



ELECTRIC TRIASSIC

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Force seminar Triassic Park
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Spot the difference.

Content

ELECTRIC

The 3D CSEM method

Exploration solution

Non-Triassic case examples

ELECTRIC TRIASSIC

Snadd channels

Seismic challenge

Integration of seismic and CSEM



Electric

Spot the difference.

Marine EM / CSEM method

Passive source (MT)

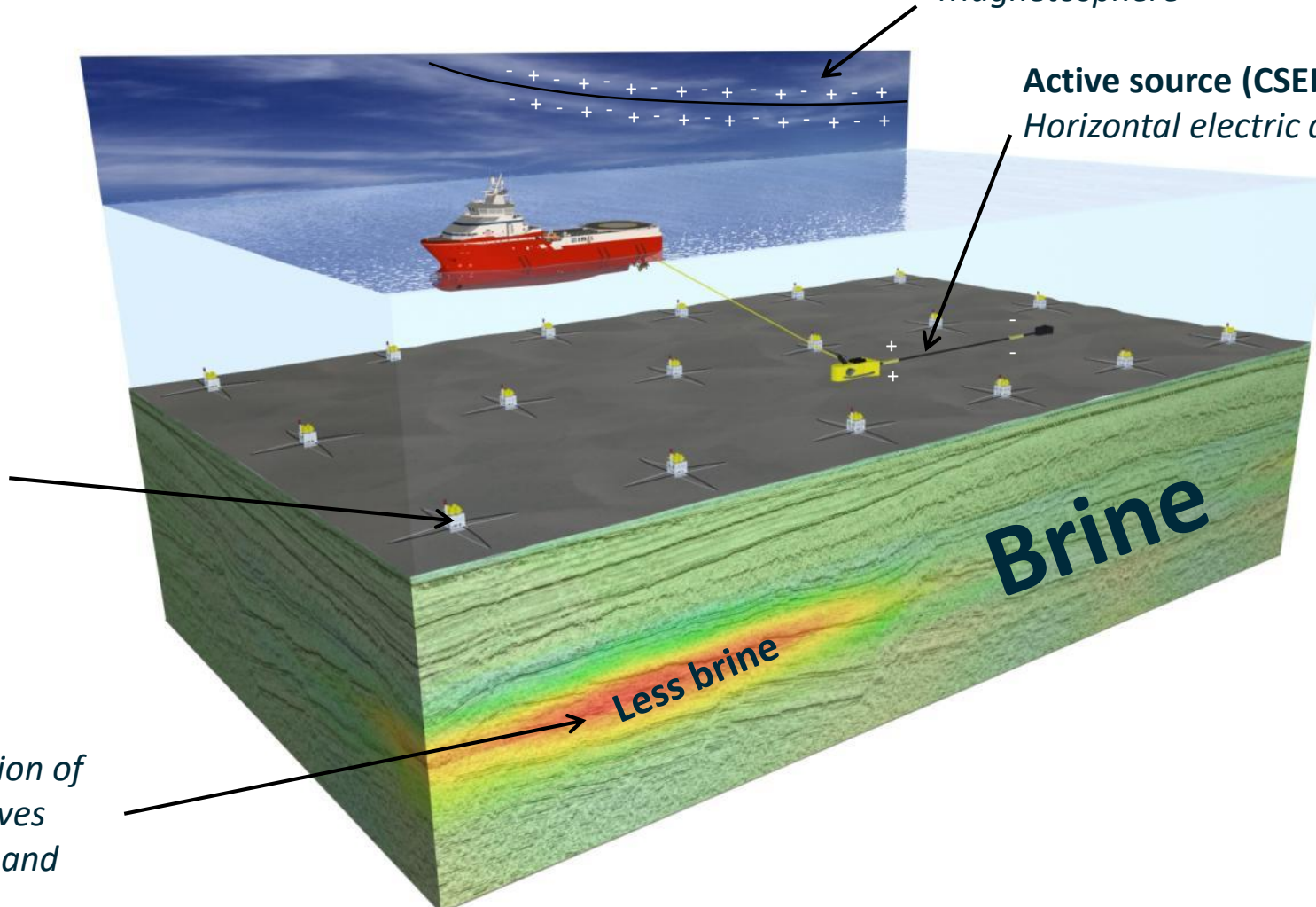
Natural EM field generated by the interaction of solar wind with the Magnetosphere

Active source (CSEM)

Horizontal electric dipole (HED)

Multi-component EM seabed receiver
Electric and magnetic field sensors

Result
Integrated interpretation of seismic and EM improves exploration outcomes and reduces risk

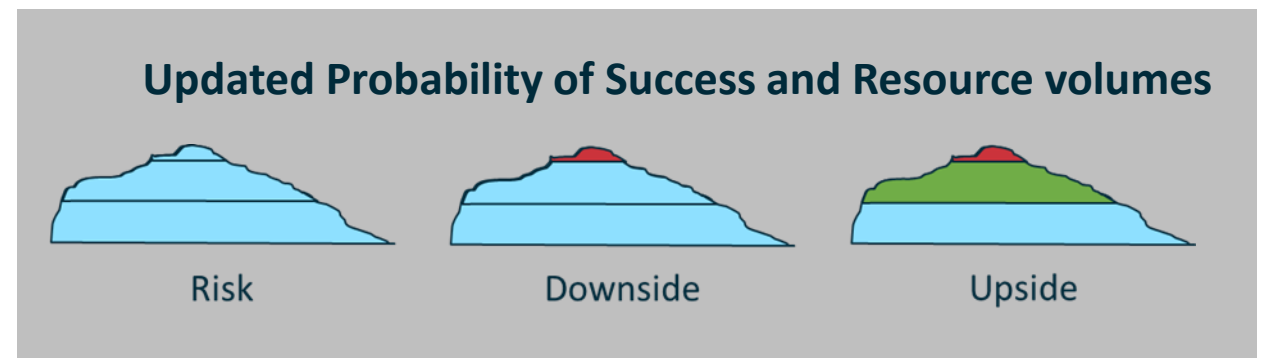
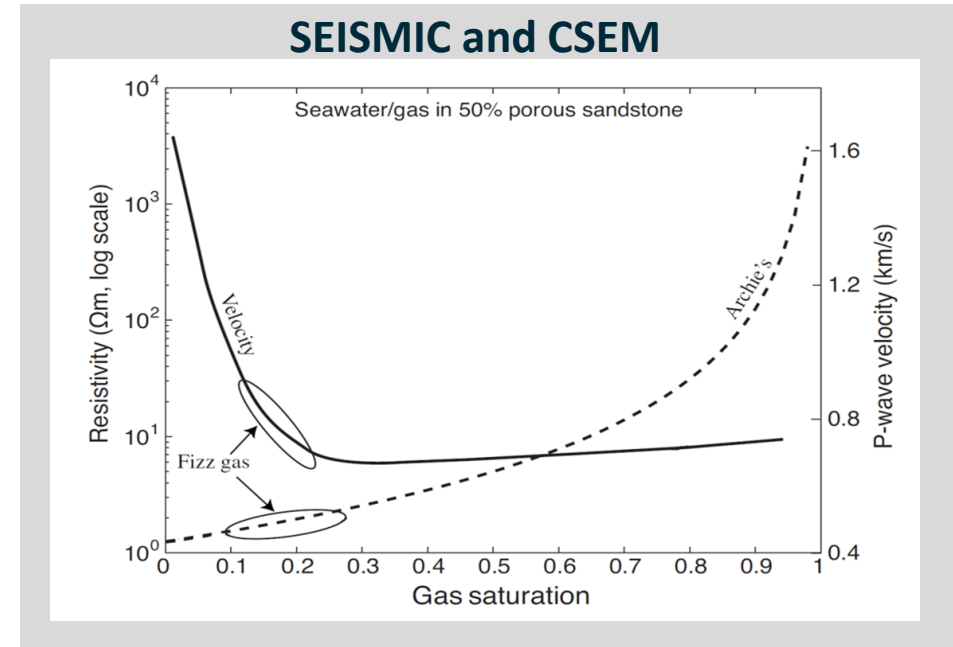
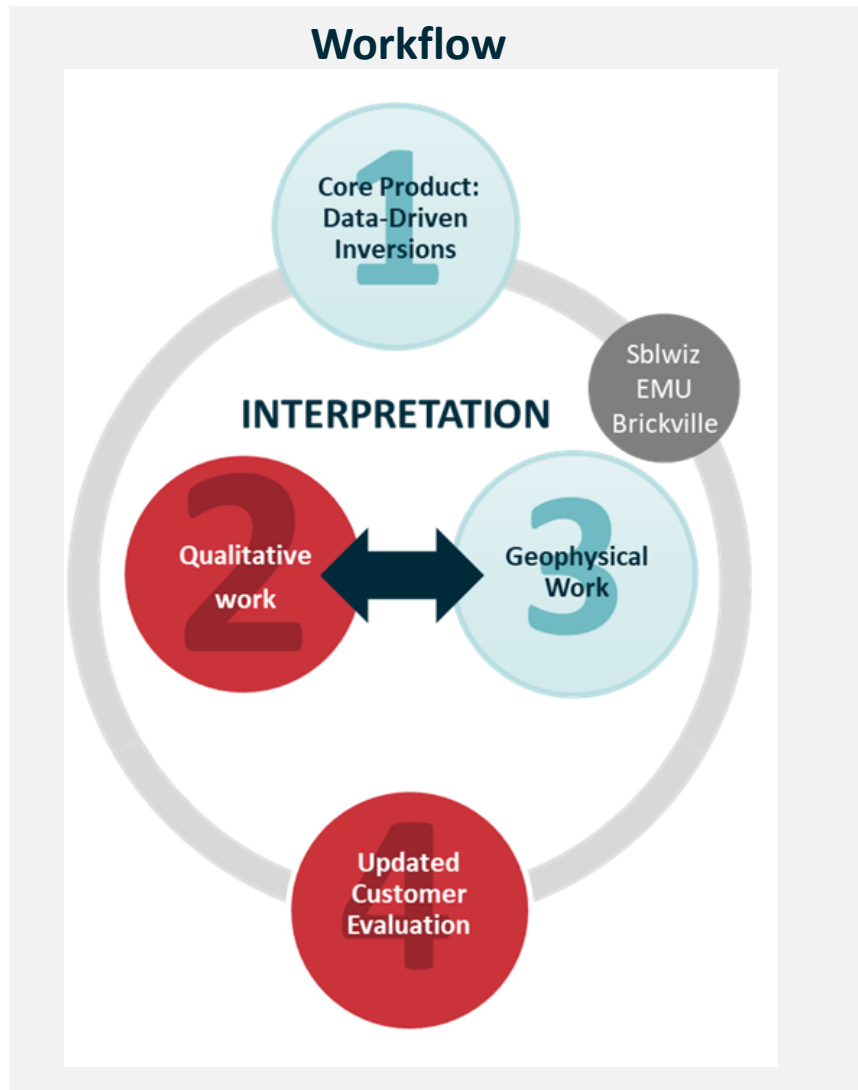


