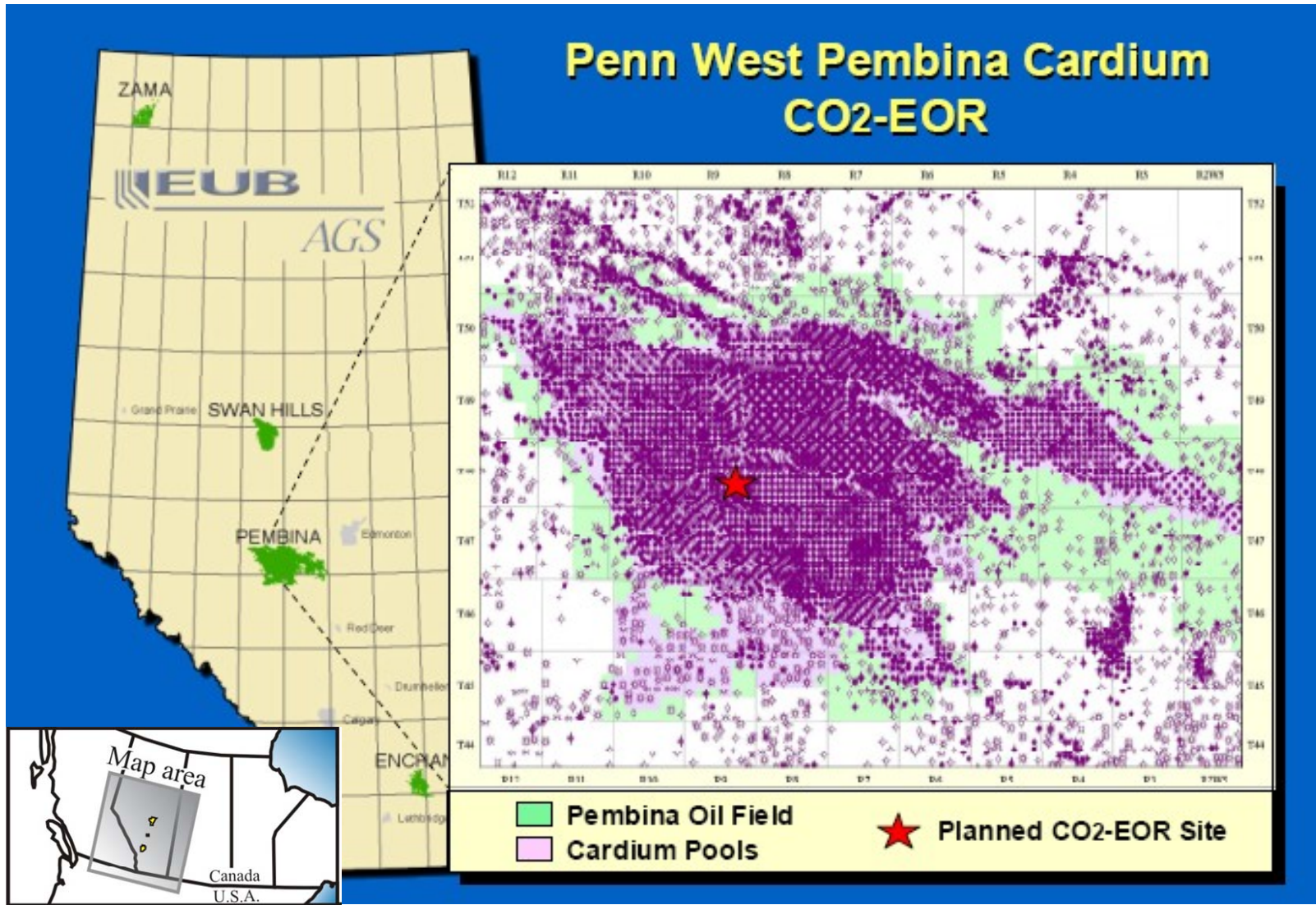


# Penn West Pembina Cardium CO<sub>2</sub> EOR seismic monitoring program

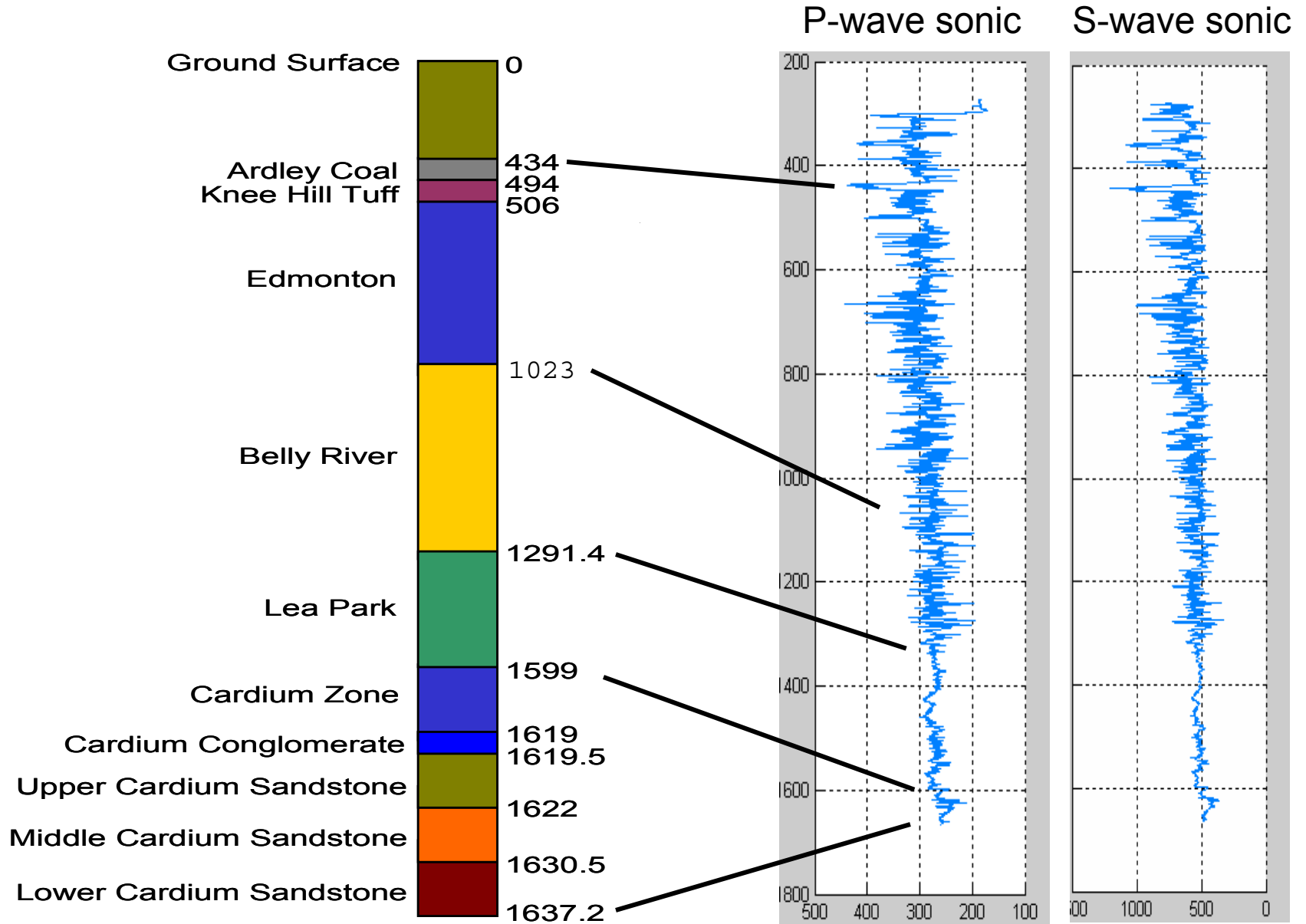
Don Lawton & Abdullah Alshuhail

University of Calgary  
Calgary, Alberta, Canada

