

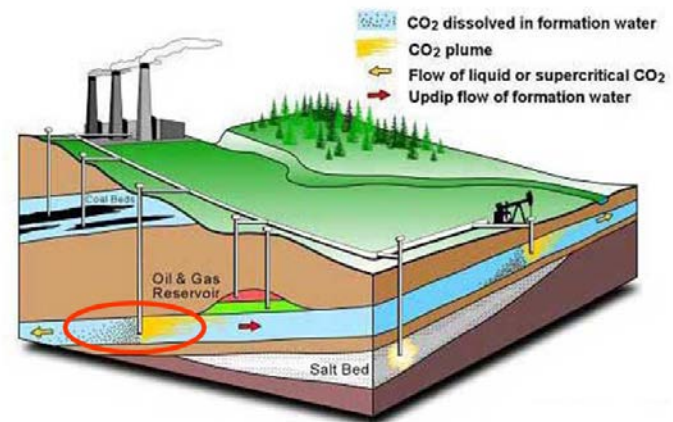
Development and Characterization of a Geostatic Model for Monitoring Shallow CO₂ Injection

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Outline

- Objectives
- Location of Study (geographically, stratigraphically)
- Model workflow
- Petrophysical updates
- Fluid-flow simulation results
- Conclusions
- Acknowledgements



Various means of CO2 geological sequestration.

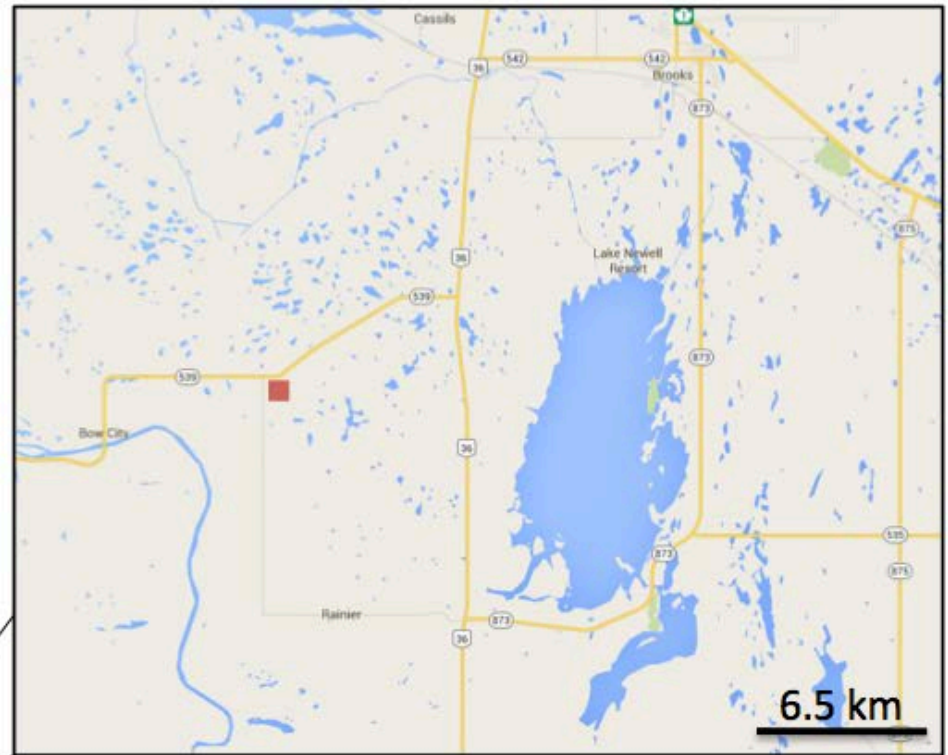
Objectives

- **Construct static geomodel for FRS site**
 - Geological and geophysical data input
 - Initial baseline characterization of target/seal A
 - Storage capacity and caprock integrity
- **Geodynamic modeling – review results**
 - Inject 5000 t/CO₂ over five-year period
 - Observe CO₂ and pressure plume behaviour
 - Shape, size, and distribution
 - Illuminate uncertainties in static and dynamic realm

Location of study



Newell County No. 4



■ FRS Study Area

Location of study

McNeil and Caldwell (1981) Webb et al. (2005)* Nielsen and Schröder-Adams (1999)** Leckie and Smith (1992) ***		THIS STUDY After Nielsen et al. (2003), Leckie et al. (2004), and Christopher et al. (2006)		Well Tops Used	General Lithology	Reservoirs & Seals
PERIOD	STAGE AGE (Ma)	SEDIMENTARY CYCLES		ALBERTA SOUTHERN PLAINS		
CAMPANIAN	84	REGRESSION	MONTANA GROUP	BEARPAW FORMATION	BEARPAW	
				OLDMAN FORMATION	OLDMAN	
				FOREMOST FORMATION	FOREMOST	Seal A
					BASAL BELLY RIVER SST	Target A
				PAKOWKI FORMATION	PAKOWKI	
				MILK RIVER FORMATION	MILK RIVER	
		SANTONIAN	87	TRANSGRES	NIOBRAR	FIRST WHITE SPECKS MEMBER
MEDICINE HAT MEMBER	MEDICINE HAT					

