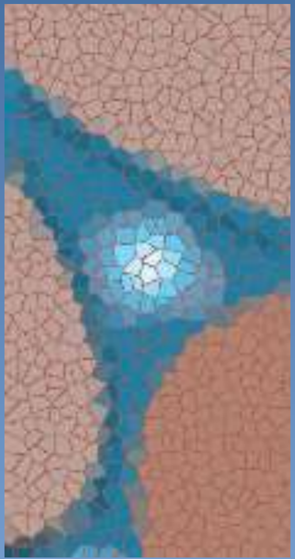
ANALYSIS OF NATURAL CO_2 RESERVOIRS TO VERIFY GEOCHEMICAL MODEL RESULTS



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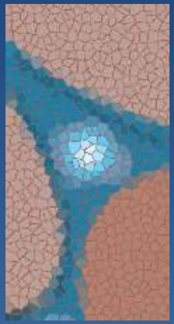
XLV. Meeting of Young Geoscientists
Balatonföldvár, 2014

Overview



- Introduction
- Geological background
- Potential CO_2 reservoir
  - – Results of the geochemical models
- Natural CO_2 occurrence
- Comparison of the two areas
- Conclusions

Introduction

- Relationship between climate change and increasing amount of atmospheric CO_2

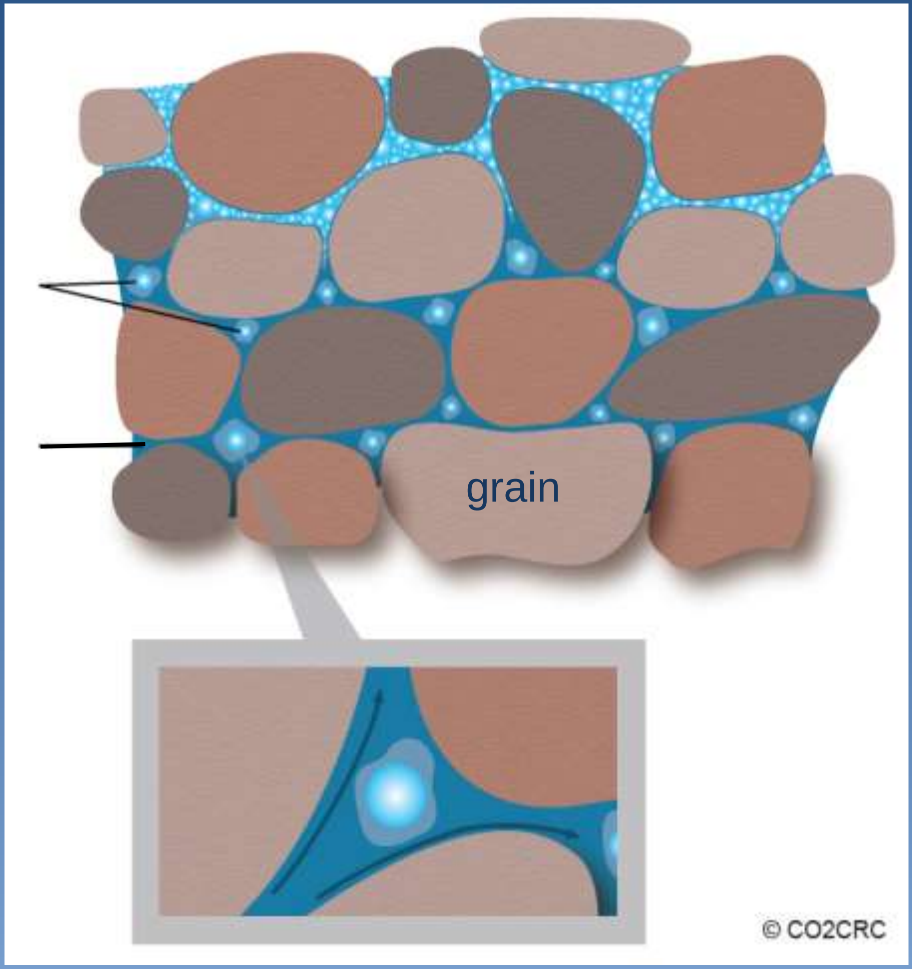
- Possibilities of reducing CO_2 emission

- **C**O_2 **C**apture and geological **S**torage: **CCS**

Questions in CO_2 storage (safety)

CO_2 in the pore

Pore water

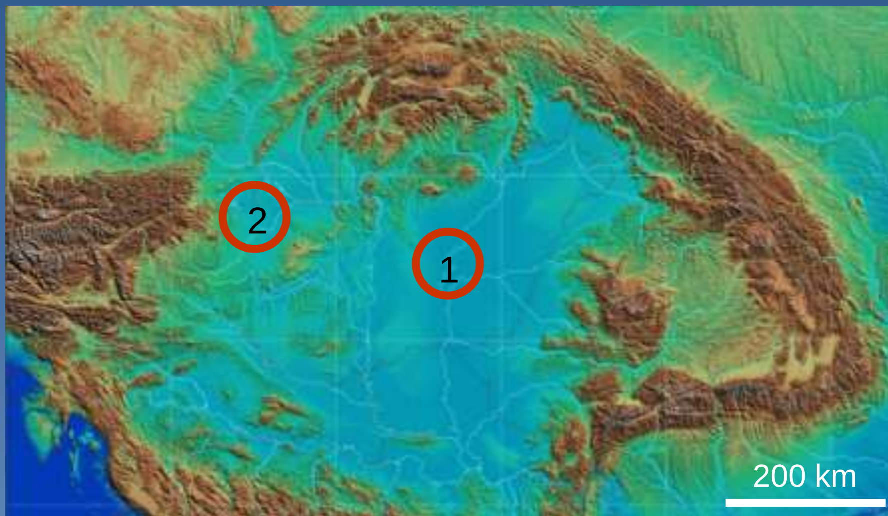


Reservoir and caprock:
- physical and
- chemical properties
    - change of these properties
        - time dependence of change

-Geochemical models
-Natural CO_2 occurrences
-Experiments (labor and field)

Combination of these is the most effective to study the behavior of the complex system

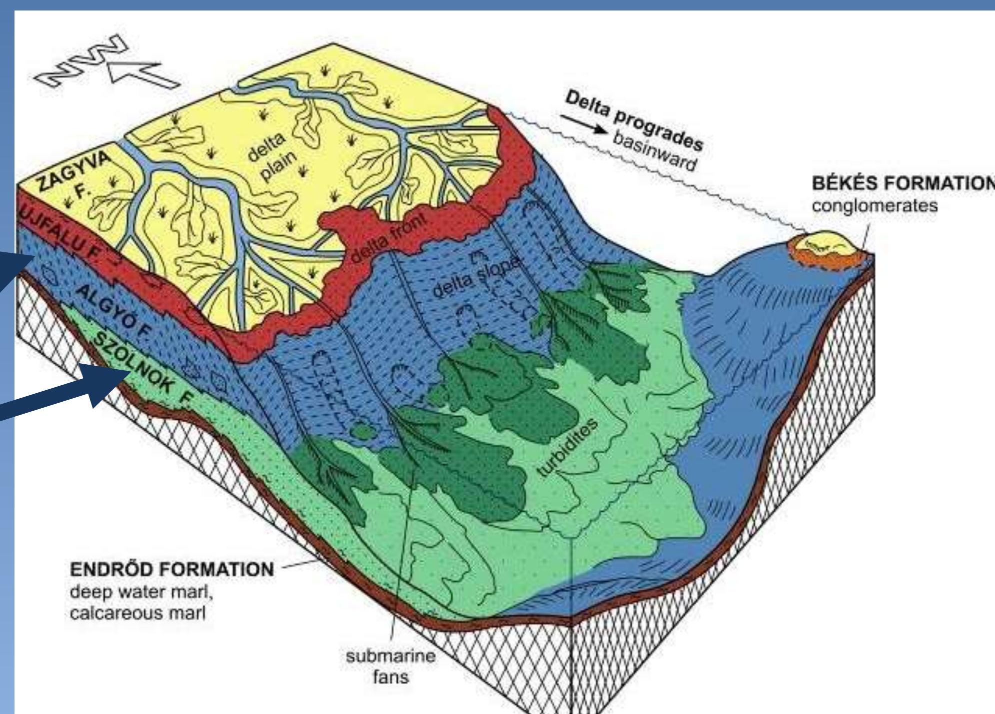
Geological background



1.) Potential CO_2 reservoir (Nagykunság area)
2.) Natural CO_2 occurrence (Mihályi-Répcelak)

