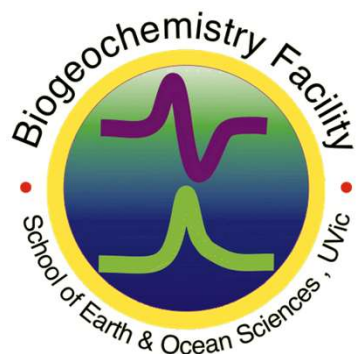


BC Natural Gas Atlas

*'Preliminary insights into
Geochemistry from Profiles'*

Curtis Evans

School of Earth and Ocean Sciences
University of Victoria



UGTF April 2018

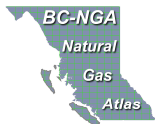


Goals of BC-NGA

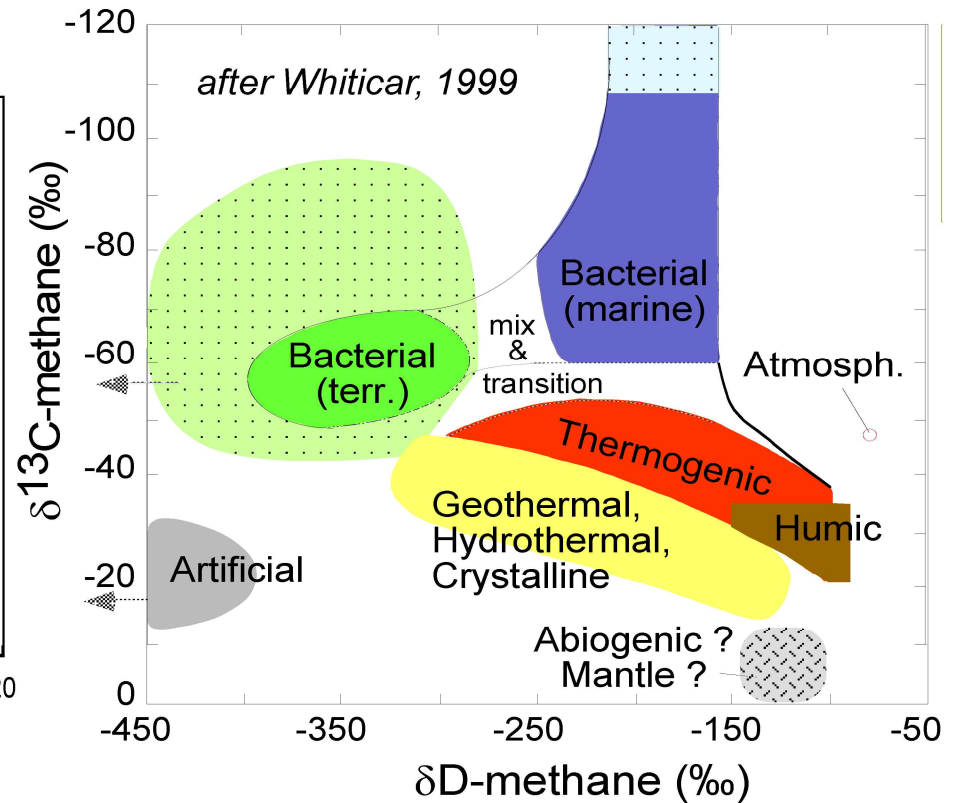
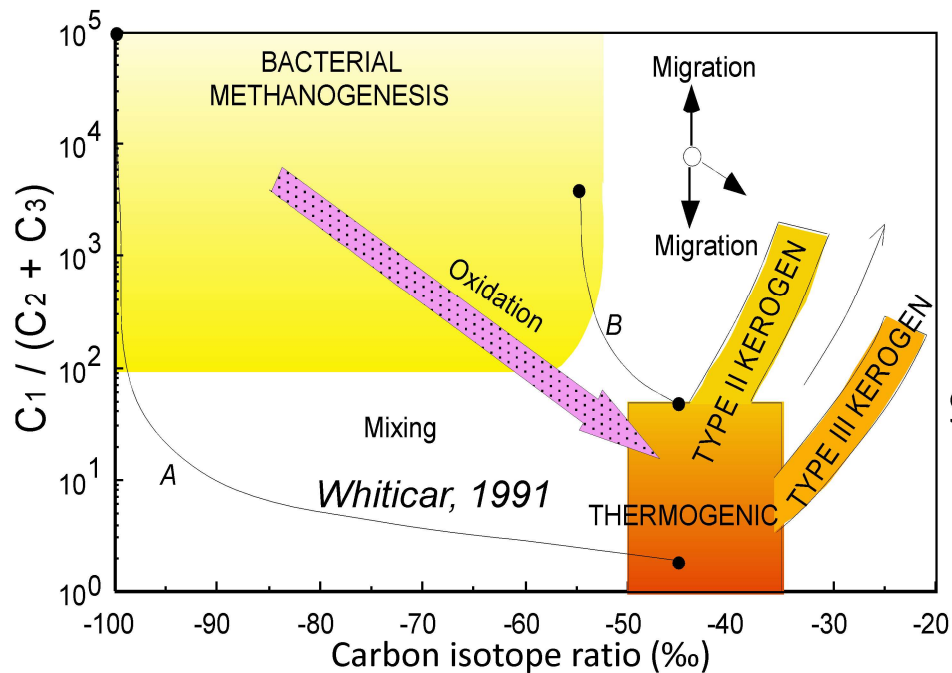
- *Create a thorough, searchable **geochemical inventory and mapping of natural gases** in BC (Phase I is NE BC)*
- *Develop an **accessible geochemical database** for a broad range of users, e.g., industry, government and non-government groups, and general public*

This atlas will inventory the **molecular** and **stable isotope signatures** of natural gas coming from the relevant geologic units and locations in BC. These natural gas fingerprints will: *(see previous presentation)*

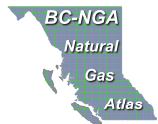
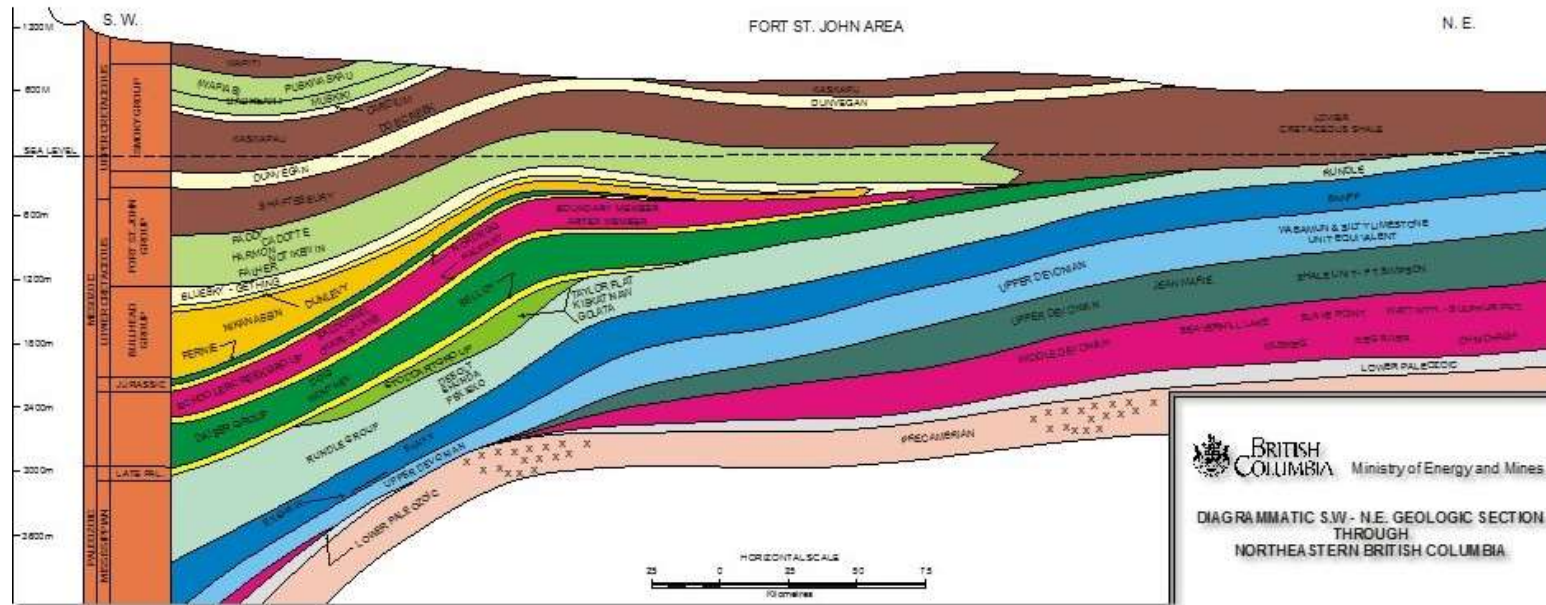
1. Catalogue unique natural gas compositional IDs for active gas operations around BC (Phase I is NE BC)
2. Map the geochemical conditions of BC's major ongoing and future regions of petroleum exploration and production
3. Contribute to understanding the geologic framework of natural gas deposits at scales of fields to basin levels
4. Assist petroleum system models to de-risk plays by understanding and predicting generation occurrences, histories and potential productivity of natural gas in BC
5. Provide robust baseline of gas signatures to identify and track fugitive emissions of natural gas (groundwaters and atmosphere), e.g., distinguish microbial gas from thermogenic gases (associated, shale, CSG, etc.)
6. Offer a "geochemical DNA" catalogue for different gas sources for provenance work in production, well completions, processing and transport
7. Establish a database for fugitive emissions in surface waters and the atmosphere



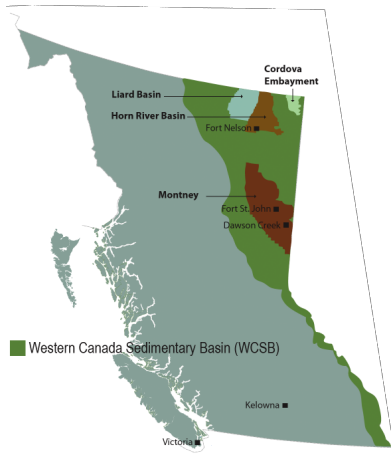
What is Natural Gas “Fingerprinting”?



