

Identifying indicators of residual oil zone formation in the Illinois Basin

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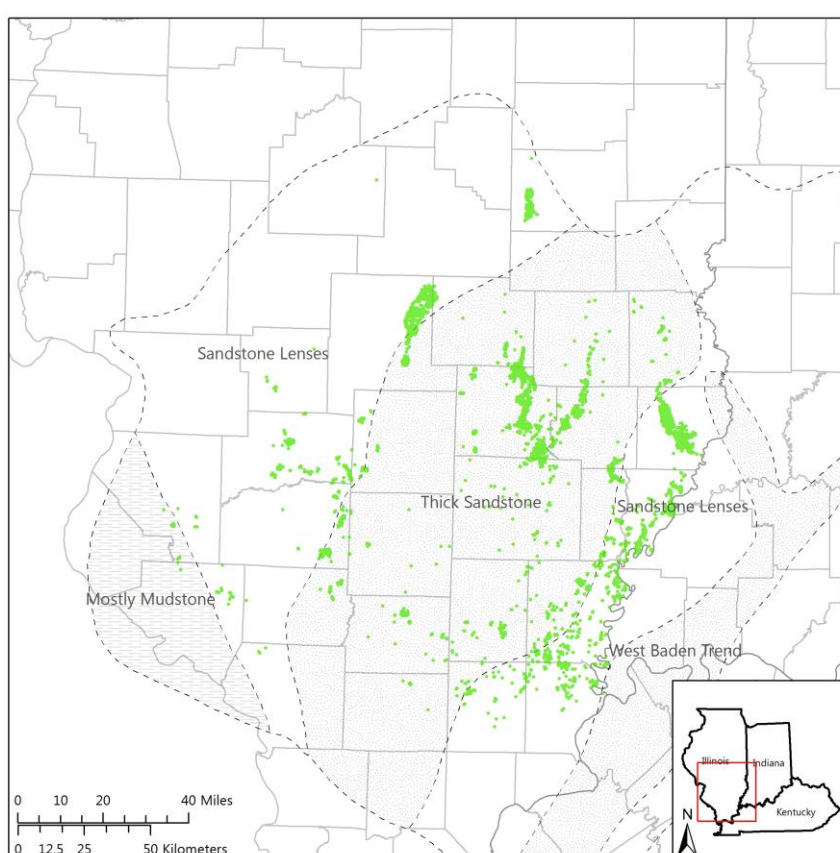
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Project Description

The thick Cypress Sandstone is being investigated in the Illinois Basin to determine if a basin-wide residual oil zone (ROZ) exists. To form a ROZ, oil must be displaced throughout the formation and then be displaced by natural brine migration over geologic time. Studies have focused on the mechanisms of ROZ formation and localized ROZ indicators, but, by understanding the regional consequences of ROZ formation, additional criteria emerge for ROZ identification. For example, if the Cypress Sandstone contains a ROZ, the thickness and areal extent of the sandstone across the Basin implies huge fluid flux. Thus, a regional ROZ has broad implications for the Basin, raising questions as to where the displaced oil went and from where the invading water was sourced.

The Cypress Sandstone is truncated in the subsurface along its northern and western termini by younger Pennsylvanian strata along an angular unconformity, whereas the southern and eastern boundaries are exposed in outcrop. Depending on the timing of oil emplacement and basinal hydrodynamic regime, three possible ROZ indicators are postulated: (1) oil was trapped below the unconformity to the north or west or passed into overlying Pennsylvanian sandstones, (2) migrated to the south or east where oil seeps and tar mats might be expected in the outcrop belt, or (3) migrated into updip Cypress strata that were subsequently eroded in the geologic past. Integrating studies of fluid properties with broader regional indicators via basin analysis increases confidence in the mechanisms of ROZ formation and aids in identifying ROZs.

