



Delineation of Unconventional Groundwater:

(I) Soda Groundwater in Songkhla, Southern Thailand



กองทุนพัฒนาน้ำบาดาล
Groundwater Development Fund

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... THAILAND ...**

THA 2019 International Conference, 23-25 January 2019, Bangkok

Outline



- I** Soda-rich Groundwater, ...
- II** Soda-rich Groundwater in Thailand, ...
- III** Soda-rich Groundwater Explorations, ...
- IV** Conclusions

What is Soda-rich Groundwater ?

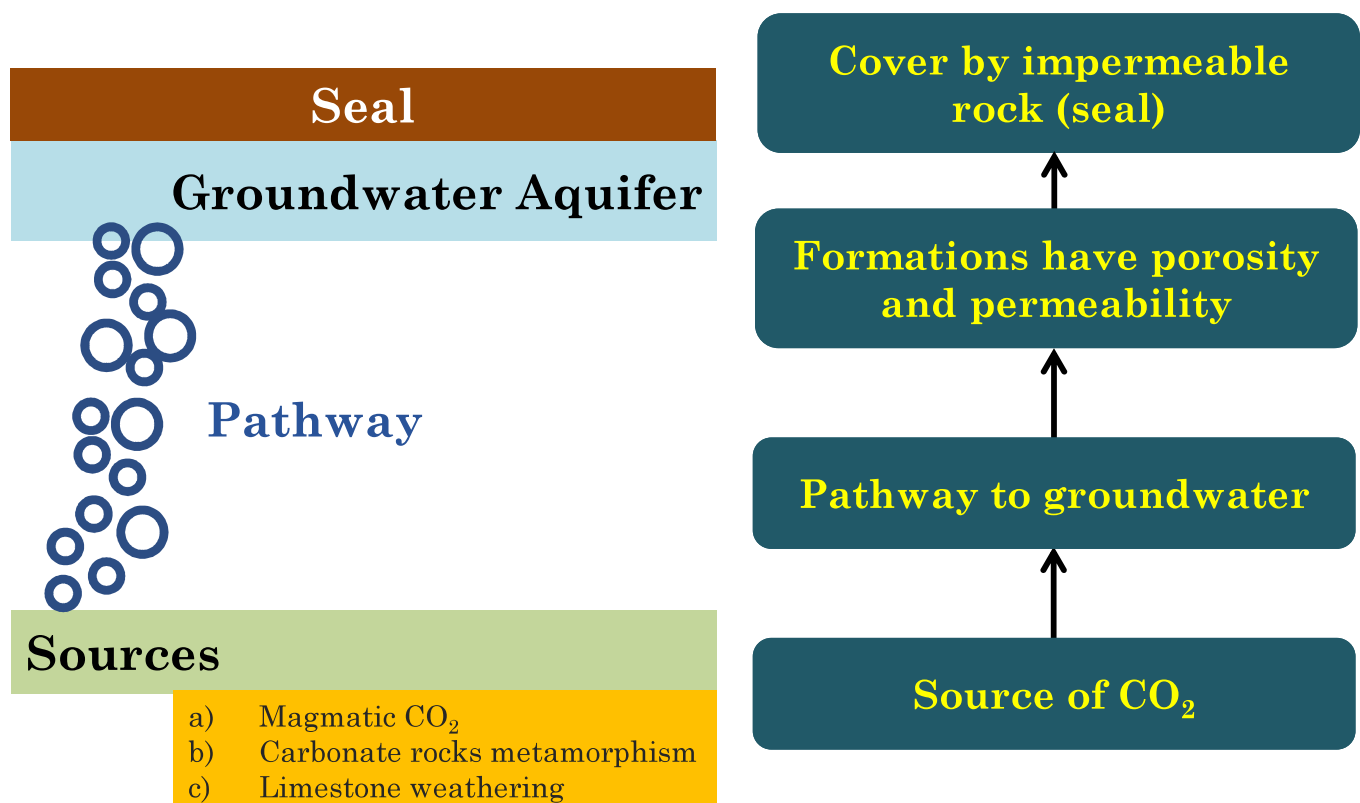
- Natural Soda groundwater
- Groundwater with dissolved carbon dioxide
- CO₂-rich groundwater

Parameters	CO ₂ -rich Groundwater	Groundwater
pH	slightly acidic	neutral
HCO ₃	800-2,500 mg/L	20-200 mg/L
Total dissolve solid	1,000-4,000 mg/L	10-300 mg/L
P _{CO2}	>10 ⁻² atm	<10 ⁻³ atm