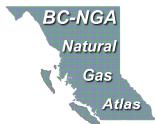
Stratigraphic Control



Areas of Study and Profile location maps

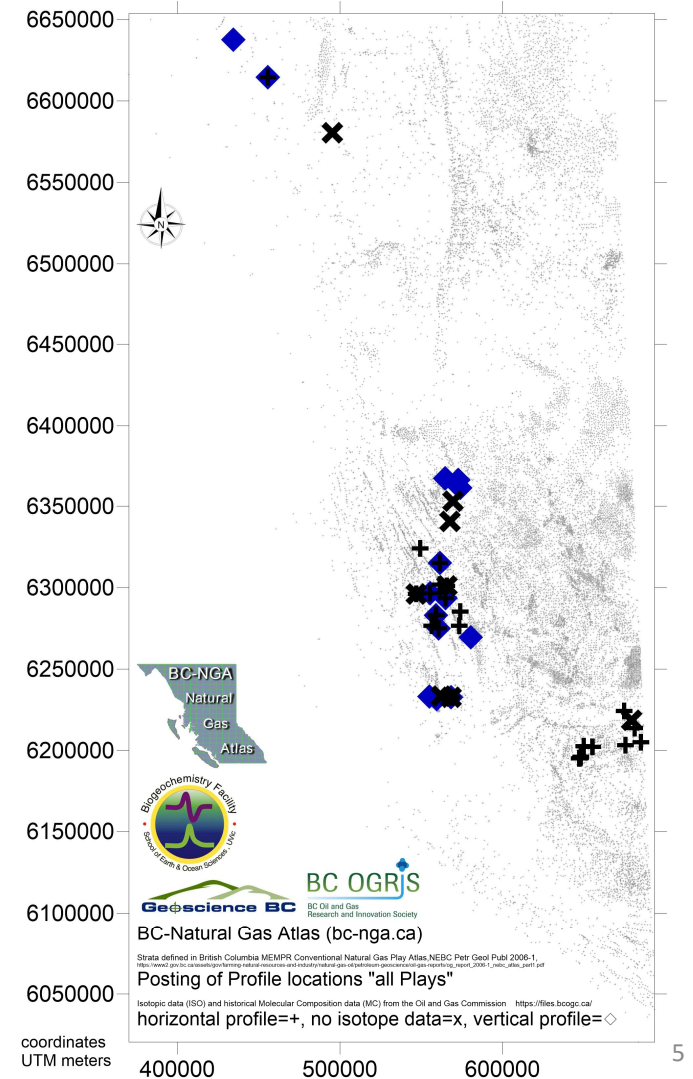


BC OGC 2013. Area-based Analysis: Overview April 2013



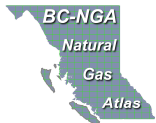
- 36 Horizontal (HZ) Montney
- 2 Horizontal (HZ) Besa River
- 8 wells reported as ISO with no ISO (isotopic) data
- 17 vertical wells including 2 with limited ISO
- 5 preliminary interpretations presented later

UGTF 2018 by BC-NGA

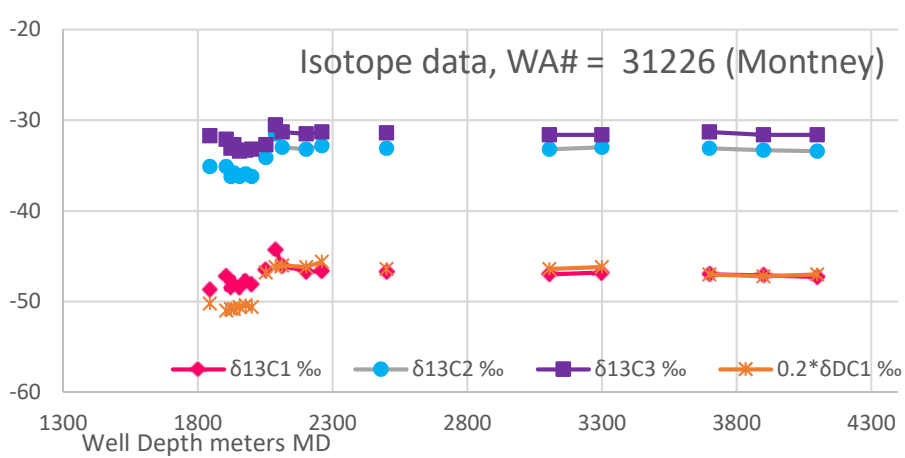
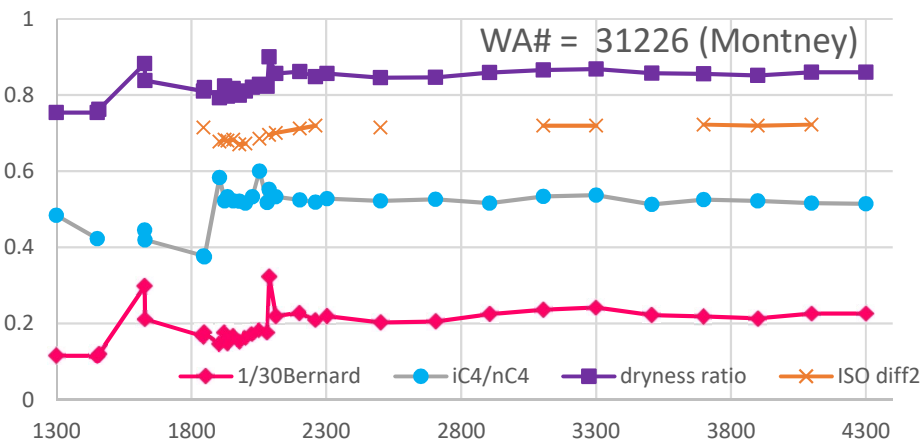
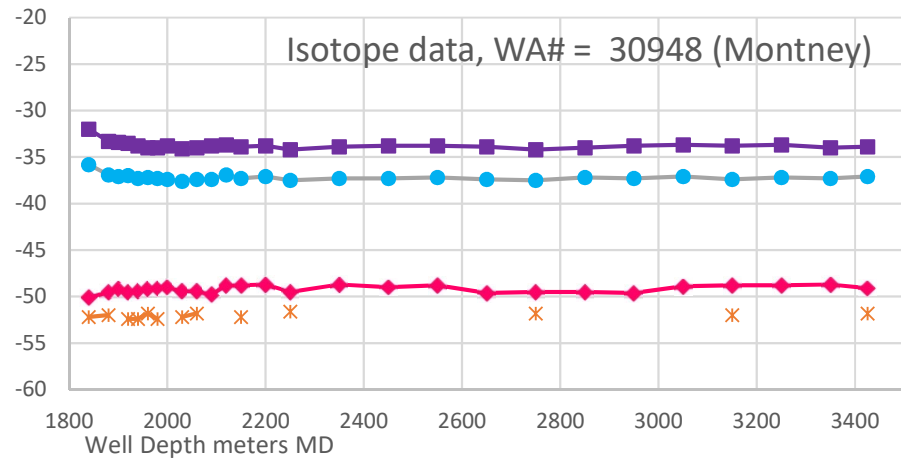
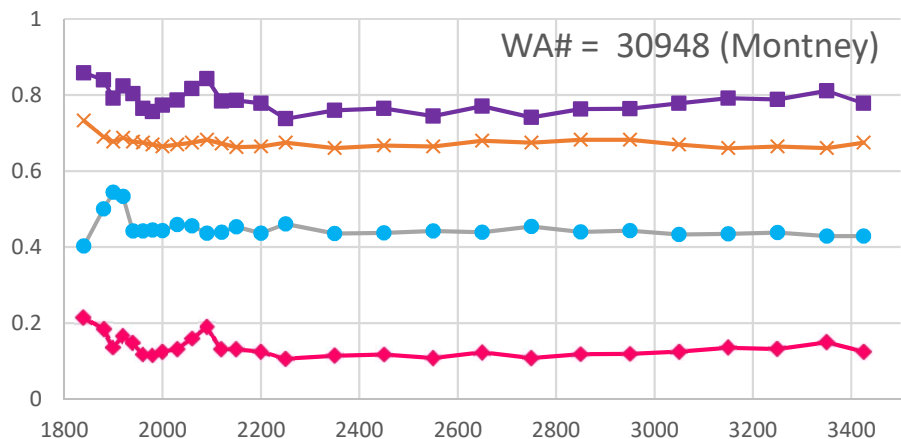