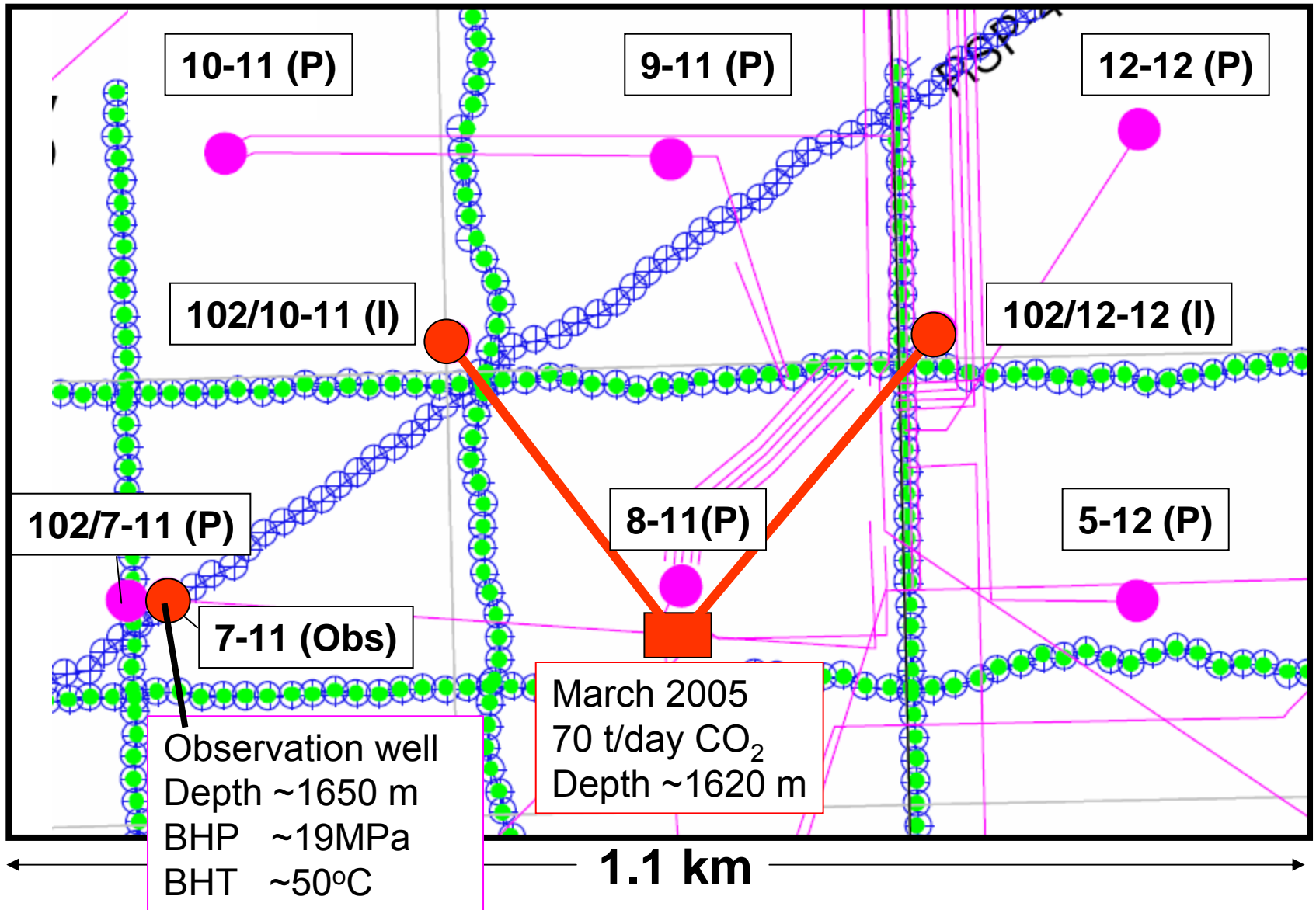
# Penn West Petroleum CO<sub>2</sub>-EOR Pilot



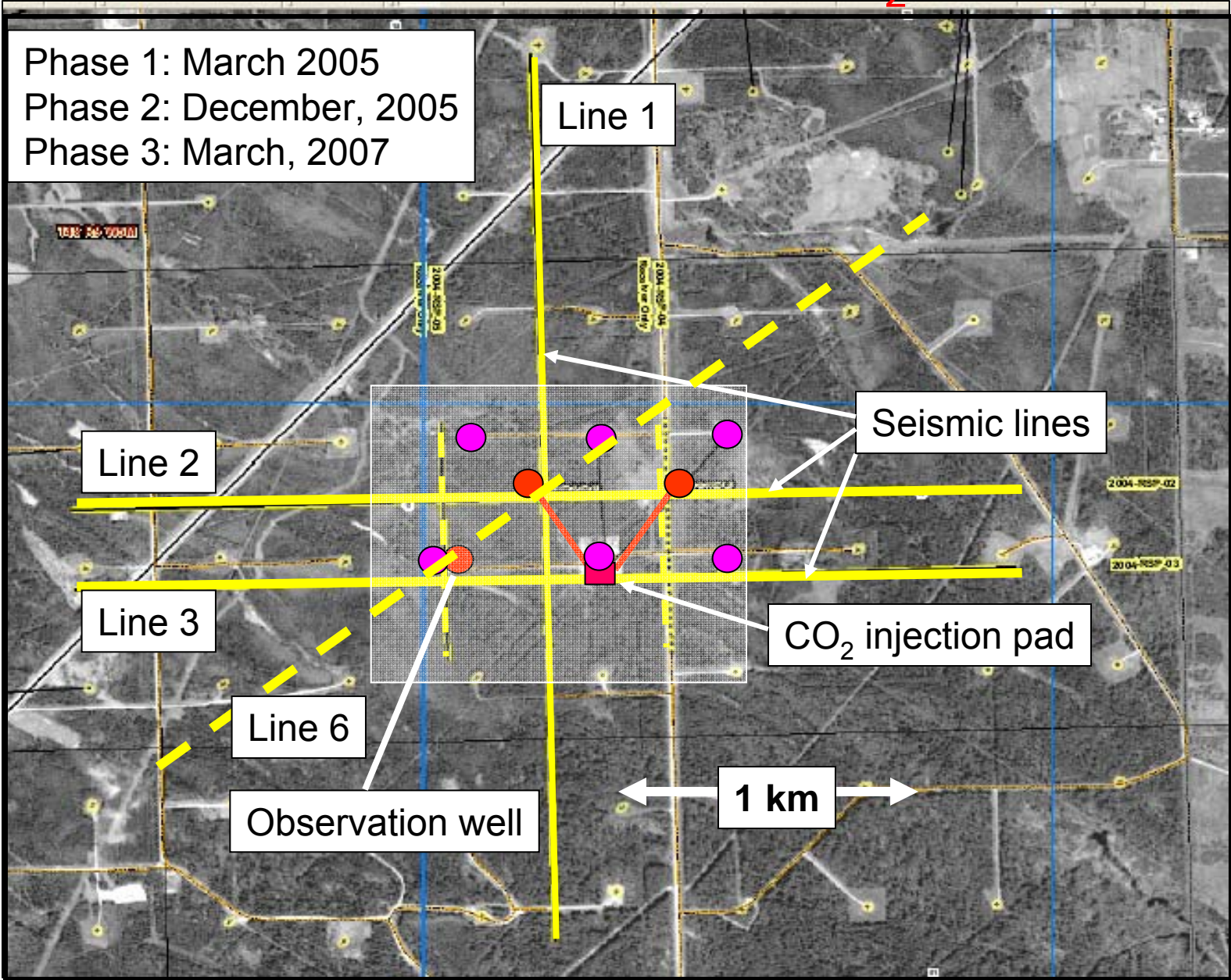
# Stratigraphy and sonic log response



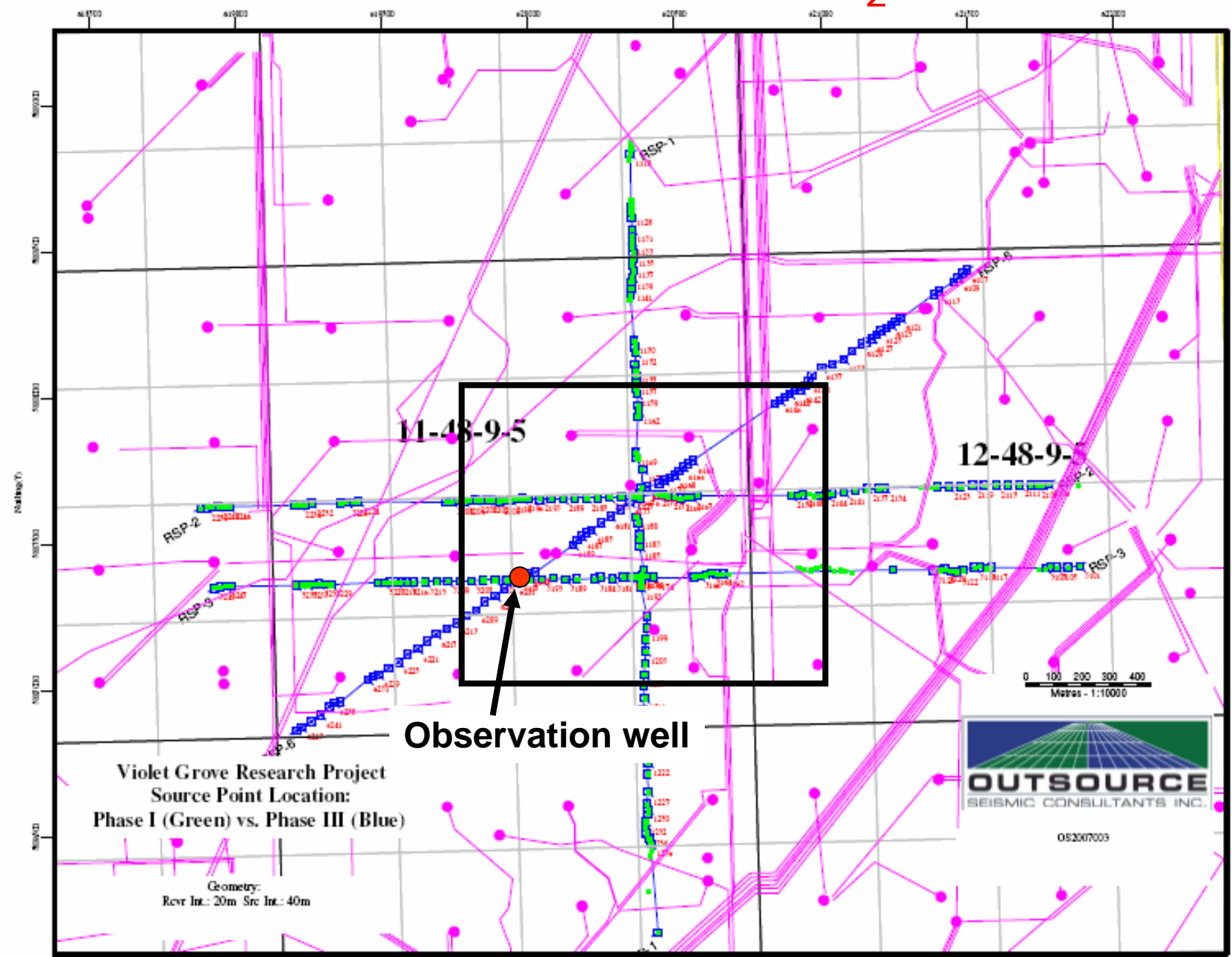
# PennWest Pembina Cardium CO<sub>2</sub> Pilot