← 300 m

Cored intervals of caprock and target

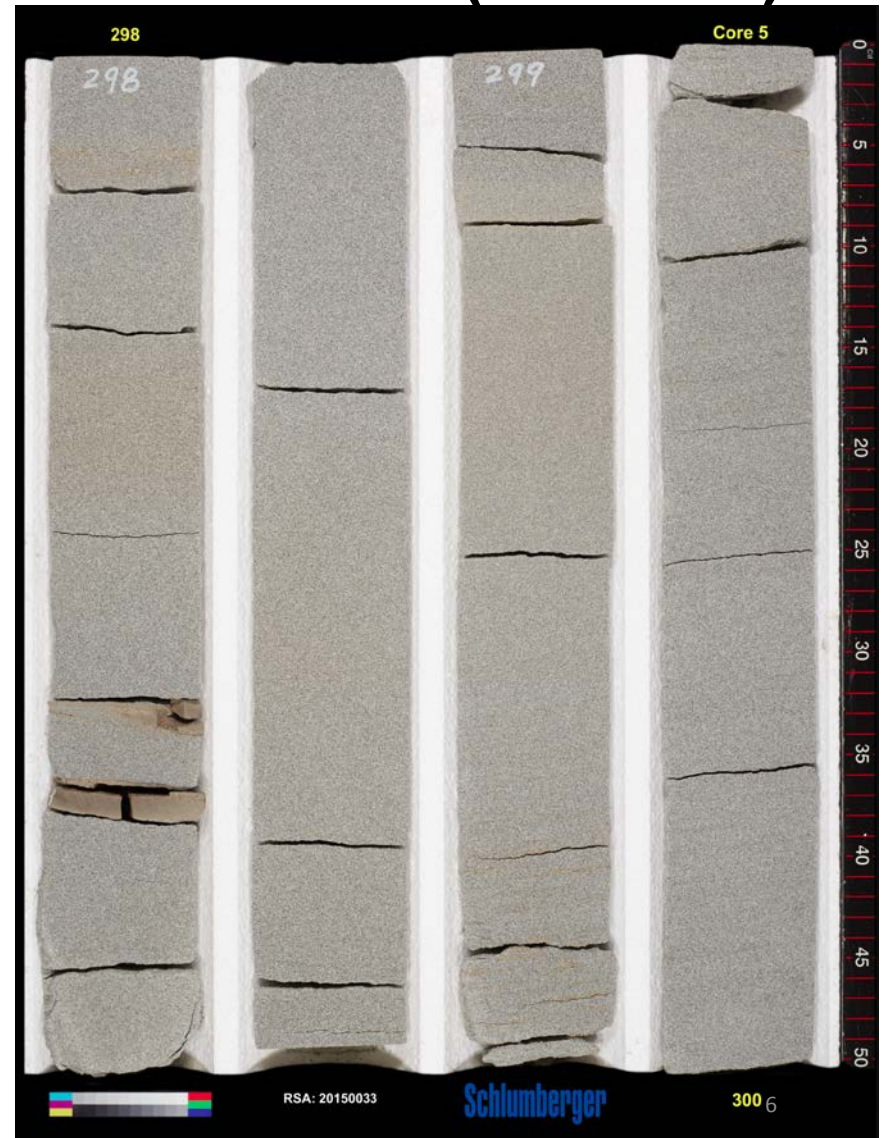
Cap Rock (152 m thick)

Reservoir (7 m thick)

