Gravimetric monitoring for existing and future use (CCUS)

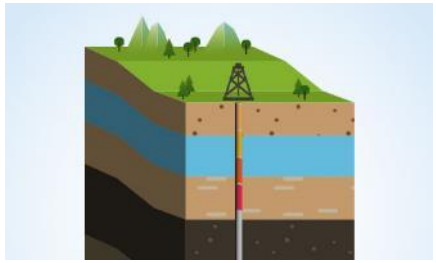
Dr Jez Lofts, Oct 27th

SILICONMICROGRAVITY

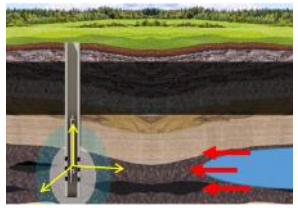
Potential for 4D time-lapse gravity for CCUS monitoring: CO2 plume growth

- Few techniques exist to map subsurface fluid movements 100's ft/m around a wellbore and cost effectively!
  - Near wellbore - Pulsed neutron/fiber optic
  - From surface - 4D seismic, *indirect* velocities

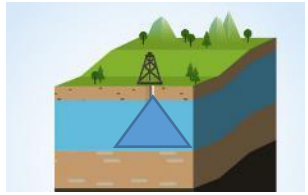
- Potential for gravity measurement to fill this gap,
  - As a *direct,* in reservoir, far-field measurement
  - Monitor CO2 plume growth