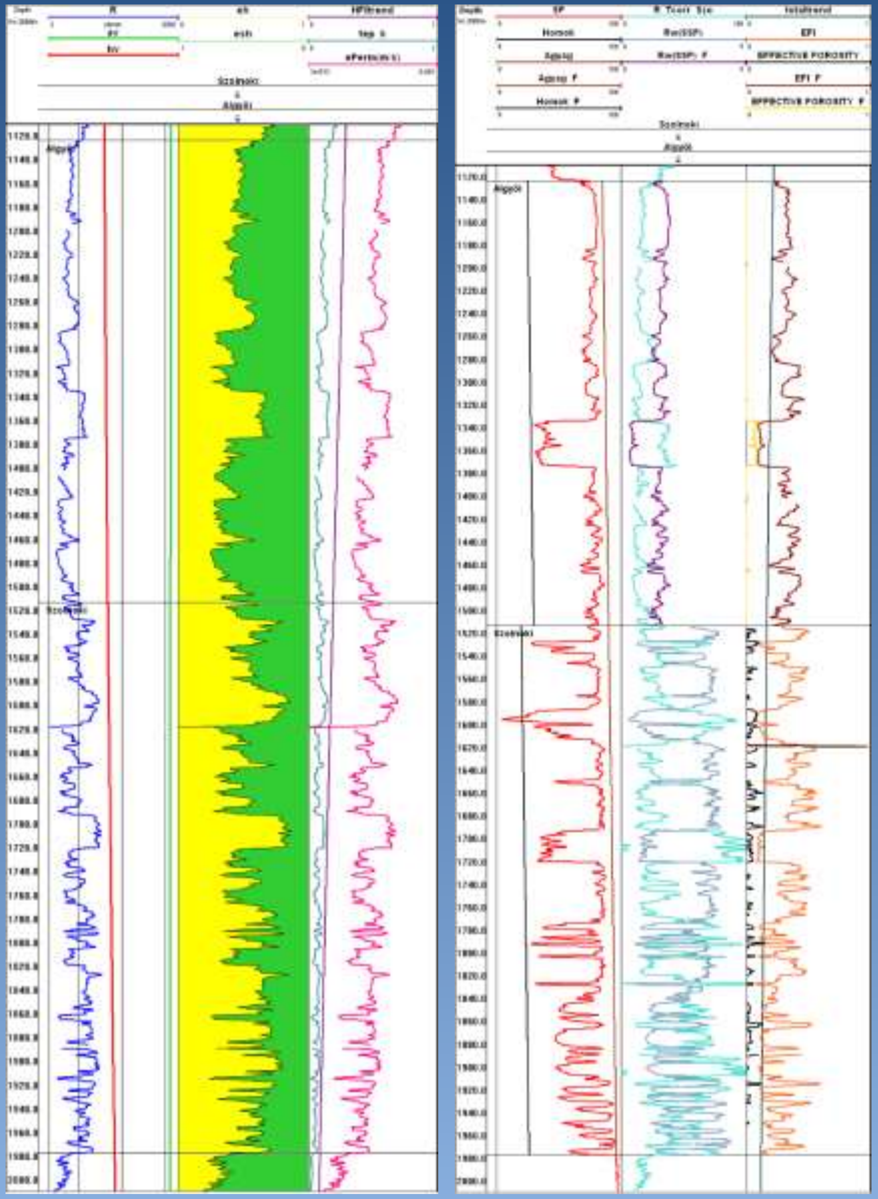
Algyő Formation

Szolnok Formation



Juhász, 1992

Potential CO_2 reservoir
Well-log geophysics



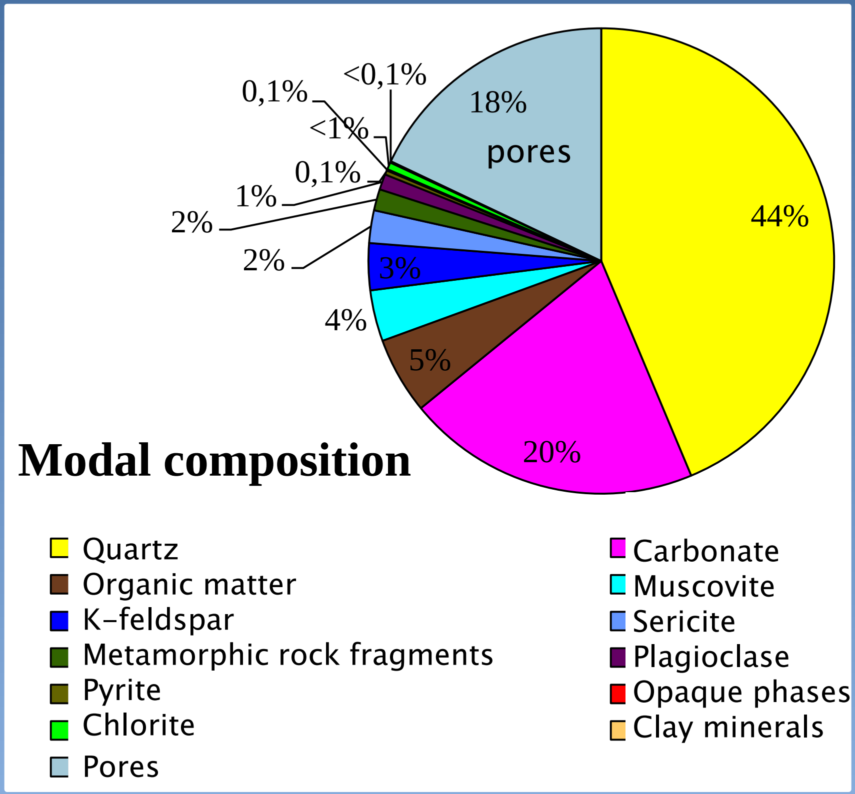
Clayeyness: ~45%

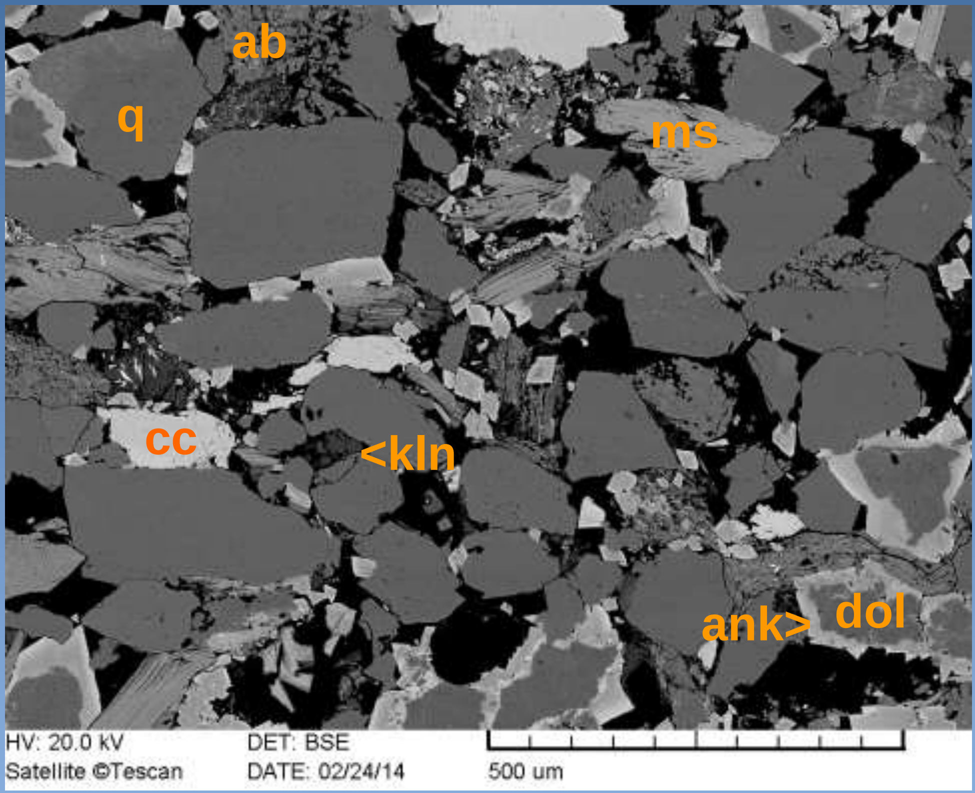
Effective porosity: ~7%

Permeability: ~ $3,12 \cdot 10^{-8}$ m/s

Potential CO_2 reservoir
Analysis of rock samples

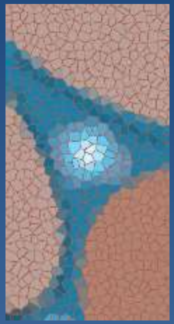
- Methods: polarization microscope, SEM
  XRD, TG, FTIR





ab-albite, ank-ankerite, cc-calcite, q-quartz, kln-kaolinite, ms-muscovite, dol-dolomite

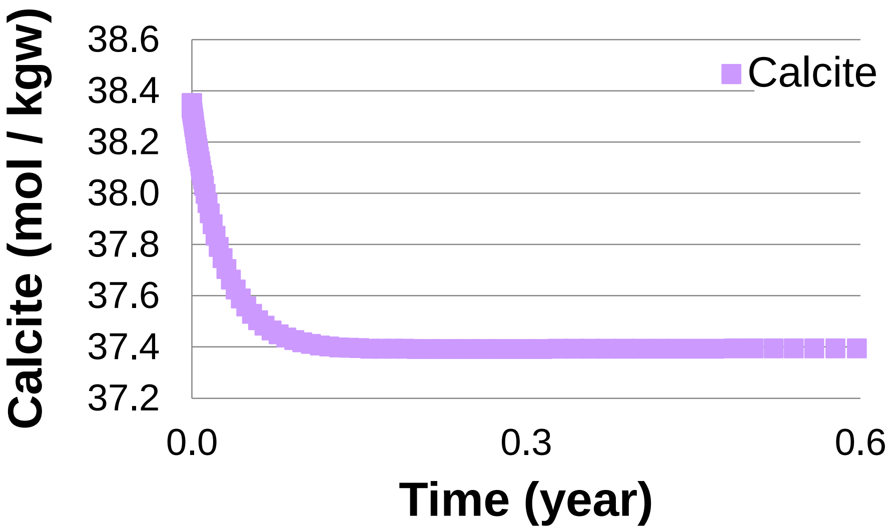