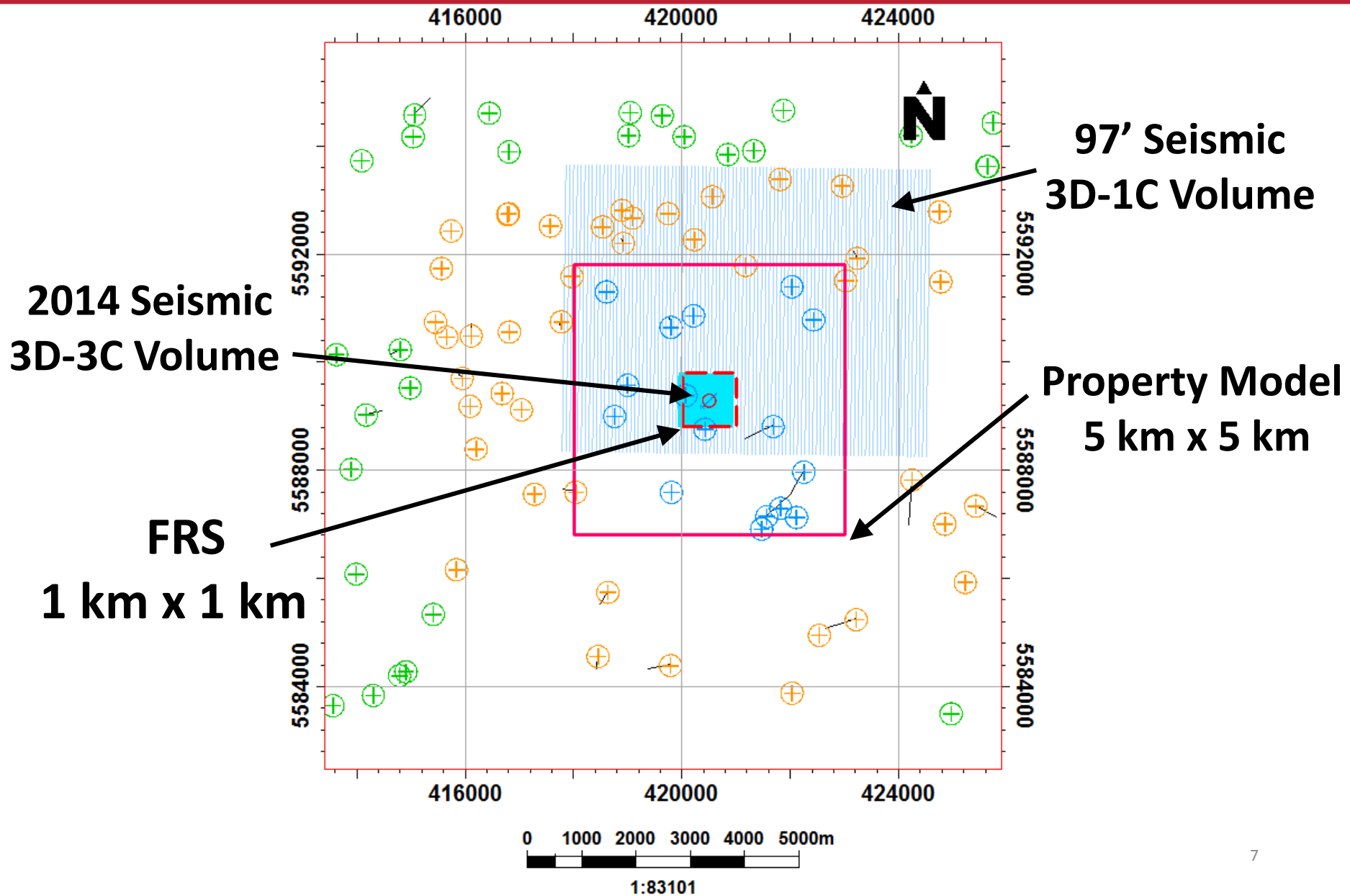
Marine Clays

Bioturbated Shales

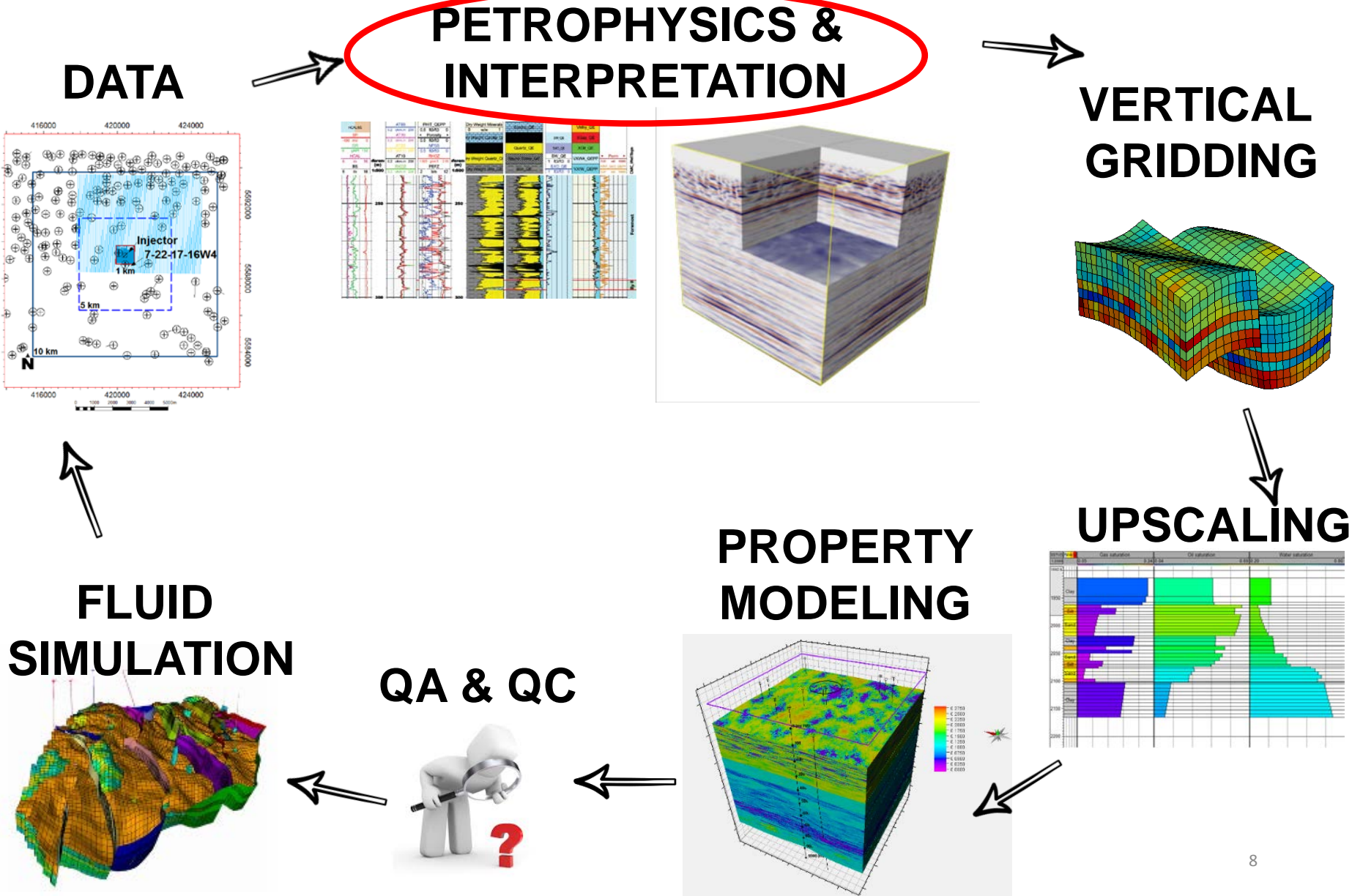
Coal



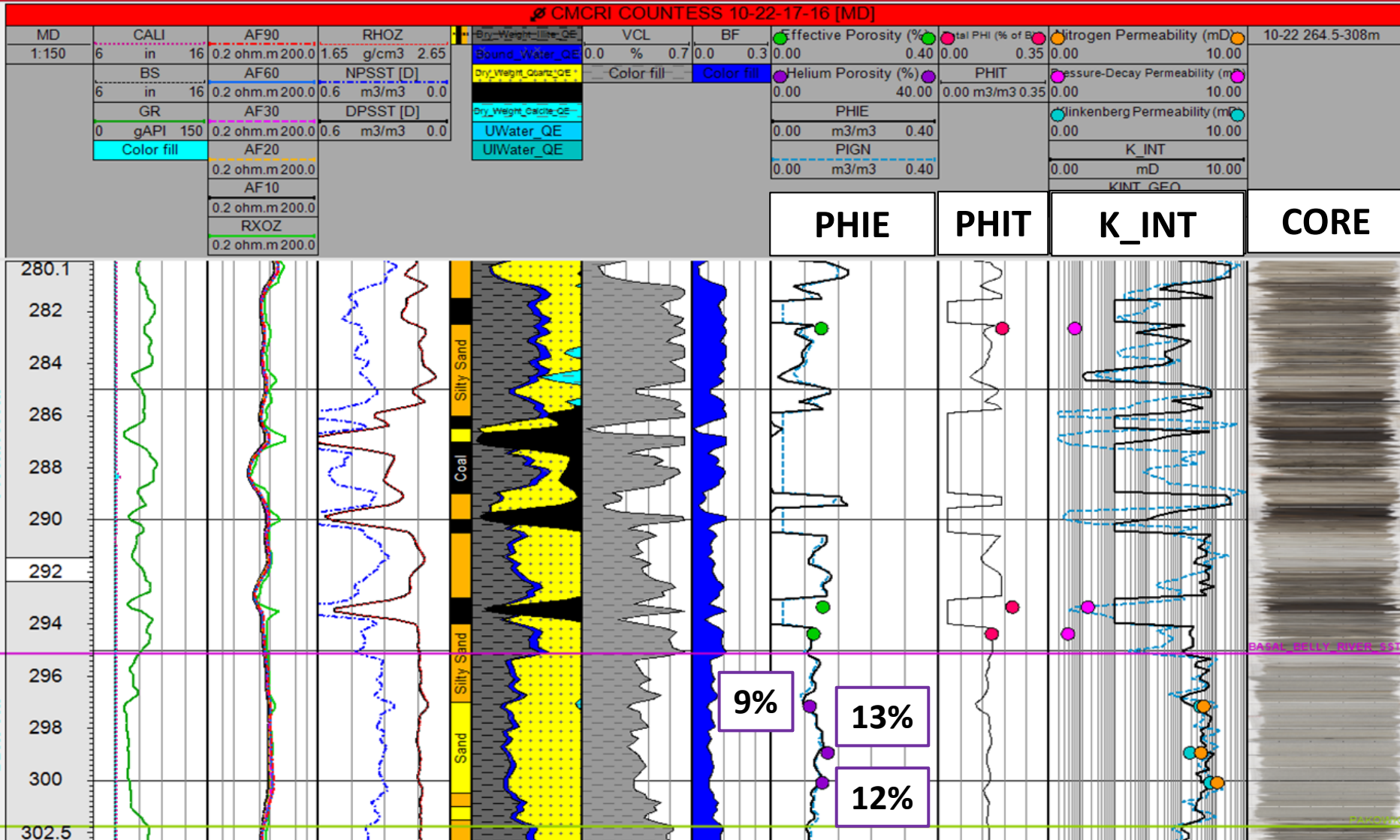
Geophysical & geological data input