Acquisition
Water depth
~ 10 – 3500m

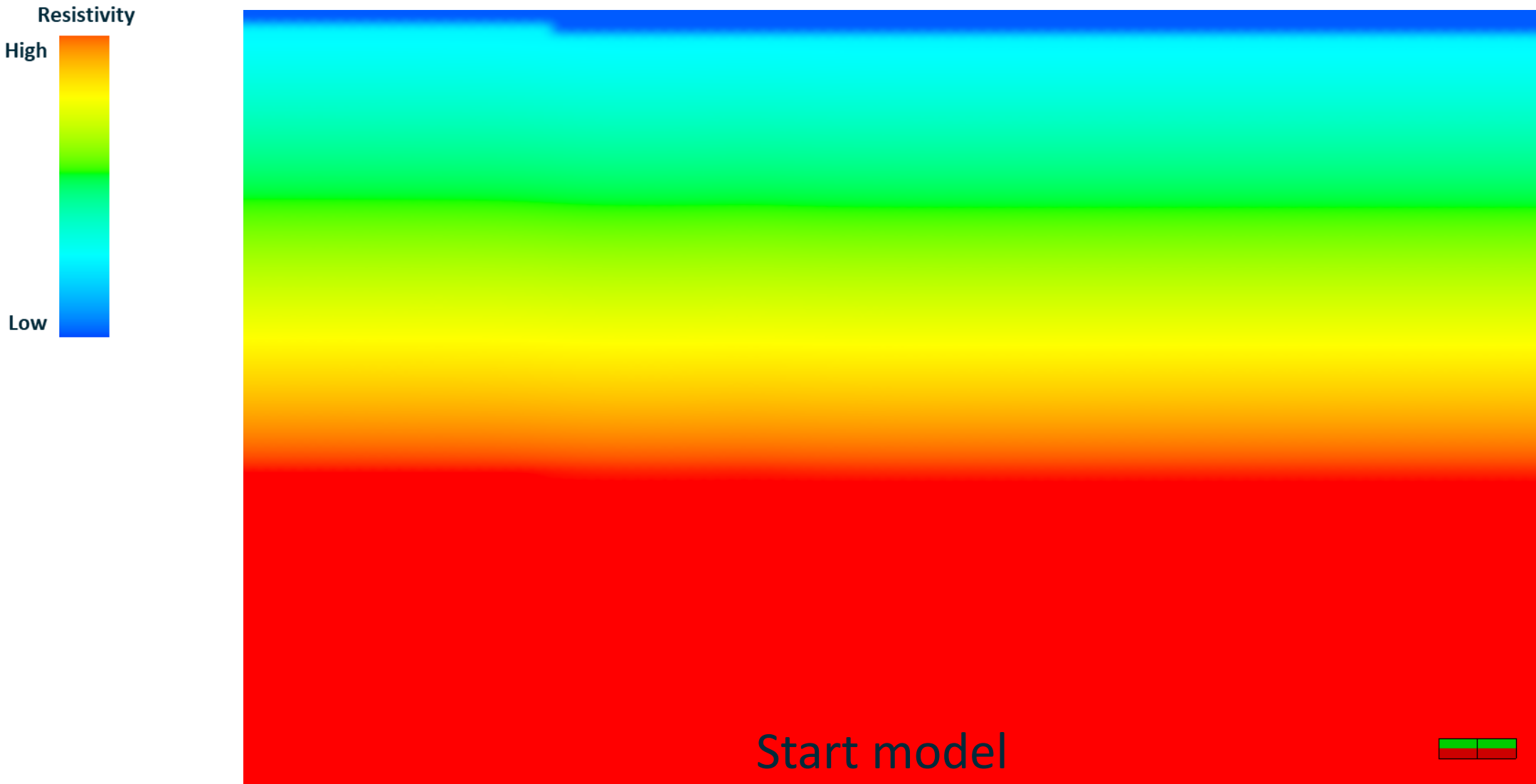
CSEM sensitivity
Typically 0 – 4000 m BML
(mainly depending of size of target)