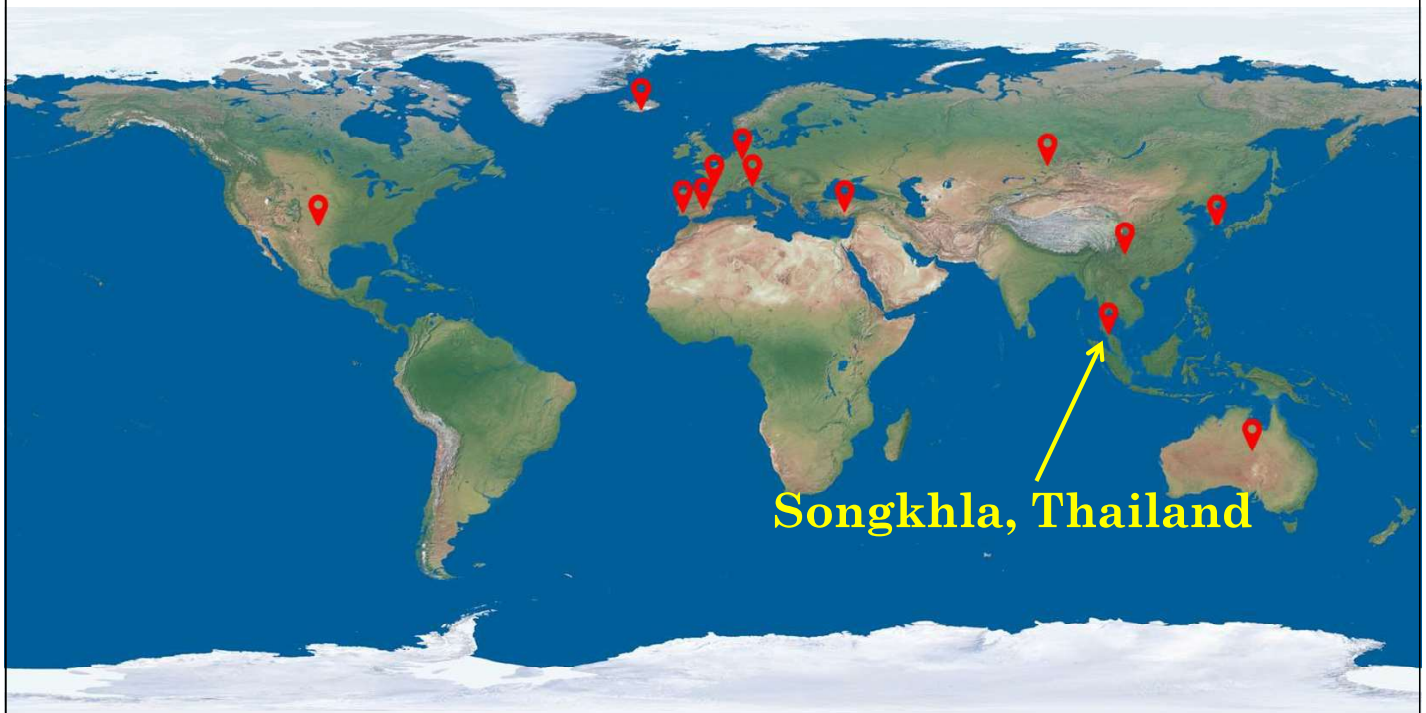
Total dissolved solid (TDS): combined total organic, inorganic substances dissolved

P_{CO2} : partial pressure CO₂ gas in equilibrium with water

Soda-rich Groundwater System



Soda-rich groundwater is not common!!



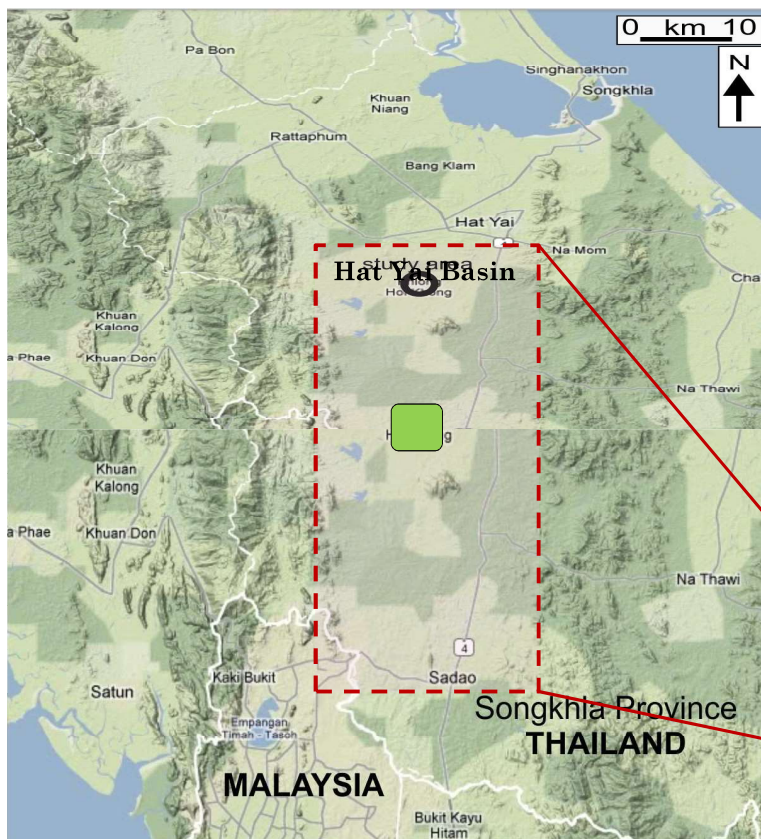
...at least 30 sites in 13 countries (from literature search)

Geophysics Research Center (GRC), PSU, Thailand

Ref. <http://www.shadedrelief.com>

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Soda-rich Groundwater in Thailand



Study area:

Royal Research Farm
at Khlong Hoi Khong,
Songkhla Province

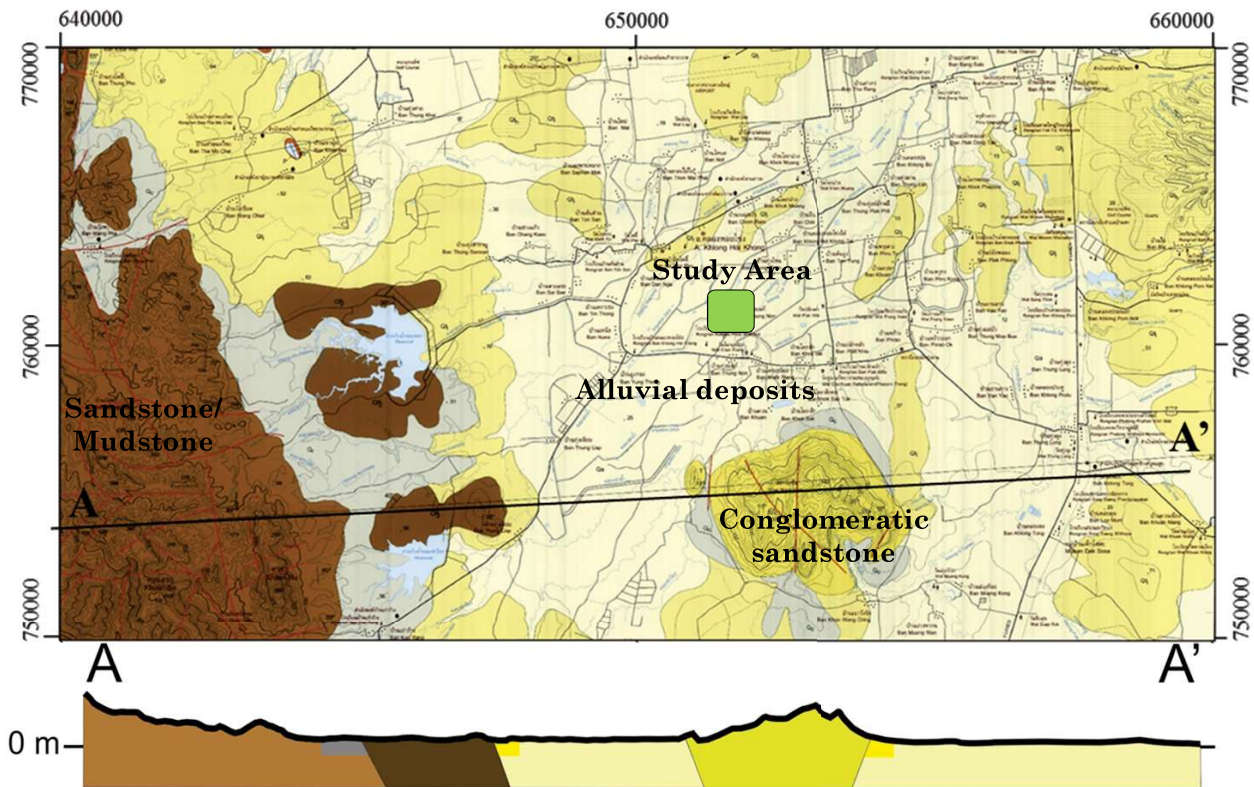


Geophysics Research Center (GRC), PSU, Thailand

Ref. GoogleMap

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Geology of HatYai Basin