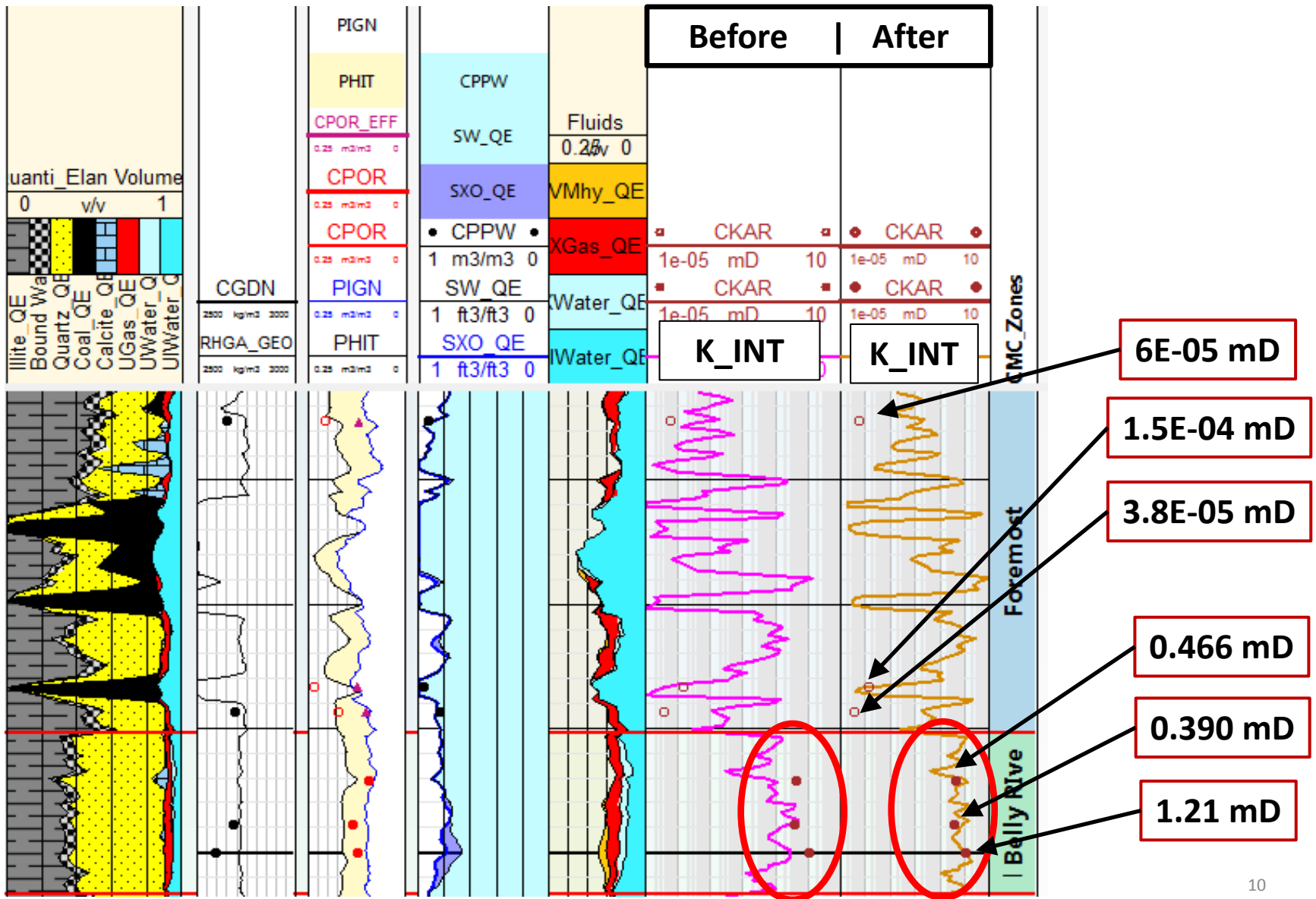
Model workflow



Baseline characterization - geological



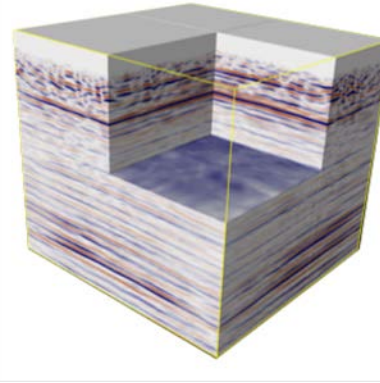
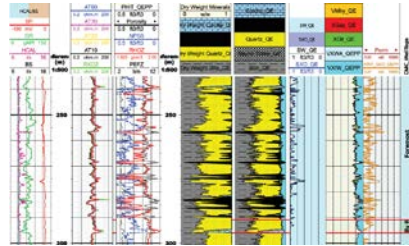
Log-to-core calibration