Subsurface fluid substitution



Flood-front prediction



Monitoring Water coning

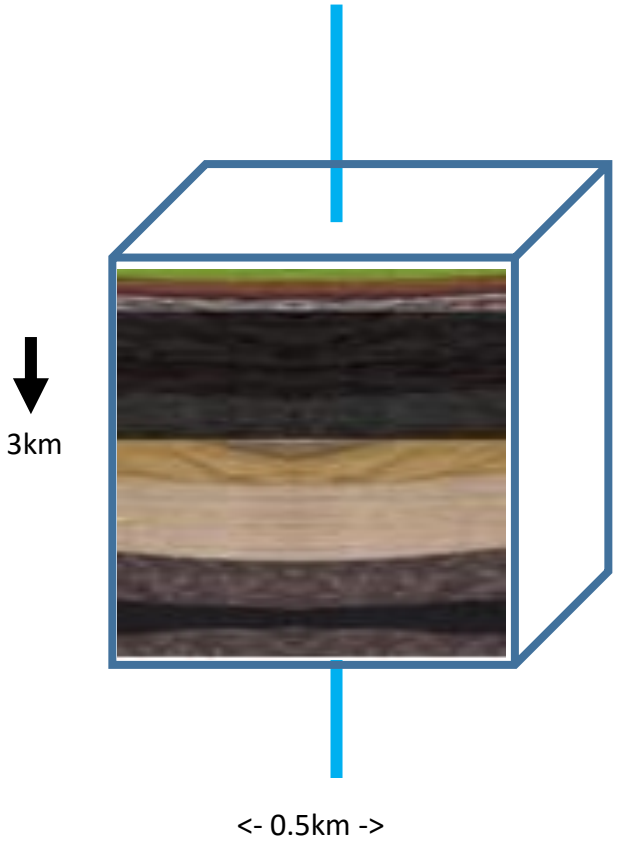
CO2 plume monitoring

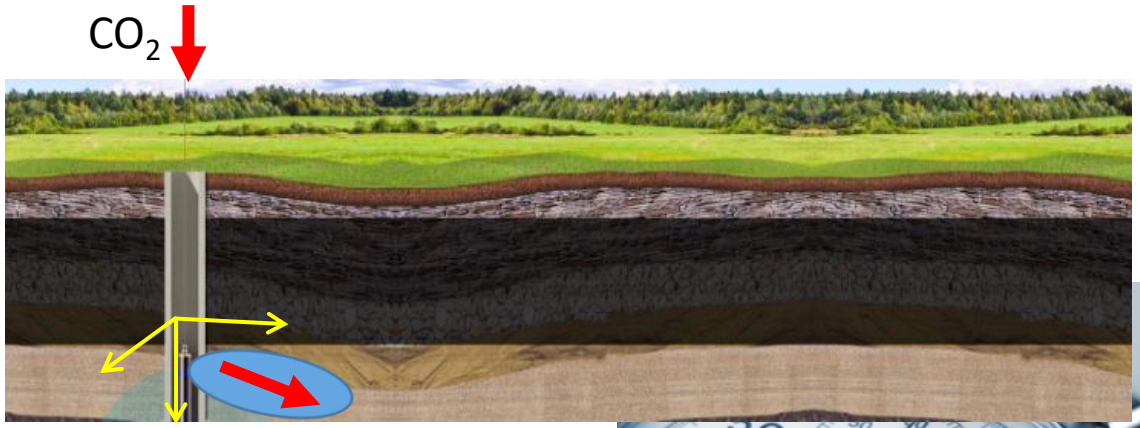
O&G reservoir surveillance

CCUS surveillance

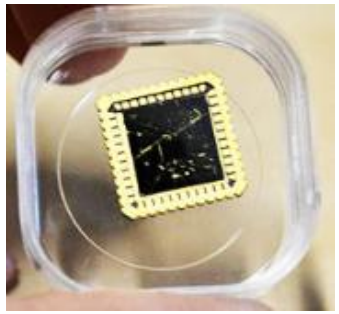
Premise of 4D Time-lapse gravity

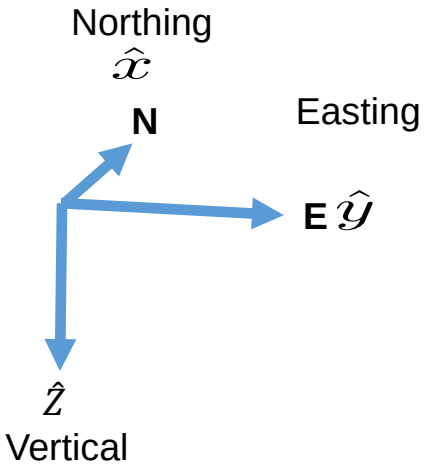
- Difference over time is directly proportional to density change
  - Fluid substitution of reservoir fluids (oil, gas, water or CO2)
- 3-axes would allow directional information





Emerging Wireline Borehole Gravity Technology





Highly sensitive MEMS accelerometer

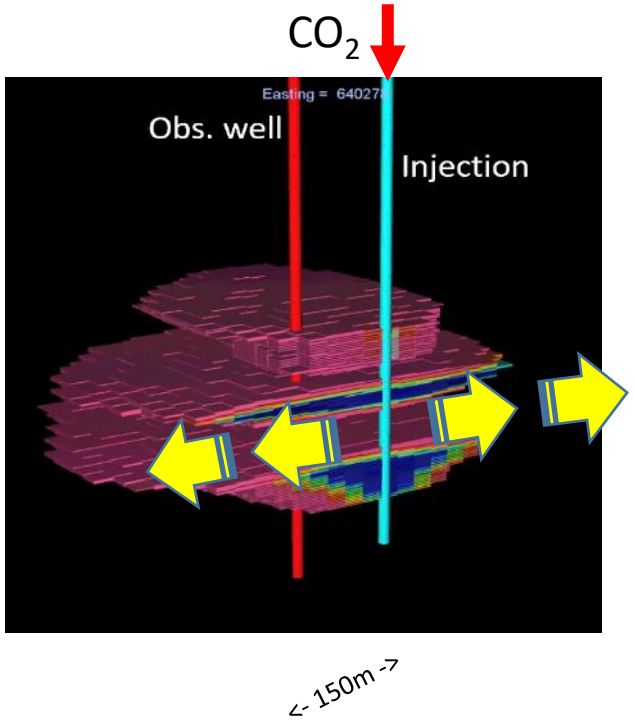
- Ultimate resolution of approx. Billionth Earth's gravity
- Developing world first, 3-axis arrangement
- 'Slim' wireline deployment
- Similar data workflows to seismic