Potential CO_2 reservoir Modeling the effect of CO_2

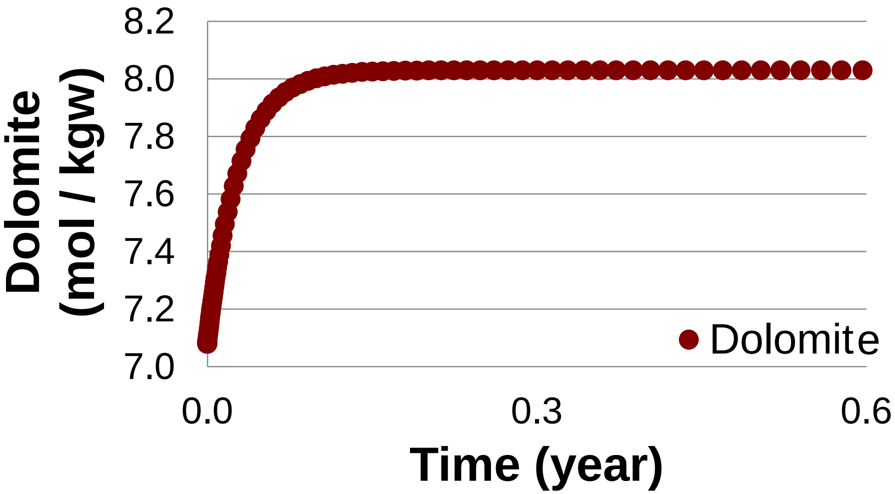


- PHREEQC-3
  - Equilibrium and <u>kinetic</u> models
- Input data:
  - Modal composition of the potential reservoir rock
  - Water chemistry
  - Pressure (21 MPa) and temperature (114 °C) of the reservoir, assumed partial pressure of the injected CO_2
  - + to the kinetic models:
    - Rate constant
    - Activation energy
    - Specific surface area of the minerals

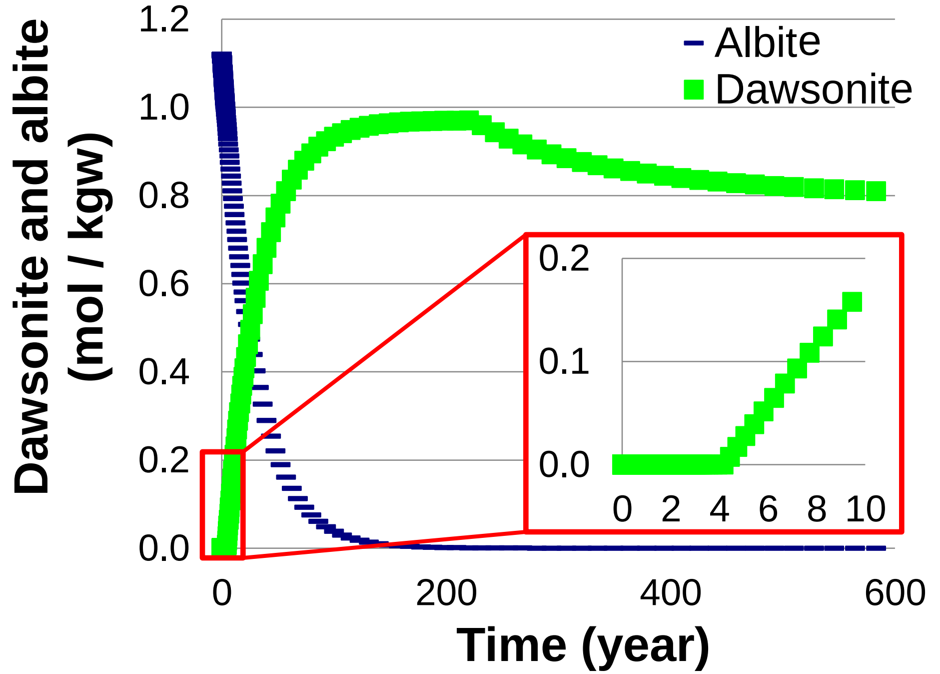
Potential CO_2 reservoir Geochemical models