MT sensitivity
0 – 15000m
BML

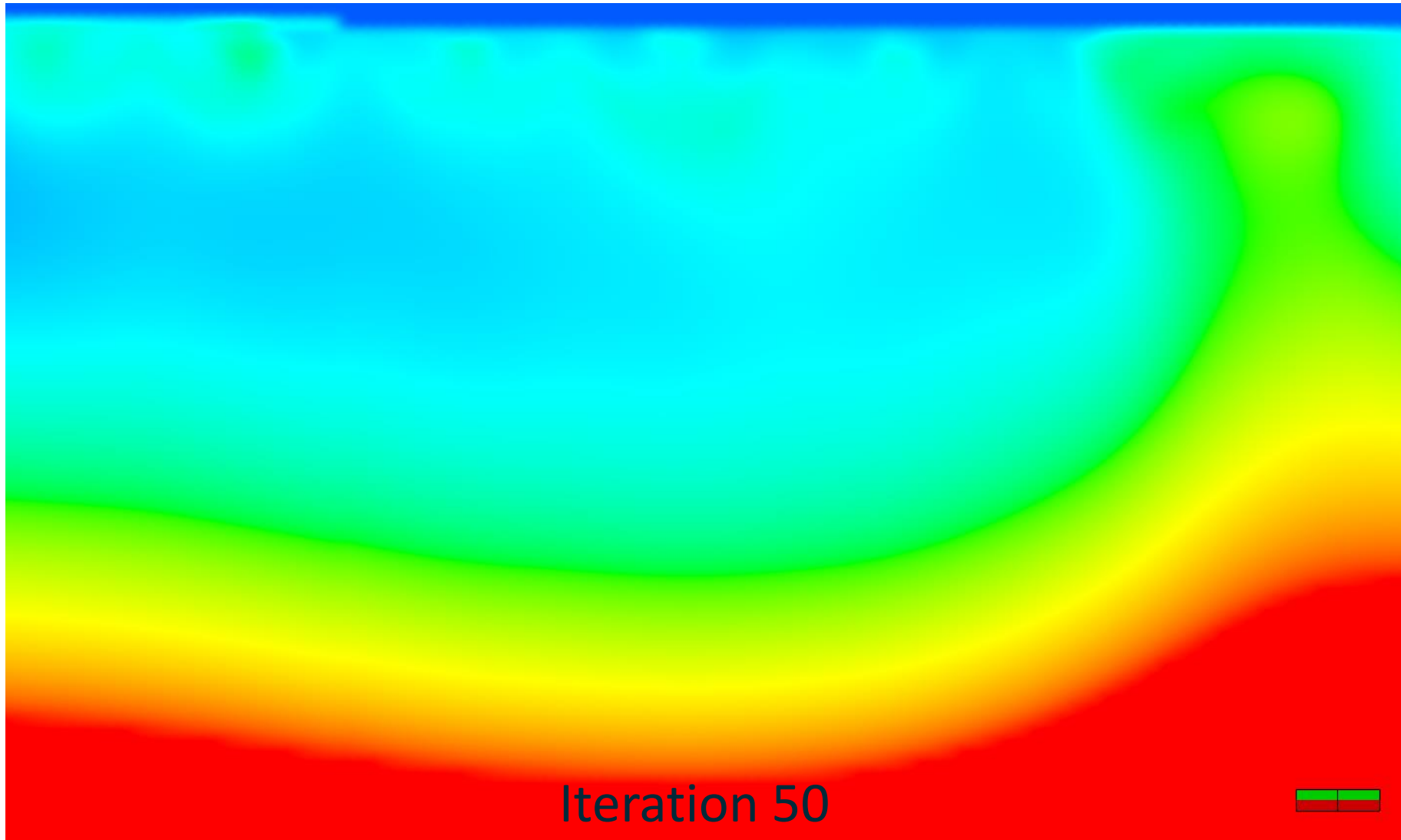
Exploration solution



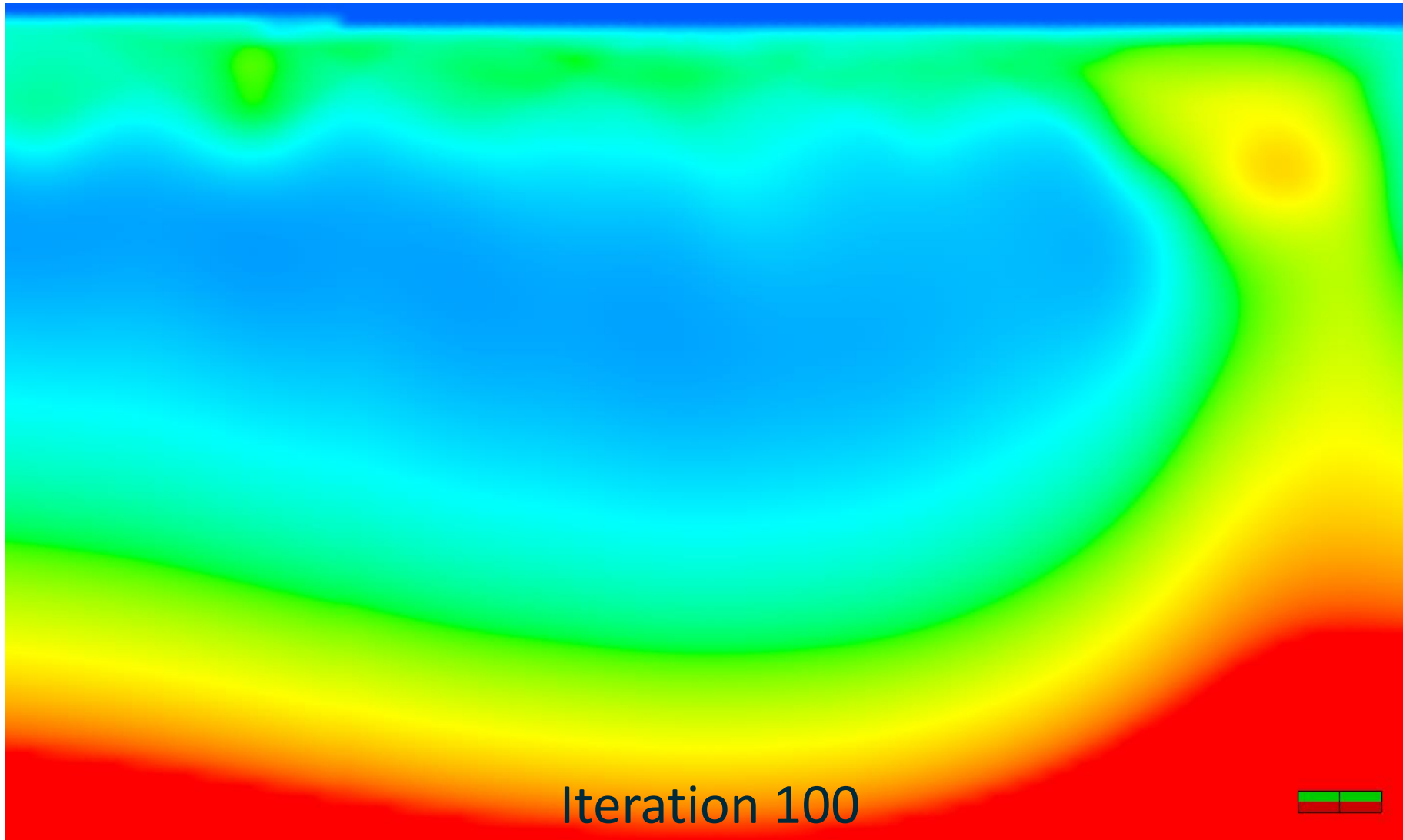
3D CSEM is measuring geology



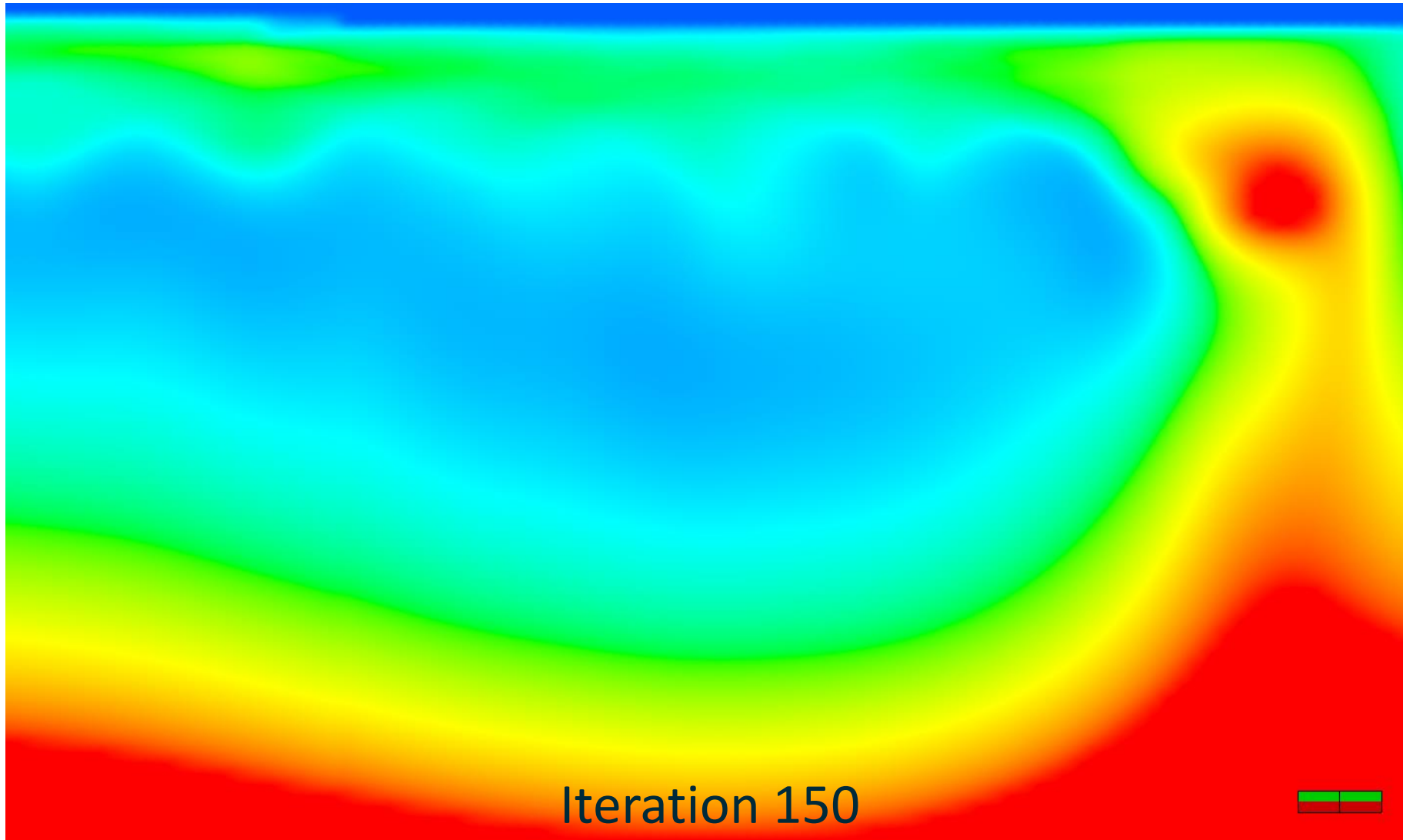
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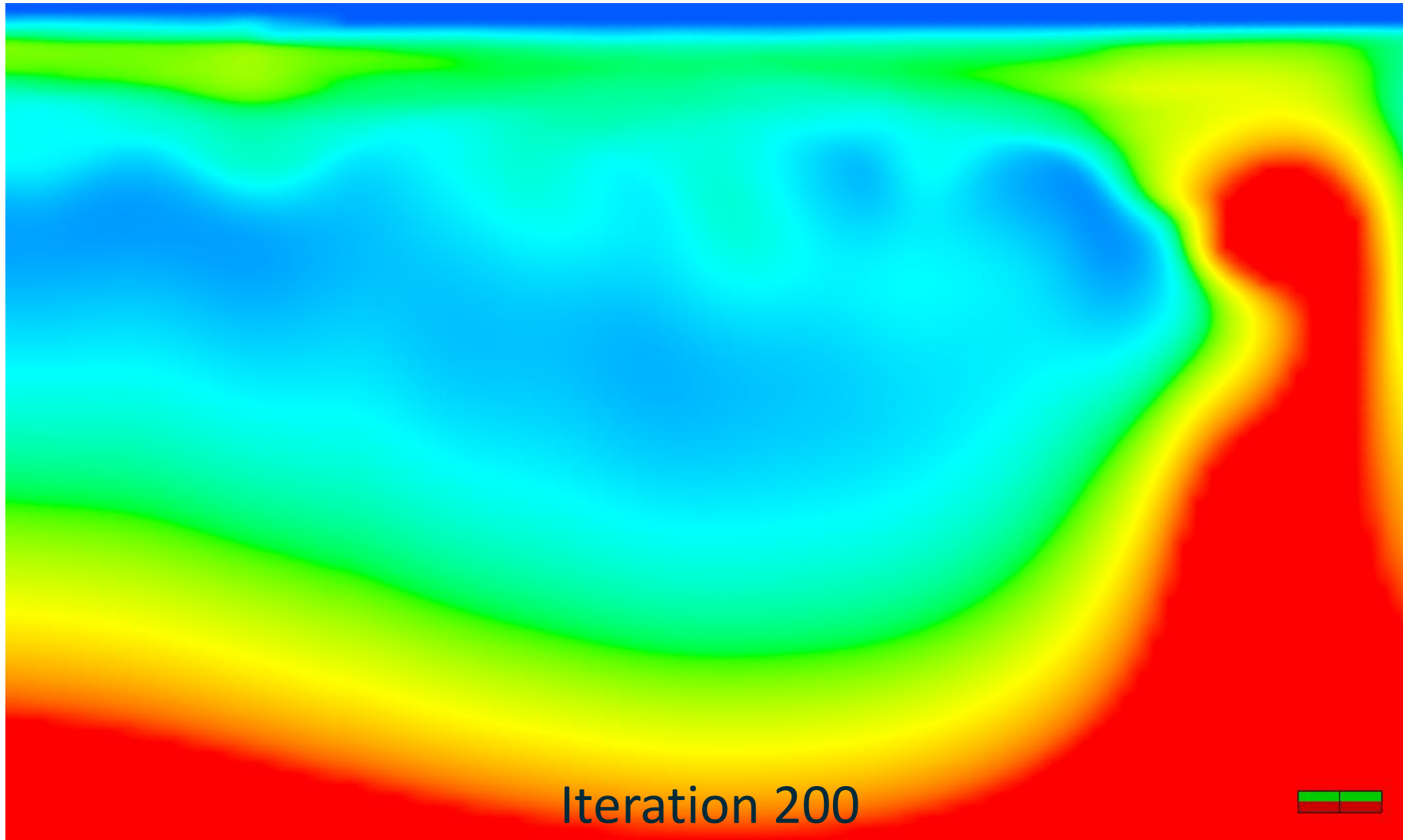
3D CSEM is measuring geology