	Target Specifications
Diameter OD	2-1/8" (54mm)
Temp. / Press.	125°C / 15,000 psi
Gravity Sensor	3-axis, resolution <10μGal

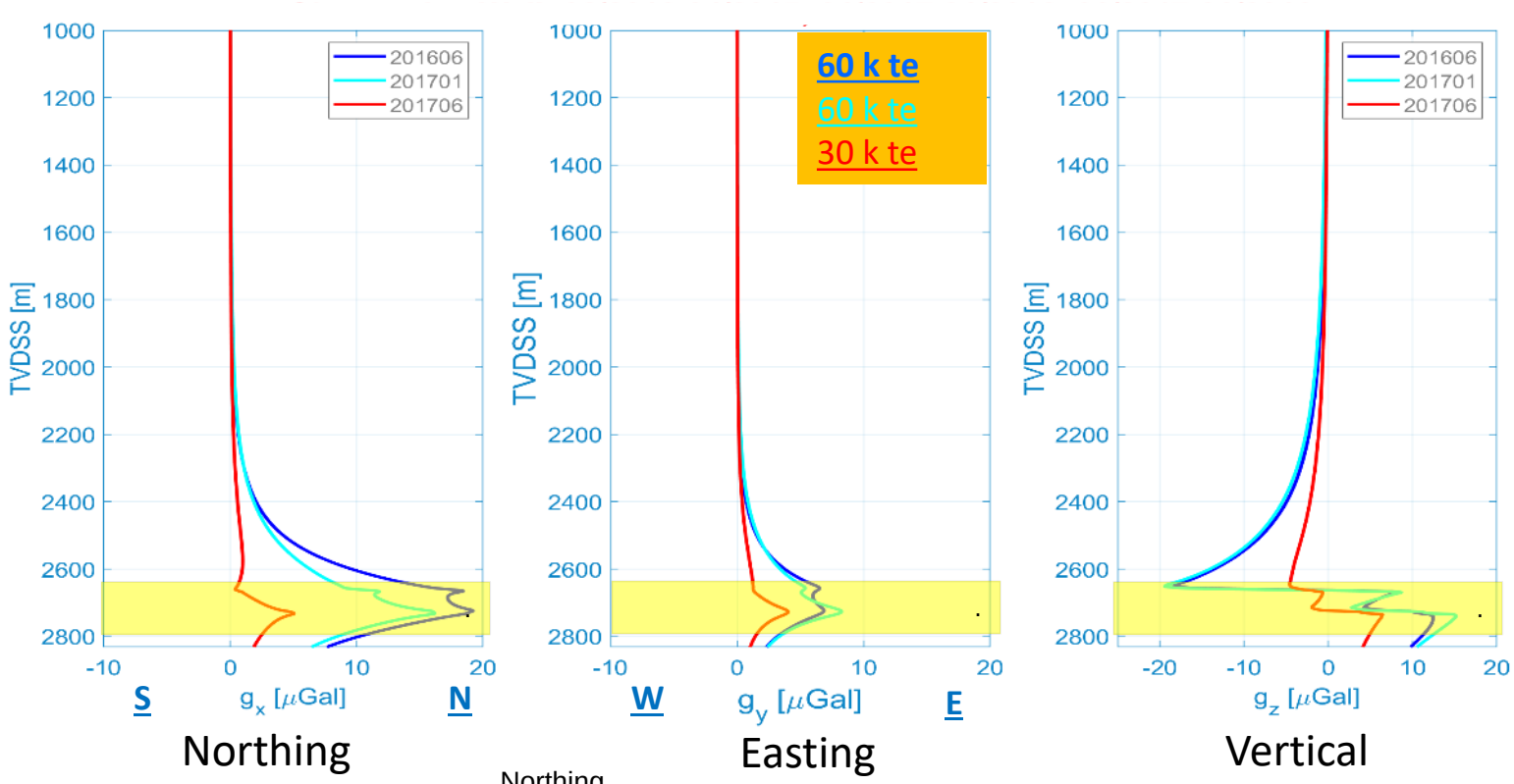
SPE 194845 • Lofts et al.