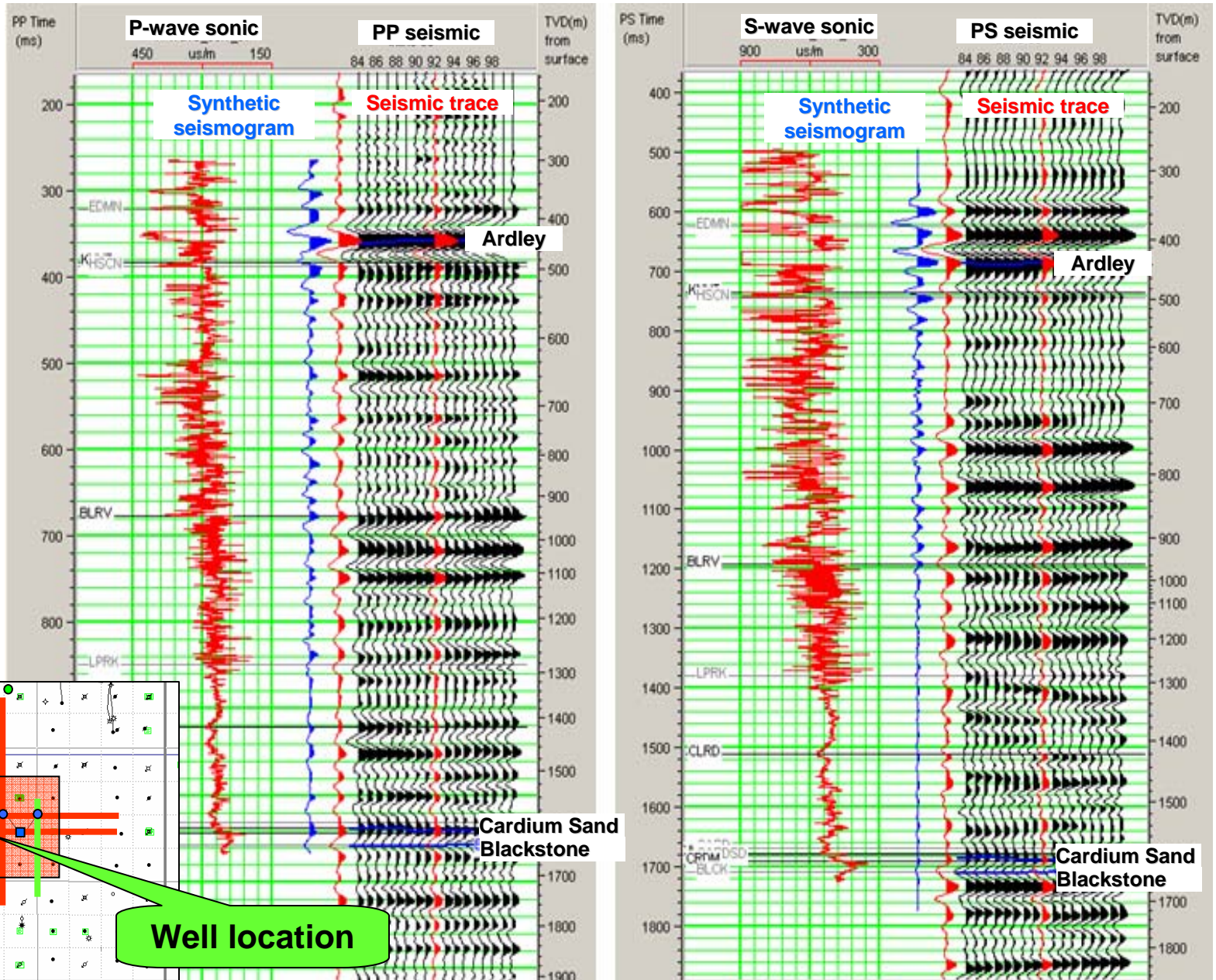
# Seismic lines, Penn West CO<sub>2</sub> EOR Pilot



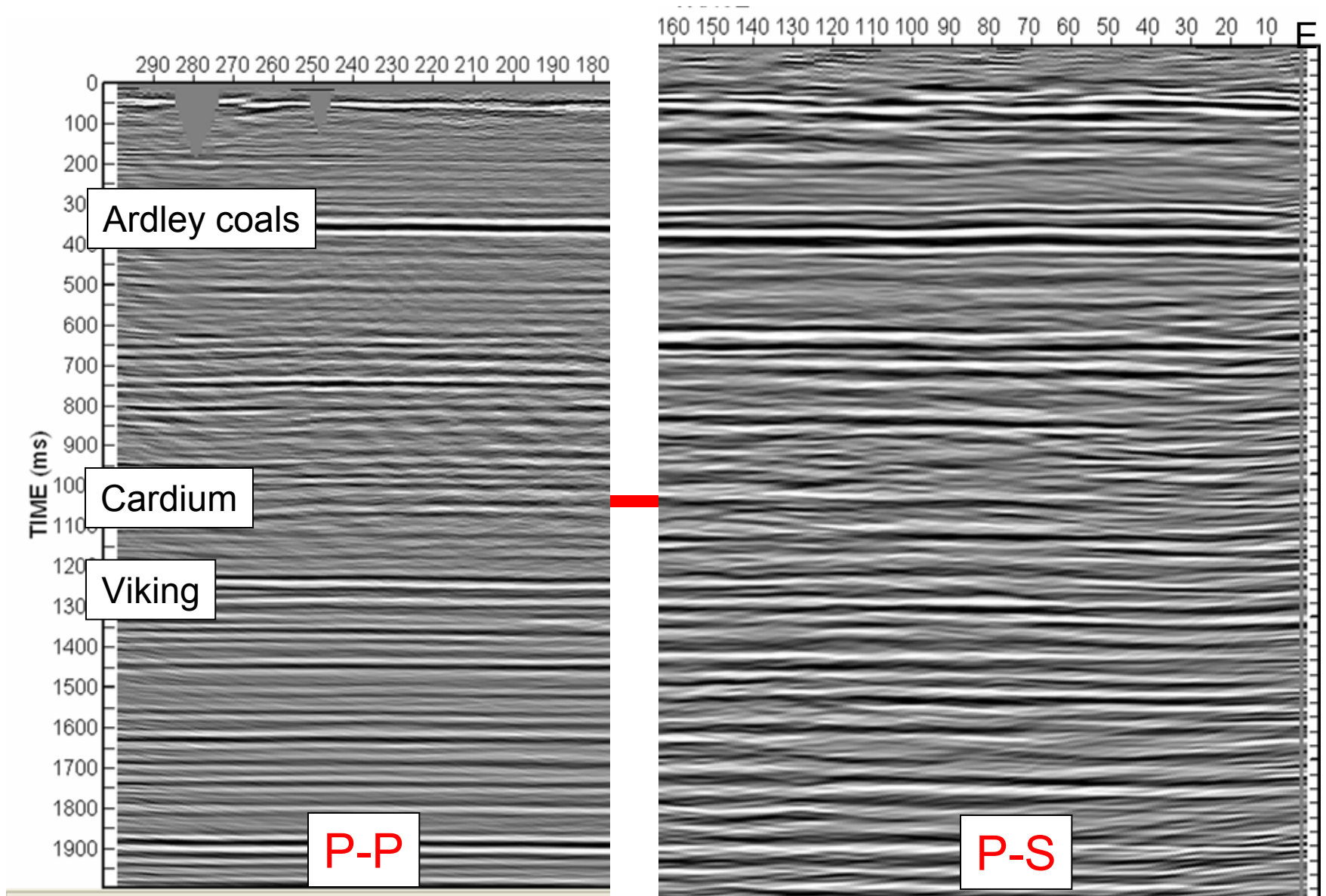
# Seismic lines, Penn West CO<sub>2</sub> EOR Pilot