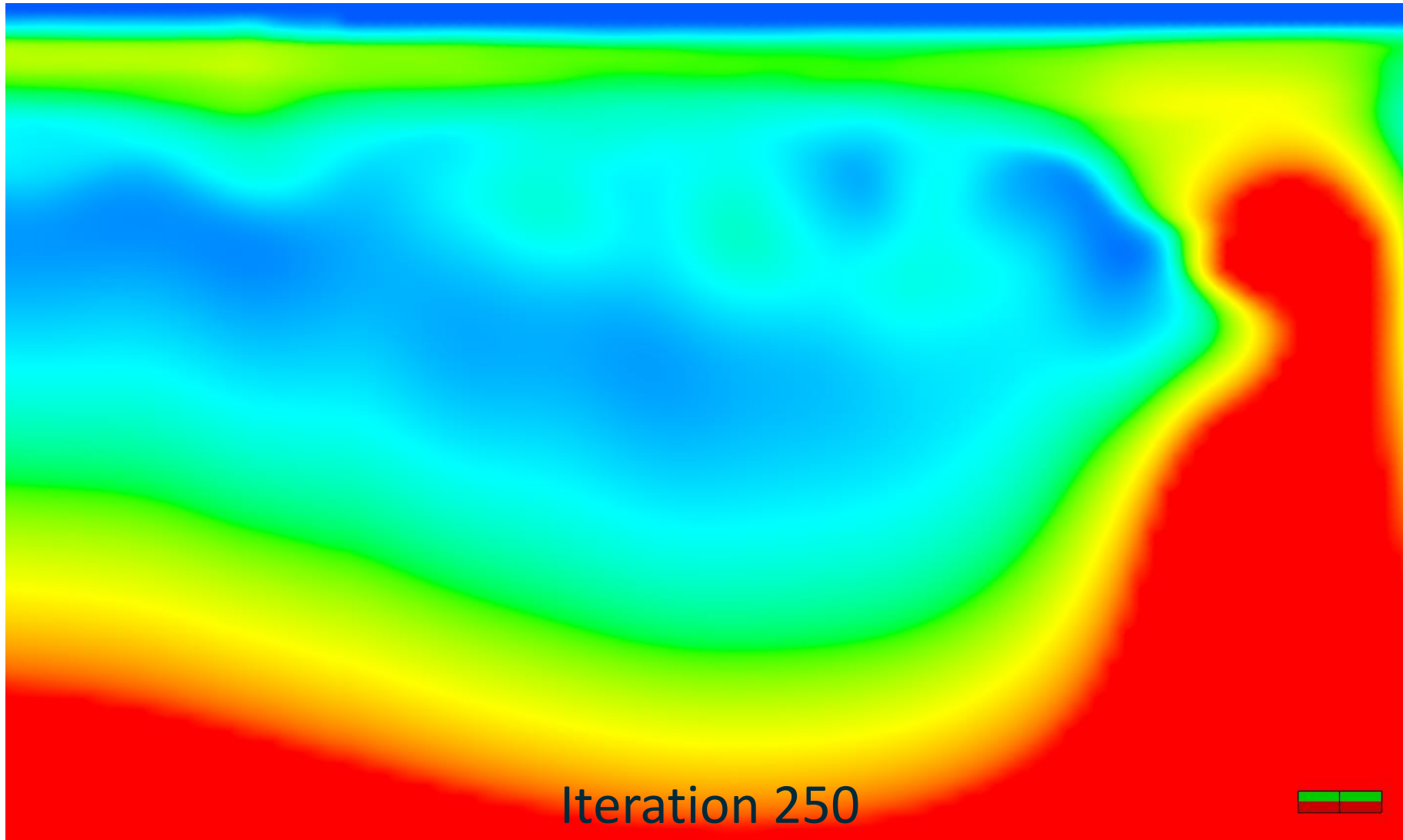
3D CSEM is measuring geology



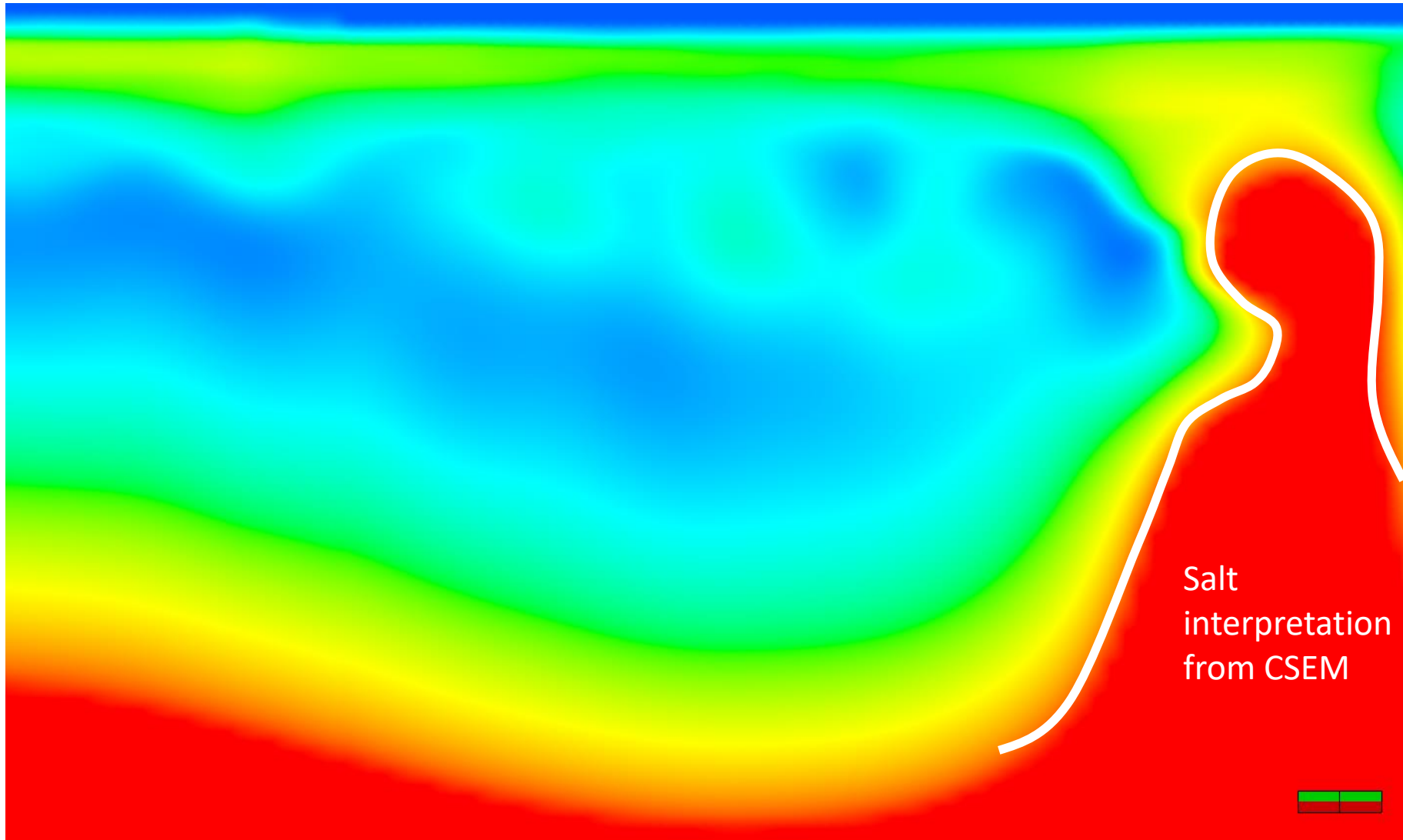
3D CSEM is measuring geology



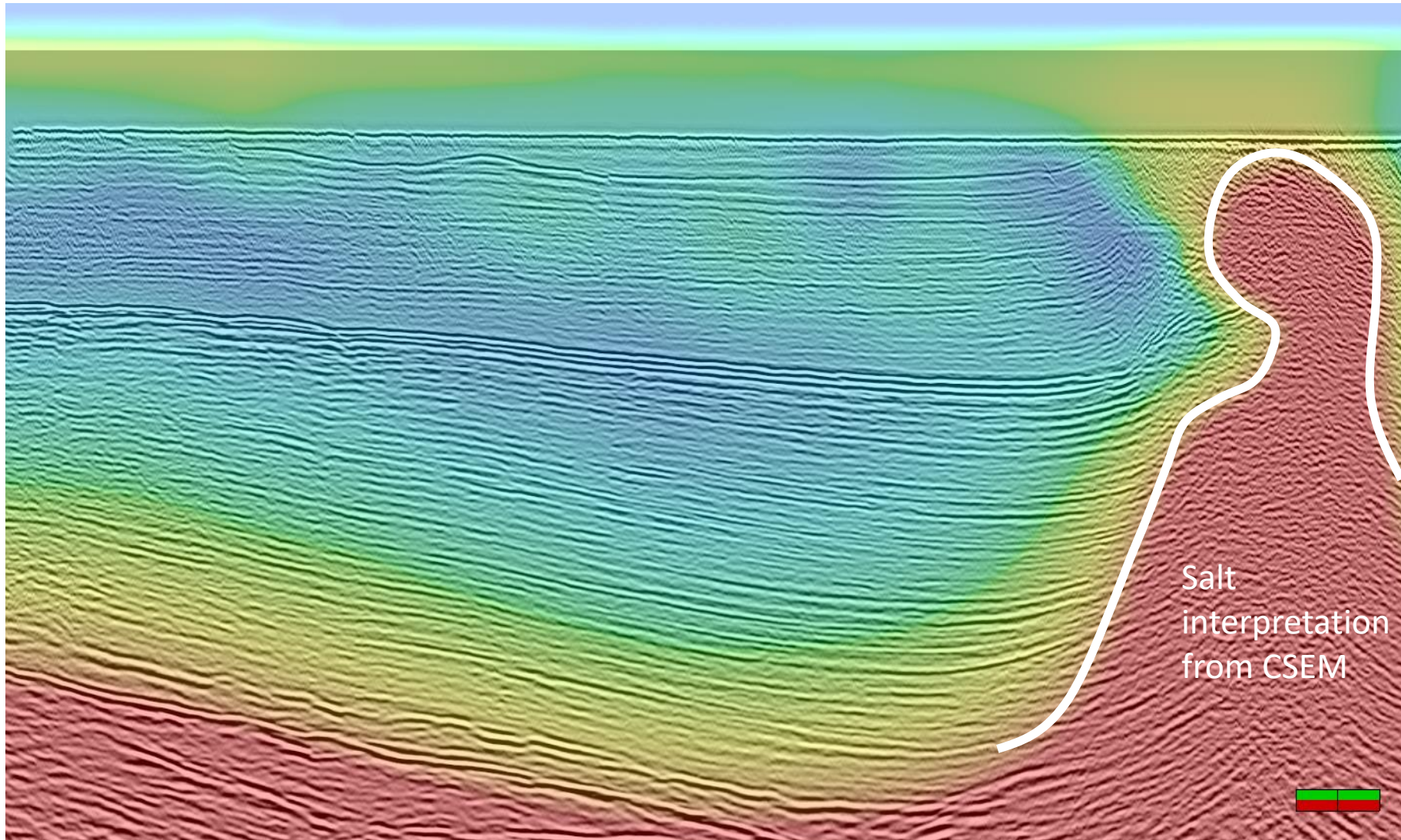
3D CSEM is measuring geology



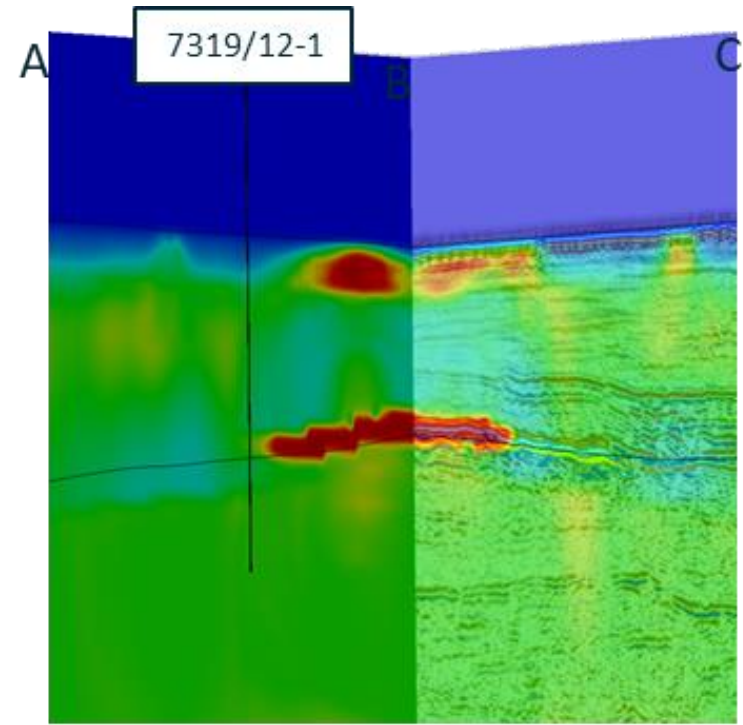
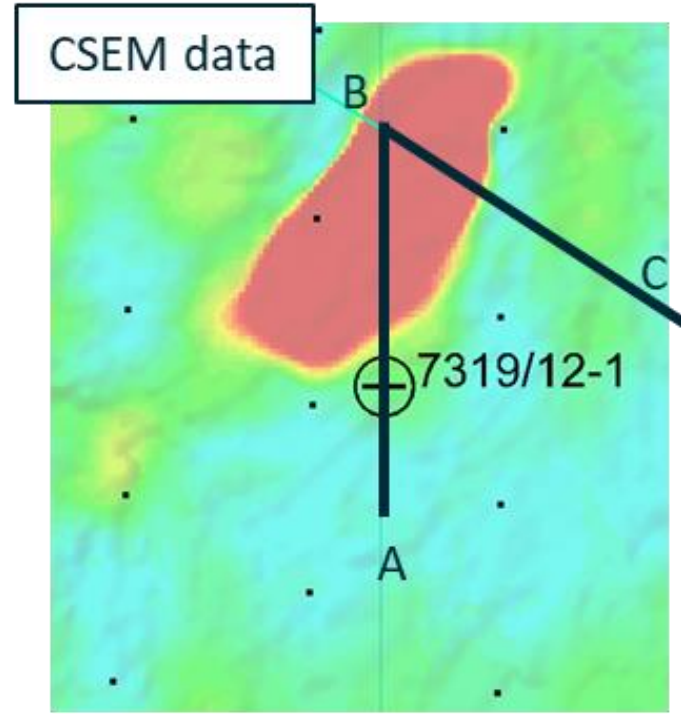
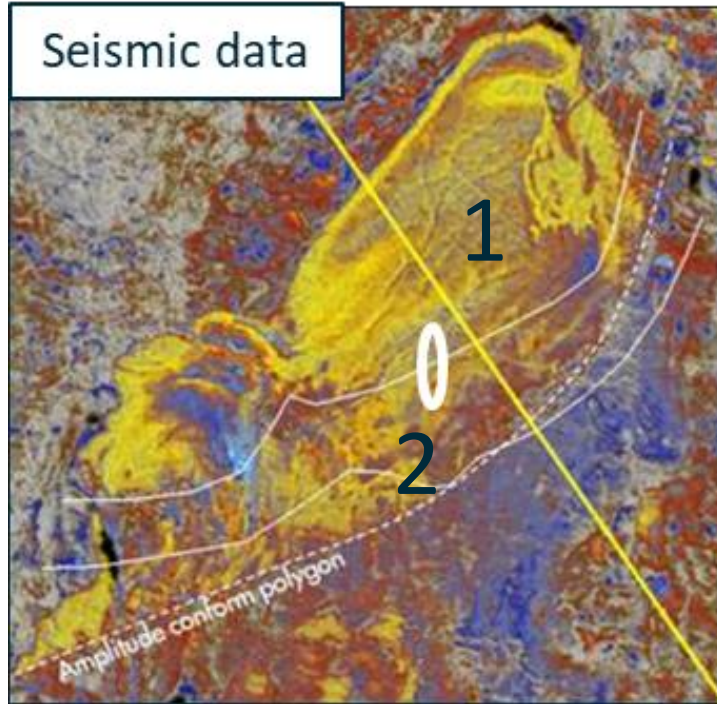
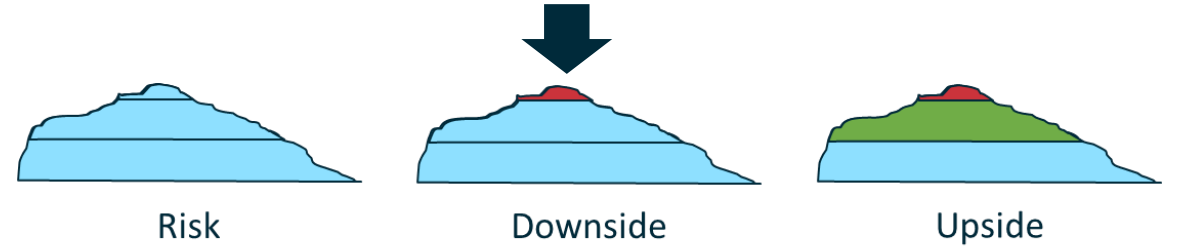
3D CSEM is measuring geology