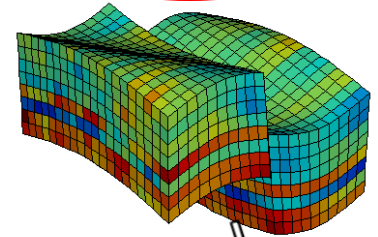
Model workflow

PETROPHYSICS & INTERPRETATION

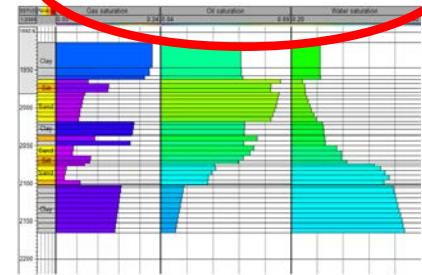
DATA



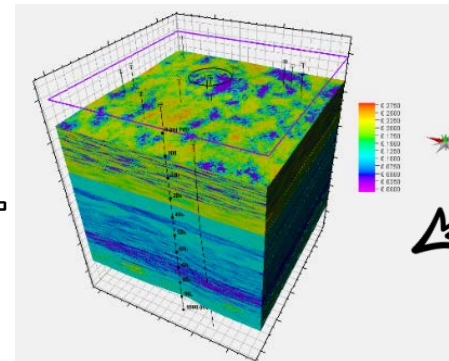
VERTICAL GRIDDING



UPSCALING



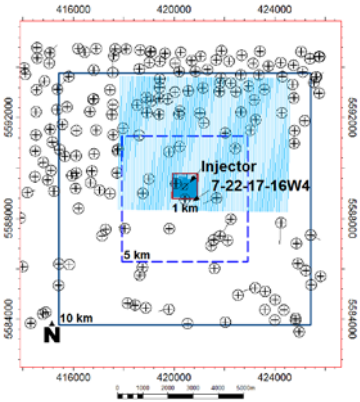
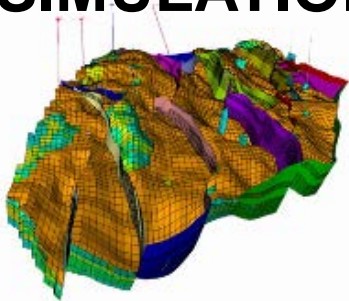
PROPERTY MODELING



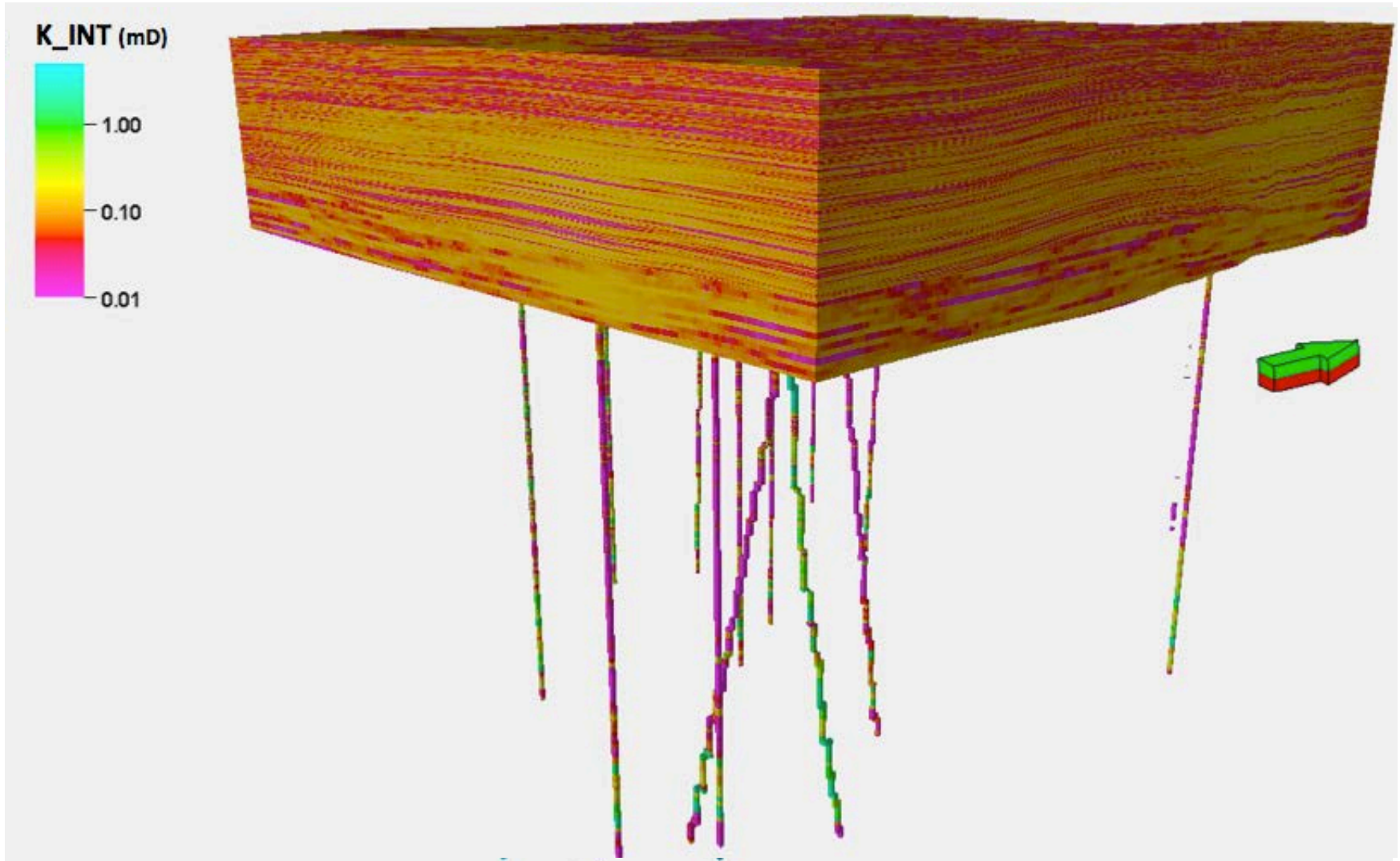
QA & QC



FLUID SIMULATION

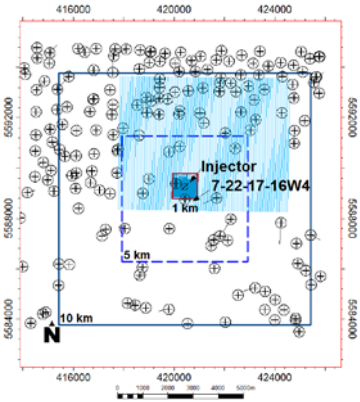


Geostatic model (PHIE & K_INT)

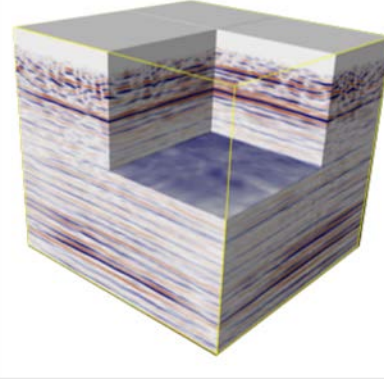
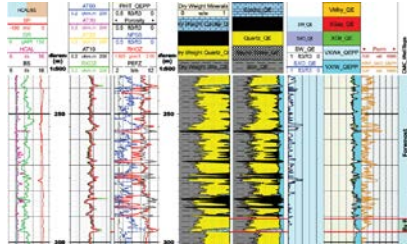


