Interest
- Low potential in the south-eastern corner of the Area of Interest

Outside Area of Interest:

- Moderate potential in thicker and older basin fill to the east



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Petroleum Resource Assessment Results : Unconventional Gas Hydrates Potential

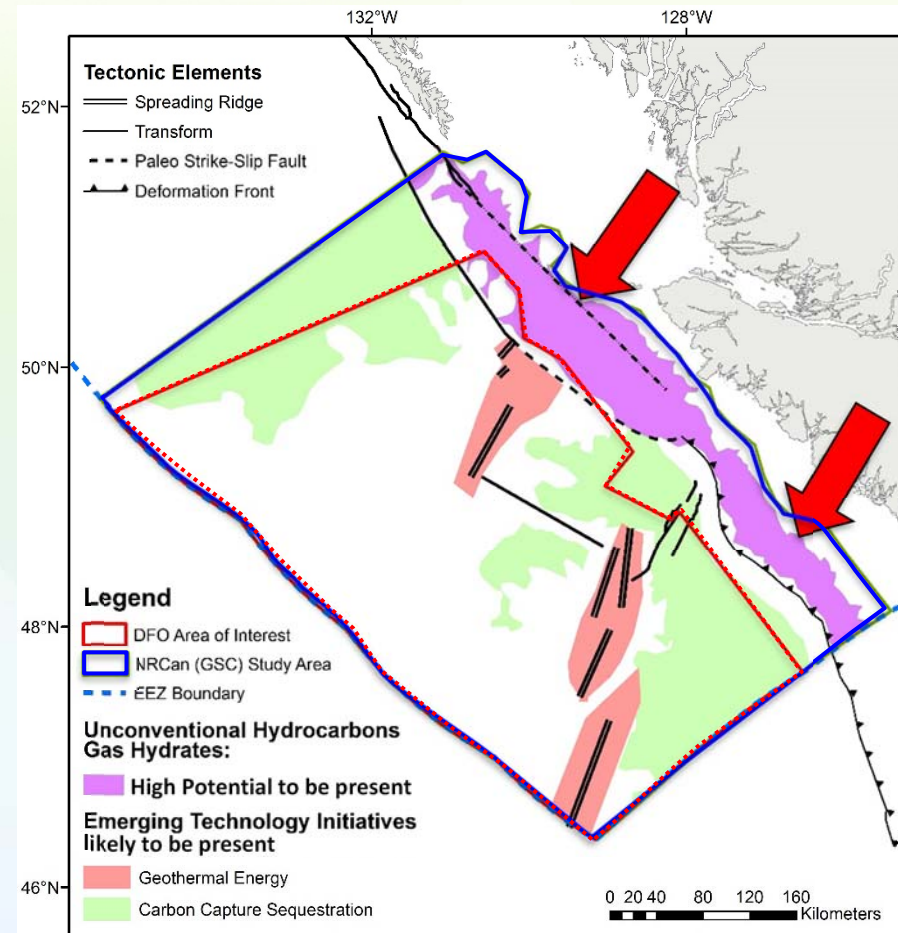
Gas hydrates:

- ***mounds of ice (crystallized structures of methane and ice) that form in low temperature and high pressure conditions.***
- ***Common in cold climates and in deep water.***



Photo from Ocean Networks Canada: Gas hydrates in Barkley Canyon. Photo taken by Ross Chapman)

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- Hydrates in marine settings remain a globally unproven exploitable natural gas source.

Gas hydrate potential:

- A limited area of potential occurs along the north easternmost edge of the AOI
- Areas with high potential to contain gas hydrates identified east of the AOI