Change in the amount of calcite and dolomite in 0,6 year



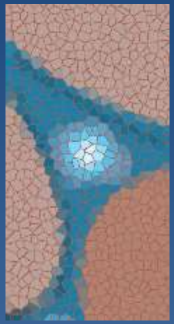


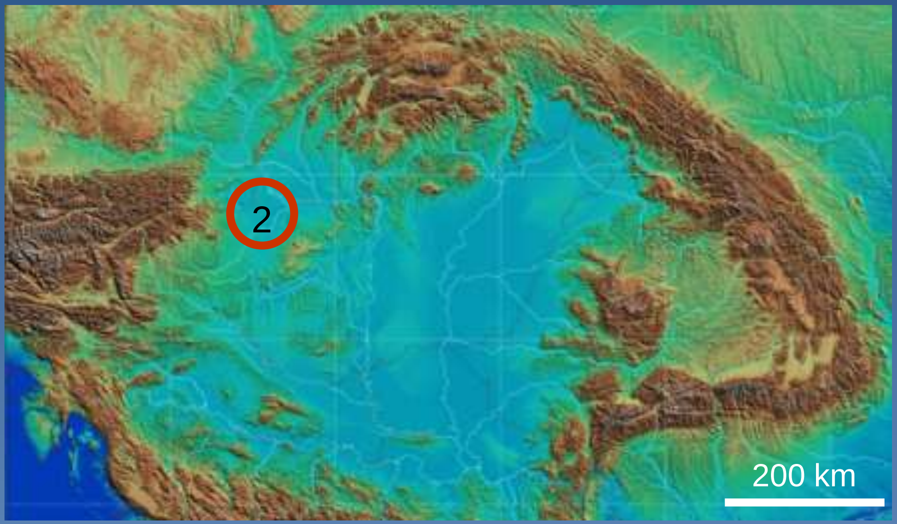
Change in the amount of dawsonite and albite in 600 years



Dawsonite: $NaAlCO_3(OH)_2$

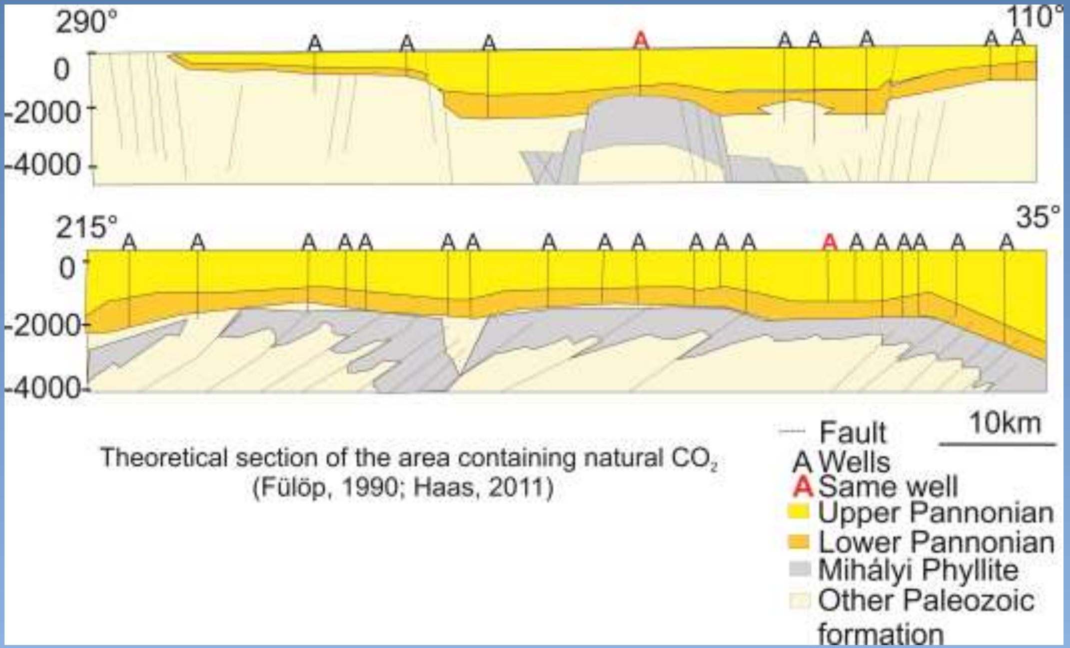
Natural CO_2 occurrence





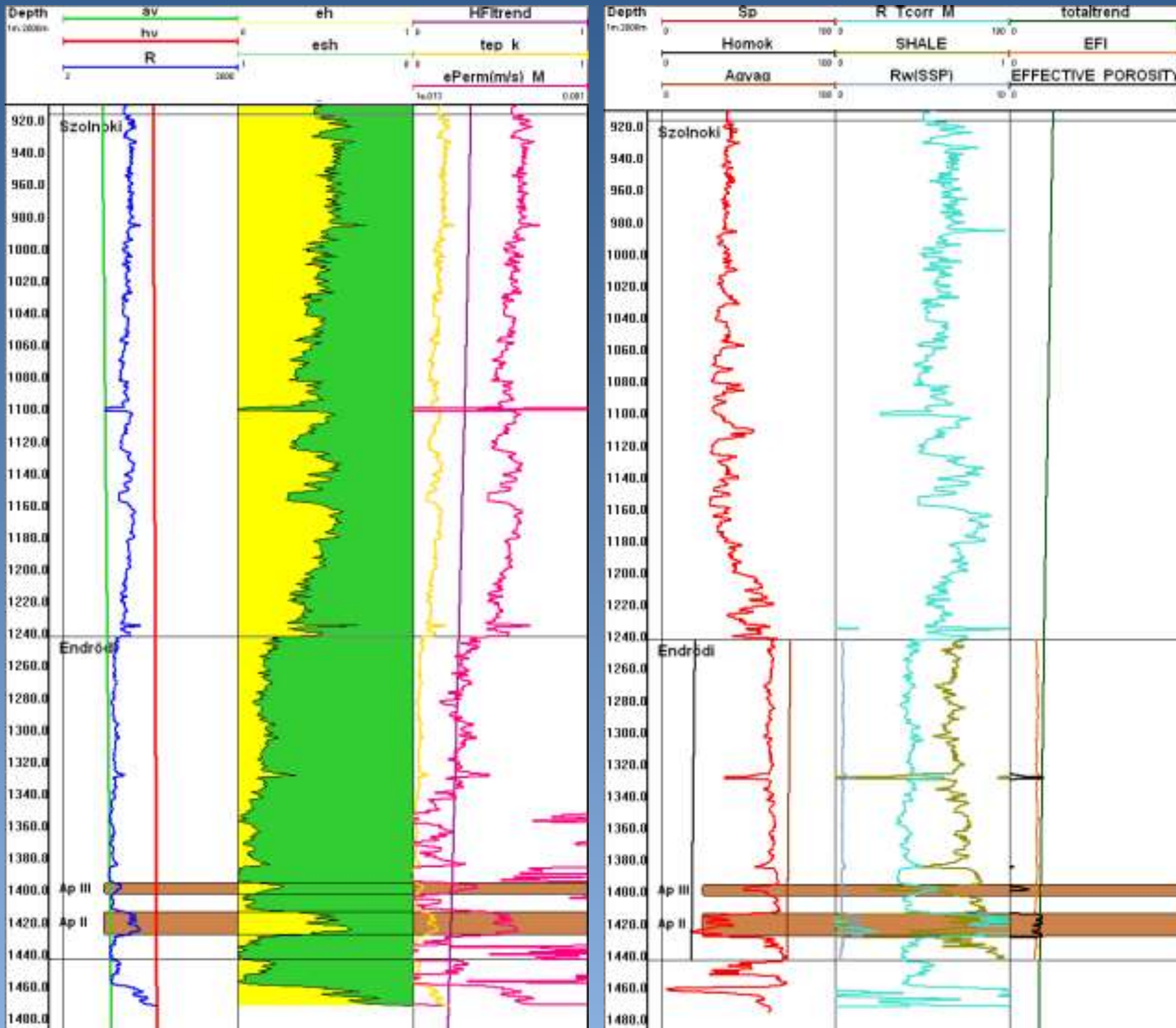
- 40 wells (deeper than 1100 m)
- 28 well-log data available and studied