Model workflow

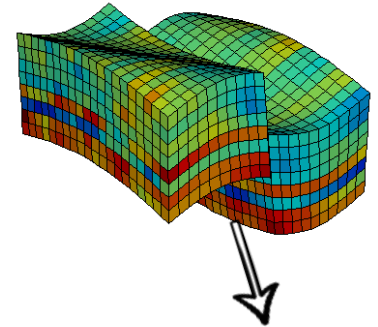
DATA



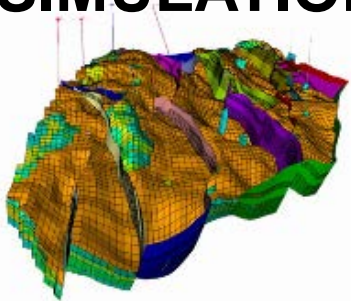
PETROPHYSICS & INTERPRETATION



VERTICAL GRIDDING



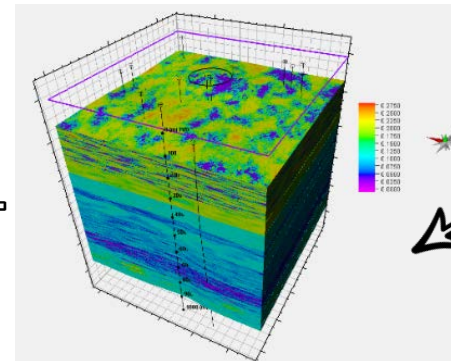
FLUID SIMULATION



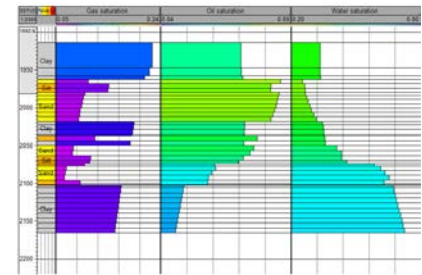
QA & QC



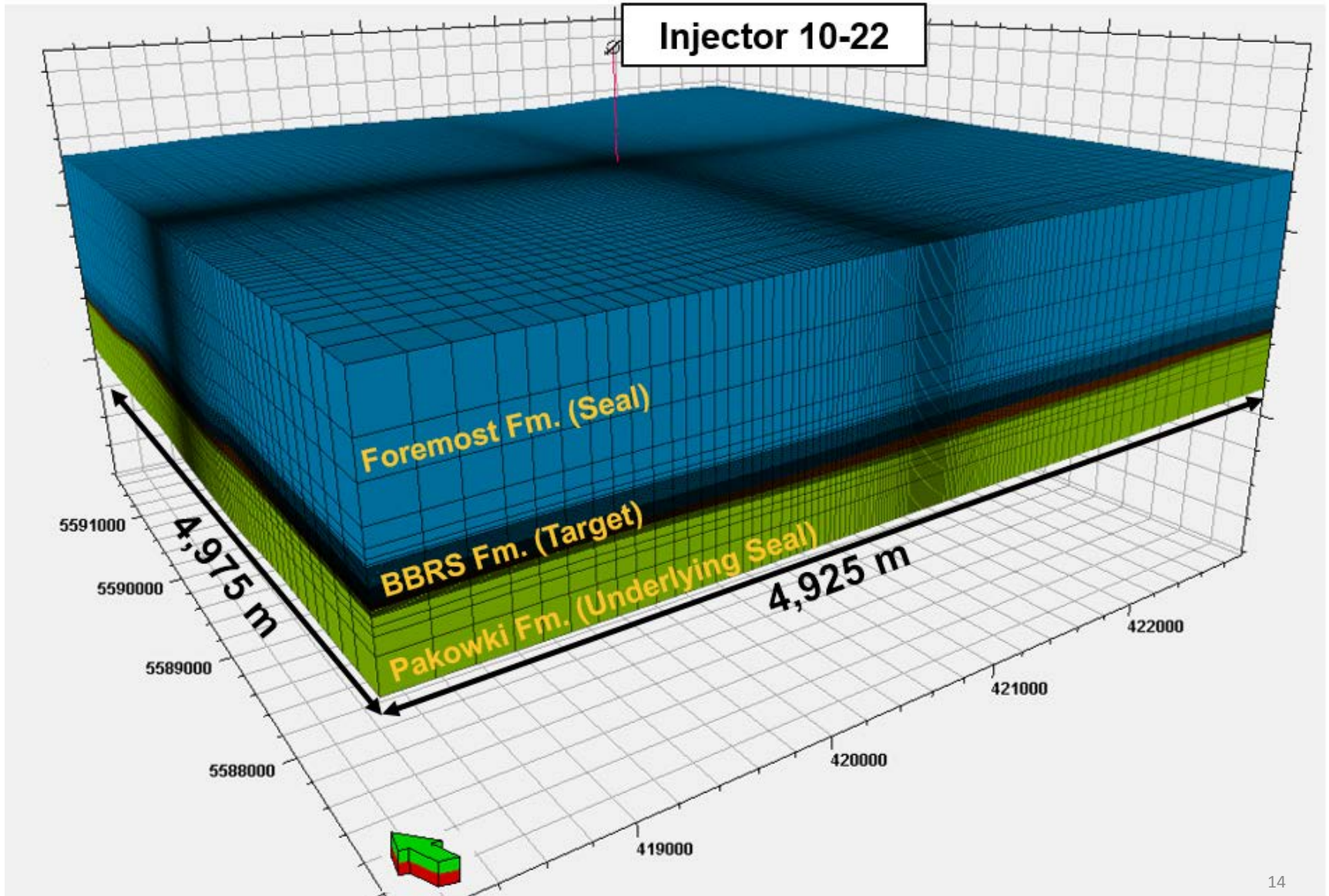
PROPERTY MODELING



UPSCALING



Dynamic Modeling

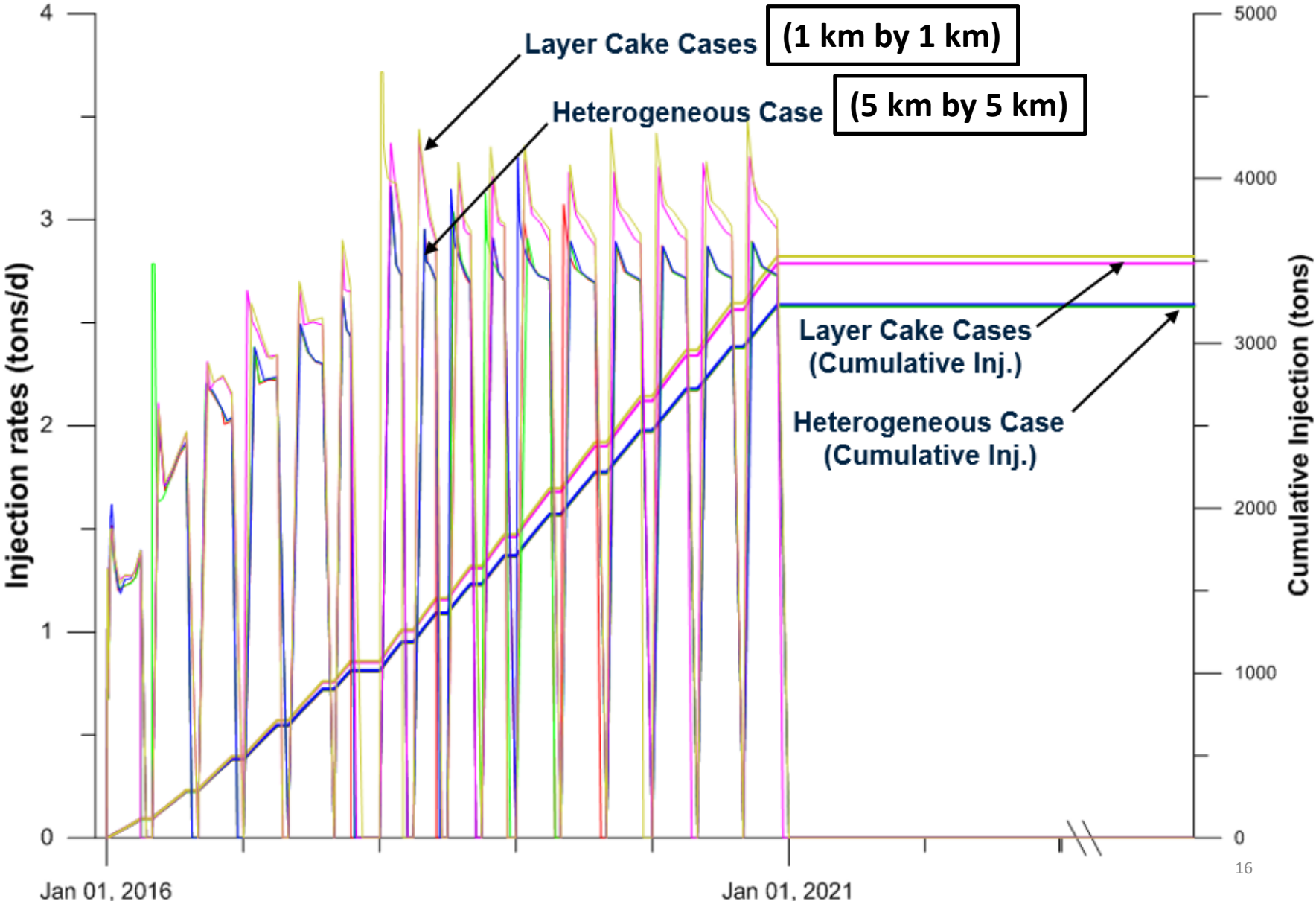