# PP (left) and PS (right) correlation

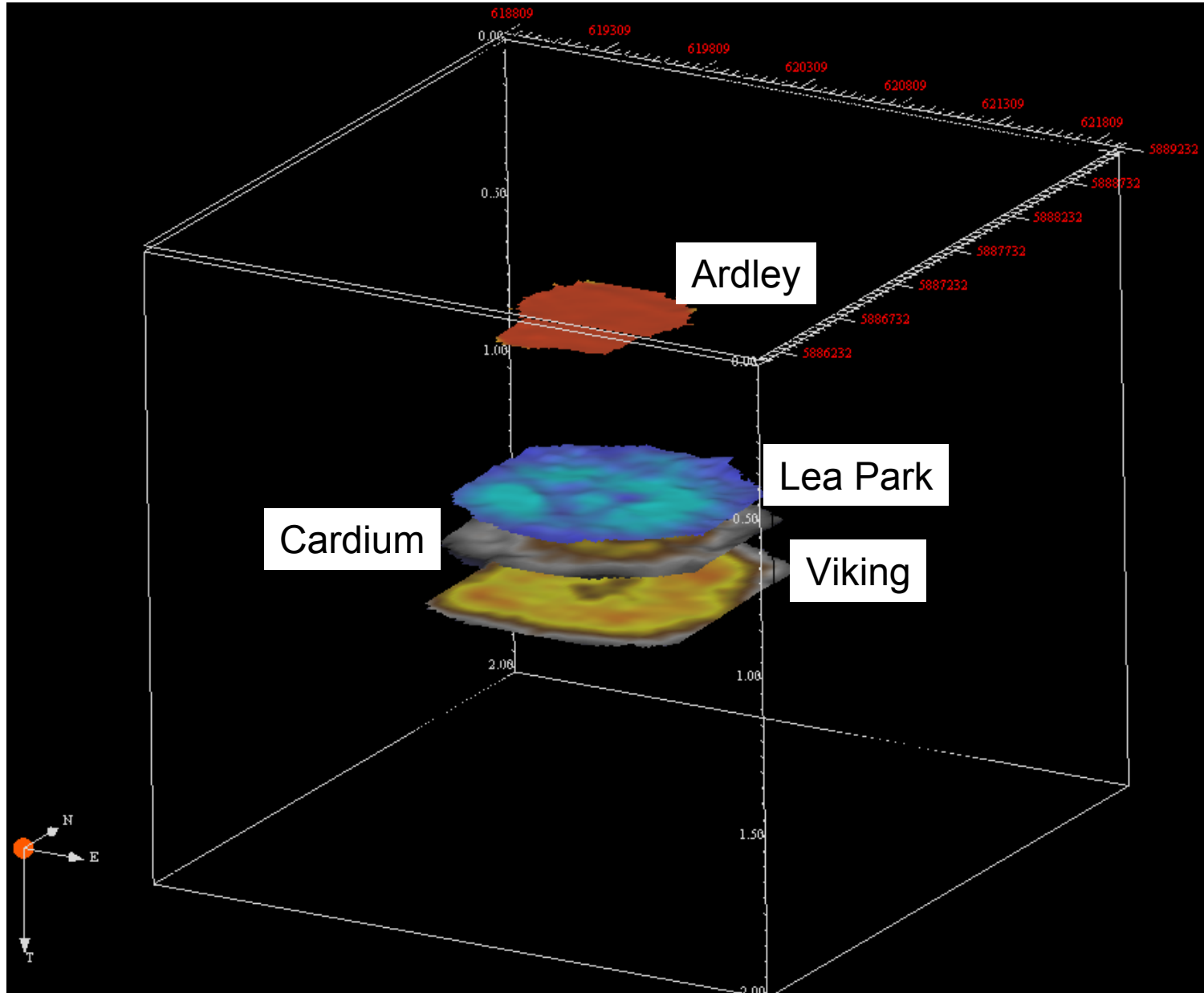


# P-P & P-S registration

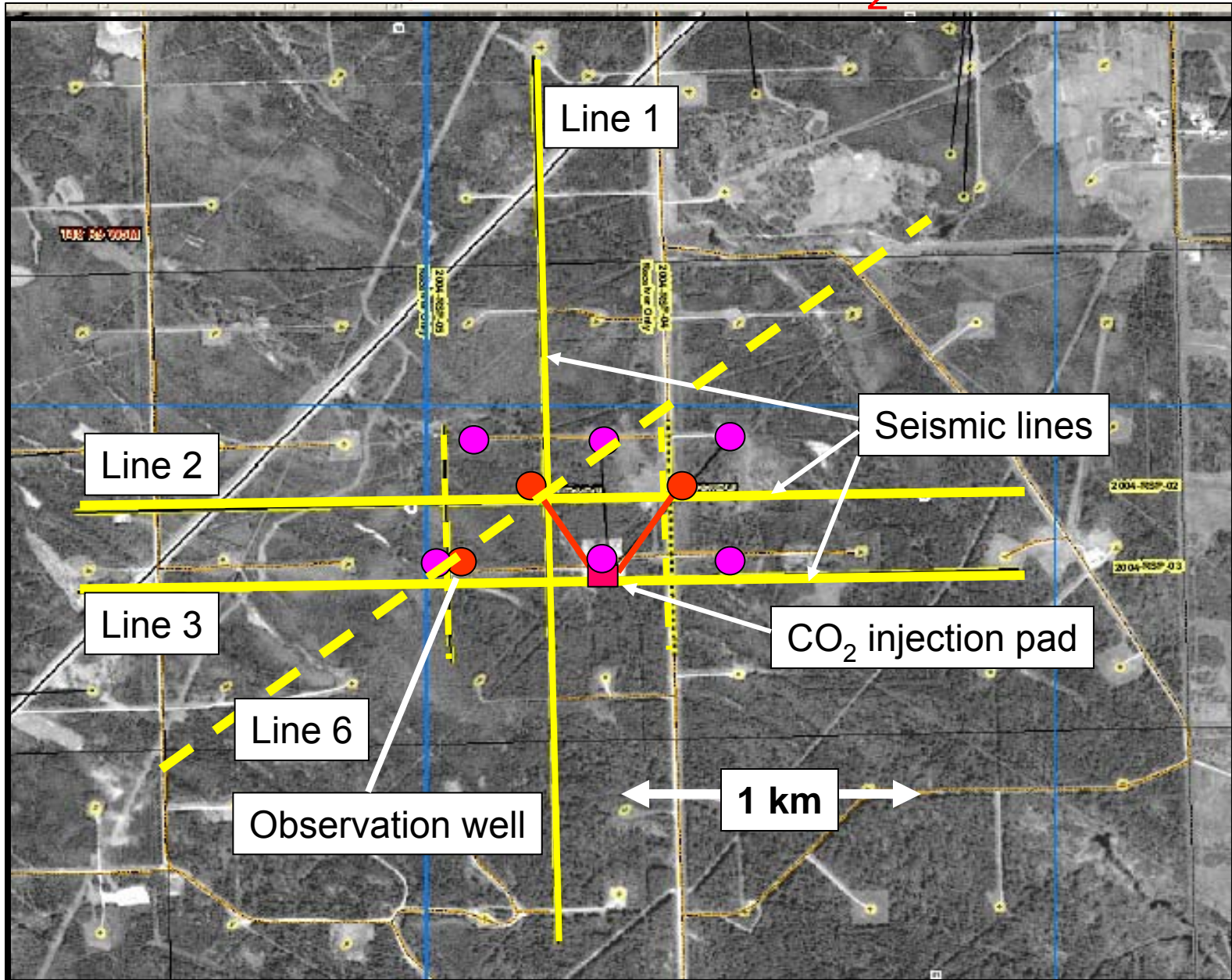




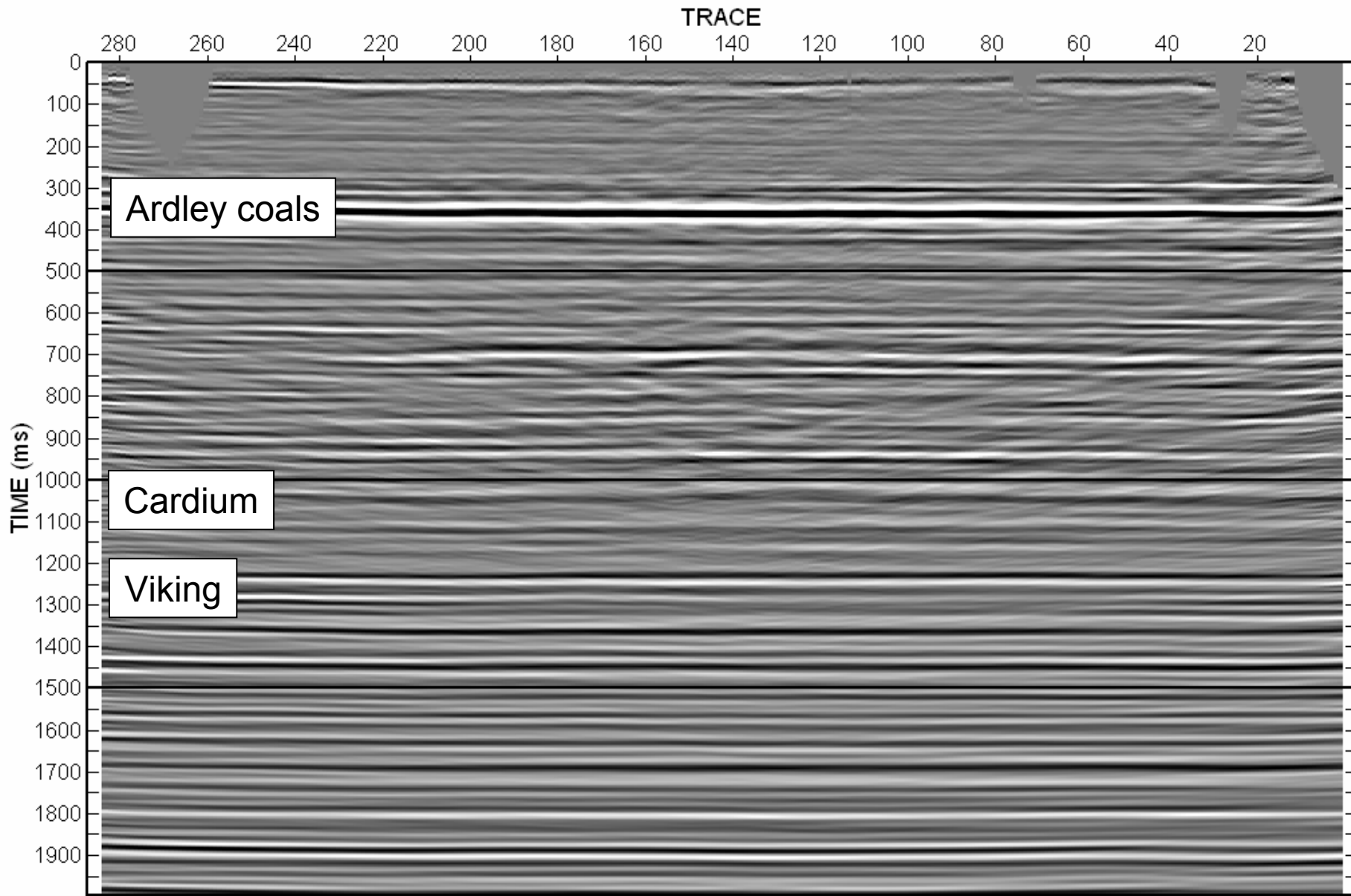
# 3D Horizon picks (PP data)