Profiles - assumptions

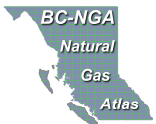
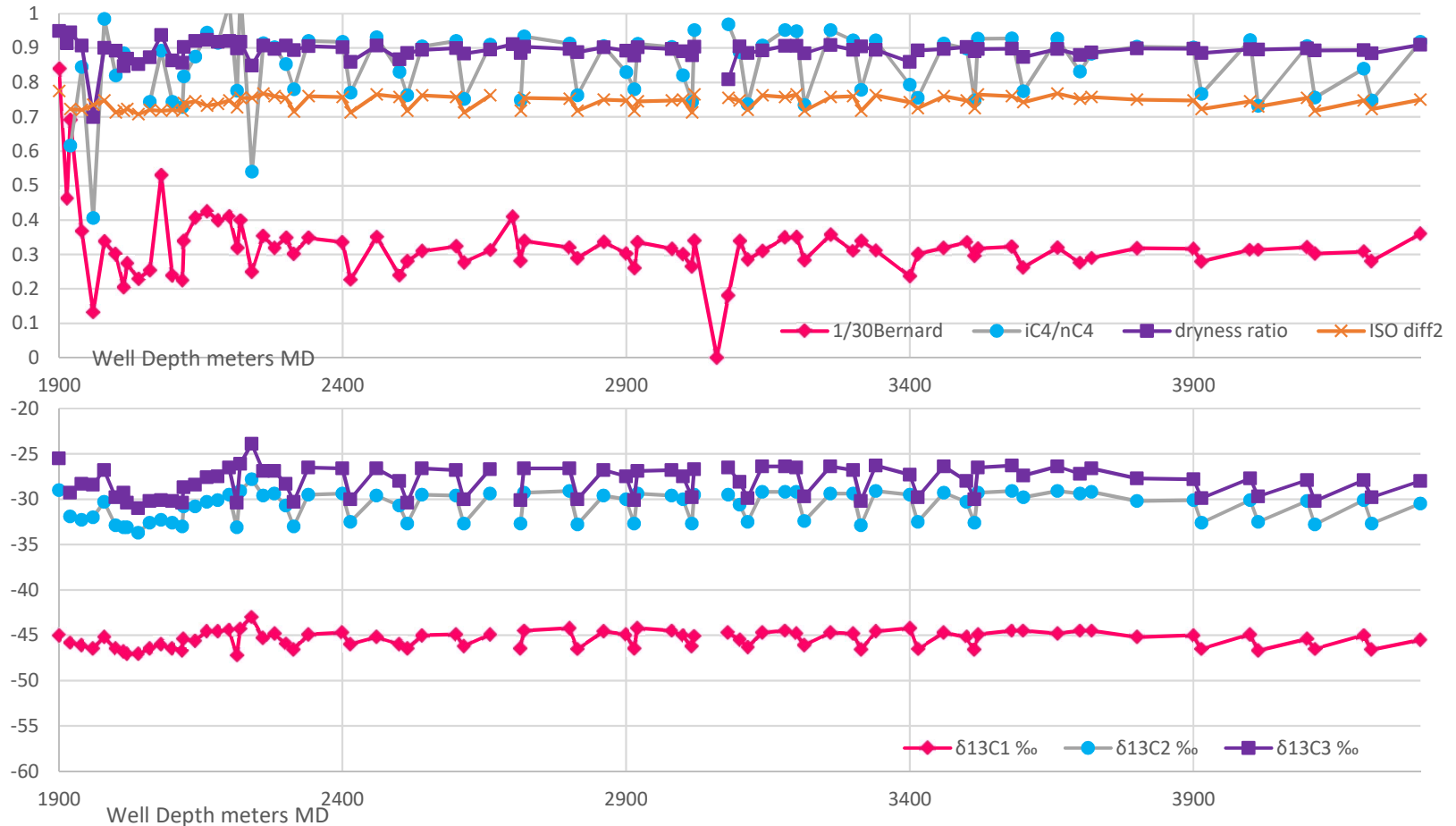
- 1) Data is only from **mudgas as small concentration gas samples** while drilling (one exception has chip samples in jars);
- 2) Absolute molecular composition depends on **drilling conditions**: circulation rates, mud density, atmospheric pressure, etc.;
- 3) Only usable values are **ratios** between compositions as should be comparable irrespective of changes in drilling variables;
- 4) Data is expected to show a stratigraphic **profile of geochemistry** with possible “breaks” due to changes in deposition, provenance, organic type, catagenesis, etc.;
- 5) **New ratio shown** as isotopic difference vs “expected values” determined from average of common profiles plus one standard deviation (values of those are 13.8 + 2.2).



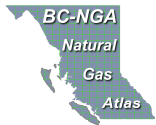
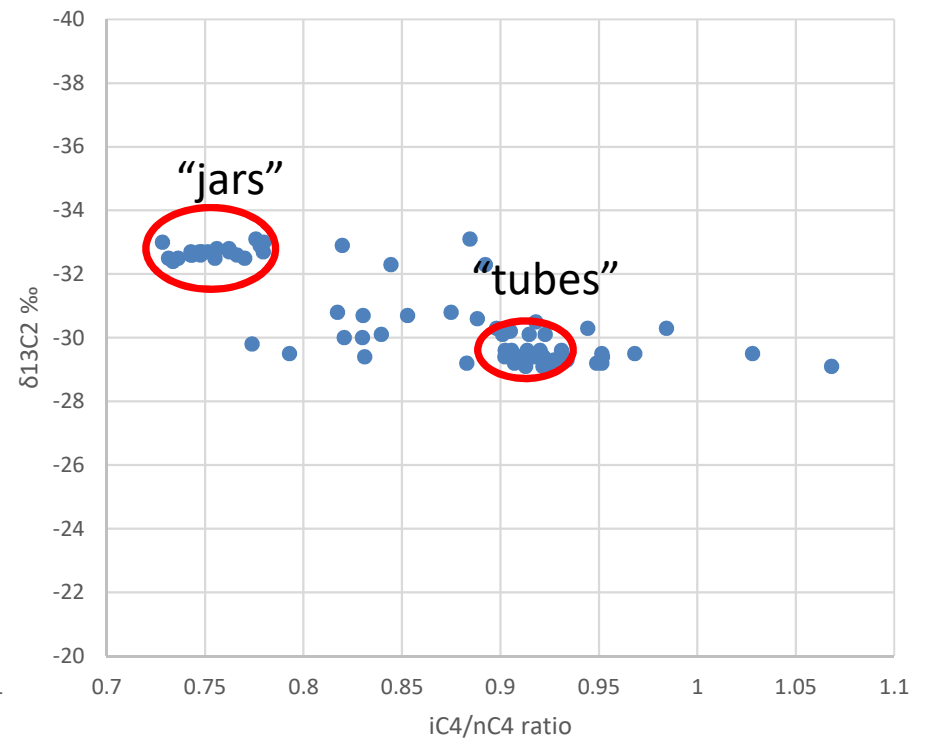
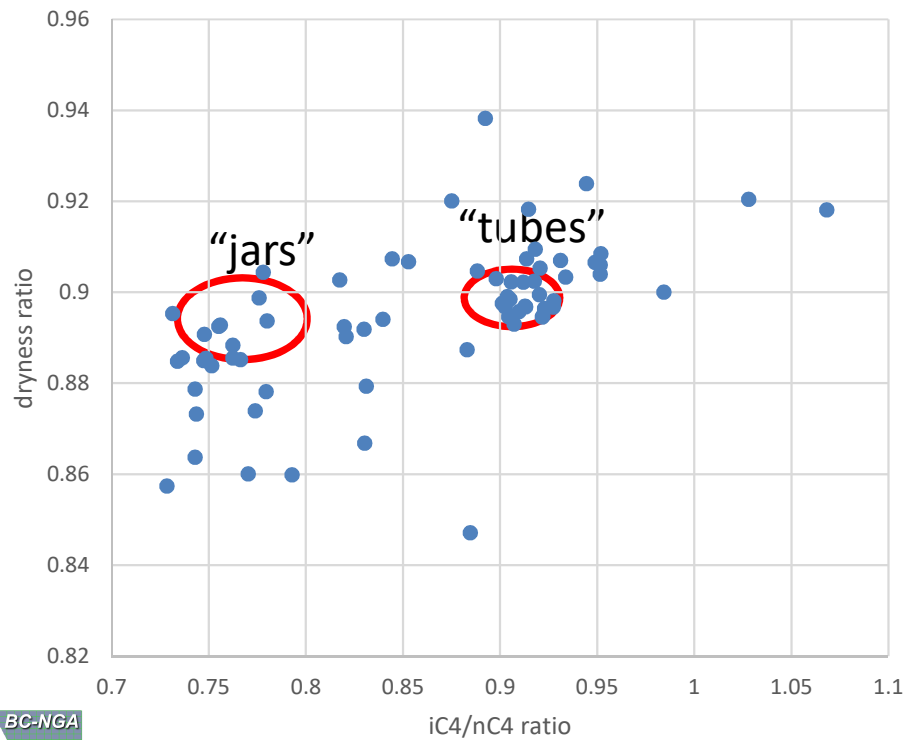
Horizontal Profiles 1 – Montney (2 wells)



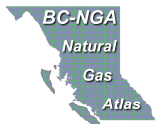
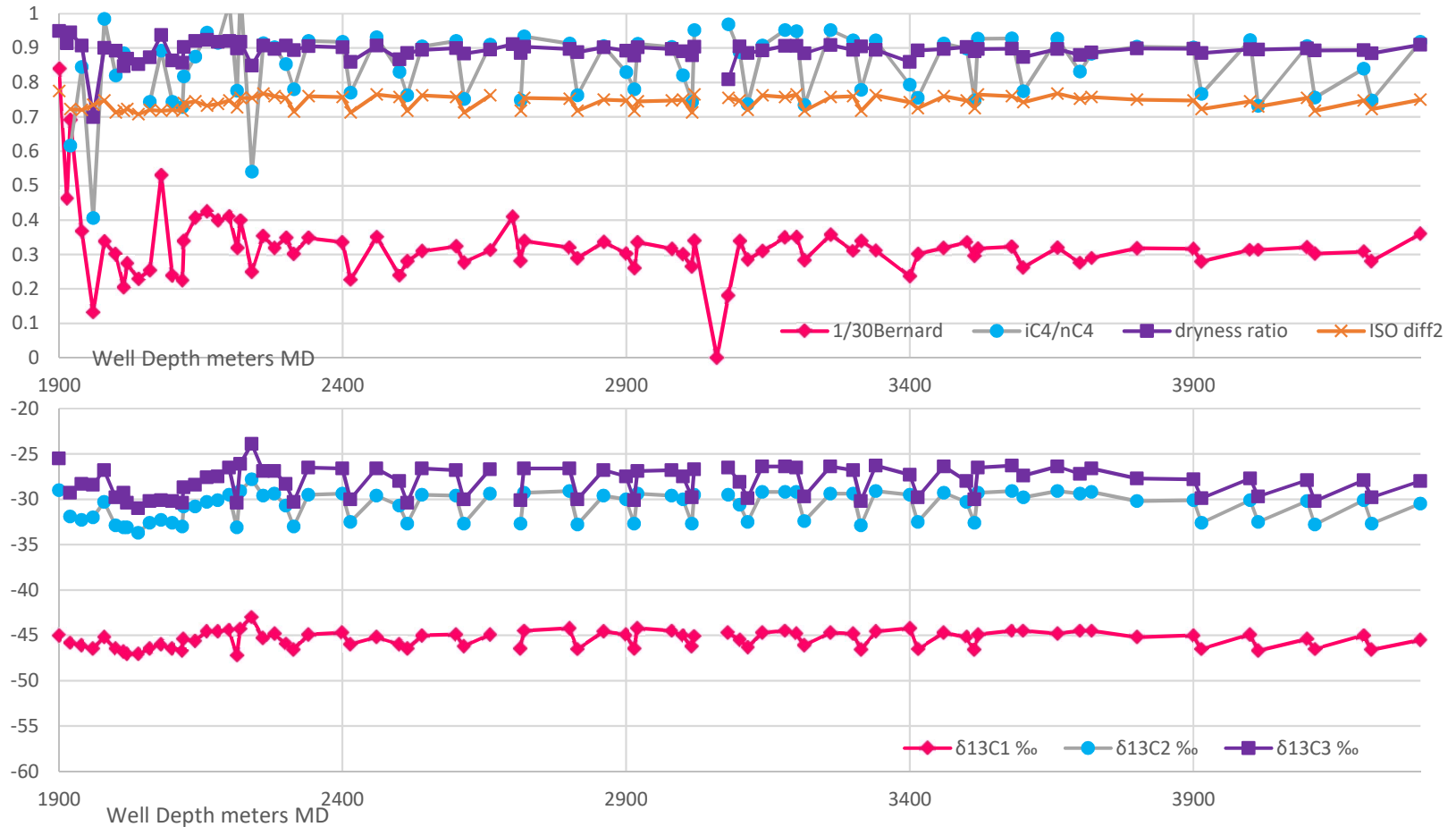
Horizontal Profiles 2 – Montney WA# = 28770