3D CSEM is measuring geology



Case 1 : Pingvin in Tertiary

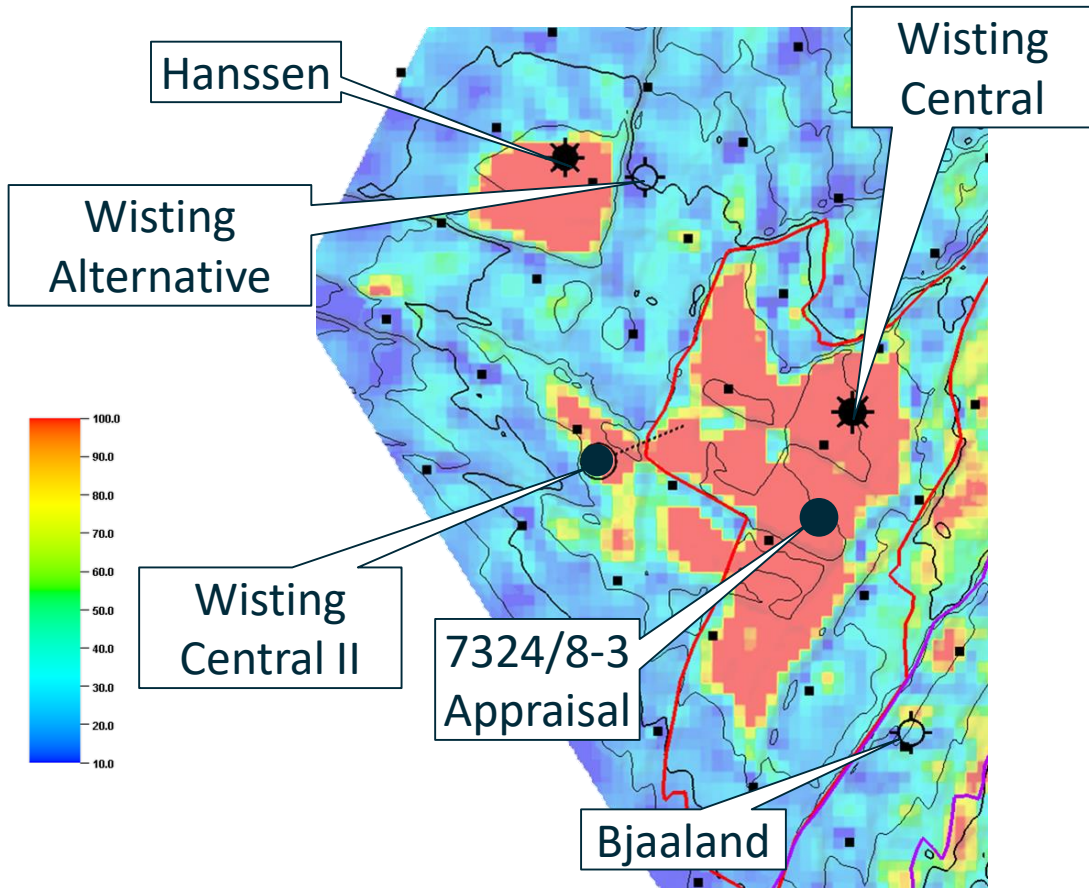


Area 1: seismic AVO and CSEM anomaly

Area 2: seismic AVO and no CSEM anomaly

Well result : Located at border between 1 and 2. Found GWC in transition zone

Case 2: Wisting and surroundings



Predicting OWC within +/- 5m for 2 out of 2 wells
 Predicting low-medium-high hydrocarbon saturation correctly for 3 out of 3 wells