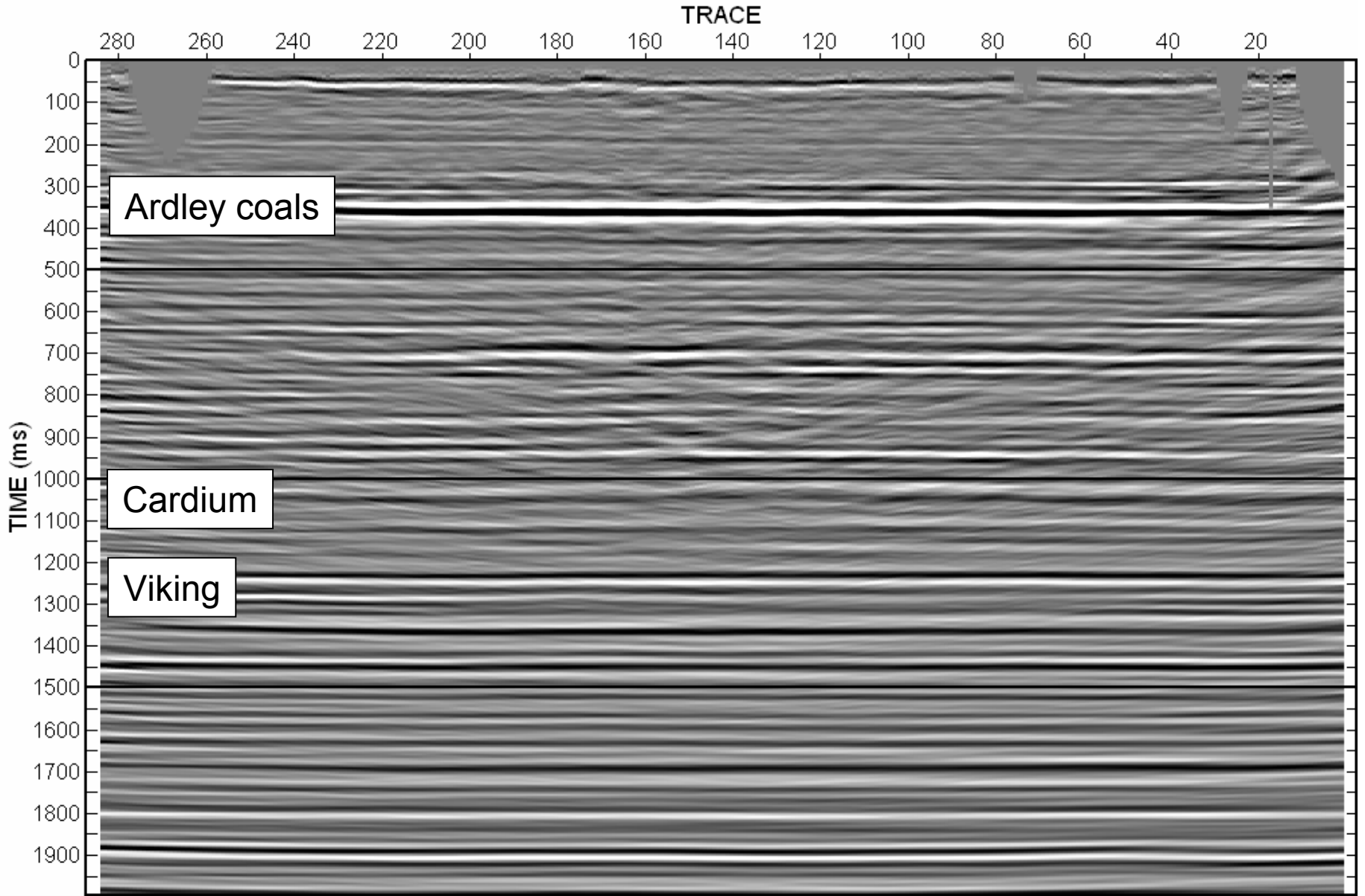
# Seismic lines, Penn West CO<sub>2</sub> EOR Pilot