- Numerous CO_2-reservoirs studied
- Industrial CO_2 production since the 1940s from 3 larger reservoirs



Theoretical section of the area containing natural CO_2
(Fülöp, 1990; Haas, 2011)

Natural CO_2 occurrence
Well-log geophysics



LP III. reservoir

Clayeyness:~65%

Effective porosity:~7%

Permeability:~1,9*10^{-9} m/s

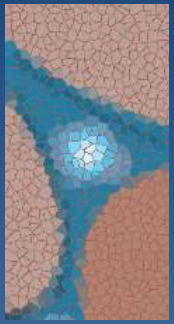
LP II. reservoir

Clayeyness :~50%

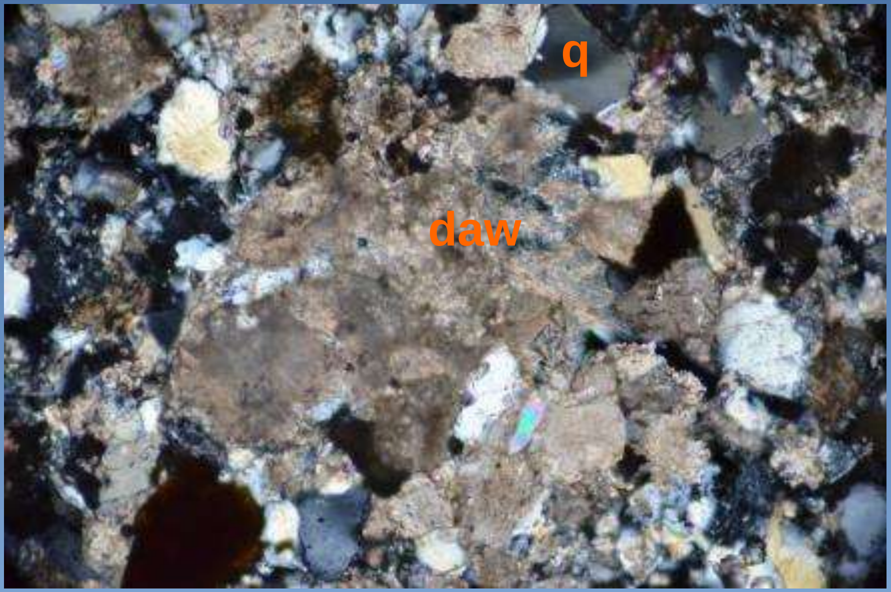
Effective porosity:~15%

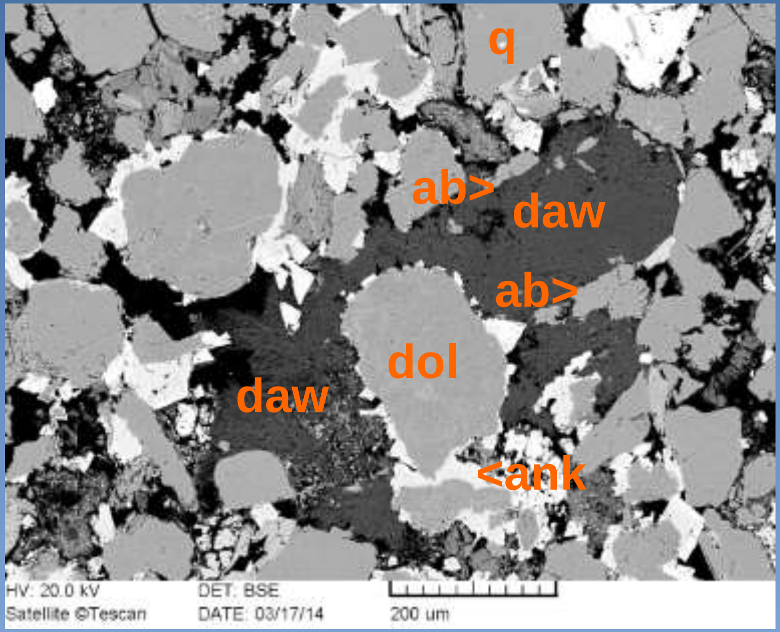
Permeability:~1,01*10^{-7} m/s

Natural CO_2 occurrence
Analysis of rock samples



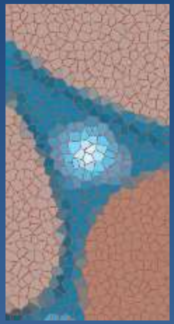
- Methods: polarization microscope, SEM
  XRD, TG, FTIR, Raman