4D gravity time-lapse, CO_2 Plume injection feasibility modelling

Aquistore Project, Canada, Zone 1 ~2620m



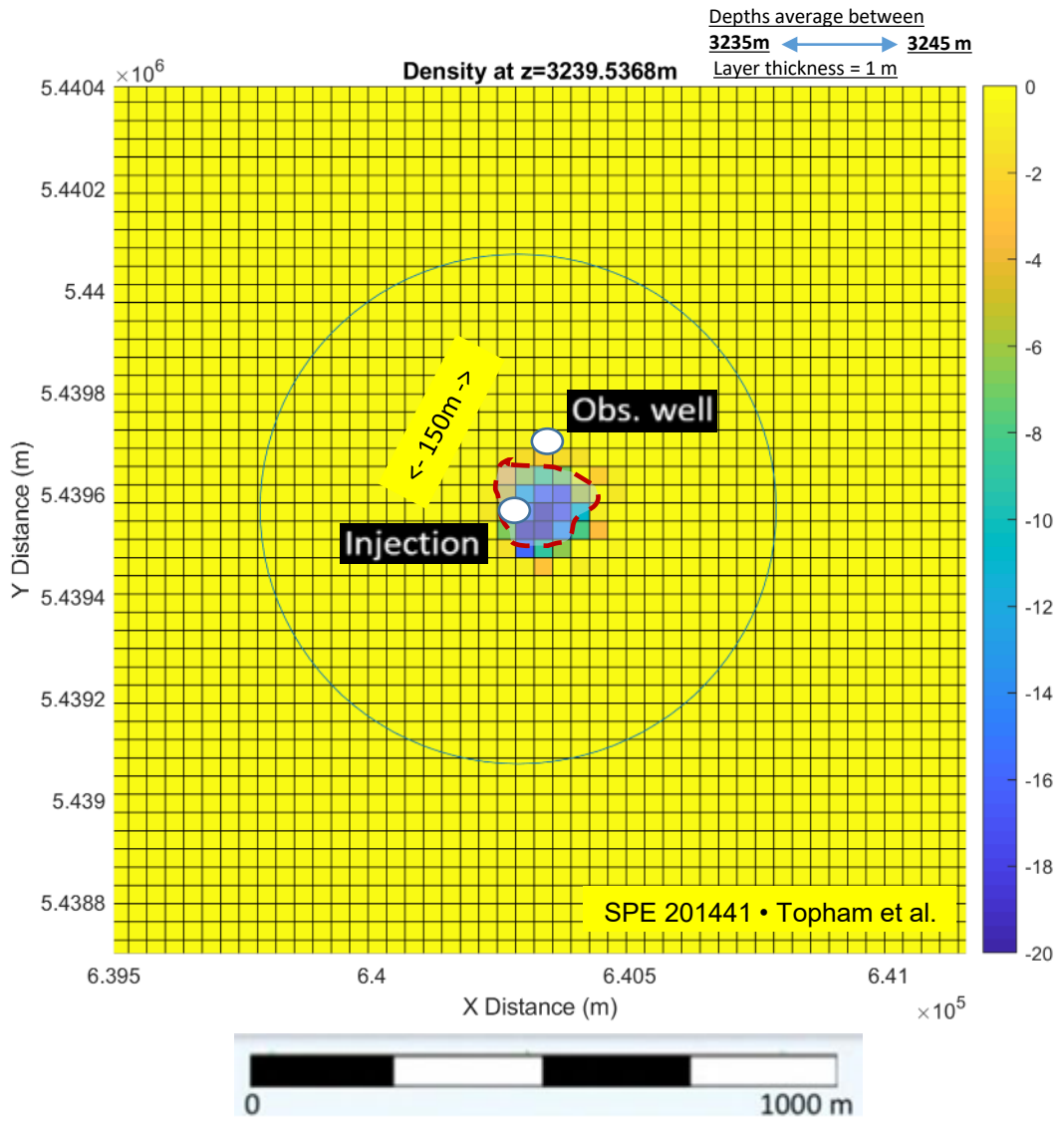
- Measurable response (~ 20 µGal) from CO_2 replacing water over 12 months
- NE anomaly