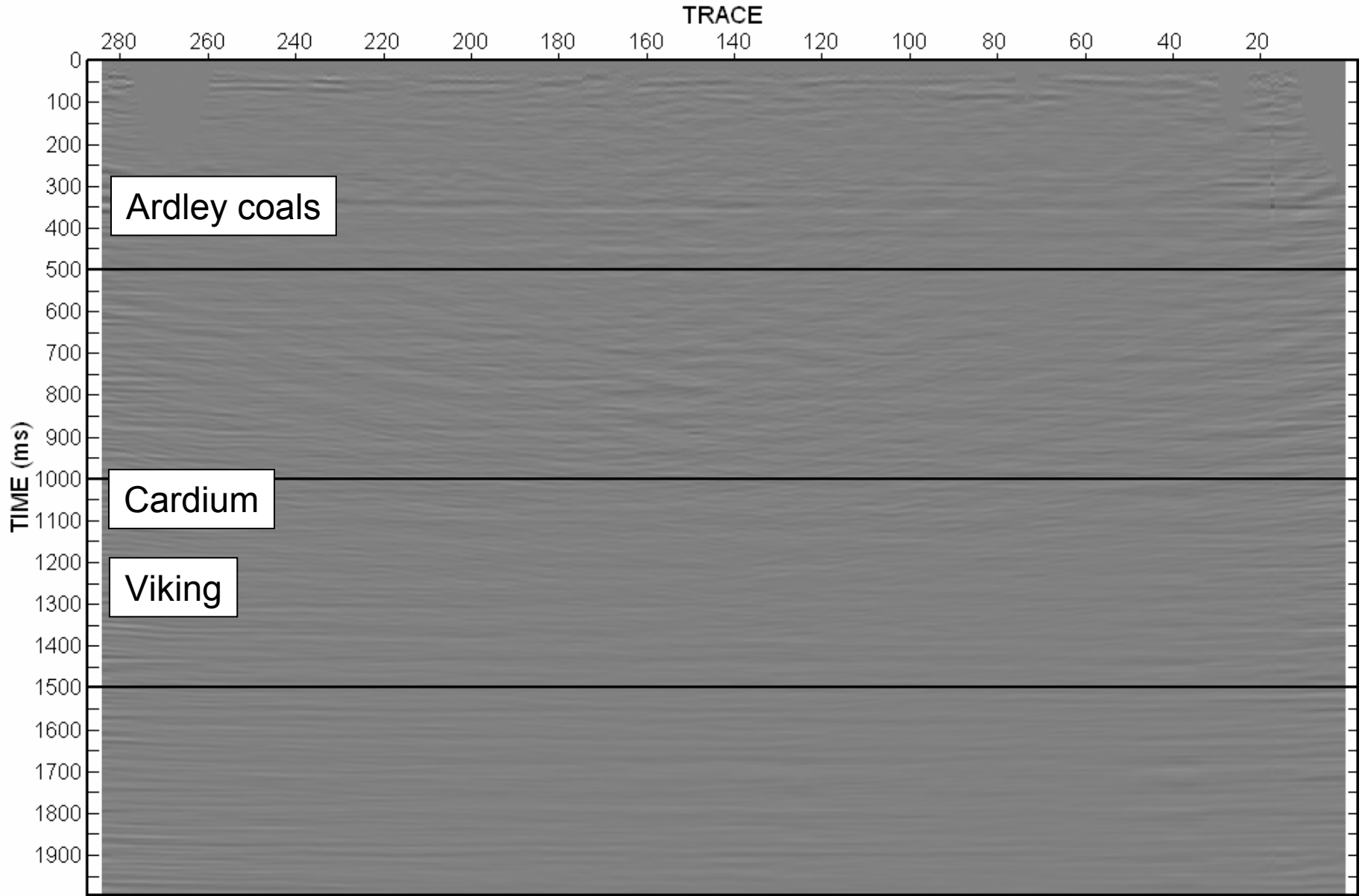
# Line 1 Phase I



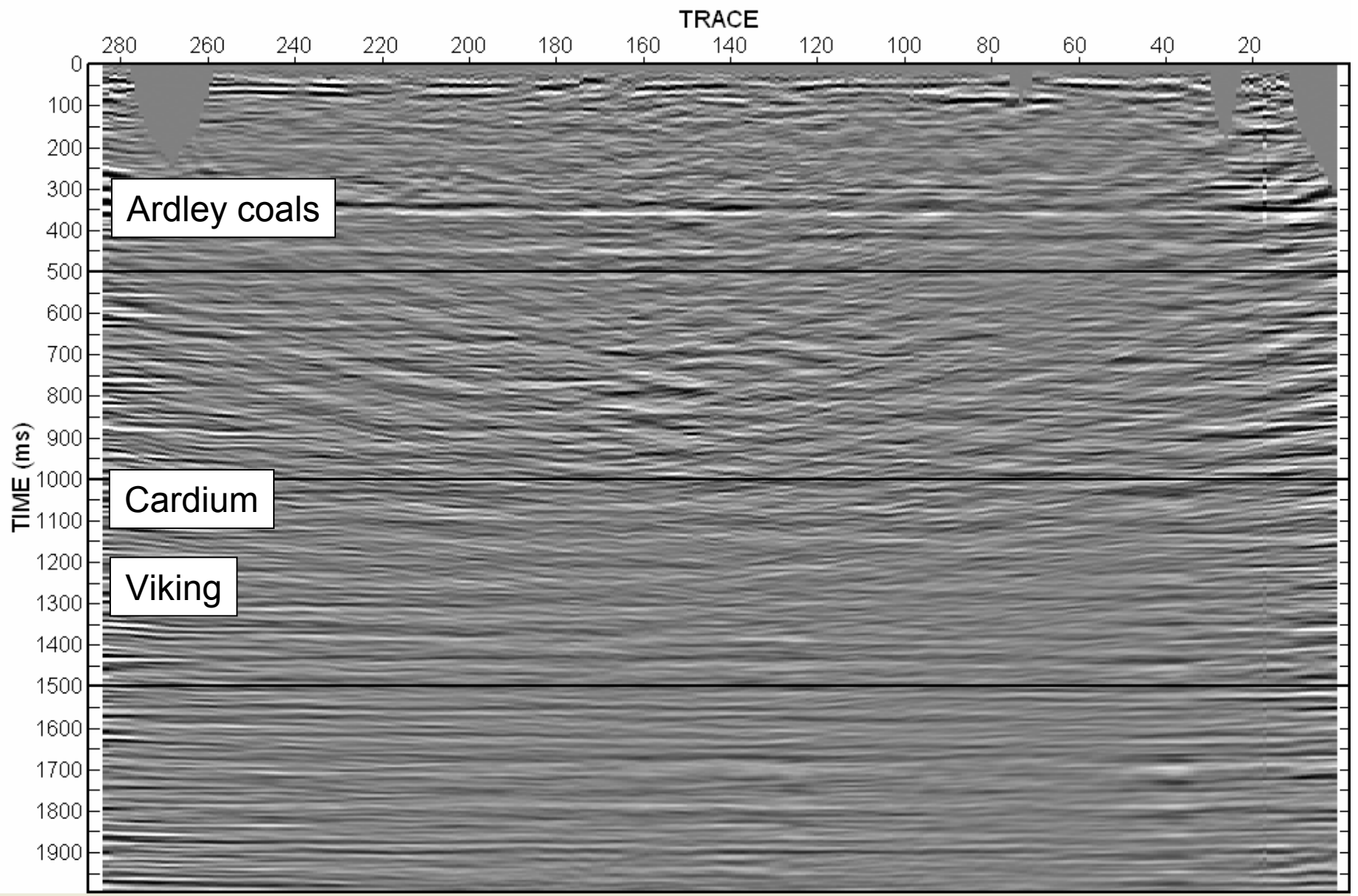
# Line 1 Phase III



# Line 1 Phase III – Phase I



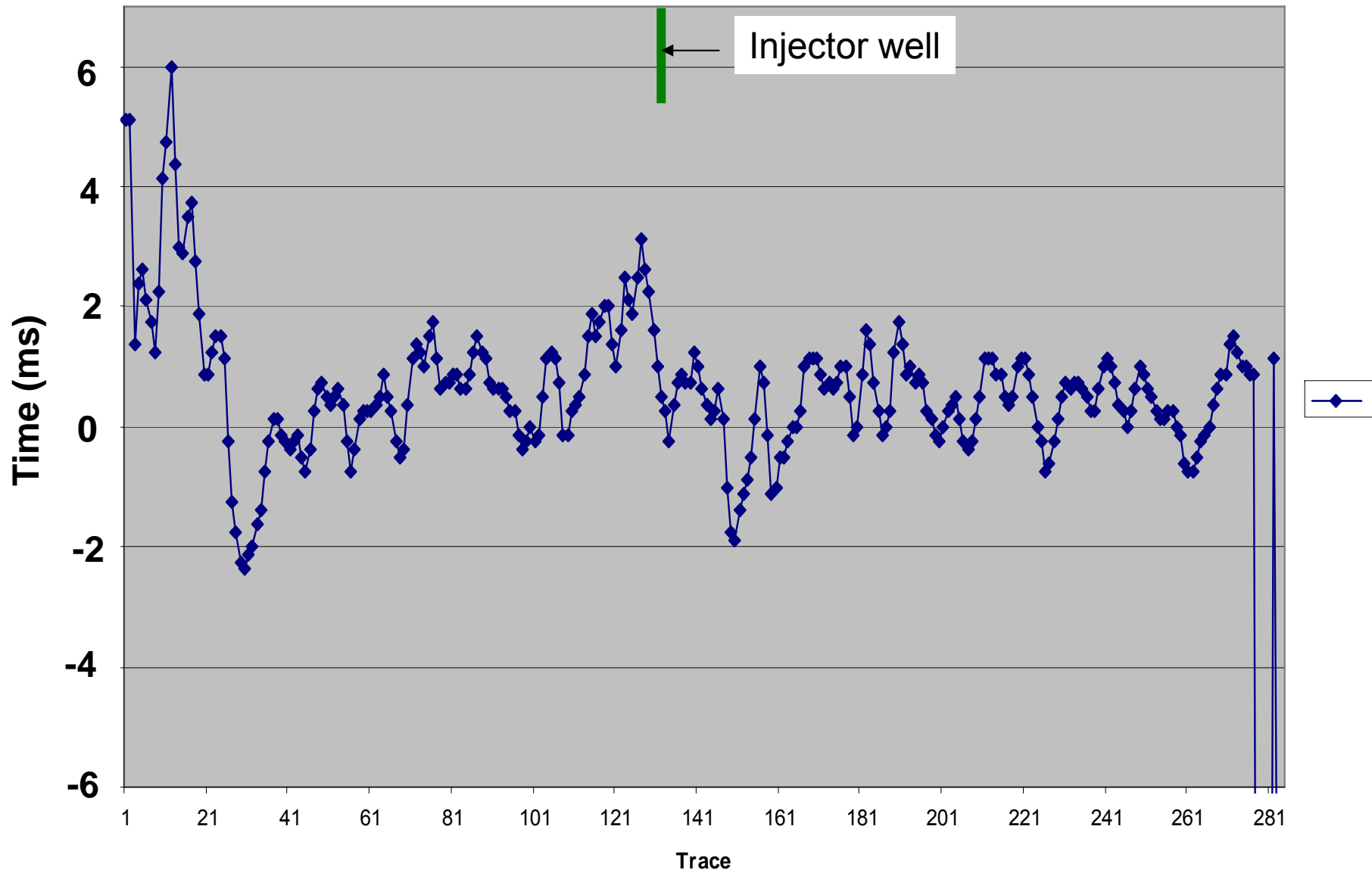
# Line 1 Phase III – Phase I (+12 dB)