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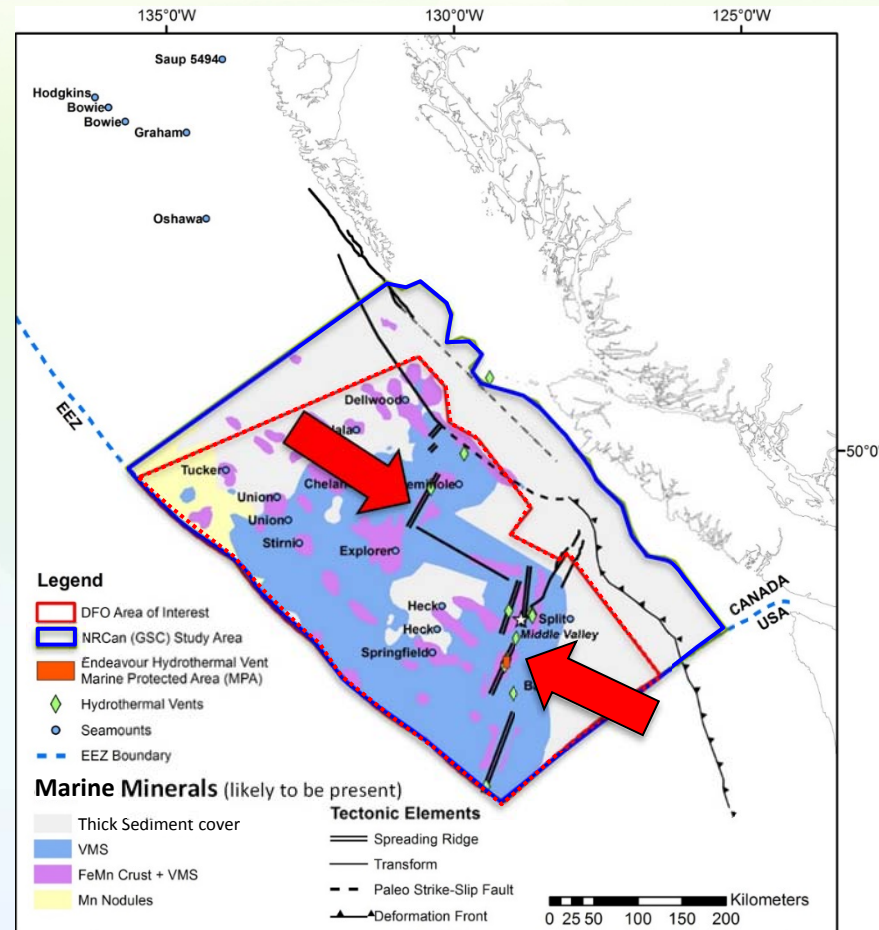
Marine Mineral Assessment Results: Volcanogenic Massive Sulphide Deposits

Volcanogenic Massive Sulphides:

- form around hydrothermal vents or hot springs at the seafloor and often contain high concentrations of iron, copper, zinc and precious metals.



Photo from Ocean Networks Canada: A smoker, Sully Vent, Main Endeavour Vent, EHV MPA



- Japan has very recently begun mining deep sea VMS deposits

Volcanogenic Massive Sulphide Deposits:

- Areas likely to contain VMS deposits are identified on oceanic crust that formed at seafloor spreading centres, with low sediment cover*

* Mineral grade, tonnage, and economic factors have not been determined or estimated.

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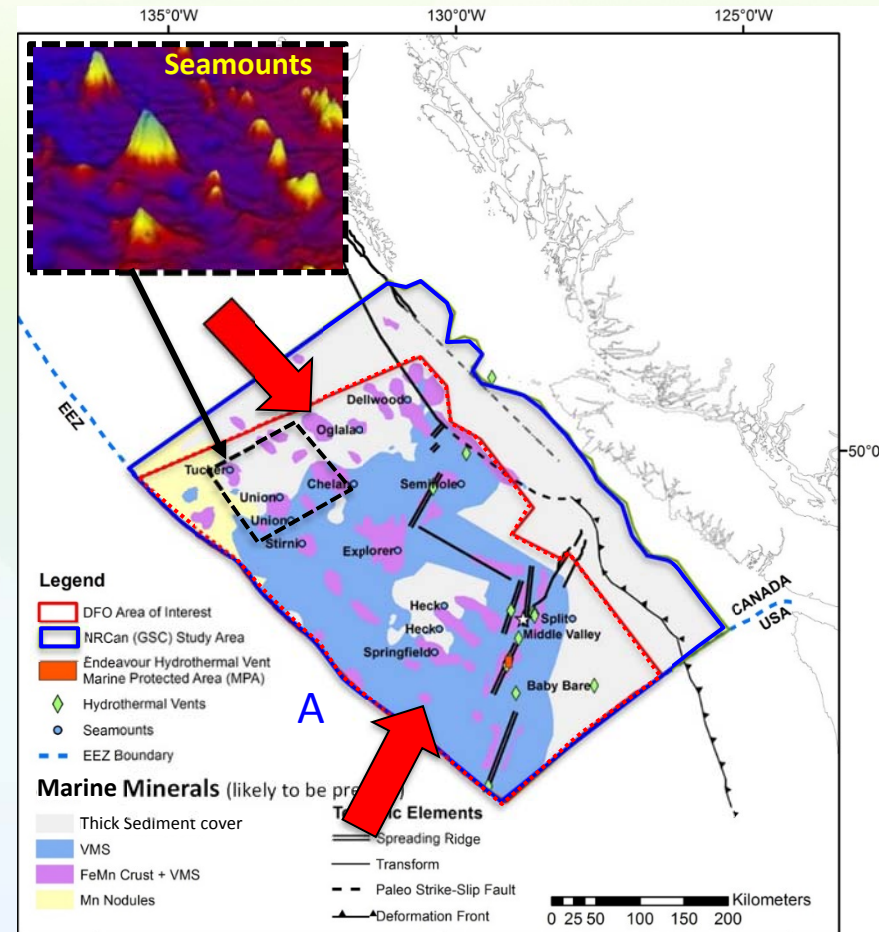
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Marine Mineral Assessment Results: Ferromanganese (FeMn) Crust Deposits