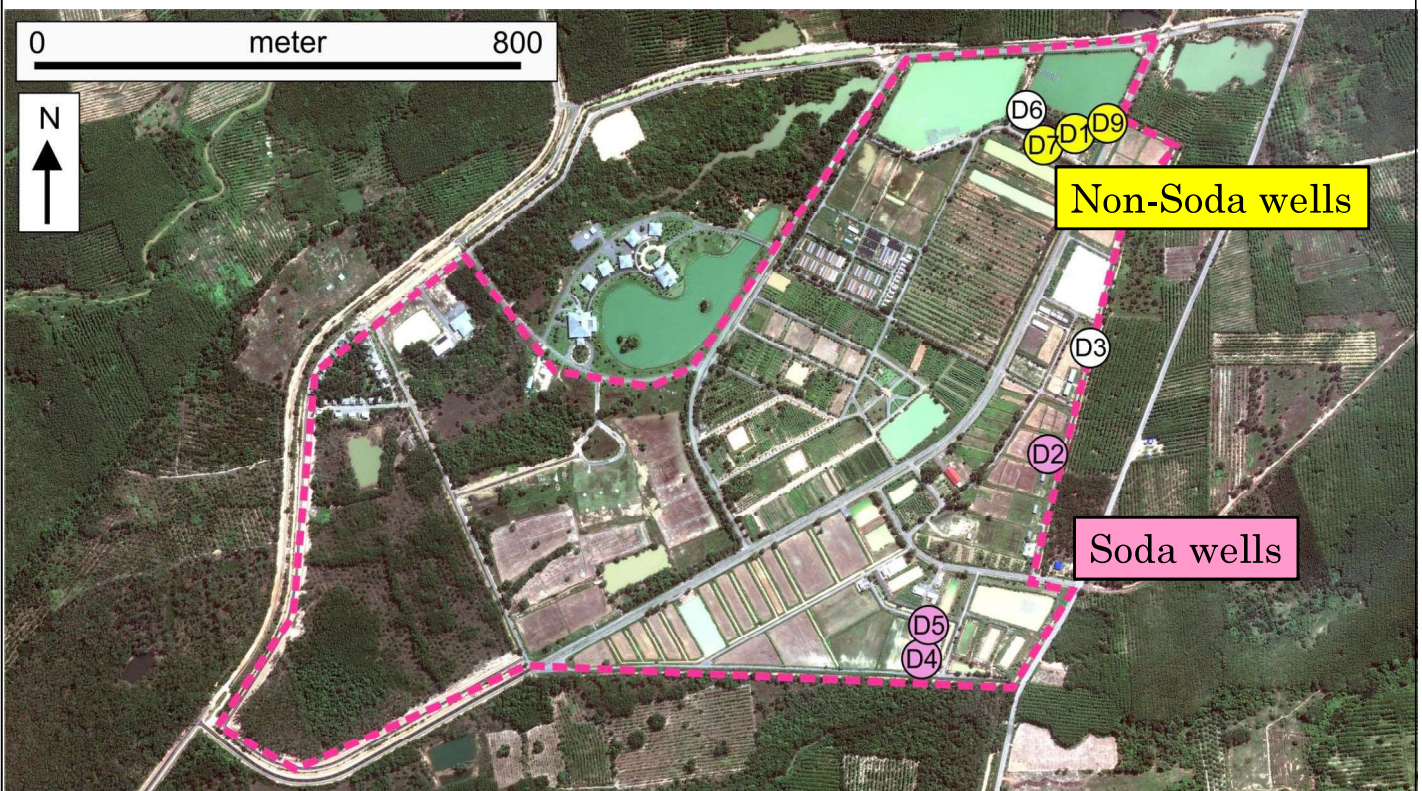


Geophysics Research Center (GRC), PSU, Thailand

Ref. DMR

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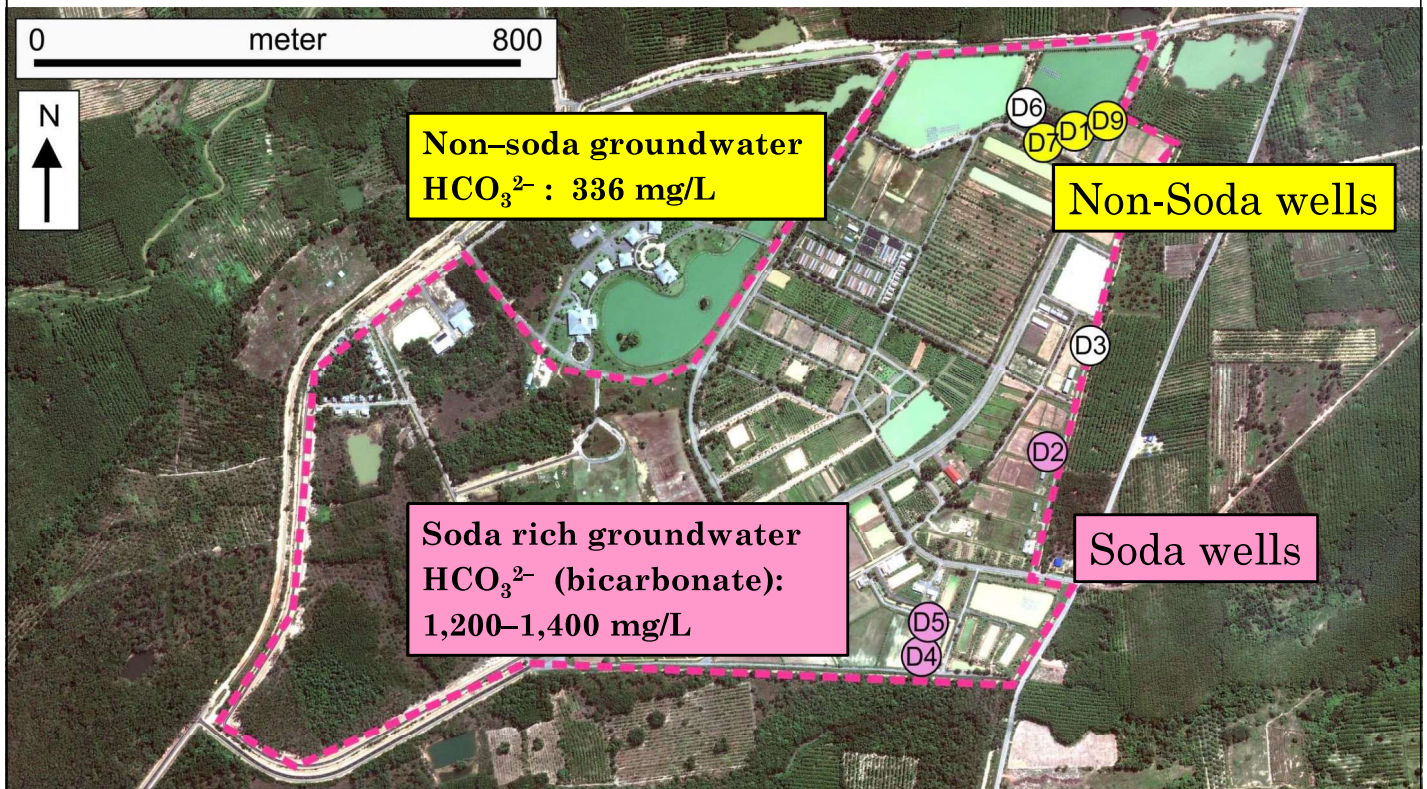
Study Area – Royal Research Farm