Fluid-flow simulation parameters

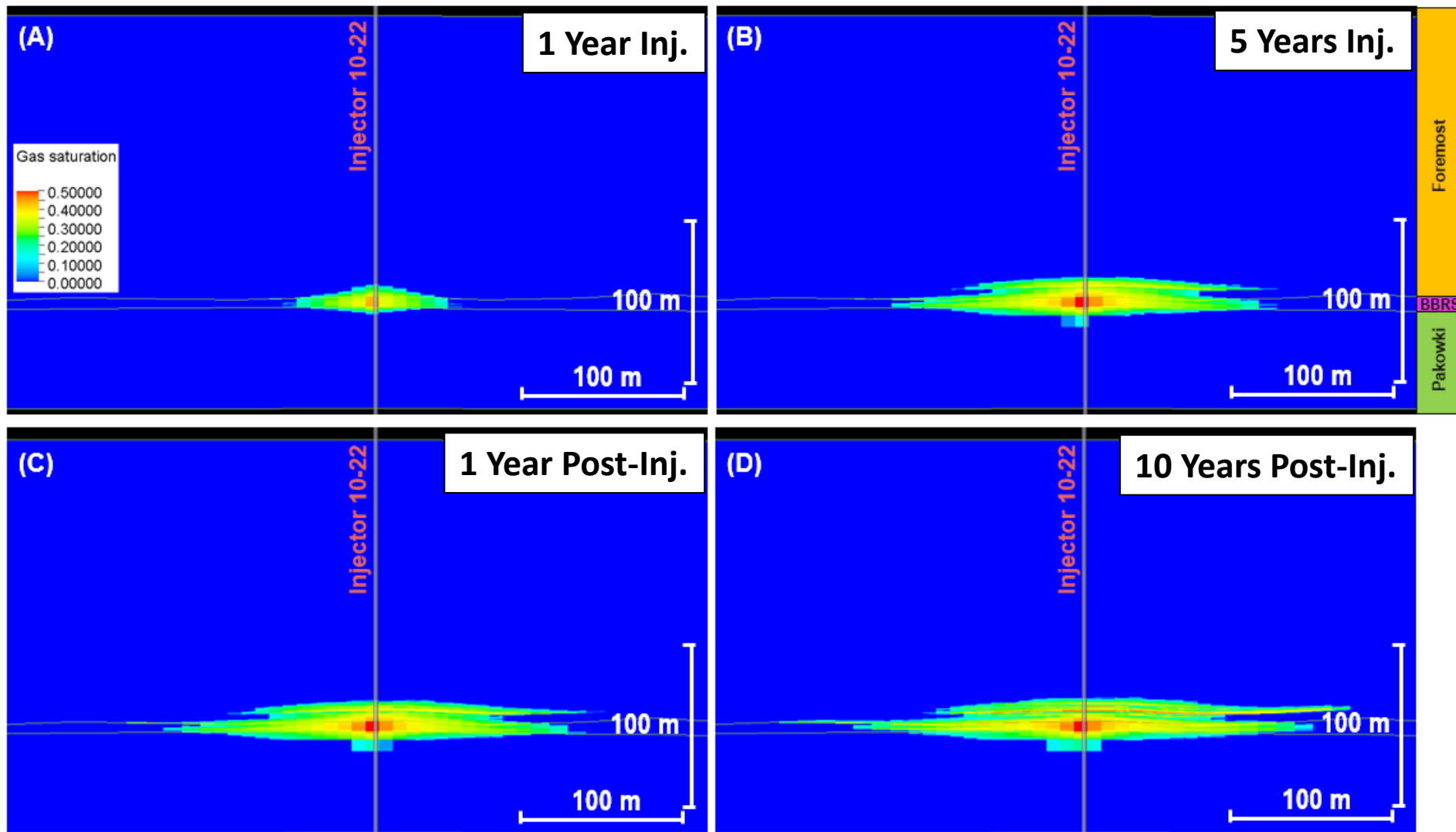
Parameter	Value
Pressure (reference datum) at 300 m depth	2.94 MPa
Reservoir temperature (isothermal)	20°C
Salinity	1,000 ppm
Rock compressibility (3 samples near 300 m)	4.18 E-04 (1/bar)
Maximum allowable BHP at 300 m depth	6.615 MPa
κ_v/κ_h	0.1
CO ₂ -water relative permeability	$S_{wmin}=0.5, \kappa_{rCO_2}=0.5$ (end-point gas κ_r)