Ferromanganese and manganese crusts:

- ***form on seamounts and can contain high concentrations of cobalt, nickel, other precious metals and rare earth elements.***



- No commercial FeMn mining activity anywhere in the world.

Ferromanganese Crust Deposits:

- Seamounts in the AOI are likely to contain FeMn crusts. FeMn crusts are also likely present on seamounts to the North and West of the AOI.

** Mineral grade, tonnage, and economic factors have not been determined or estimated.*

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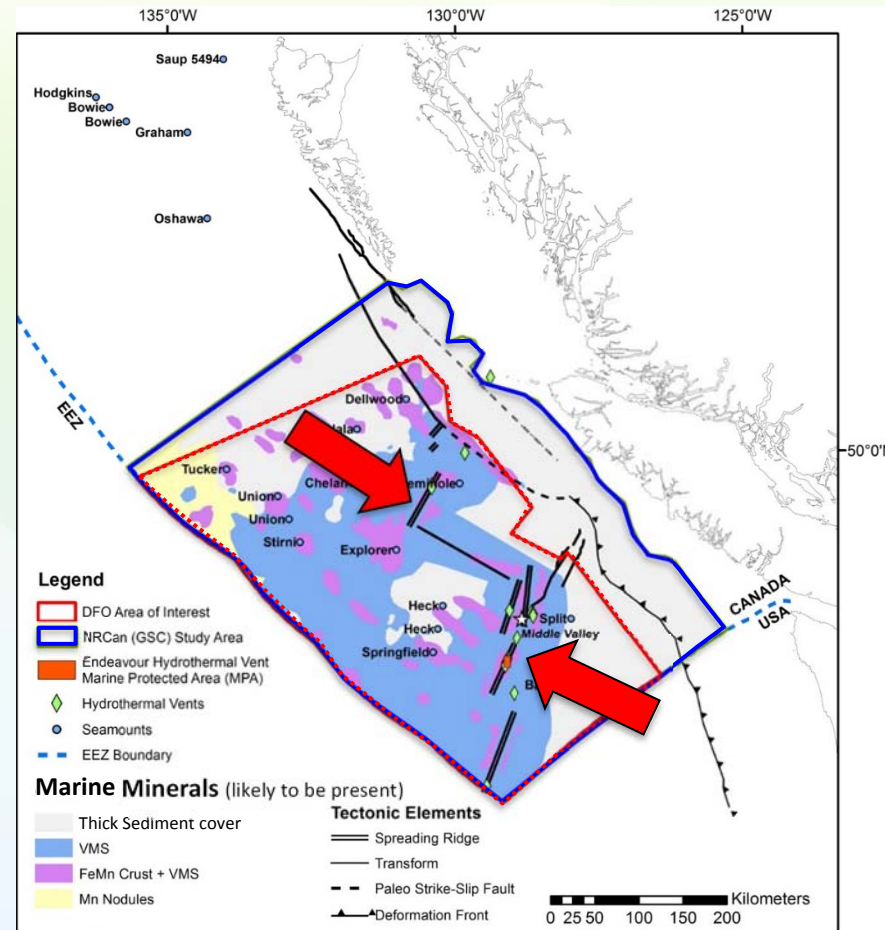
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Marine Mineral Assessment Results: Manganese Nodule Deposits

Manganese Nodules:

- form in water depths greater than 3500 m and may contain high concentrations of copper, nickel and rare earth elements.