Well	Seismic Response	CSEM response	Fluid fill
Wisting Central I	YES	YES	OIL
Wisting Alternative	NO	NO	WATER
Hanssen	YES	YES	OIL
Bjaaland	YES	NO	RESIDUAL OIL
Wisting Central II	YES	YES	OIL
Wisting Central III	YES	YES	OIL
Apollo	YES	NO	RESIDUAL GAS
Atlantis	NO	NO	WATER
Mercury	YES	YES	GAS

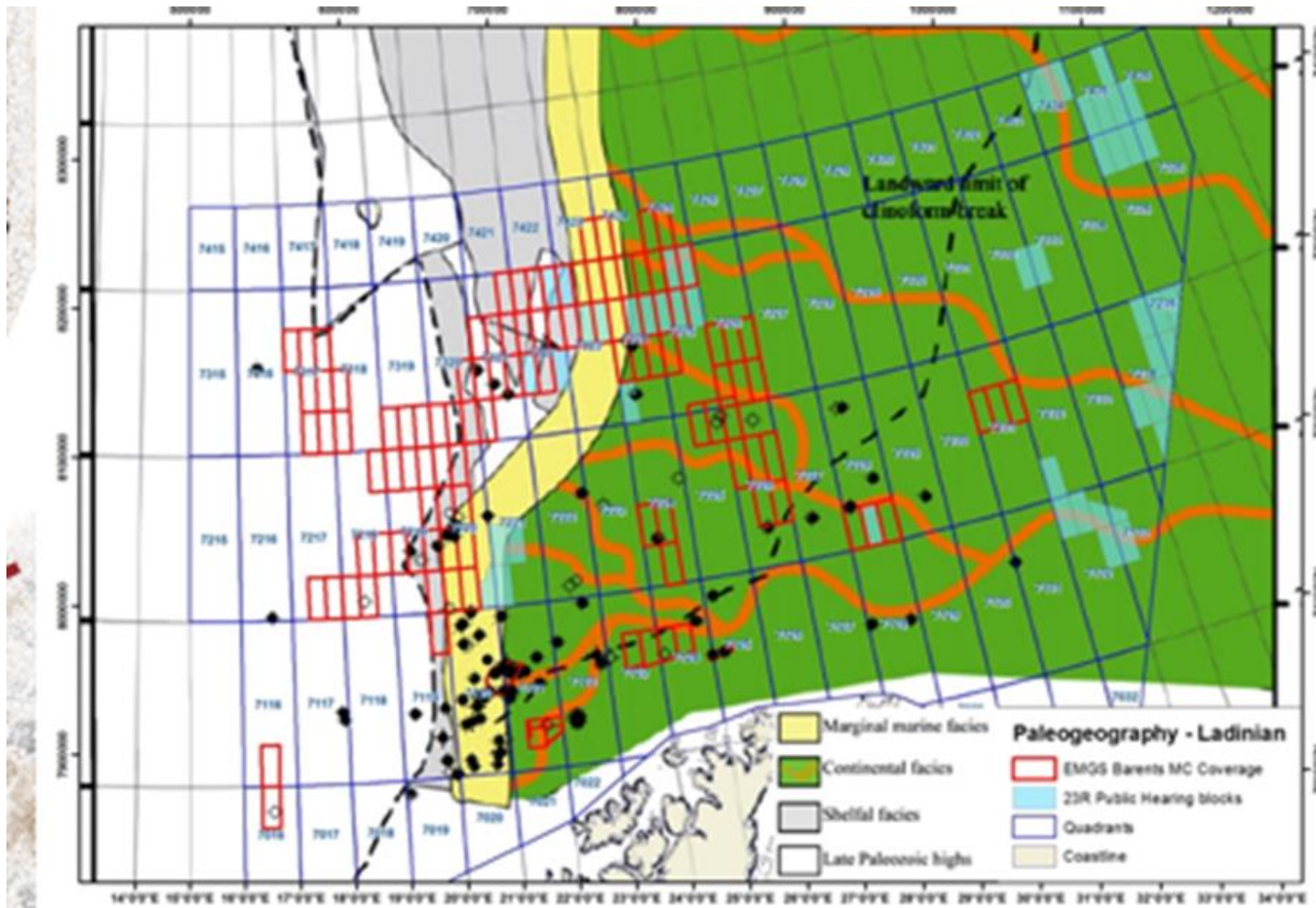
* PL537 partners are Tullow, Statoil, Idemitsu, Petoro and OMV



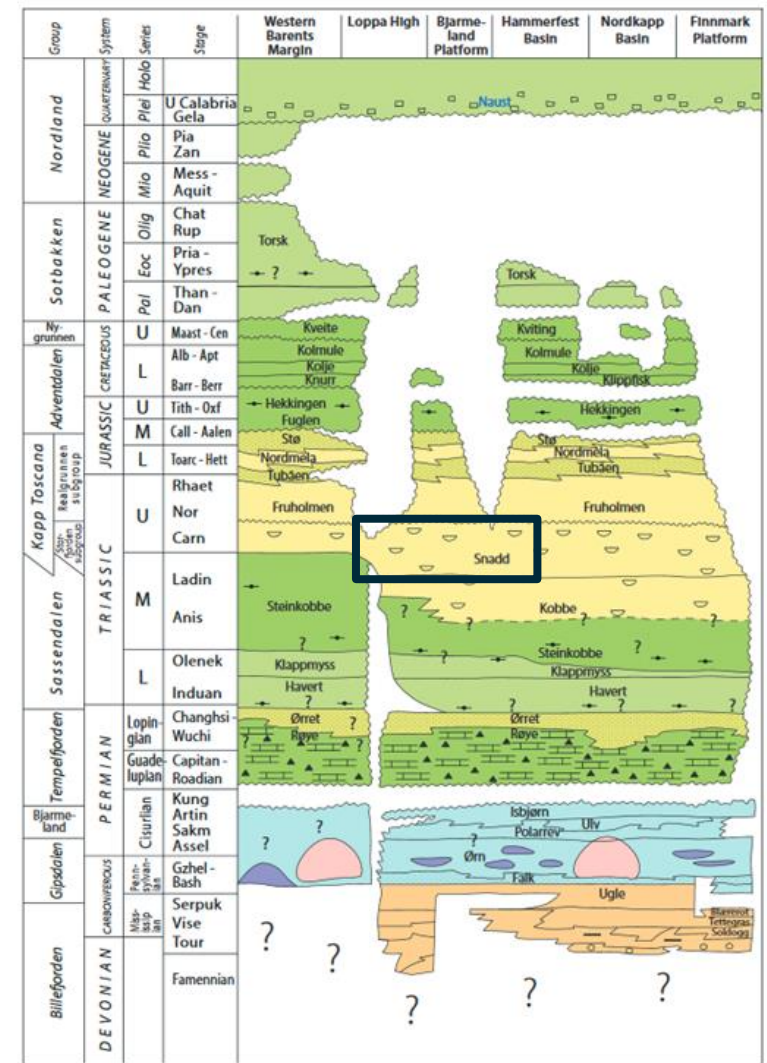
Electric Triassic

Spot the difference.