Date	Injection Period	Shut-in Period
January 1, 2016 – October 14, 2017	3 months	1 month
October 15 – December 31, 2017	-	2.5 months
January 1 – December 31, 2018	2 months	1 month
January 1, 2019 – November 30, 2020	3 months	1 month

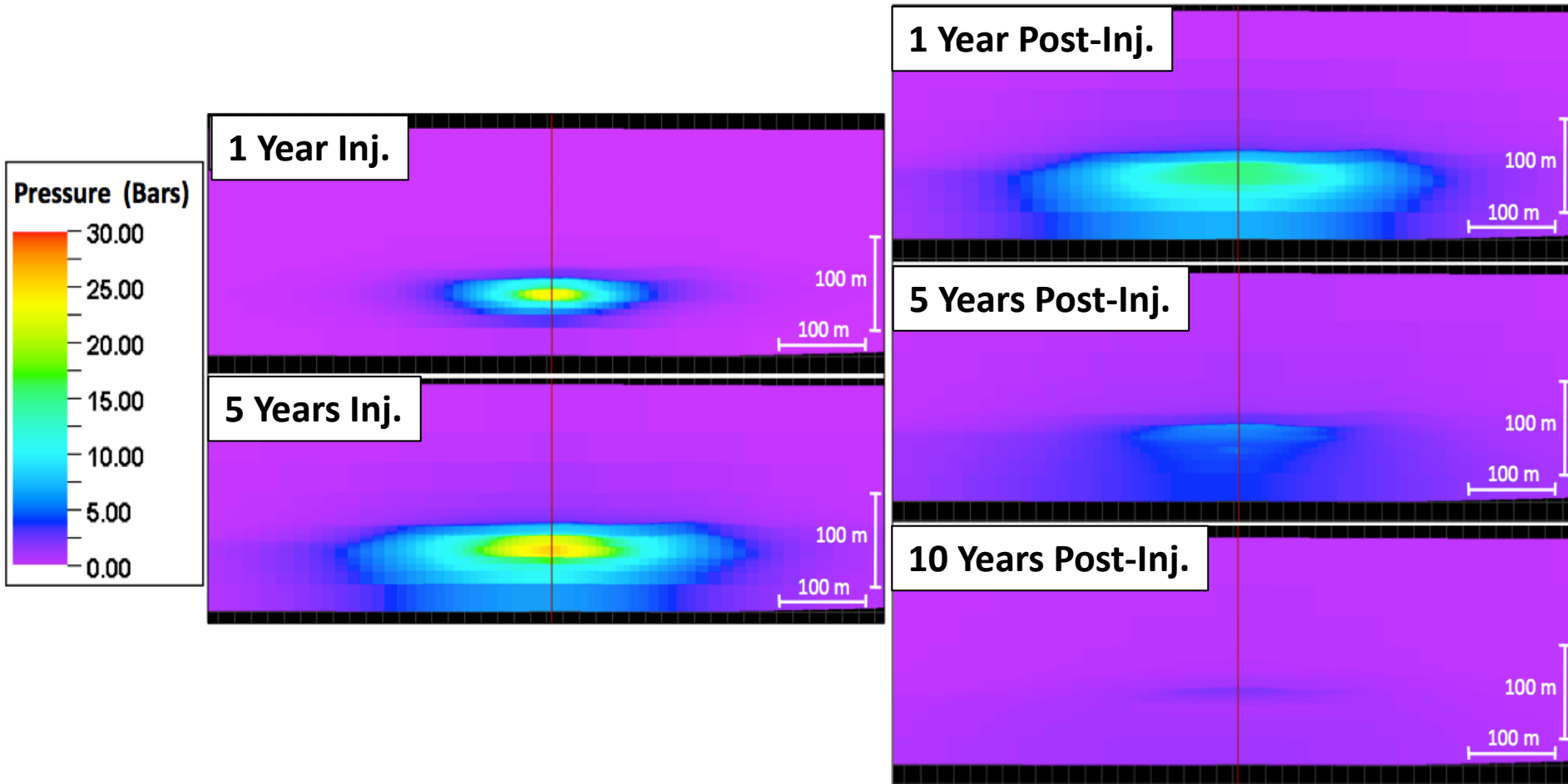
Fluid-flow simulation results



CO₂ plume behaviour – P50 case



Pressure plume differential – P50 case



Conclusions

- Developed 25 sq. km static geomodel
 - Geological and geophysical data, built-in workflows & mechanics
- Target A PHIE up to 11%, K_INT up to 0.57 mD
- Seal A complex, low K_INT up to 0.001 mD
- Fluid-flow simulations demonstrate containment of CO₂ plume in the target with minor vertical migration into seal A, totaling 3150t CO₂ over 5 years
- Pressure plume differential does not raise concern for breaching caprock, remains under 6.615 MPa maximum BHP
- Simulations best estimate of subsurface static and dynamic behaviour

Acknowledgements

- Carbon Management Canada
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Questions?