Geophysics Research Center (GRC), PSU, Thailand

Ref. Map GoogleEarth

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Soda-rich Groundwater Explorations

Geophysical Surveys

Investigated lithological boundaries and fluid pathways in upper 150 m

- 1D resistivity surveys of Vertical Electrical Sounding (VES)
- 2D resistivity surveys of Electrical Resistivity Tomography (ERT)
- Magnetic telluric survey (MT)

<Still ongoing>

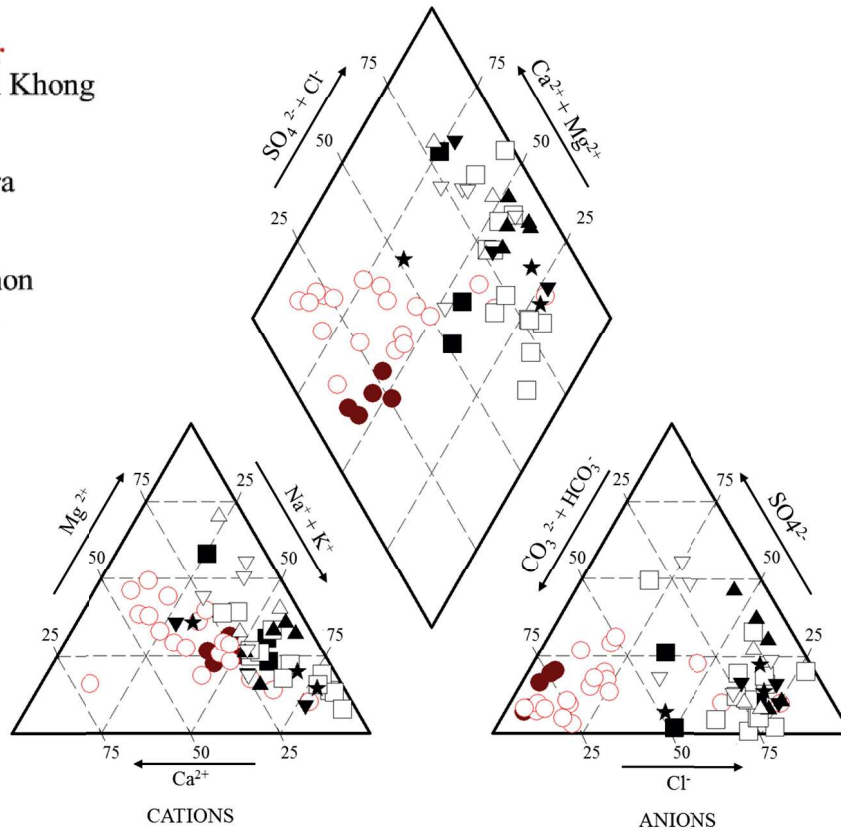
Geochemical Analysis

Understanding the distribution, source and pathways of soda rich groundwater

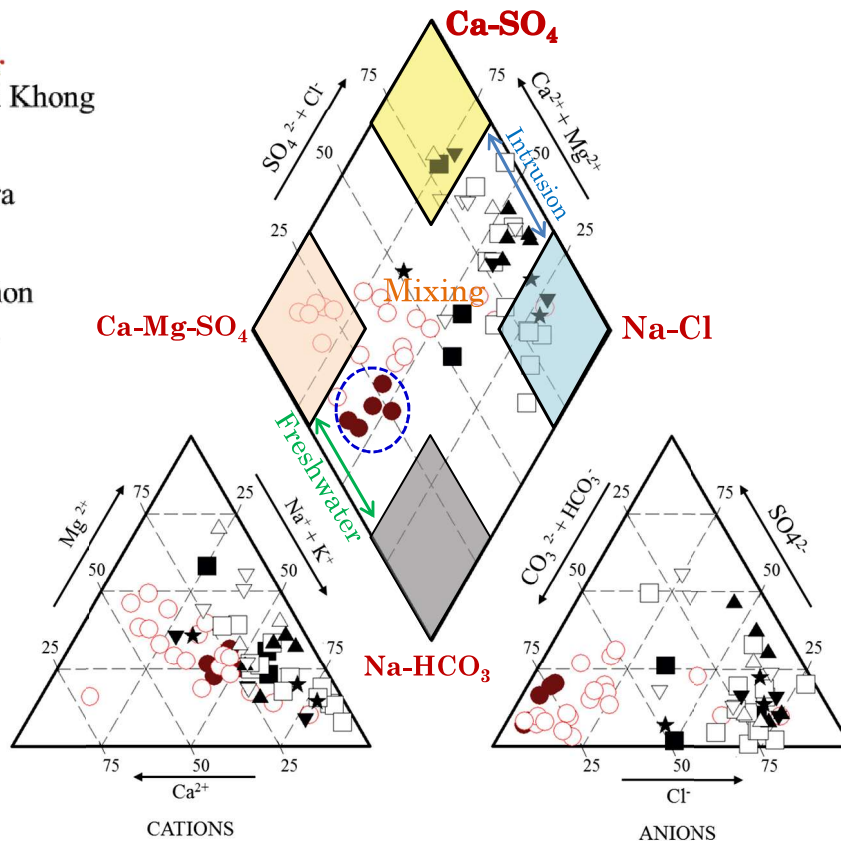
- Major cations-anions
- Rare Earth Elements
- Stable isotopes