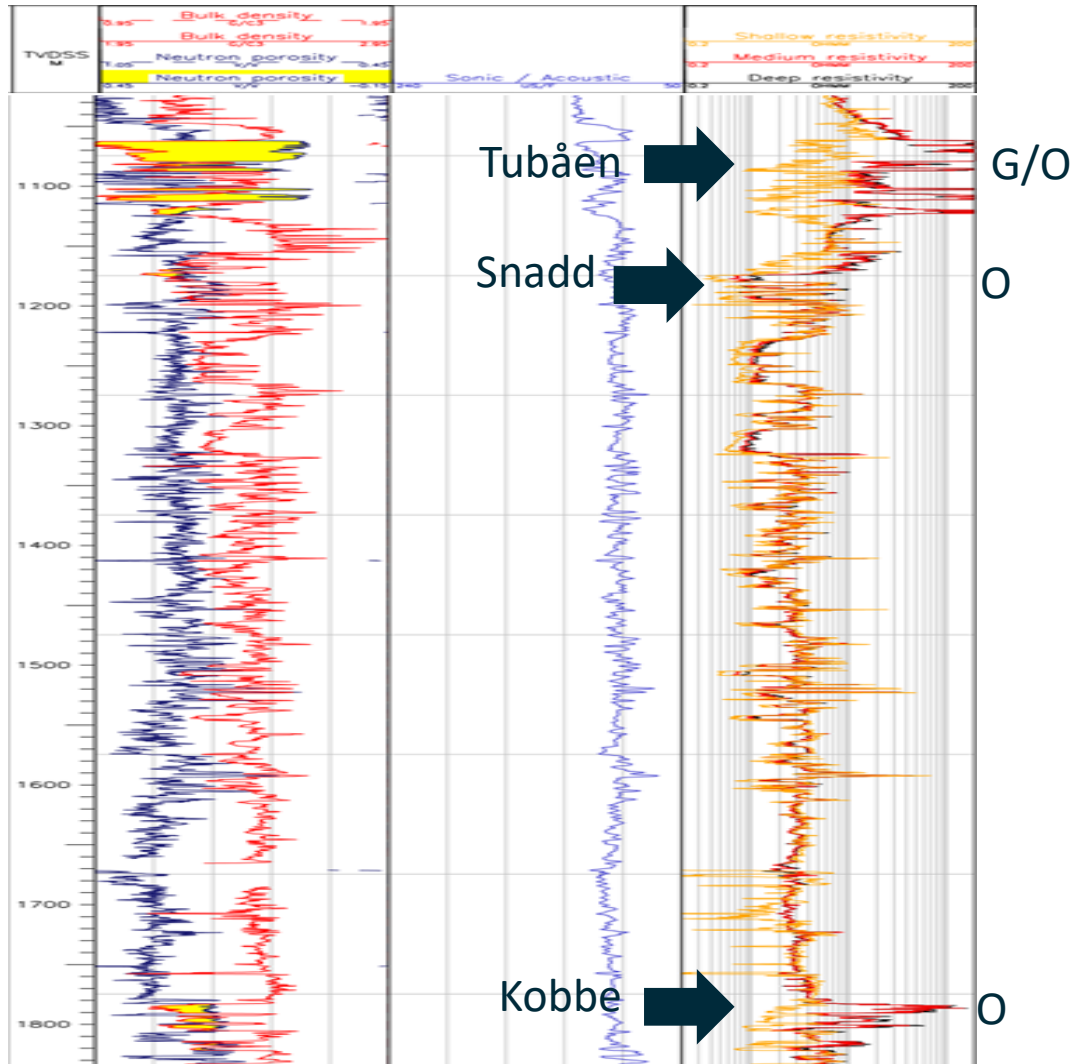
Channels in the Triassic Snadd



Glørstad-Clark et al. (2011)



Goliat

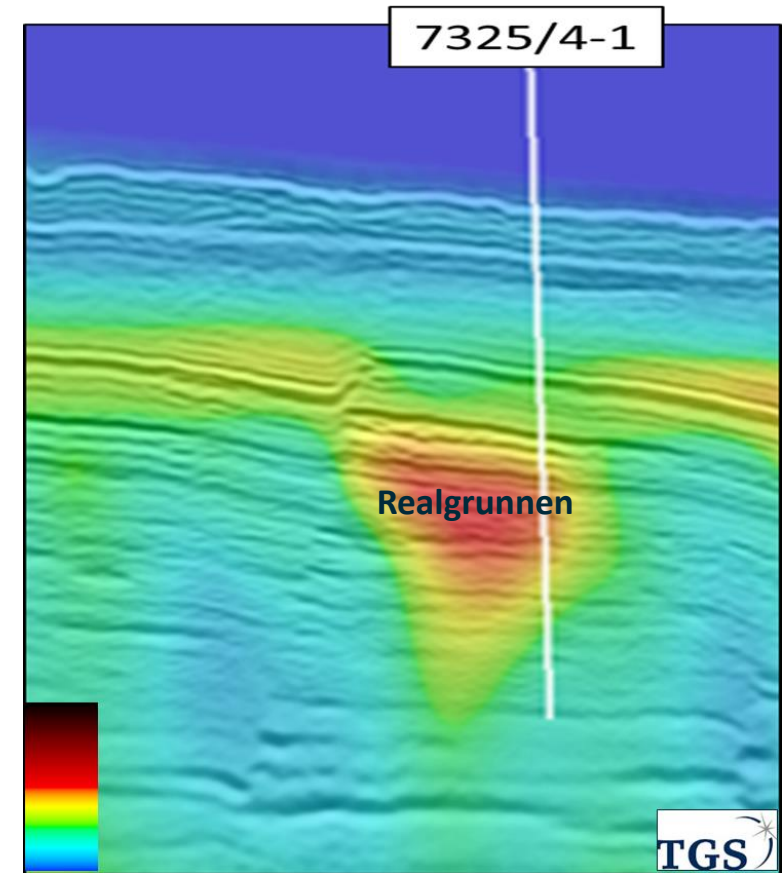
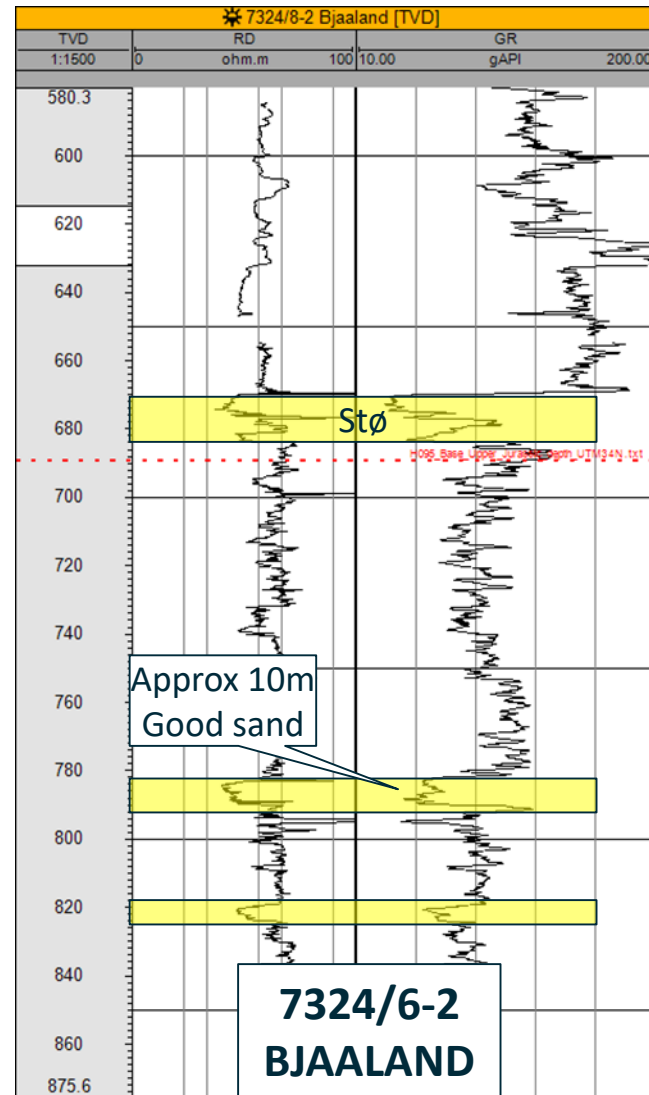
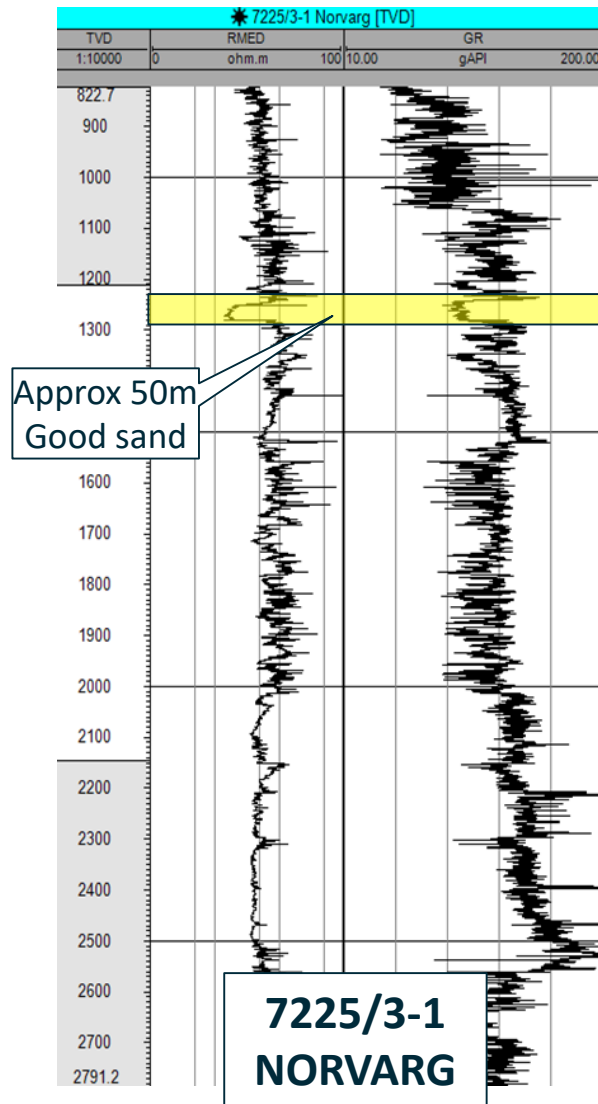


Discoveries in the Triassic

- **Goliat**
- Tornerose
- Norvarg
- Ververis
- **Caurus**
- Obesum
- Norsel
- **Pandora**
- Atlantis