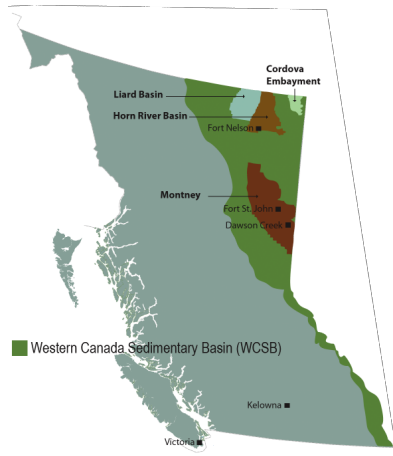
Horizontal Interpret 2 – Montney WA# = 28770



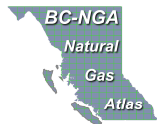
Horizontal Profiles 2 – Montney WA# = 28770



Areas of Study and Profile location maps



BC OGC 2013. Area-based Analysis: Overview April 2013



Focus on 17 vertical profiles = North South data display

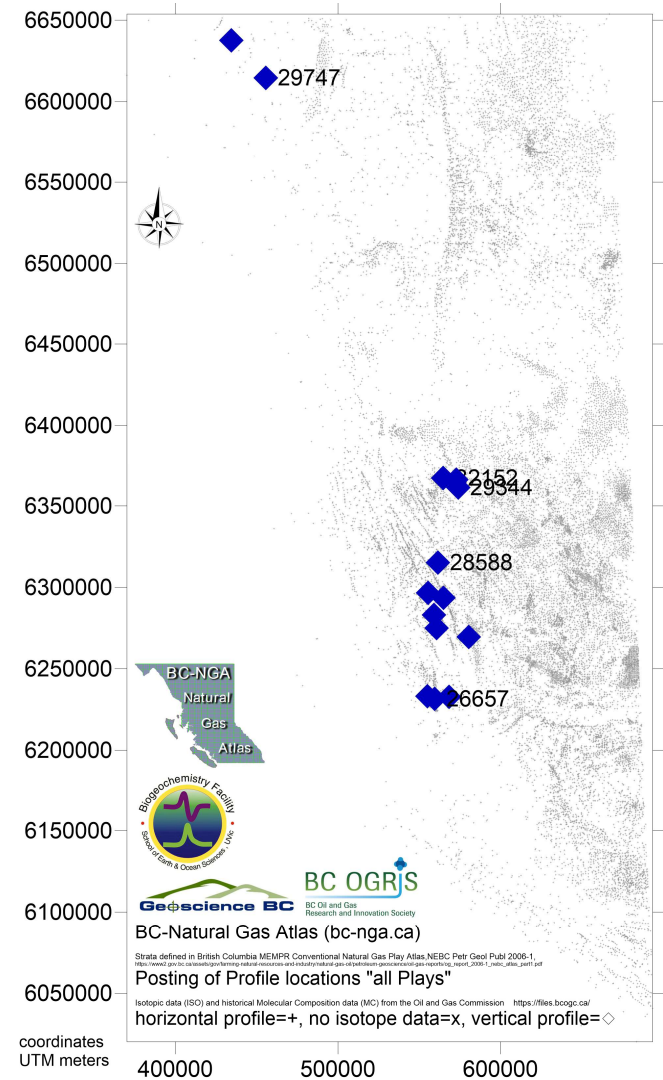
29046
29727, 29747

32153, 32152
32676, 31988, 29344

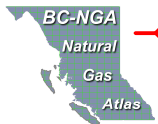
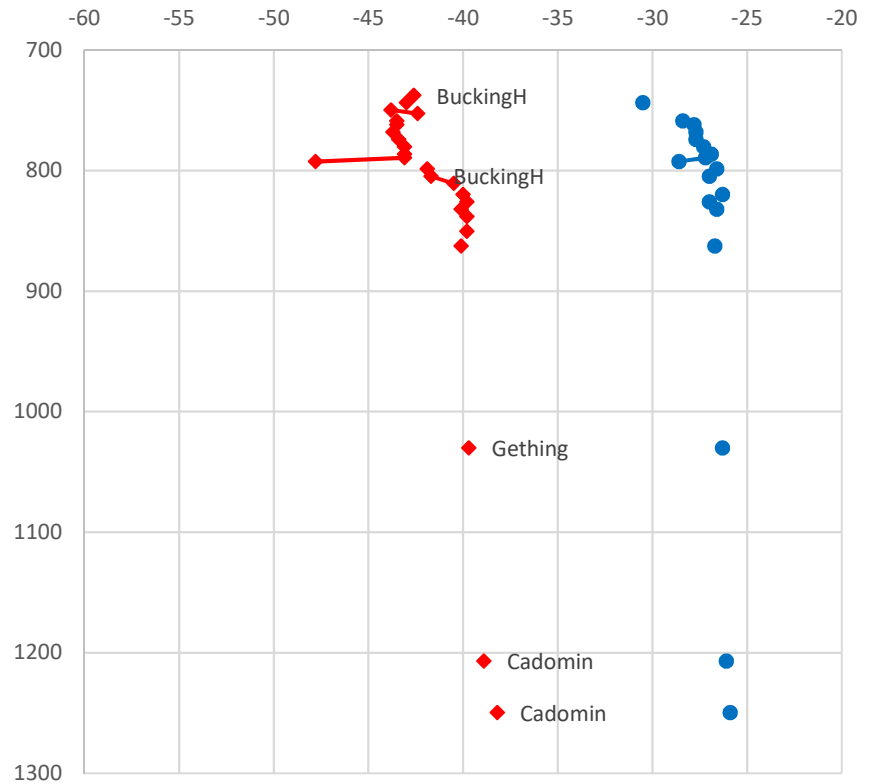
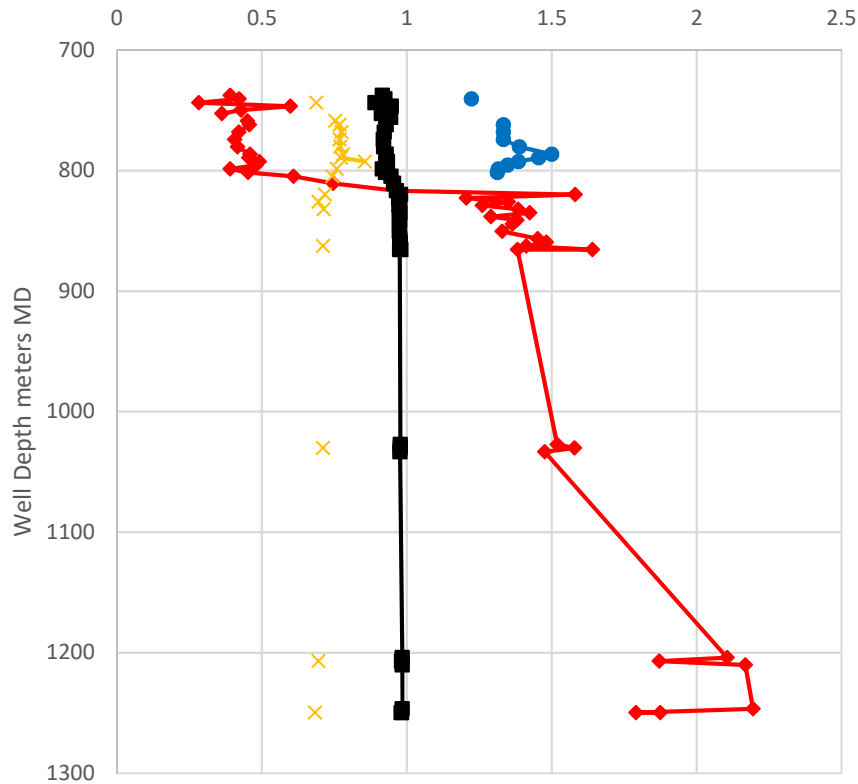
28588
28770, 31490
Confidential, 28165, 28233
26918, 26657, 26949