<Still ongoing>

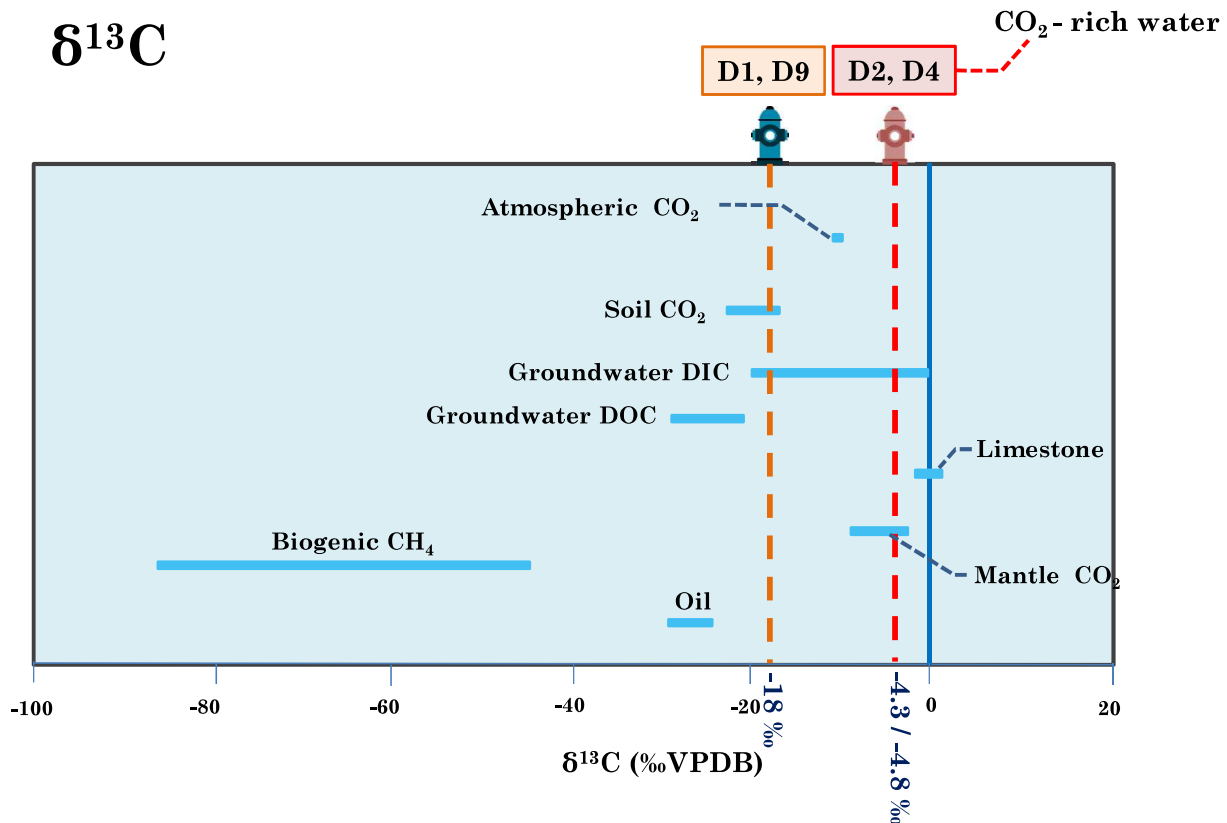
- Soda water
- Khlong Hoi Khong
- Meuang
- Ranot
- ▲ Sathing Phra
- △ Hat Yai
- ▼ Krasae Sin
- ▽ Singhanakhon
- ★ Bang Klam



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$\delta^{13}\text{C}$



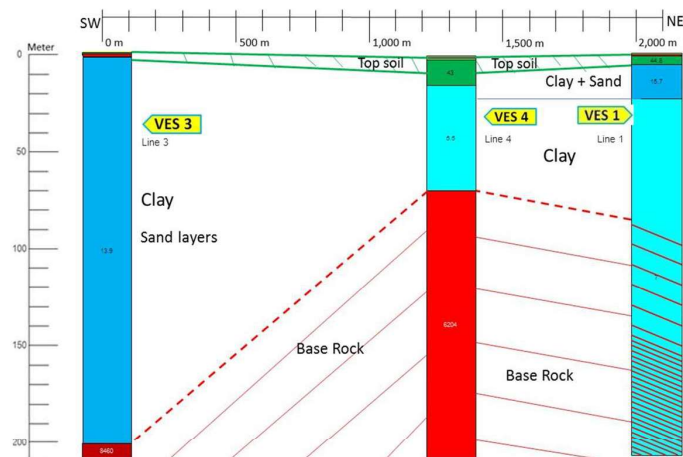
Geophysics Research Center (GRC), PSU, Thailand