Good sand

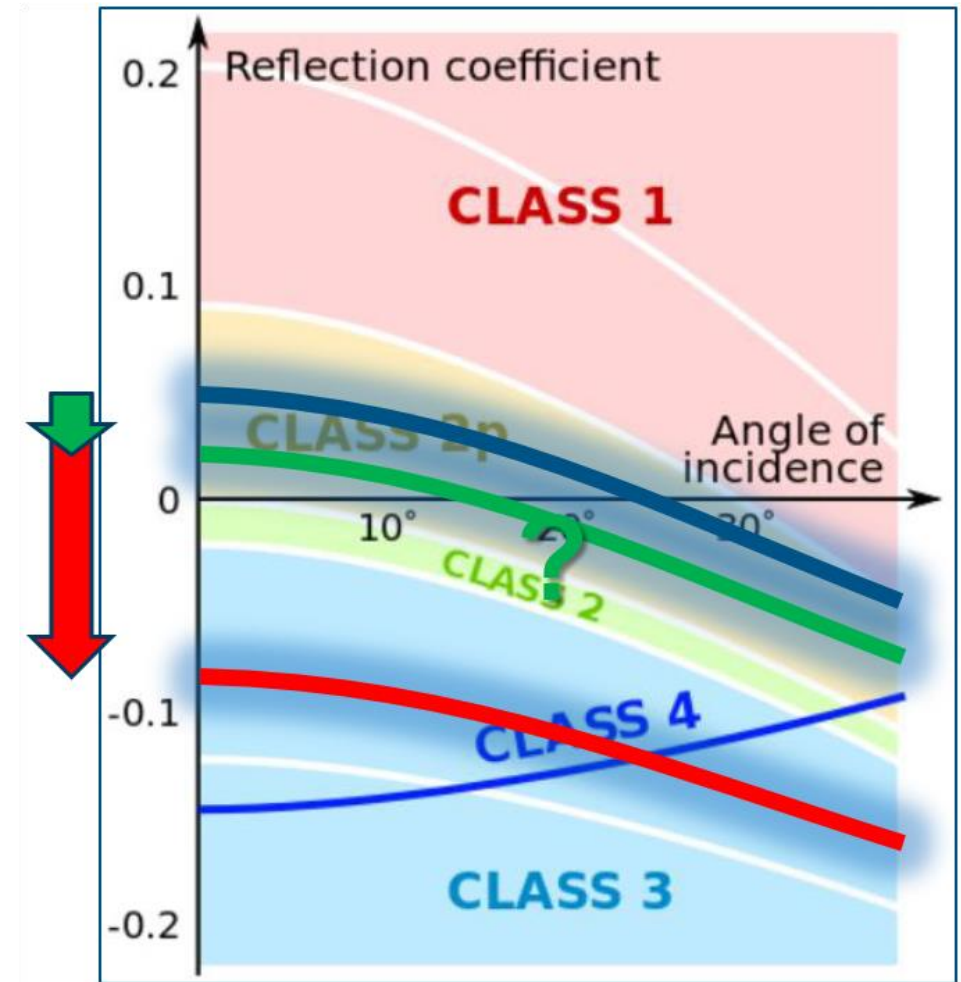
Snadd channels



Well 7325/4-1 encountered a gas column of 19 metres in the Stø formation in sandstone with good reservoir quality. Gas/water contact was not proven. In the secondary exploration target in the Snadd formation, an oil column of about 5 metres was proven in a sandstone with poor reservoir quality. The preliminary estimation of the size of the

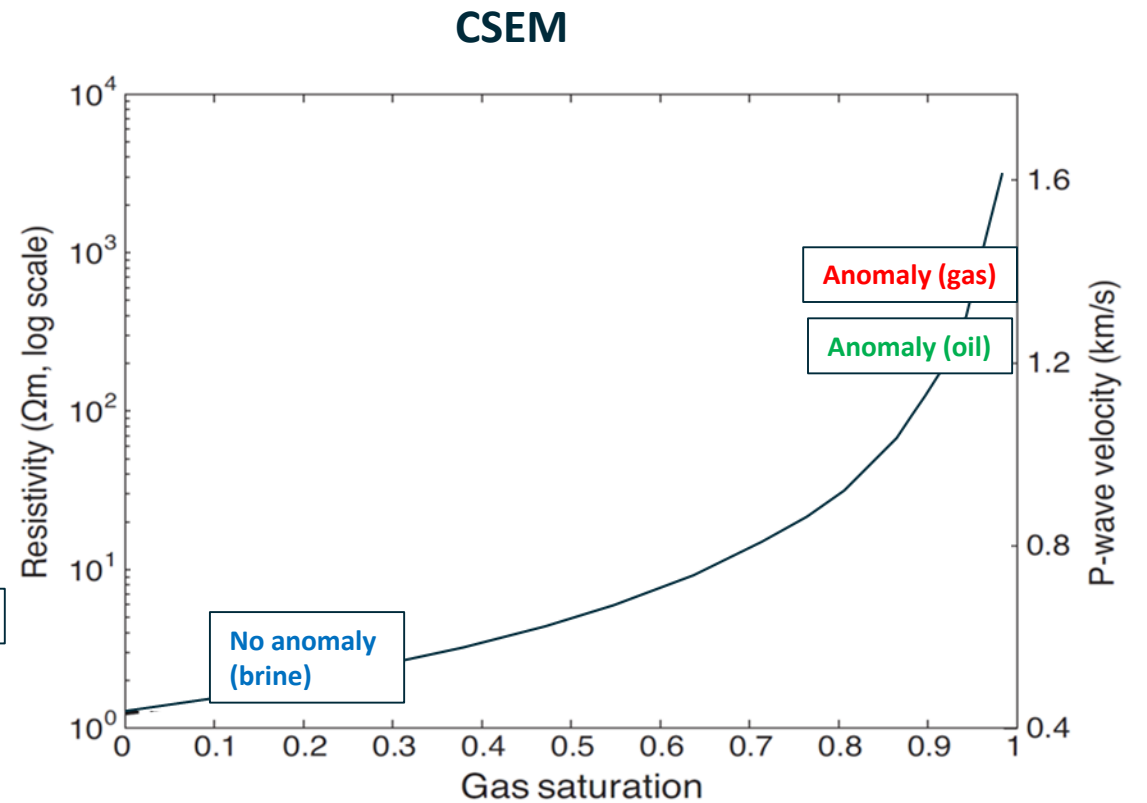
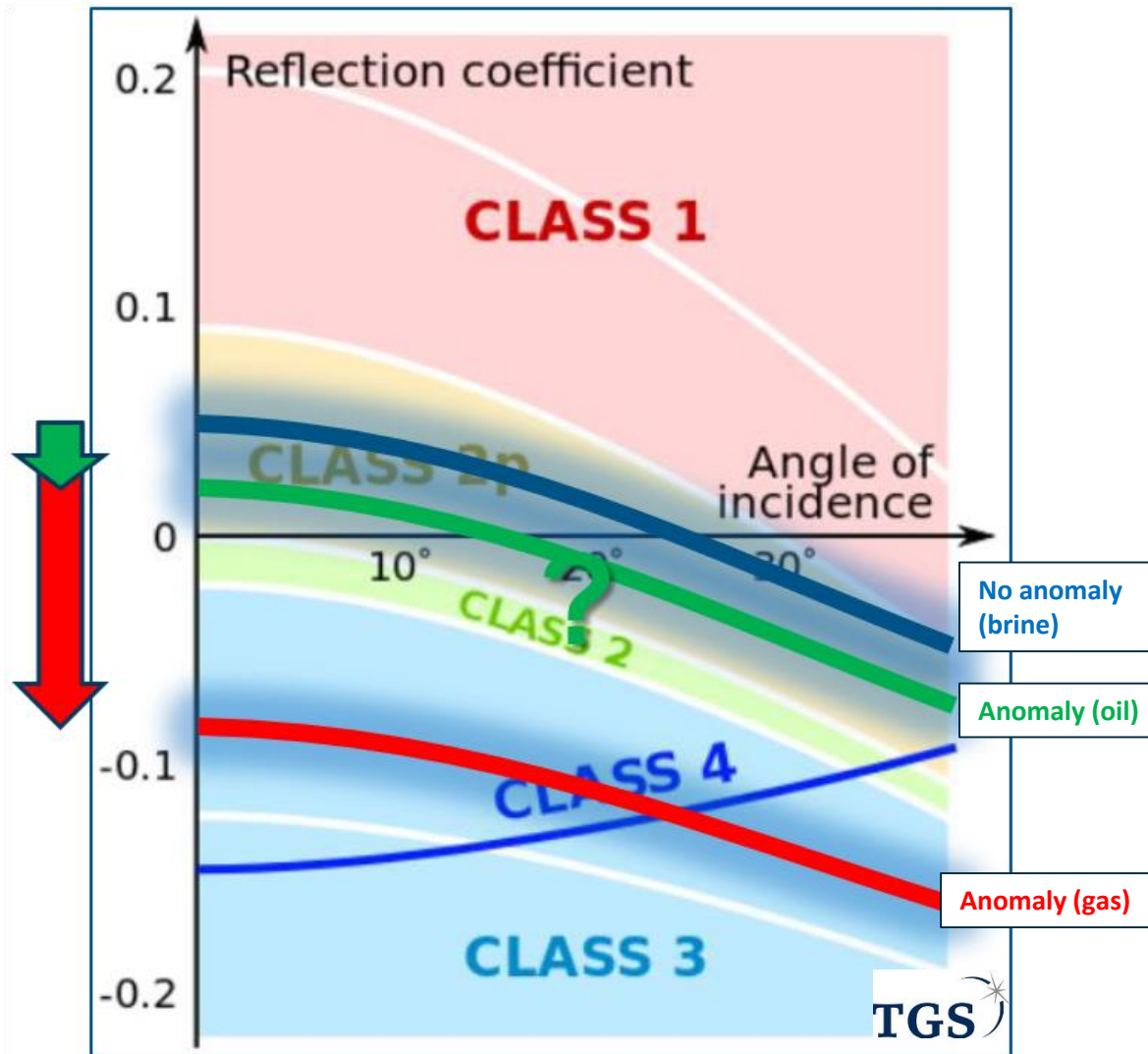
What do we expect from the seismic data?

- Oil-filled sands could have a very weak negative amplitude or be near invisible in stacked data
- Wide U-shaped nonreflective features could be stacked point-bar sands filled with oil



* Modelling based on Atlantis

Seismic and 3D CSEM



Summary

ELECTRIC

3D CSEM provides an independent data set providing geological information

Proven to de-risk seismic DHI prospects in the Realgrunnen sub-group

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Challenge to find good oil-filled Snadd channels

Seismic modelling suggests alternative model (dim not bright)

Integration of seismic and 3D CSEM data provides an efficient de-risking tool

CSEM data shows several other opportunities in the Triassic (Bjarmeland and North Cape basin)