- No commercial manganese nodule mining activity anywhere in the world.

Manganese Nodule deposits:

- A limited area likely to contain manganese nodules is identified in the northwest corner of the AOI.
- A much larger area that may contain manganese nodules is identified in Canadian waters north of the AOI.

** Mineral grade, tonnage, and economic factors have not been determined or estimated.*

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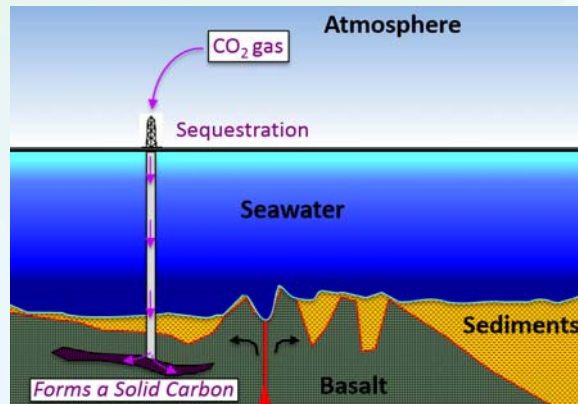
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Assessment Results:

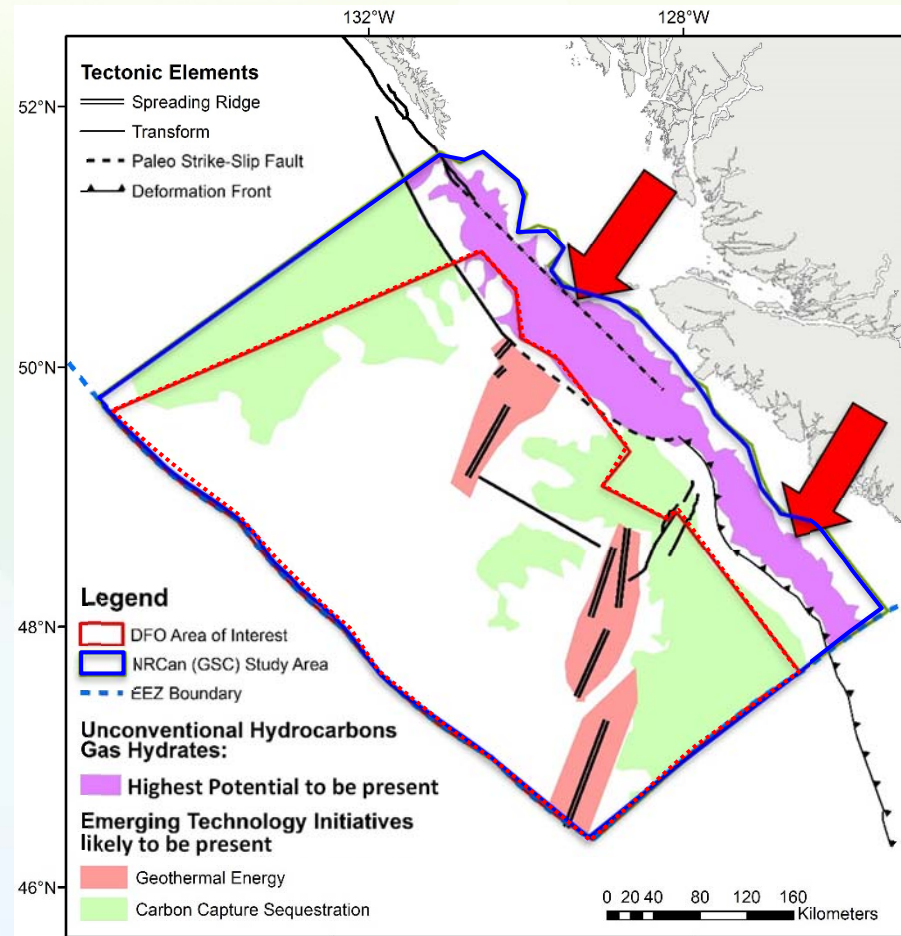
Capture and Storage Capacity

Carbon Capture and Storage:

- **When porous volcanic rocks (basalt) are injected with carbon dioxide (CO₂) and water, carbon precipitates into a solid stable non toxic mineral.**
- **CCS could help to offset increasing atmospheric CO₂ levels.**



Modified from Goldberg et al., 2013, Fig. 5.