Ref. Duerrast et al., 2019

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Geophysical Interpretations

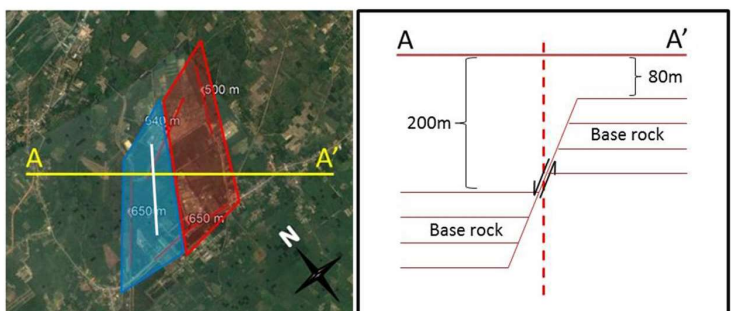
1D deep resistivity surveys



Identification of possible NW-SE fault

- Shallower base rock at soda groundwater area
- Deeper base rock at non-soda groundwater area

... but more data needed

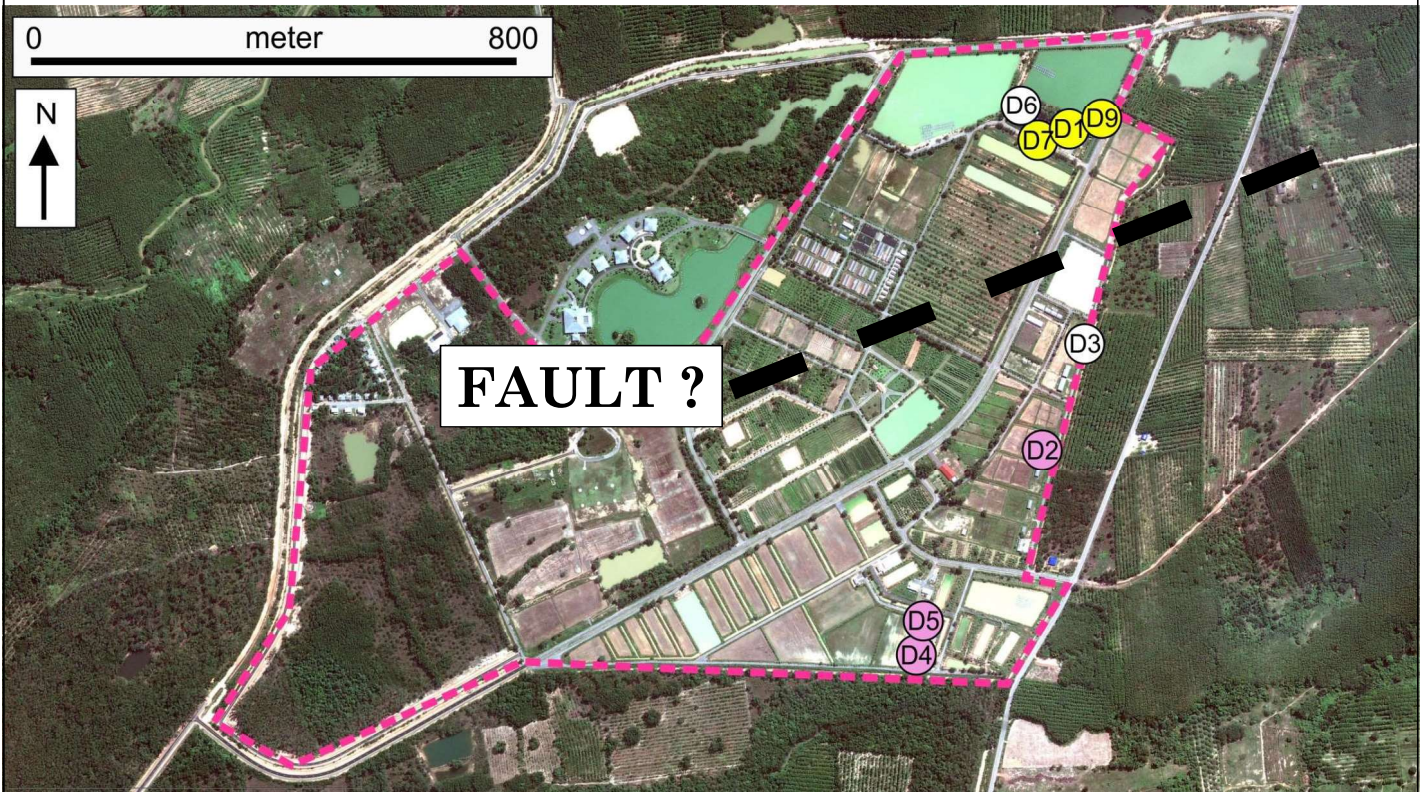


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Ref. Duerrast et al., 2019

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Conclusions

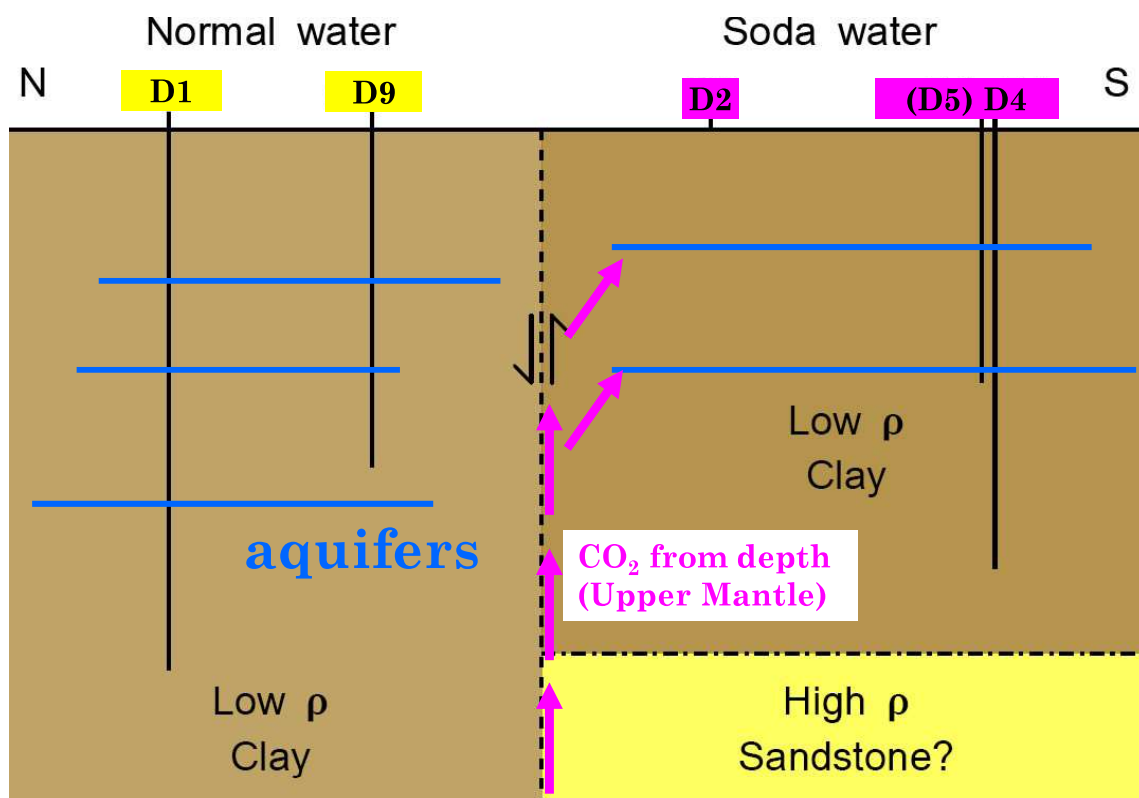


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Ref. Duerrast et al., 2019

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Hydrogeological model (draft)