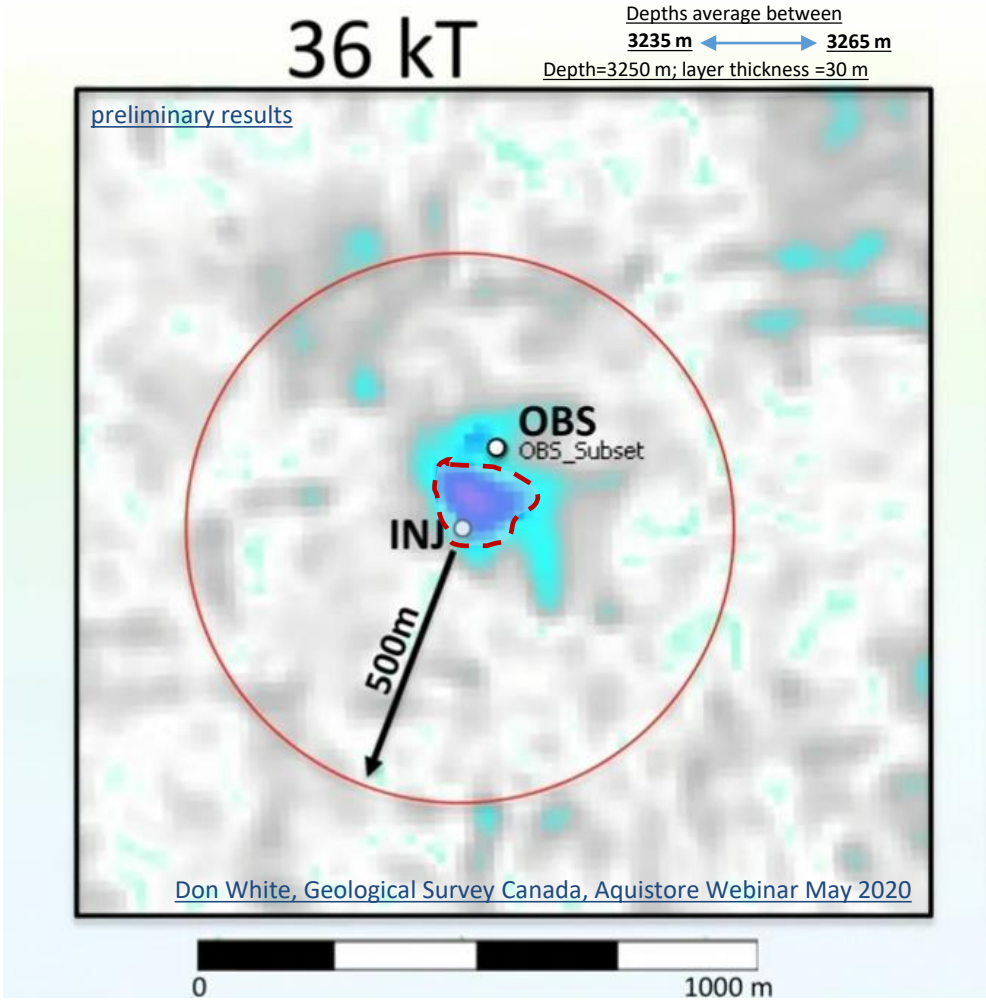


SPE 201441 • Topham et al.