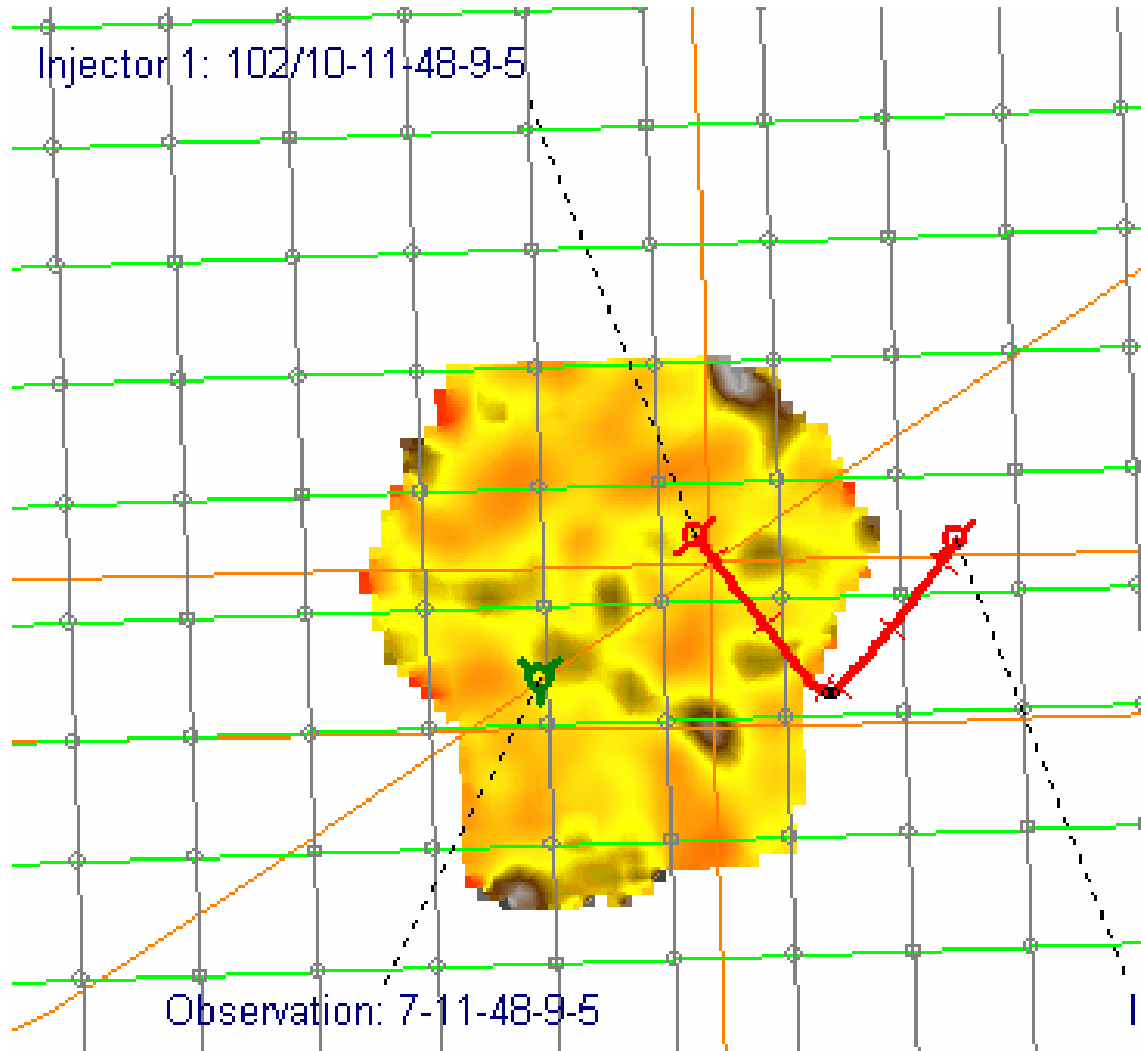
# Line 1 Phase III – Phase I Ardley – Viking isochron