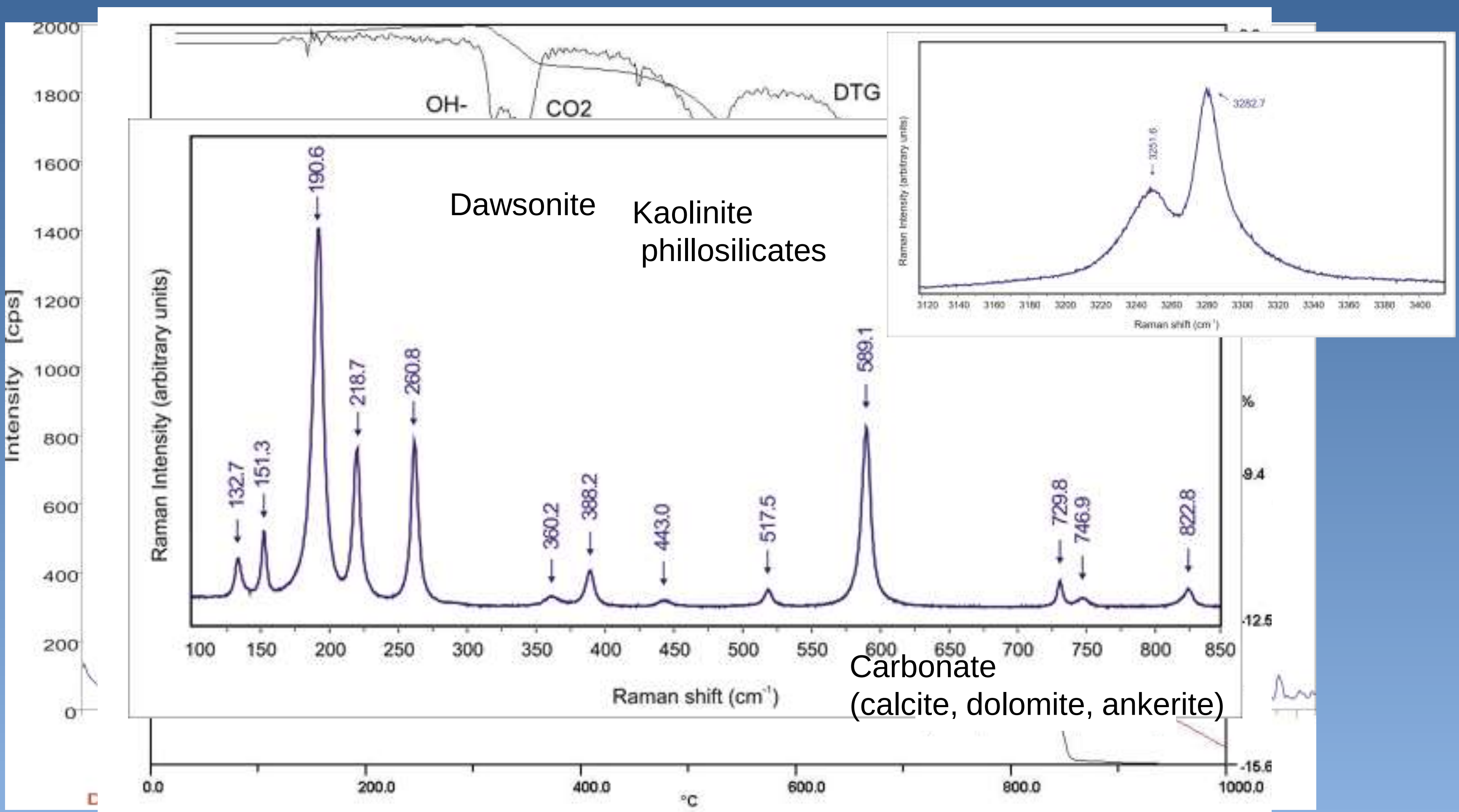


ab-albite, ank-ankerite, dol-dolomite, daw-dawsonite, q-quartz

Natural CO_2 occurrence
Analysis of rock samples

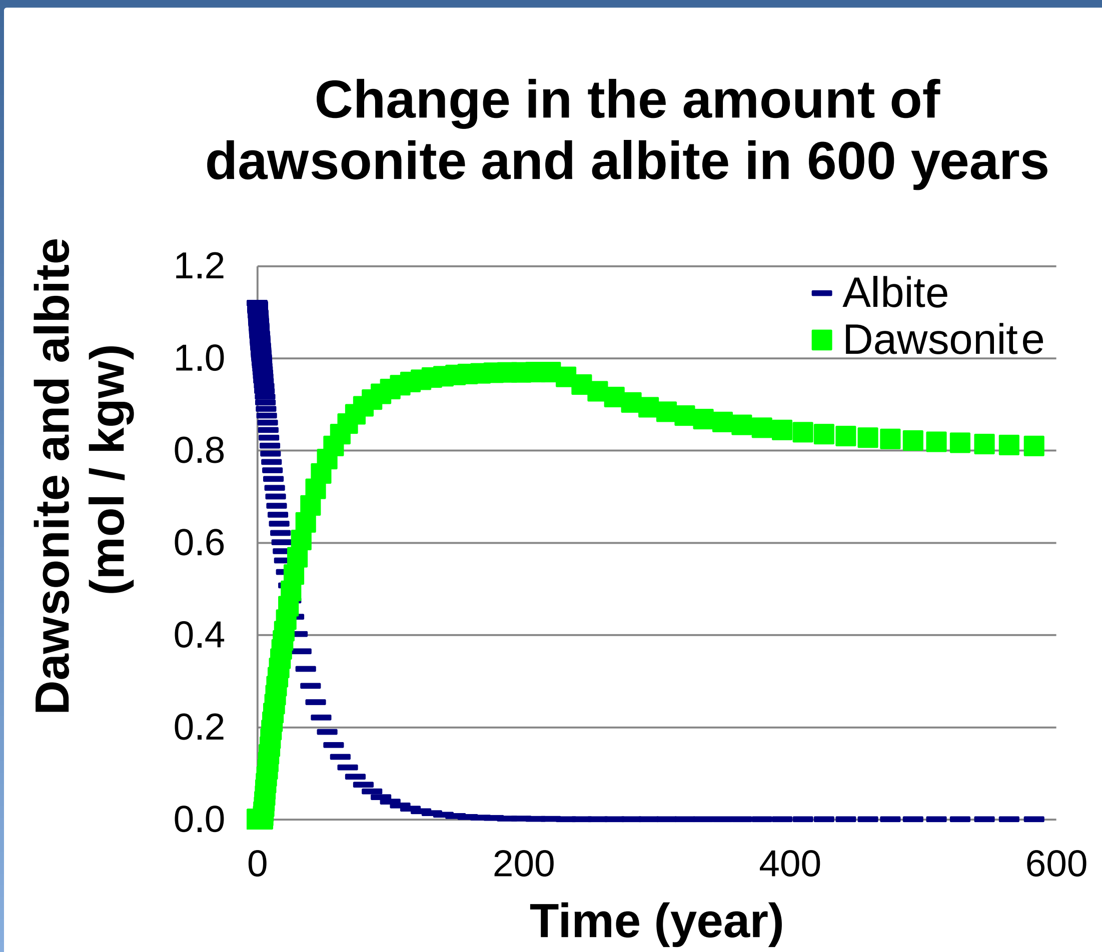


- XRD, TG, Raman

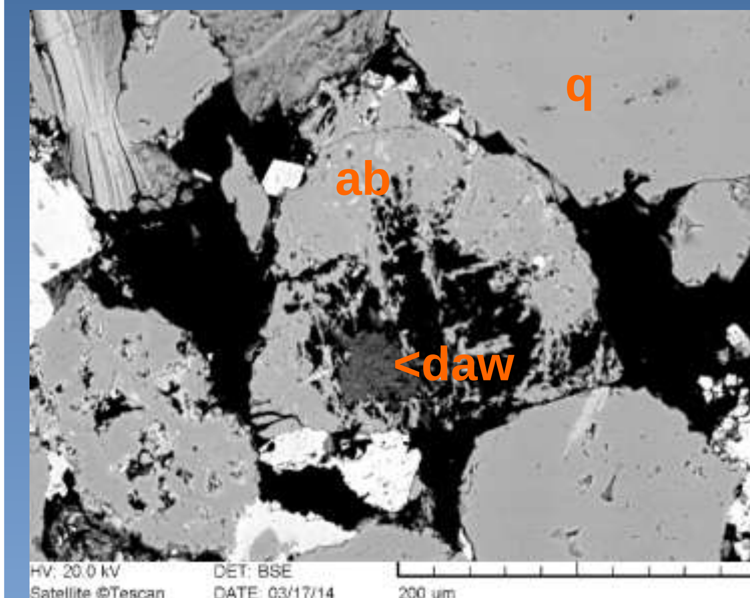


Comparison of the two areas

Potential reservoir

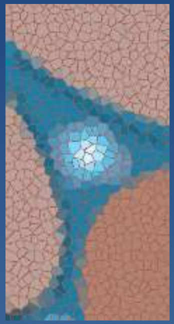


Natural CO_2 occurrence



q-quartz
ab-albite
daw-dawsonite

Conclusion



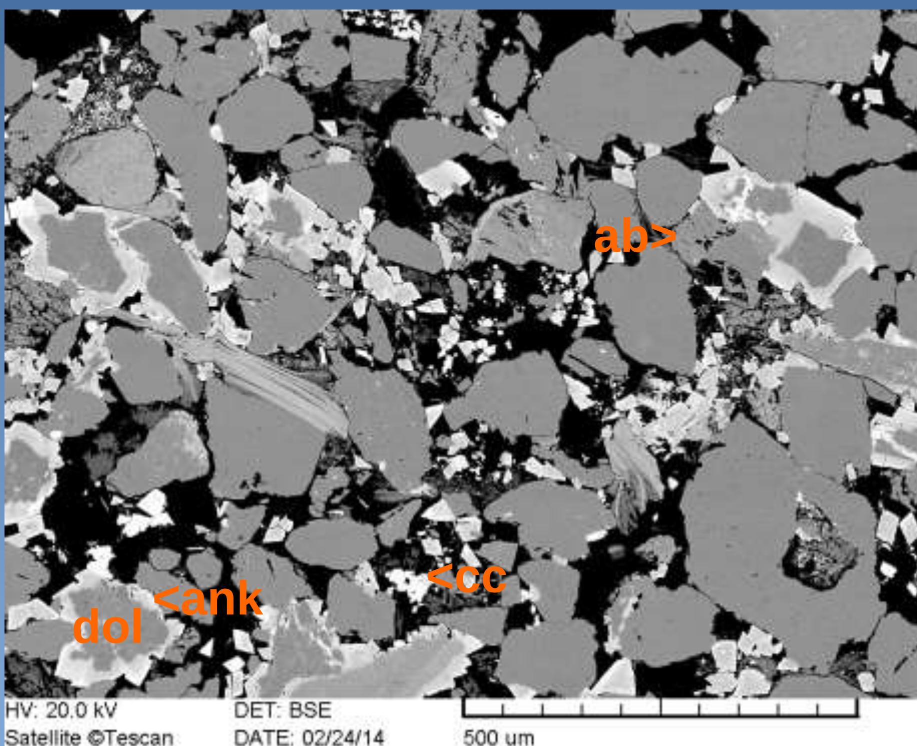