Gravity model map of fluid density change after **9 months** injection

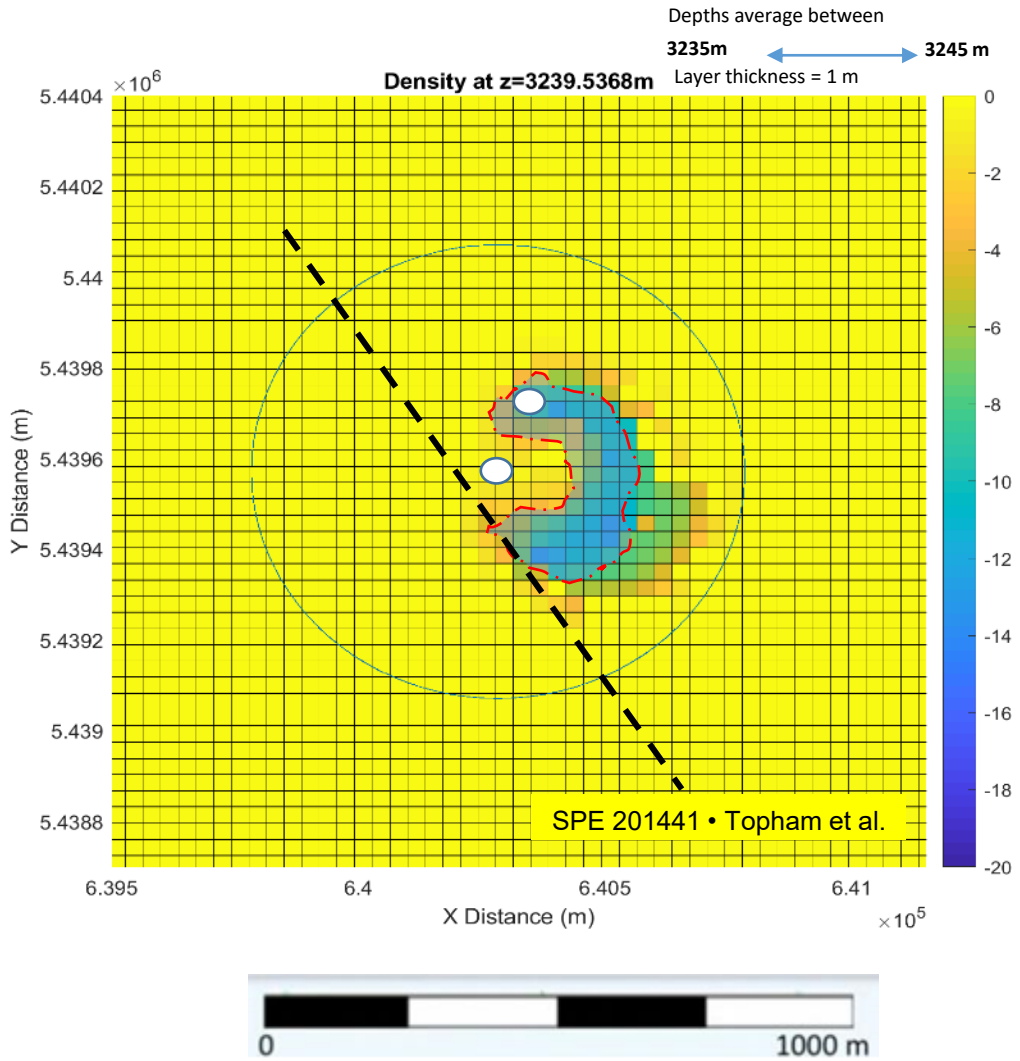
Zone 2, ~3238m, CO_2 plume at 02/2016, **36kT injected**