5 examples next

UGTF 2018 by BC-NGA



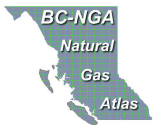
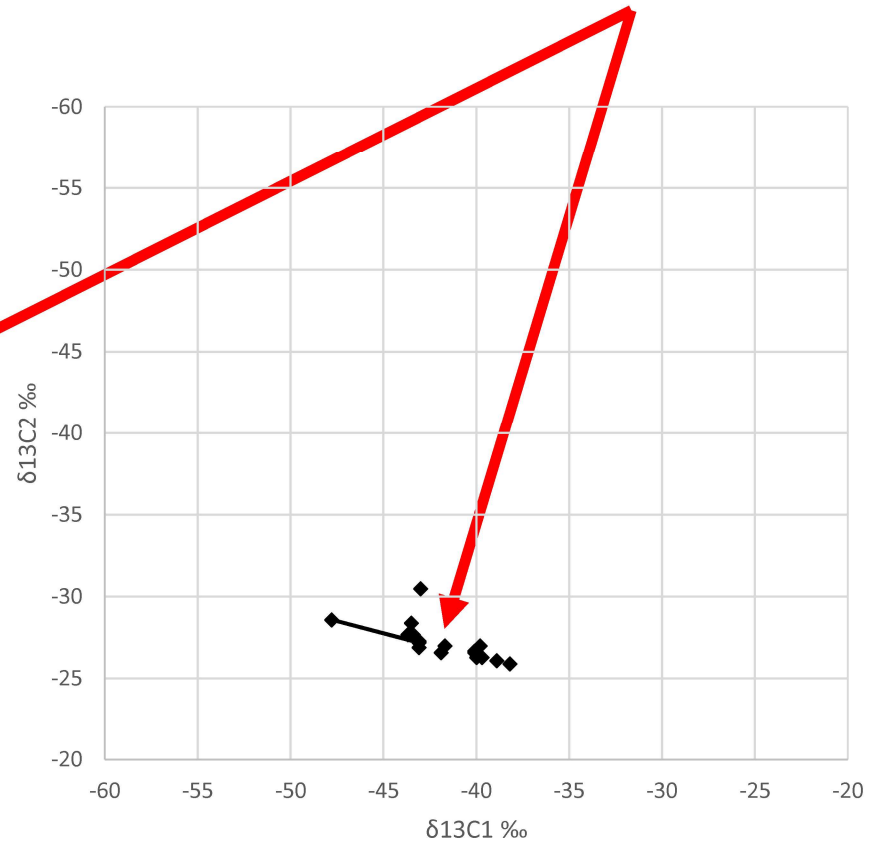
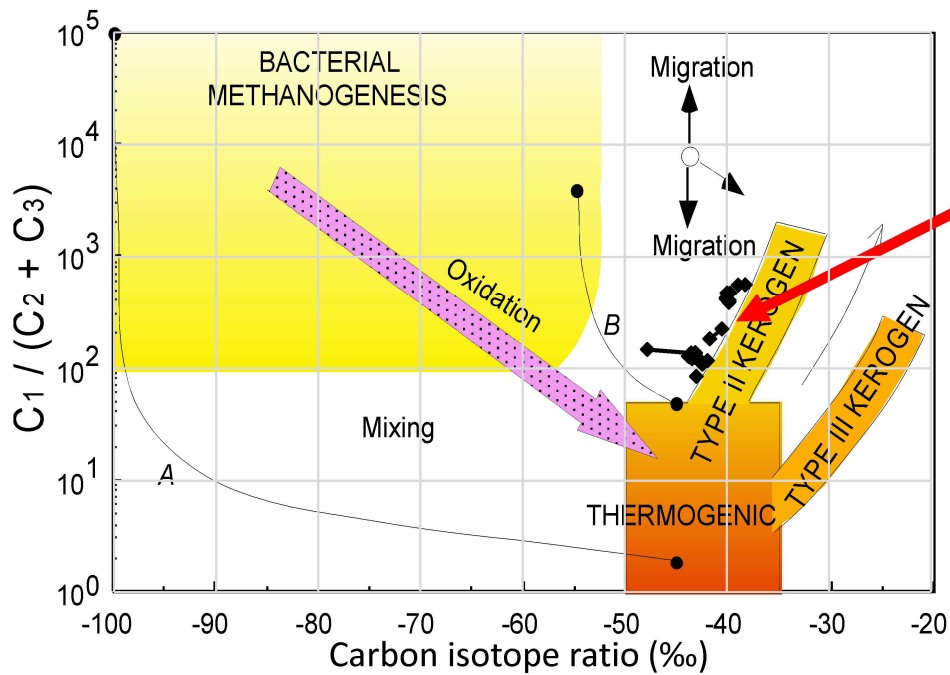
Vertical Profile1 WA# = 26657



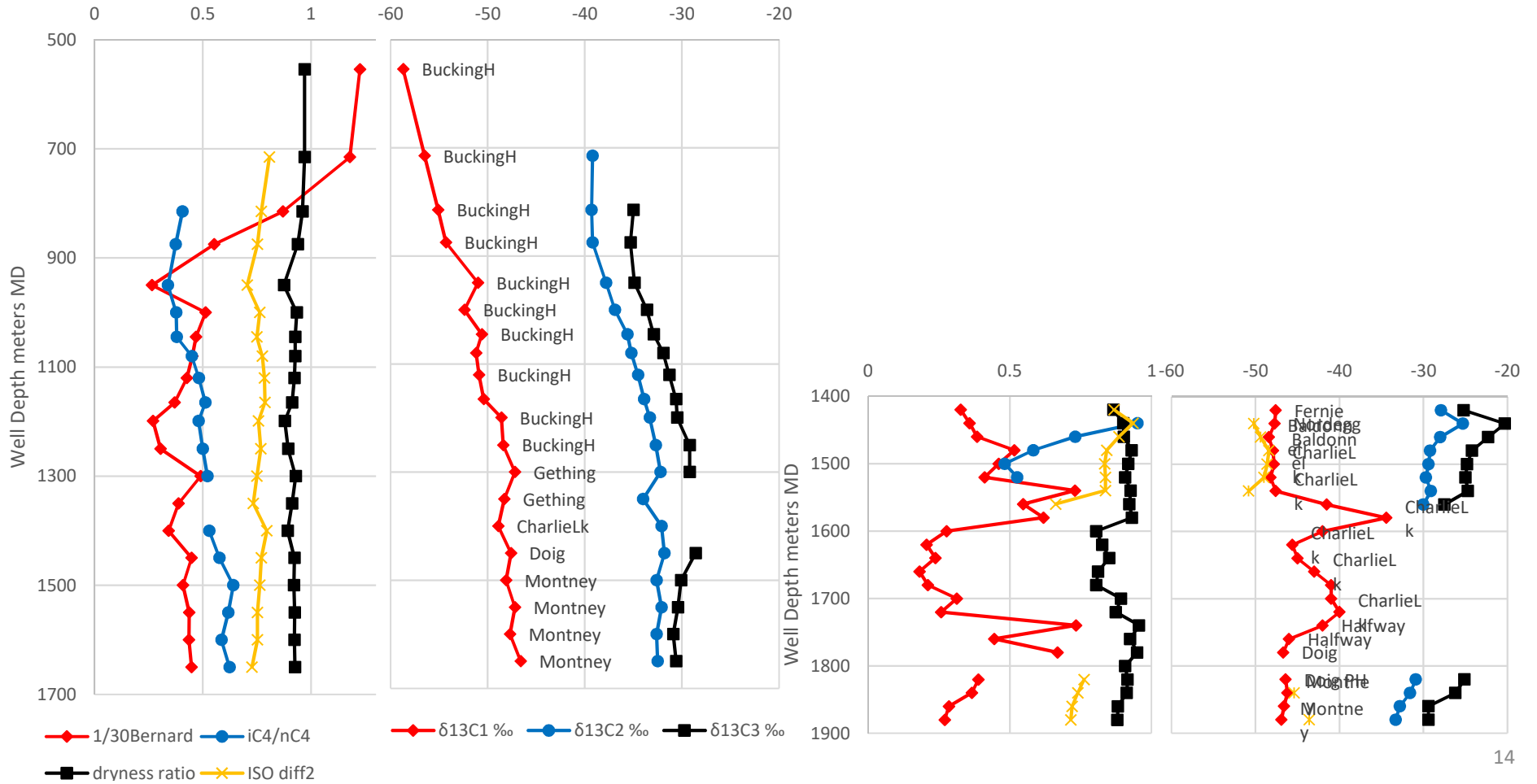
◆ 1/30Bernard
 ● iC4/nC4
 ■ dryness ratio
 × ISO diff2