- Good correlation between geochemical models and natural CO_2 occurrences
- Dawsonite – effect of CO_2
- Diagenetic vs. CO_2 effect

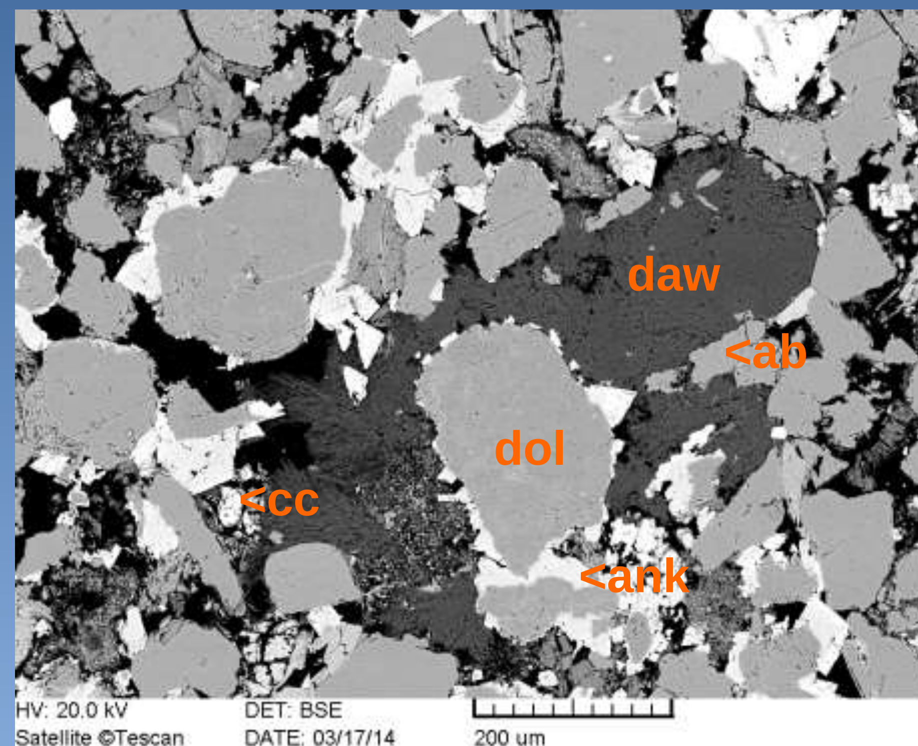
Thank you for your kind attention!

We would like to express our gratitude to Zsolt Bendő for the SEM images and for the members of LRG for all the help we received during the making of this presentation.

Comparison of the two areas

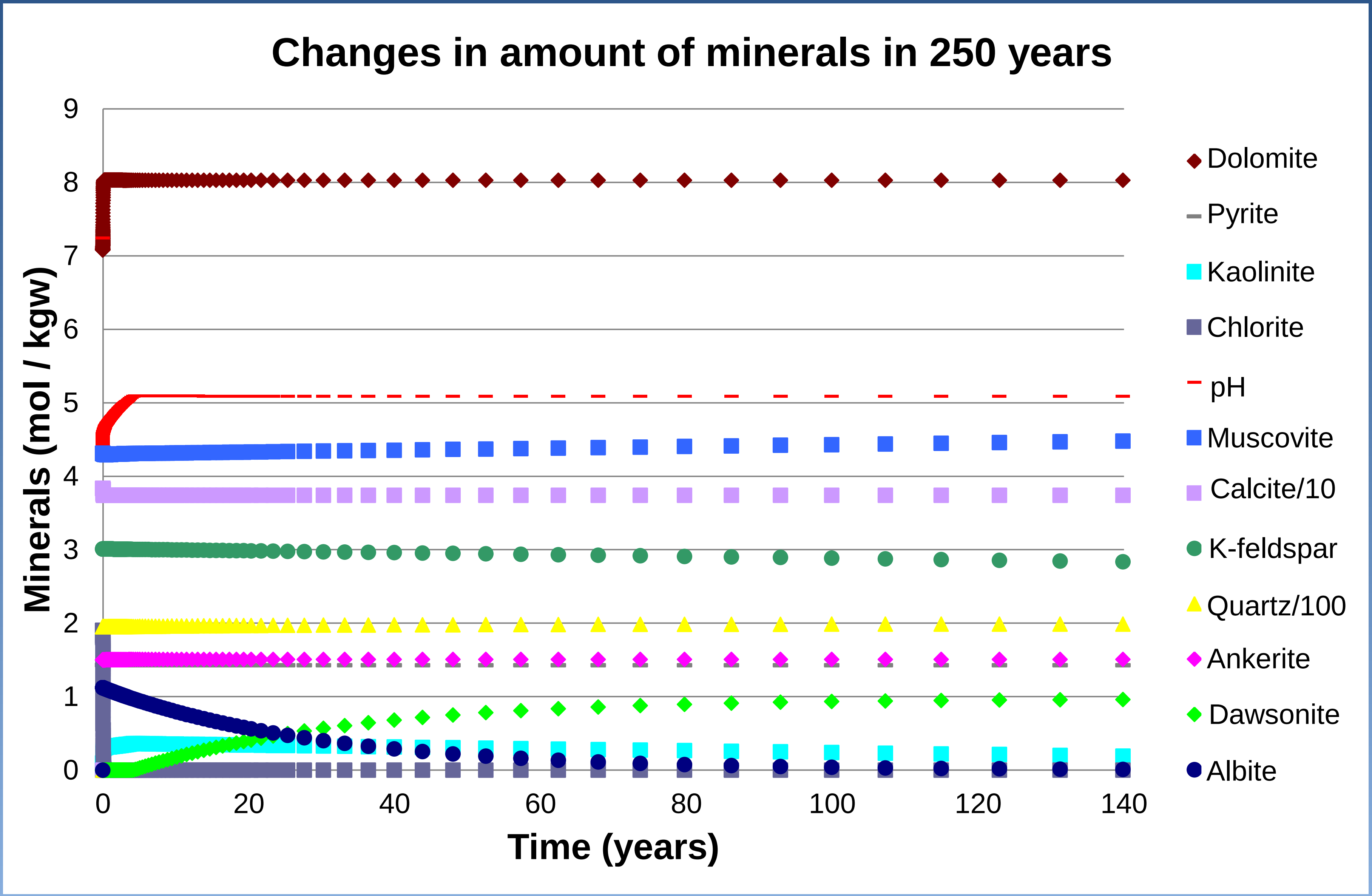
Potential reservoir	Natural CO_2 occurrence