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Ref. Duerrast et al., 2019

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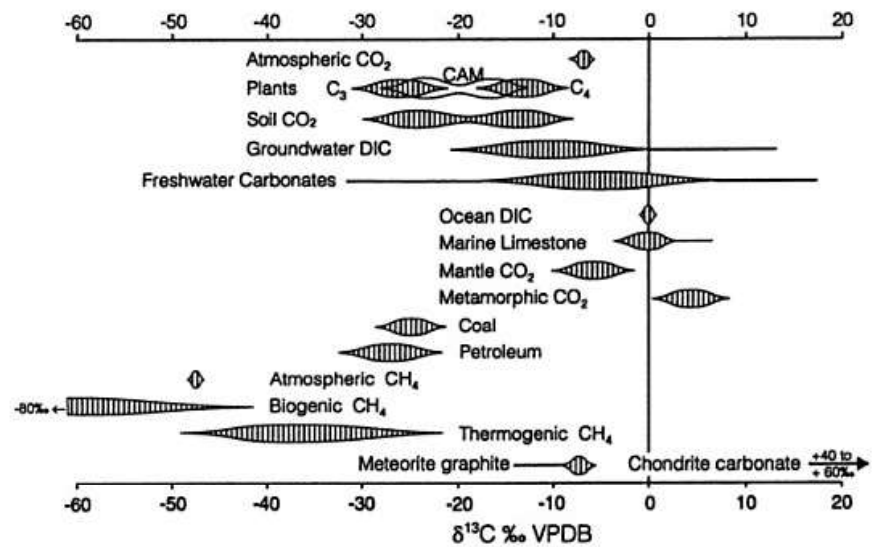
Thank you
for your attention !

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How to identify source of CO₂ ?

- Stable C isotopes values to indicate source for CO₂
- ¹³C isotope (more in CO₂ and carbonates)
- ¹²C isotope (more in organic matter)

$$\delta^{13}C = \left(\frac{\left(\frac{^{13}C}{^{12}C} \right)_{\text{sample}}}{\left(\frac{^{13}C}{^{12}C} \right)_{\text{standard}}} - 1 \right) \times 1000 \text{ ‰}$$



PDB: Pee Dee Belemnites, composition of the fossil Belemnite from the Pee Dee Formation in South Carolina is used as reference standard

Ref : <https://www.cefns.nau.edu/geology/naml/Meteorite/Book-GlossaryC.html>