◆ $\delta^{13}C1$ ‰
 ● $\delta^{13}C2$ ‰
 ■ $\delta^{13}C3$ ‰

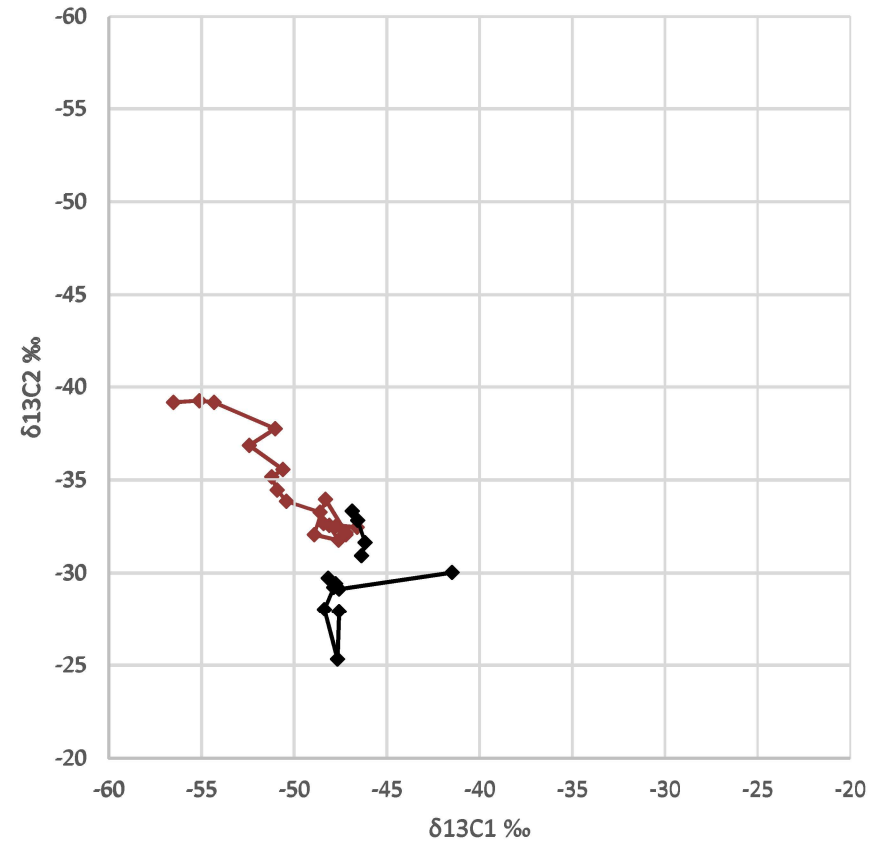
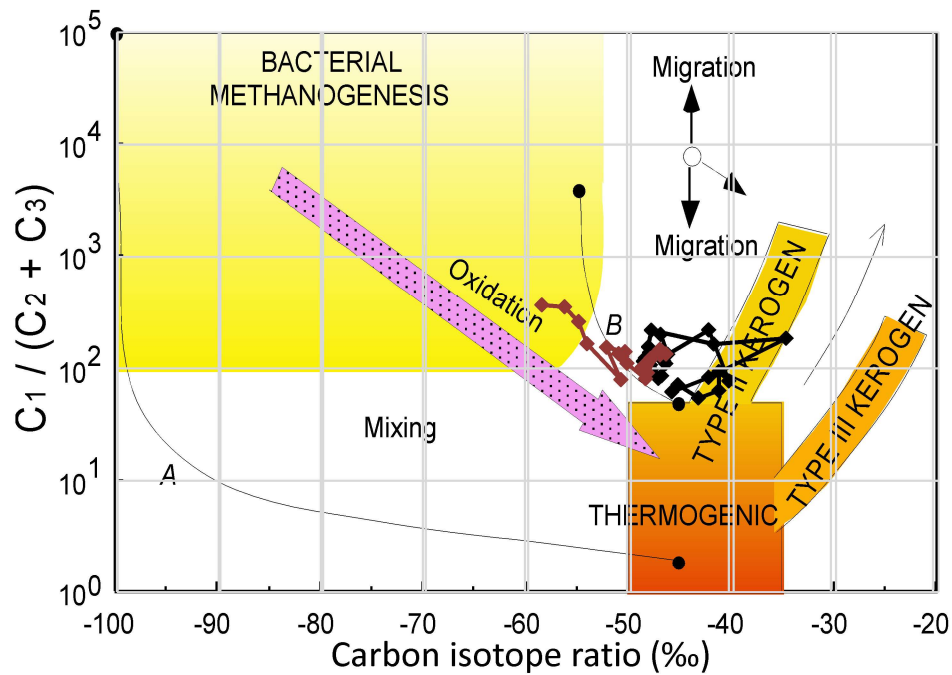
Vertical Interpretation1 WA# = 26657



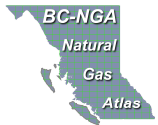
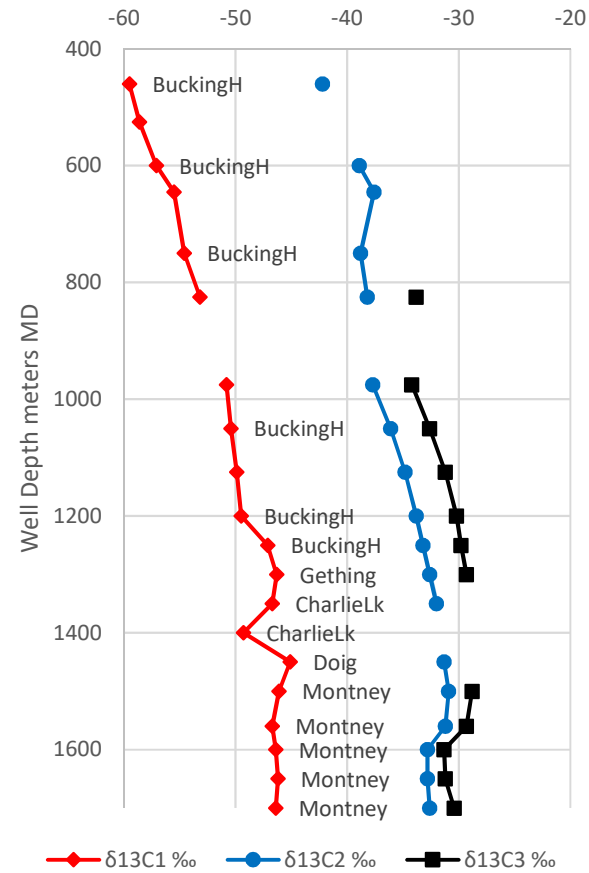
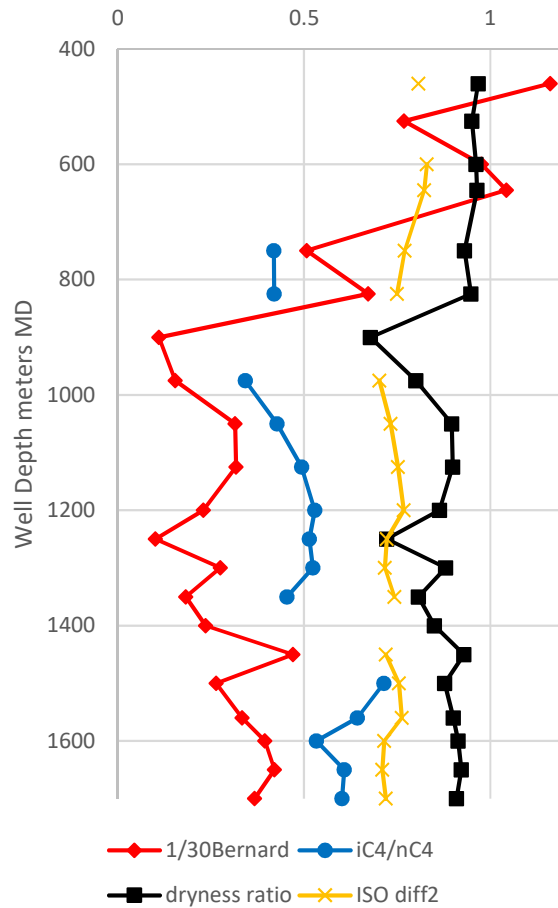
Vertical Profile2 WA# = 29344 and 28588



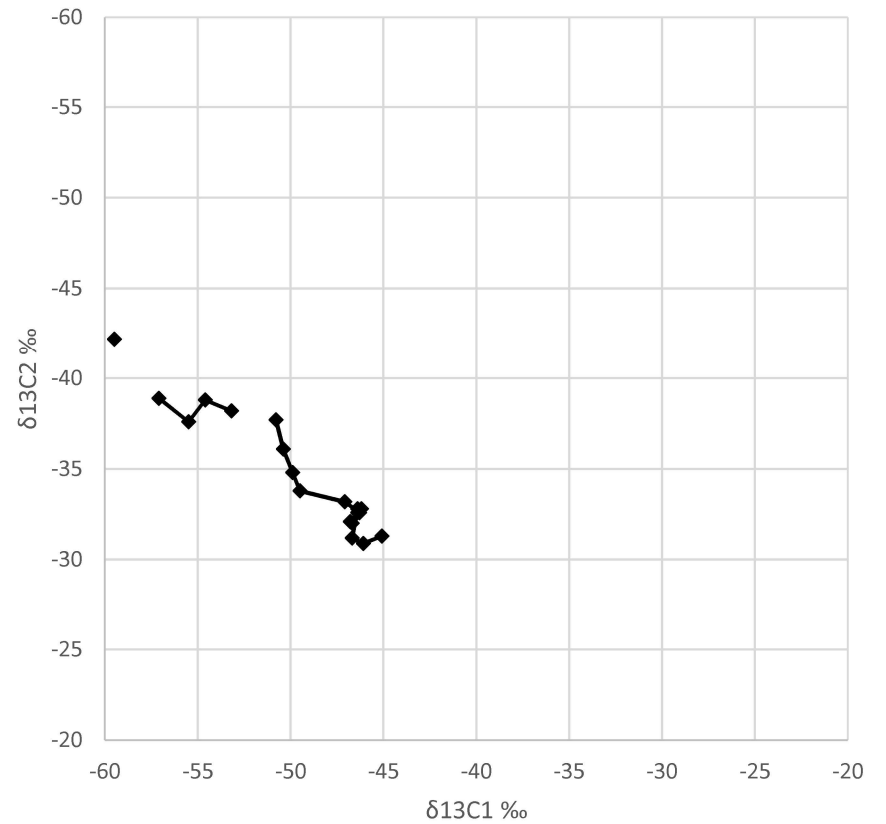
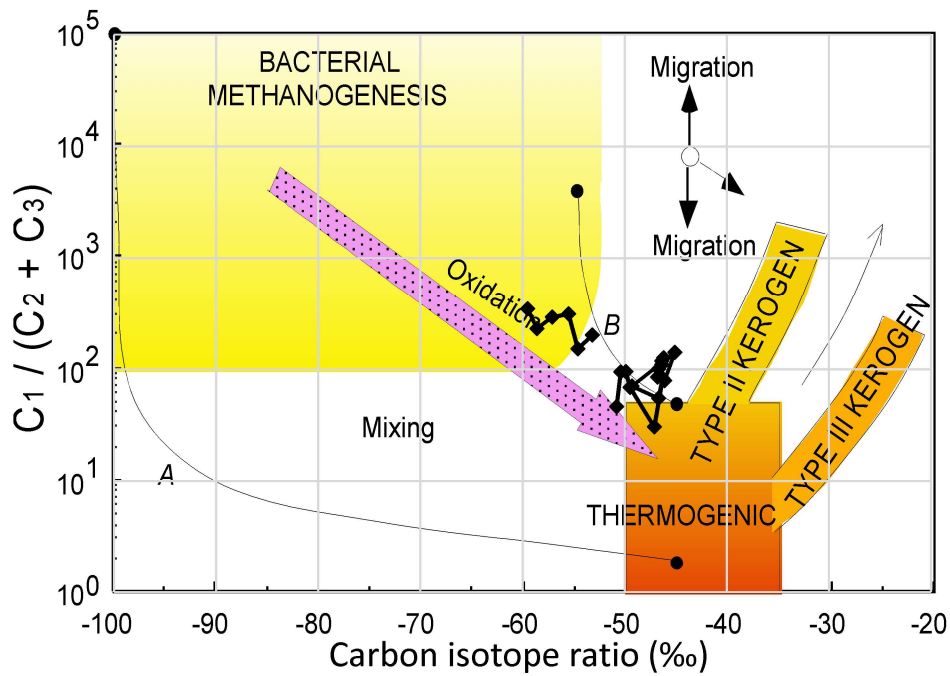
Vertical Interpretation2 WA# = 29344 and 28588