- Iceland began injecting CO₂ into onshore basalts in 2016. **Marine CCS projects might be possible in the future.**

Carbon Capture Storage Capacity:

- Areas likely to contain CCS capacity identified in sediment-covered regions of the Pacific AOI.
- It is likely that the best young basaltic CCS reservoirs occur within the study area.

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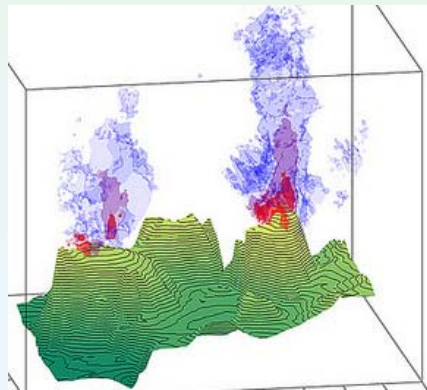
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Assessment Results: Marine Geothermal

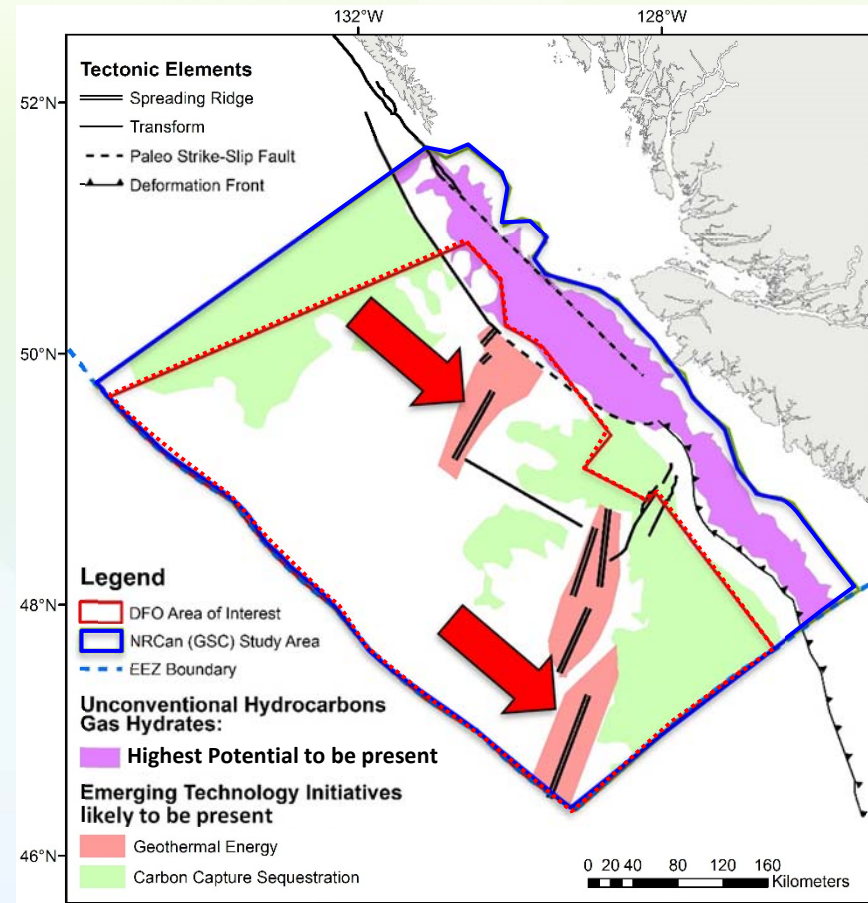
Marine Geothermal Potential:

- **Hot fluids from geothermal sources can be sent through steam turbines to generate electricity.**
- **Electricity generation potential at seafloor spreading centres may be much larger than most onshore hot springs (when technologies are developed).**



COVIS image of Grotto hydrothermal vent and plume. Image from Ocean Networks Canada.

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- Iceland granted its first marine geothermal exploration licences in 2017.
- Technologies will need to be developed before marine geothermal could be exploited.

Marine Geothermal:

- Potential is identified at active seafloor spreading centres & vent fields
- The only known marine areas in Canada with geothermal potential.



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Conclusions

We conclude that within the area of interest:

- There is no potential to low or very low potential for conventional petroleum. No areas with high potential are predicted.
- Gas hydrate potential is very limited. Area with highest potential is outside the AOI.
- Undiscovered occurrences of marine minerals are likely present.
- Areas with renewable geothermal energy potential and Carbon, Capture and Storage Capacity are also expected to be present.

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