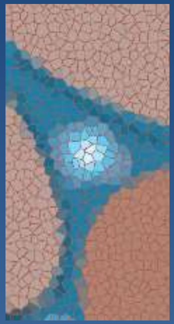


cc-calcite, dol-dolomite, ank-ankerite, ab-albite, daw-dawsonite

Potential CO_2 reservoir - Geochemical models



Equations used to determine petrophysical parameters



1.) $$eh = \frac{\log(R) - av}{hv - av} \Rightarrow ehs = \frac{1 - eh + |1 - eh|}{2}$$

2.) $$V_{SH} = \frac{SP_{measured} - SP_{min}}{SSP}$$

1.) $$tep = 1,26 * e^{-1(0{,}00051*depth)^{-4}} + 0,11 * e^{-1(0{,}0008*depth)^{4}} * eh$$

(Zilahi-Sebes, 2008)

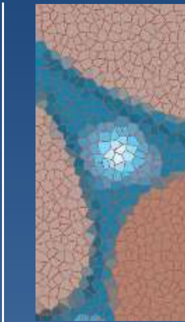
$$ePerm\ (m/s) = \frac{0,136 * 10^{-5} * temp^{4,4}}{((1 - eh) * 0,14)^2}$$

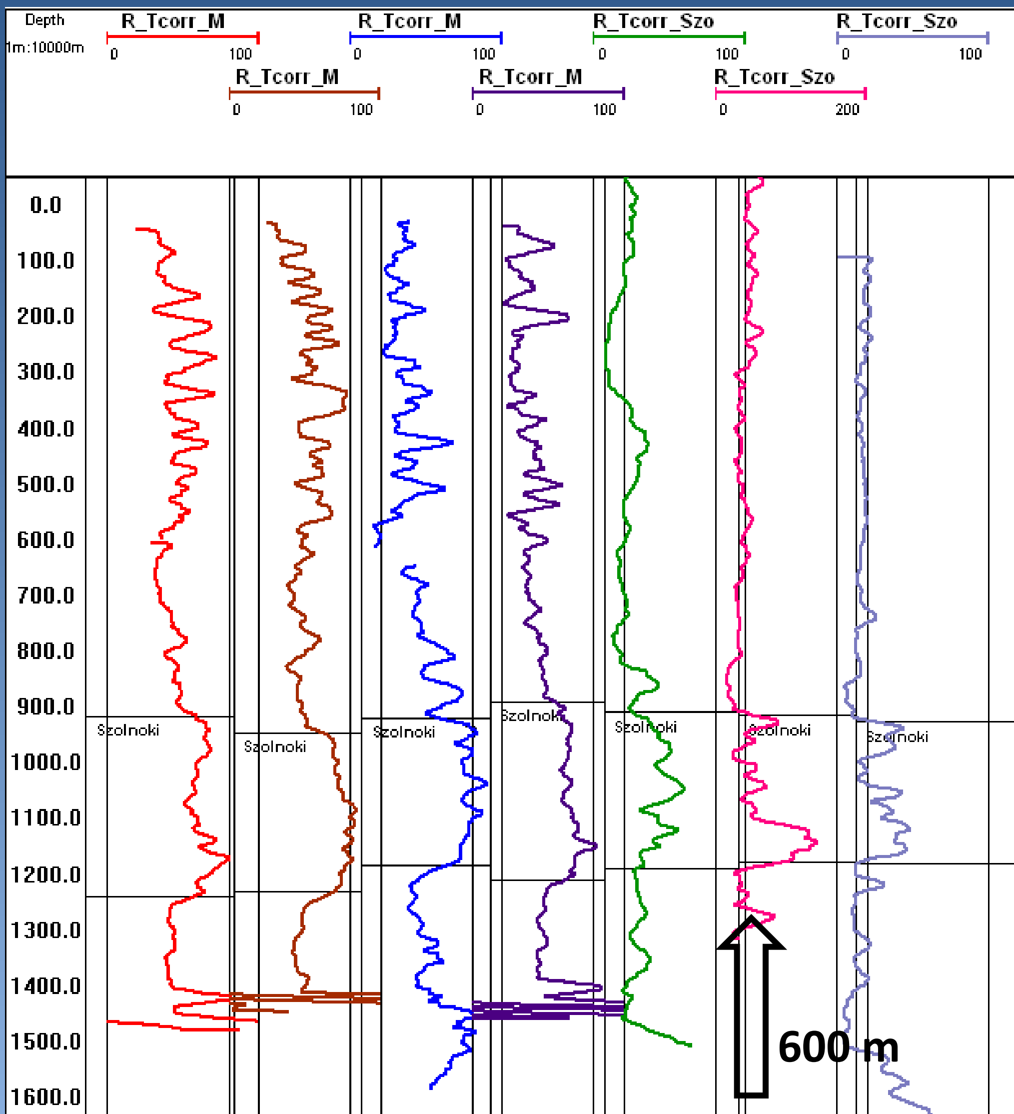
2.) $$EFI = \sqrt{\frac{R_W\,(SSP)}{R_0}} \Rightarrow \varphi_e = EFI - (0{,}14 * Sh) - (0{,}35 * Sh^2)$$

C^{+4}= dissolution: HCO_3^-
precipitation: CO_3^{2+}

Minerals	Formulas	Na^+	Ca^{2+}	Mg^{2+}	Al^{3+}	C^{+4}
		(mol / kgw)				
Albite	$NaAlSi_3O_8$	-1,12	0	0	-1,12	0
Calcite	$CaCO_3$	0	-0,96	0	0	-0,96
Dolomite	$CaMg(CO_3)_2$	0	0,94	0,94	0	1,89
Dawsonite	$NaAlCO_3(OH)_2$	0,78	0	0	0,78	0,78
Sum	-	-0,34	0,01	0,00	0,00	1,76

Comparison of the two areas





Clayeyness:

Répcelak Lp II. = Szolnok

Répcelak Lp III. > Szolnok

Effective porosity:

Répcelak Lp II. > Szolnok

Répcelak Lp III. = Szolnok

Permeability:

Répcelak Lp II. > Szolnok

Répcelak Lp III. < Szolnok