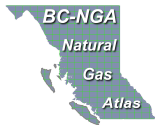
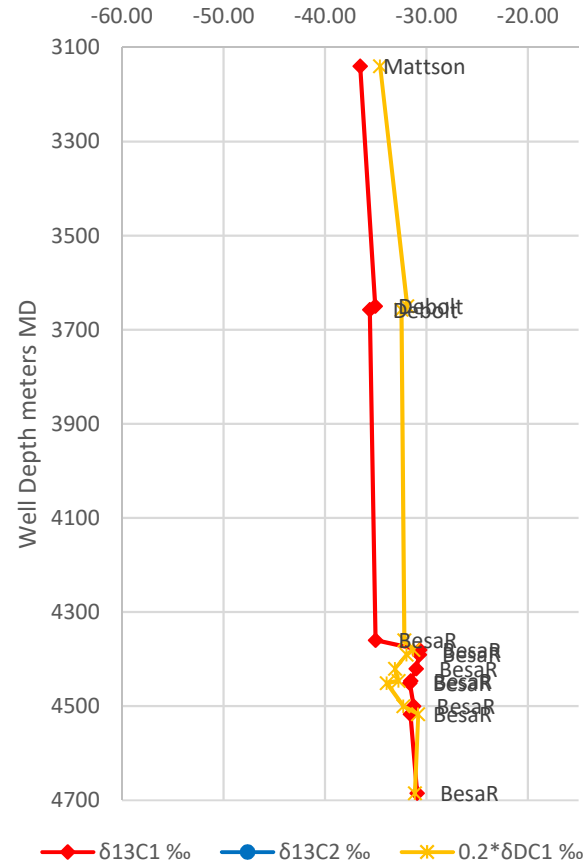
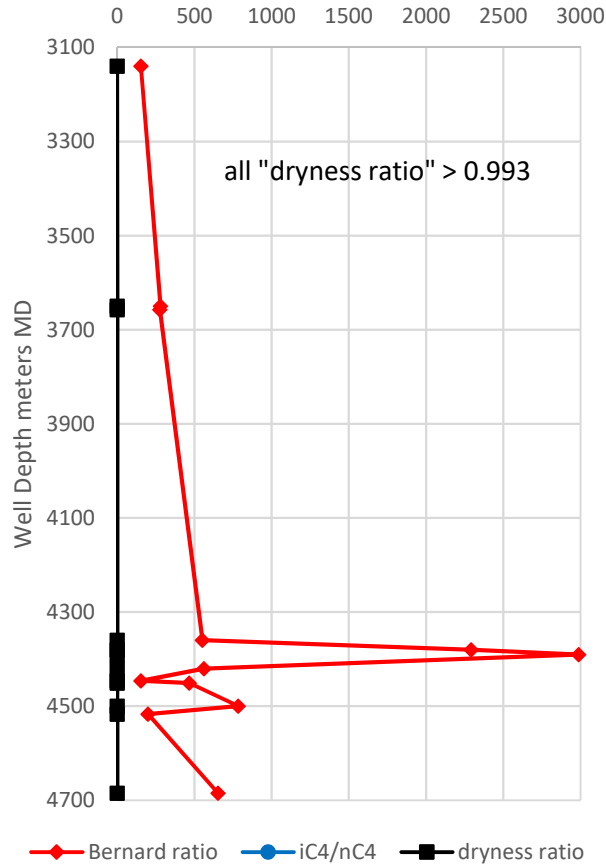
Vertical Profile3 WA# = 32152



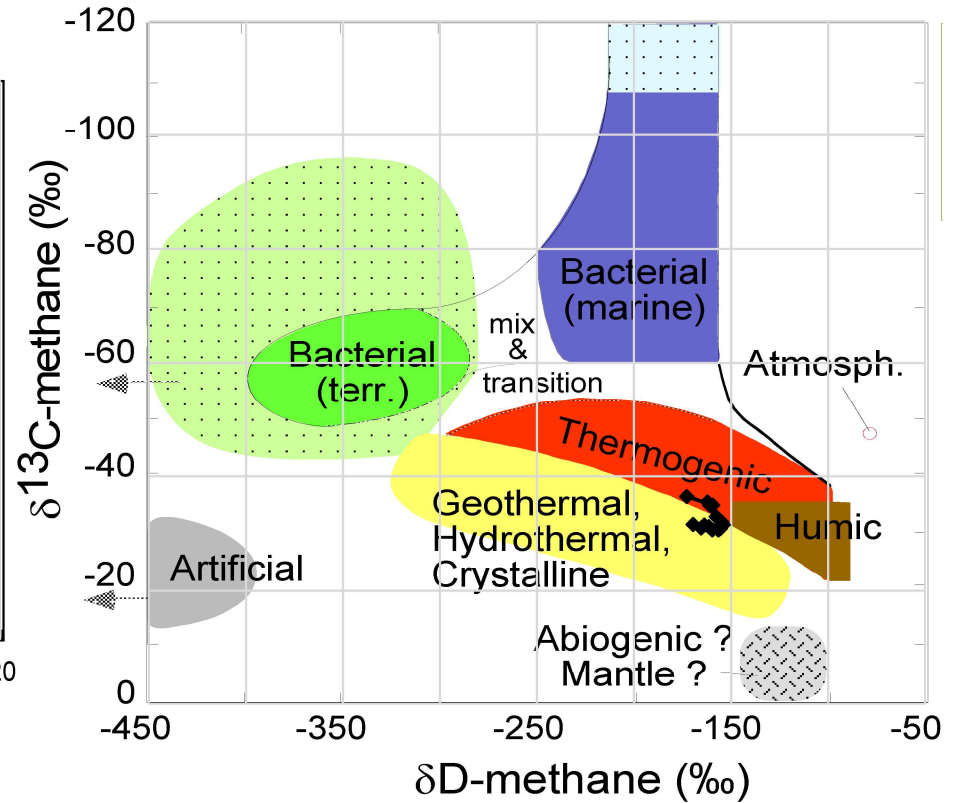
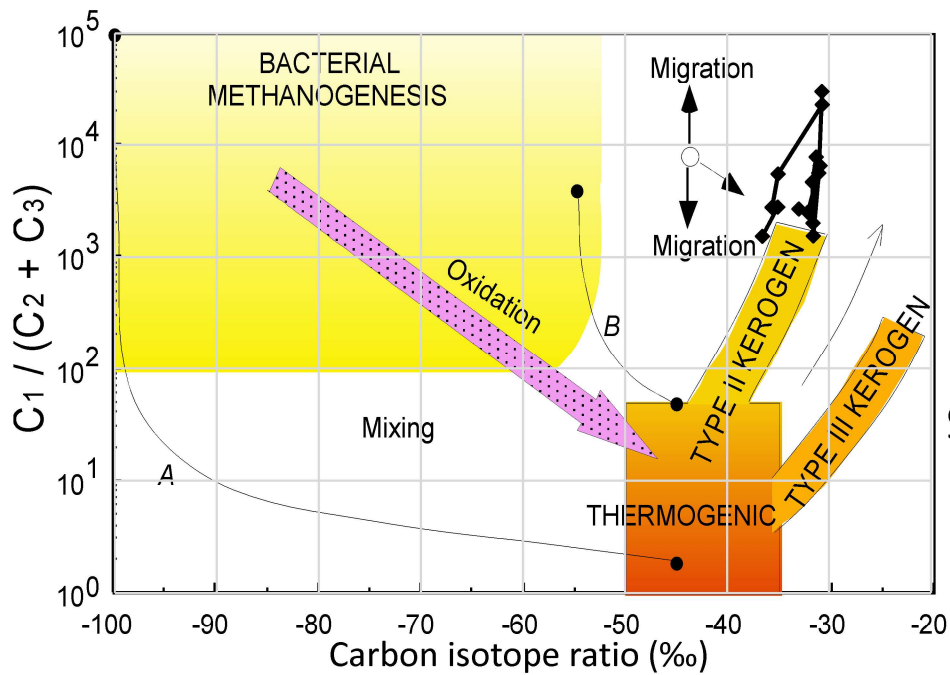
Vertical Interpretation3 WA# = 32152



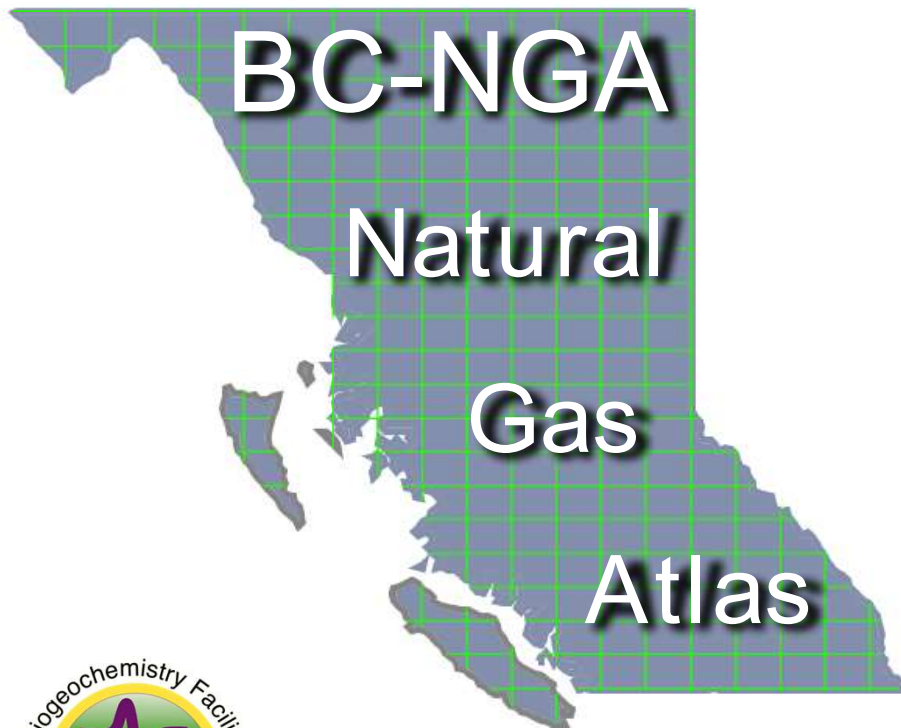
Vertical Profile4 WA# = 29747



Vertical Interpretation4 WA# = 29747



BC-NGA Profiles Summary



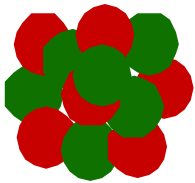
- Public data can have basic analysis;
- A small number of profiles are functional for multiple formations;
- They are not evenly distributed;
- How much data is needed for a major target like Montney horizontals?
- Multi-user participation by industry, Geosciences BC, OGC, MEMPR, UVic, UBC, NGO and public;
- Open access for database query, mapping and graphical tools;
- Integration with groundwater and fugitive emissions studies



Extra Slides

What are Stable Isotope Ratios?