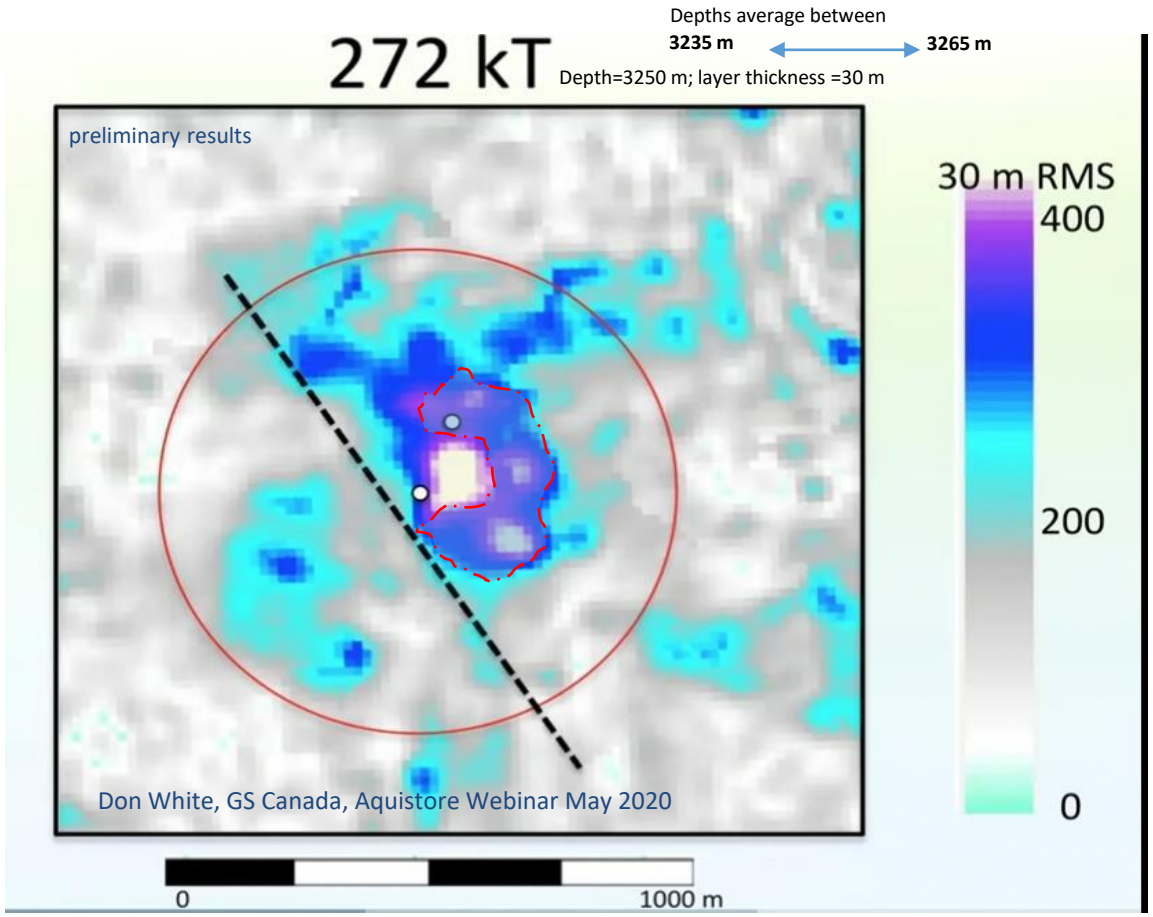




Gravity model of fluid density change after **18 months** injection

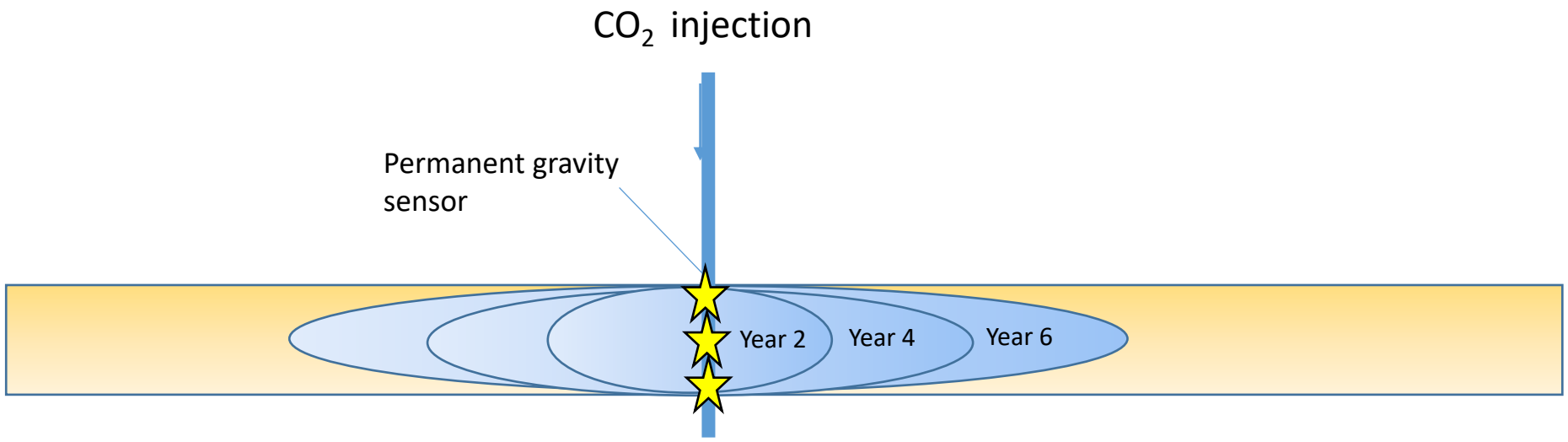
Zone 2, ~3238m, CO_2 plume at 01/2020, **272kT injected**





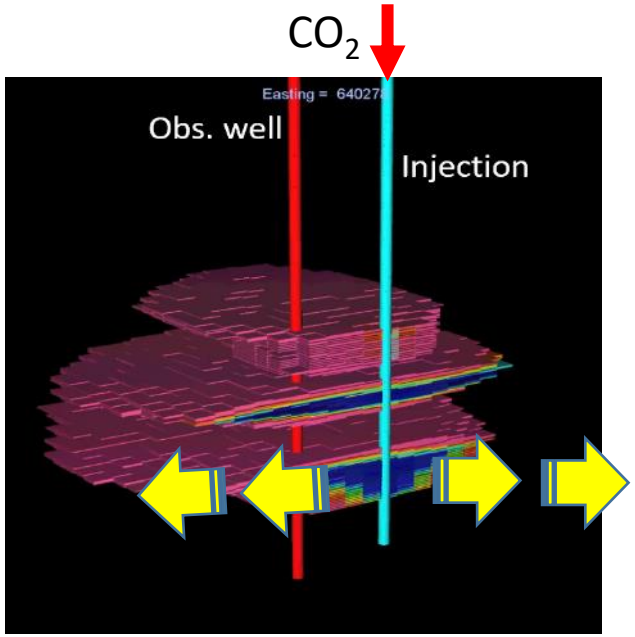
Future Value of 4D gravity time-lapse: ‘Permanent monitoring’

- Opportunity to install in a smart completion
- Life-of-well monitoring of movement of fluids 100’s m from the wellbore



Summary:

- Potential for 4D time-lapse gravity for CCUS monitoring:
  - Deep reading time-lapse measure of fluid substitution
- Complement & fill the gap between near-wellbore logs & 4D seismic, cost effectively!
- Slim wireline deployed, potential for permanent completion
- Field trials ongoing, commercial 2022



SMG references:

http://silicong.com/references.html

info2020@siliconG.com

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