N

S

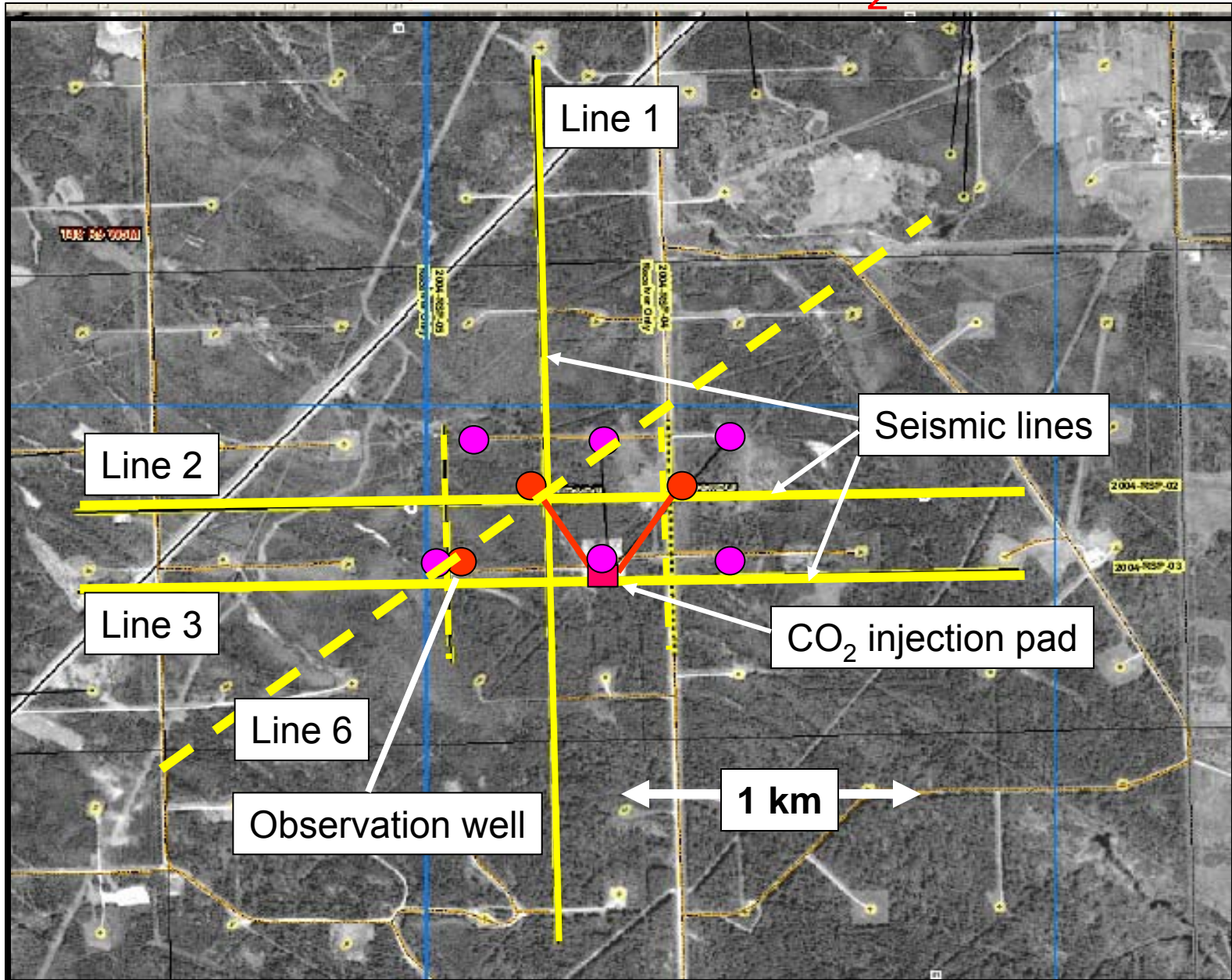


# Viking – Ardley $\Delta t$ (Phase II – Phase I)

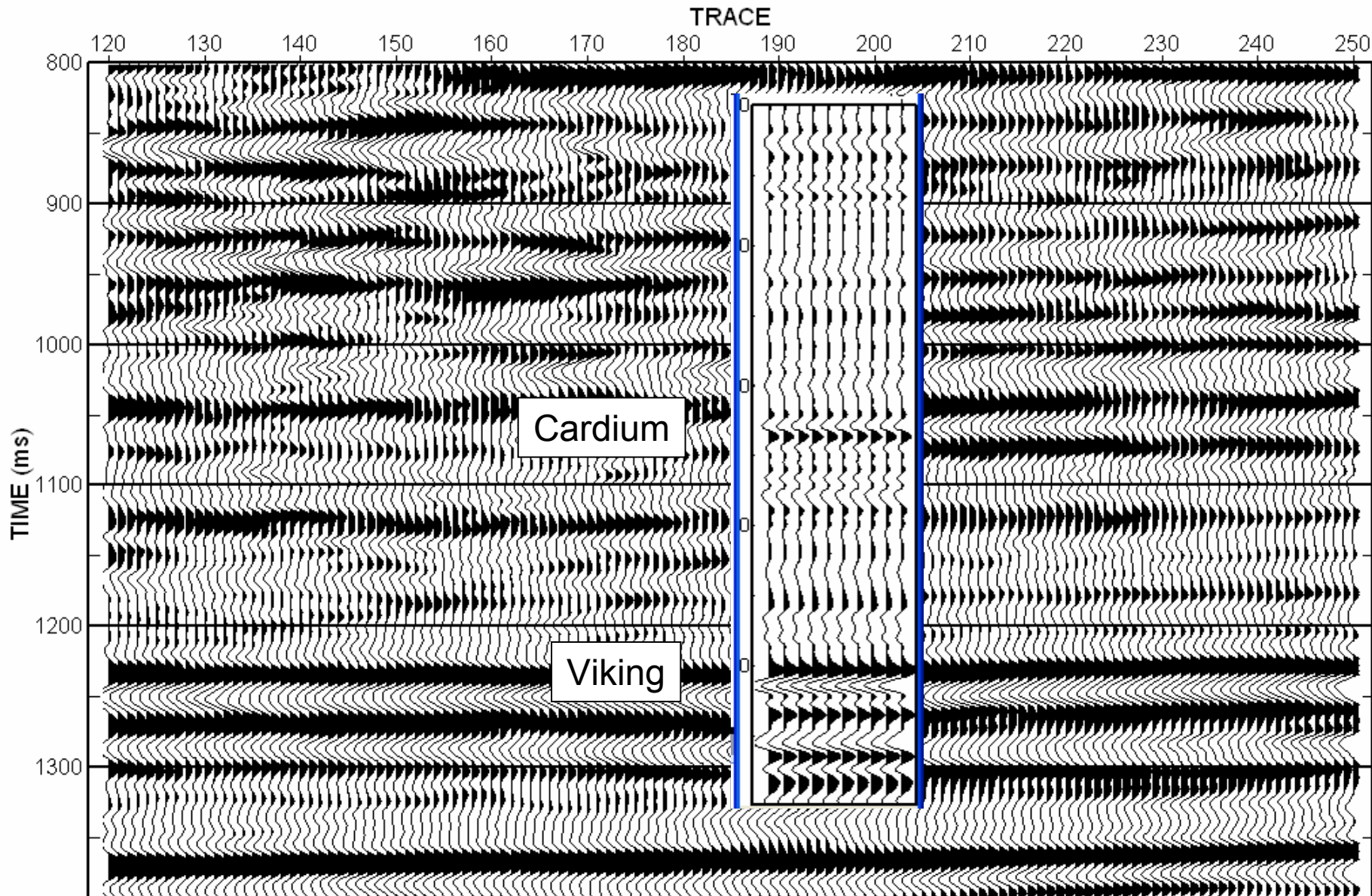




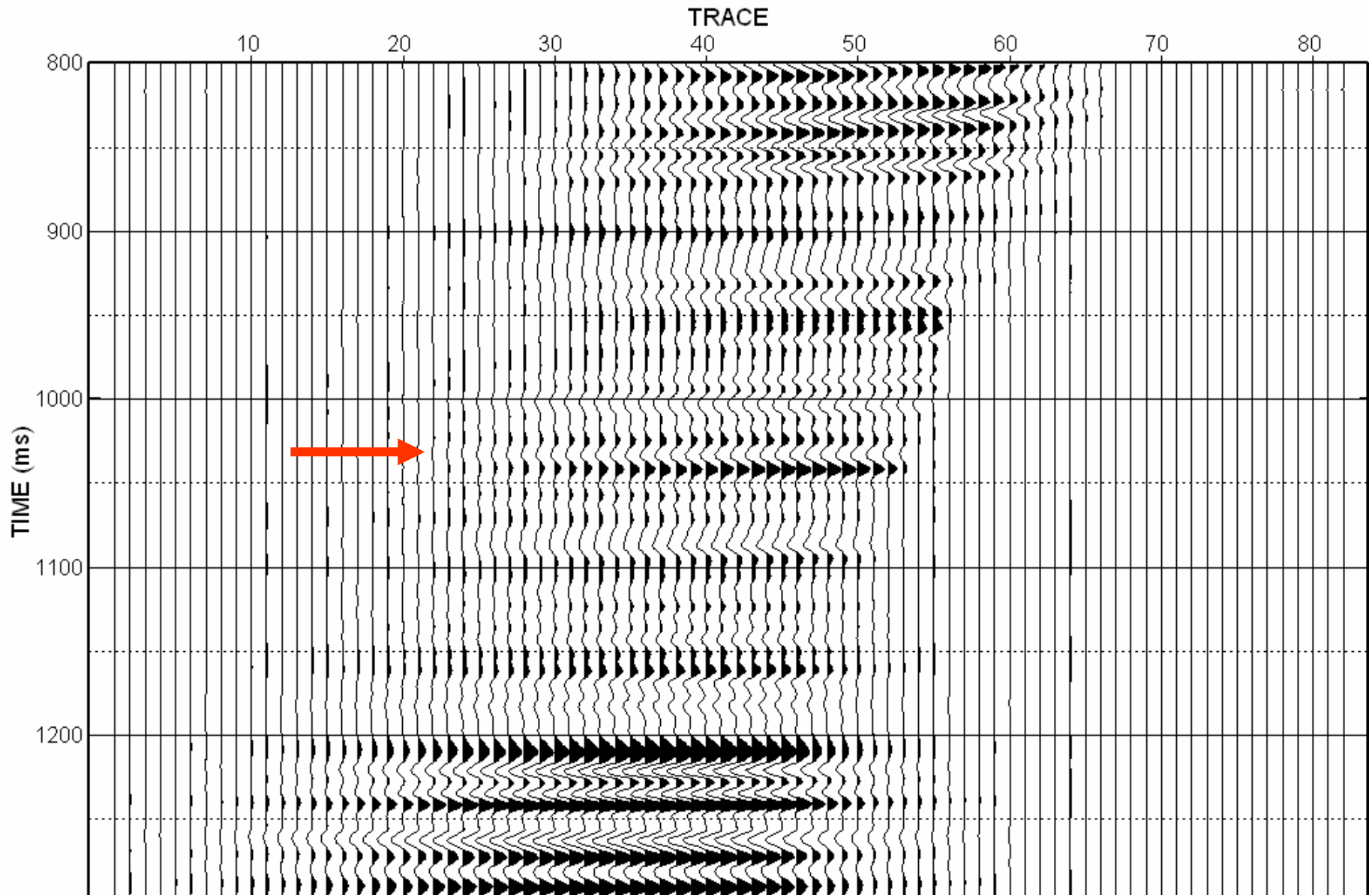
# Seismic lines, Penn West CO<sub>2</sub> EOR Pilot



# Surface seismic and VSP corridor stack

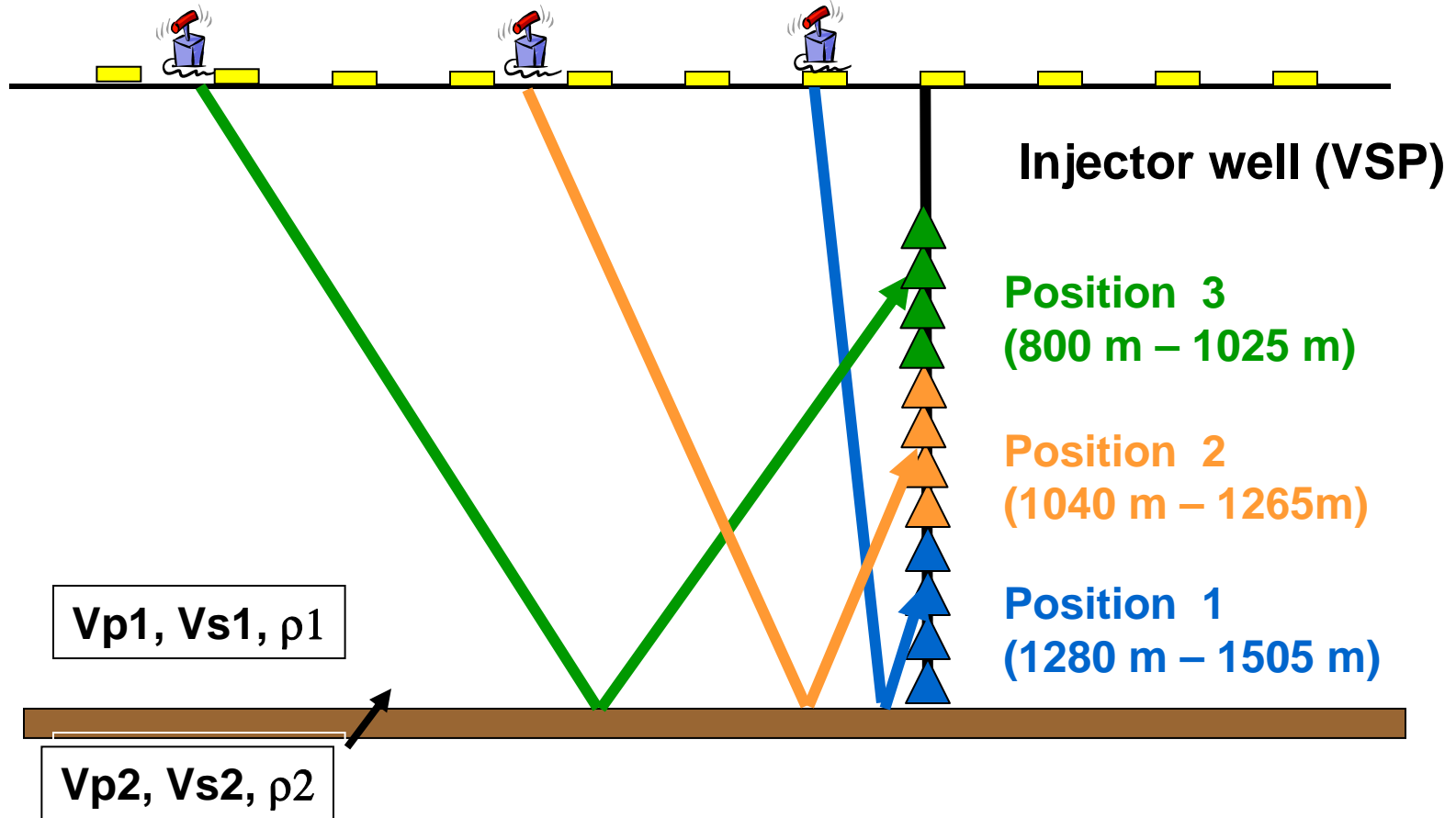


# 500 m offset VSP, migrated image



# Multicomponent surface seismic and offset vertical seismic profile (VSP)

surface seismic 3C receivers



# Discussion

- No faults were mapped in pilot area
- Time-lapse surface seismic data indicates no leakage into shallow aquifers
- CO<sub>2</sub> confined to thin zone in reservoir
- Difficult to track CO<sub>2</sub> within reservoir with surface seismic data through imaging
- VSP data exhibits amplitude change at Cardium event (previous work).
- Choice of seismic monitoring program must be site specific

# Perspective on CSS (carbon capture and storage)

- Current global CO<sub>2</sub> emissions are ~30 Gt/year
- Assume CCS contributes 20% of reductions
- Sleipner CCS project (StatOil) 1 Mt/year
- Need 6,000 Sleipner-sized projects to meet target
- All these would need to be monitored
- That's a lot of seismic data !

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- Hampson Russell (ProMC, Pro4D)
- Gedco (Vista)