Carbon 12 mass = 12

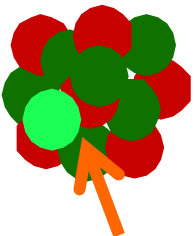
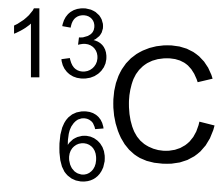


nucleus
6 protons (6P⁺)
6 neutrons (6N⁰)

e.g., $\delta^{13}\text{C}_{\text{CH}_4}$

The ratio 'R' is: $\left(\frac{{}^{13}\text{C}}{{}^{12}\text{C}} \right)_{\text{CH}_4}$

Carbon 13 mass = 13

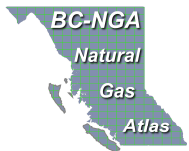


nucleus
6 protons (6P⁺)
7 neutrons (7N⁰)

additional
neutron

Relative to a standard (VPDB)

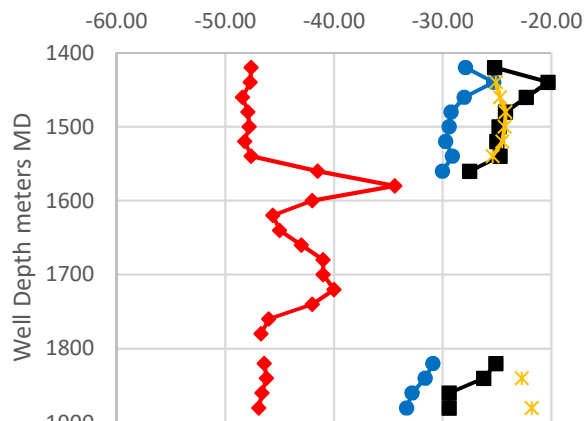
$$\delta^{13}\text{C}_{\text{CH}_4} (\text{‰}) = \left(\frac{R_{\text{gas}}}{R_{\text{standard}}} - 1 \right) \cdot 10^3$$



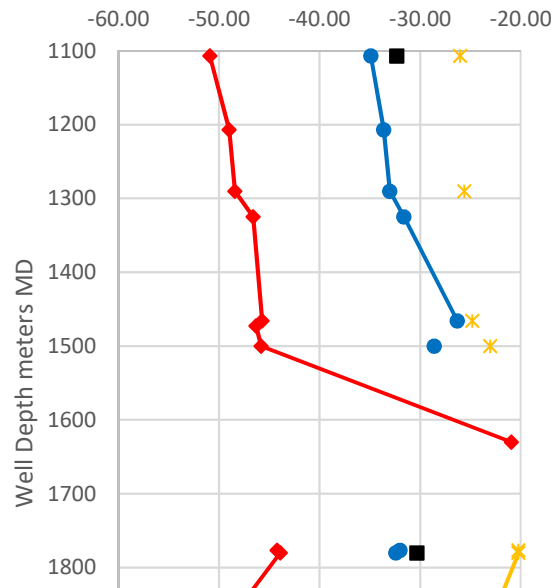
Hydrogen Isotopes

- 1650 samples have only 312 analyses
- Many HZ Montney = complete analyses
- Only 3 vertical profiles have C1, C2, C3 plus hydrogen on C1 (1 profile is conf)

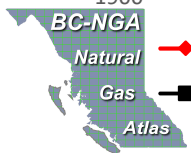
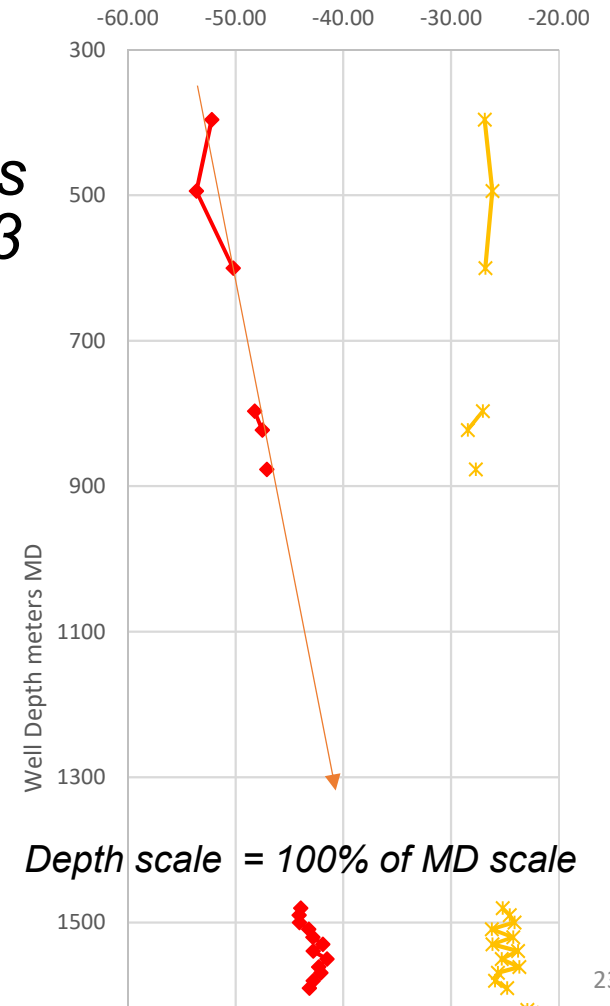
ISO data profile, WA# = 28588v



ISO data profile, WA# = 31490



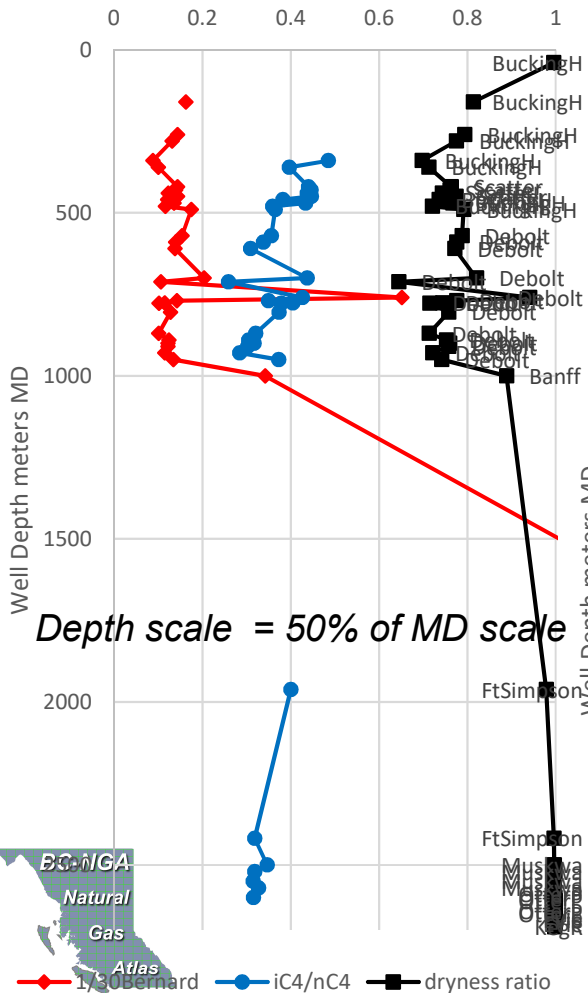
ISO data profile, WA# = 30308



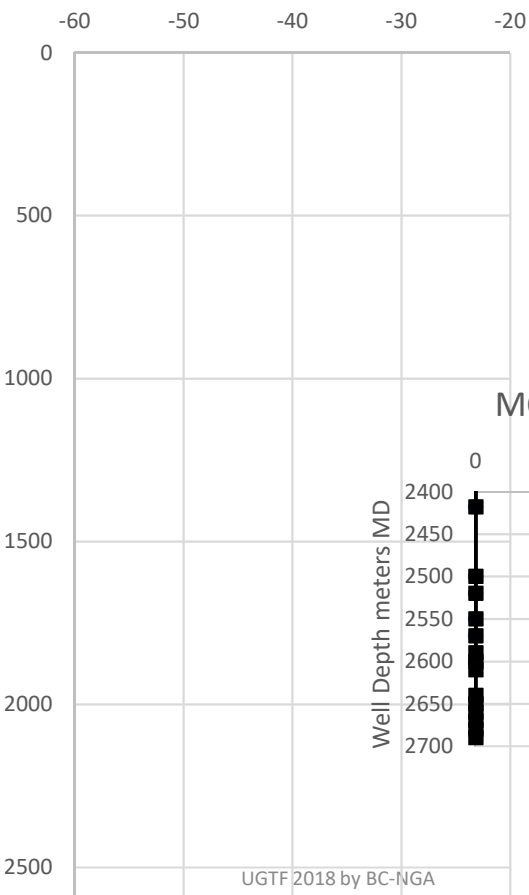
◆ $\delta^{13}C_1$ ‰ ● $\delta^{13}C_2$ ‰
■ $\delta^{13}C_3$ ‰ ✱ $0.1 * \delta DC_1$ ‰

Profiles06 – exotic location

MC ratio profile, WA# = 30415



ISO data profile, WA# = 30415



MC ratio profile, WA# = 30415 expanded