Cypress Sandstone Background

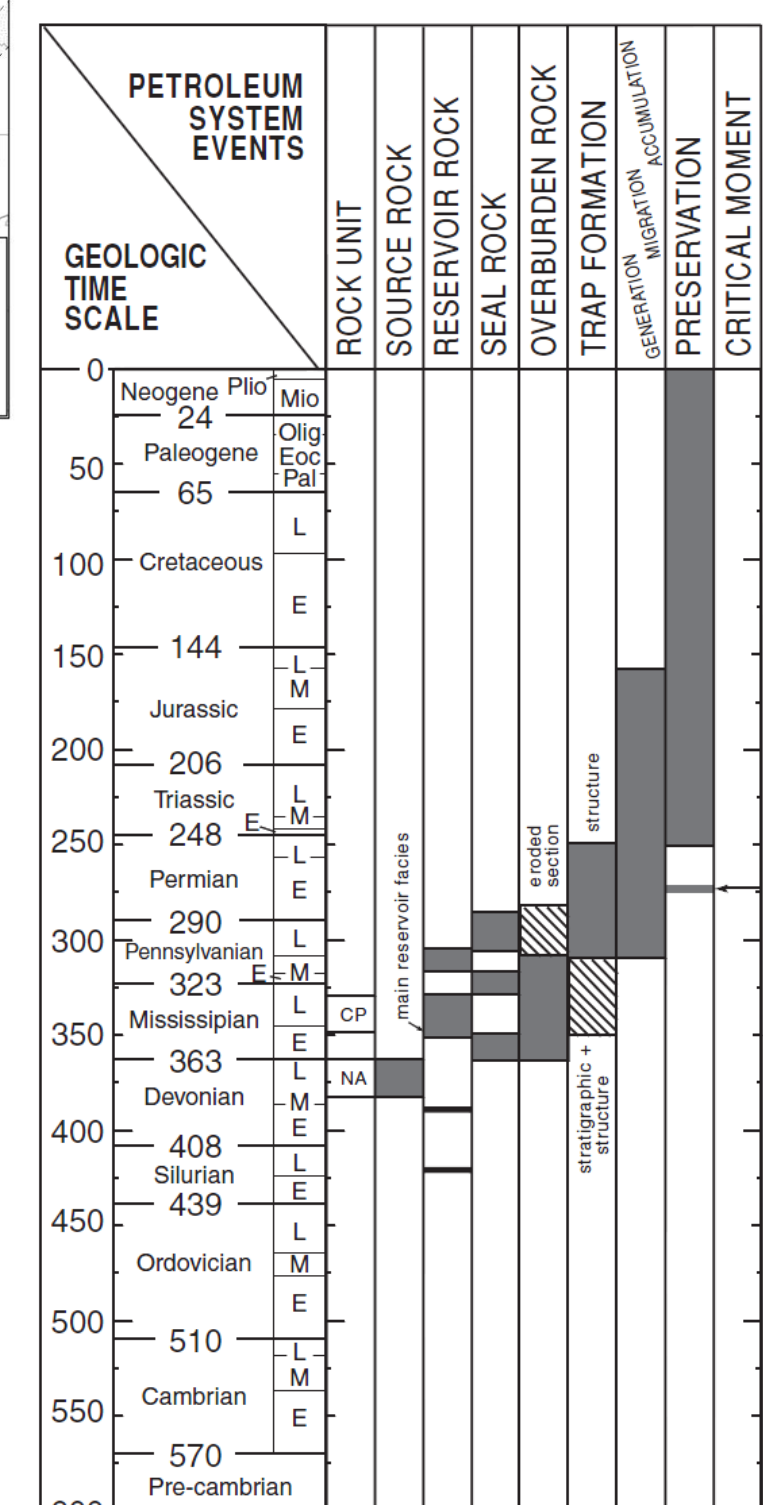


- Thick sandstones are Nonconventional CO₂-EOR target and have potential for residual oil zones (ROZ)

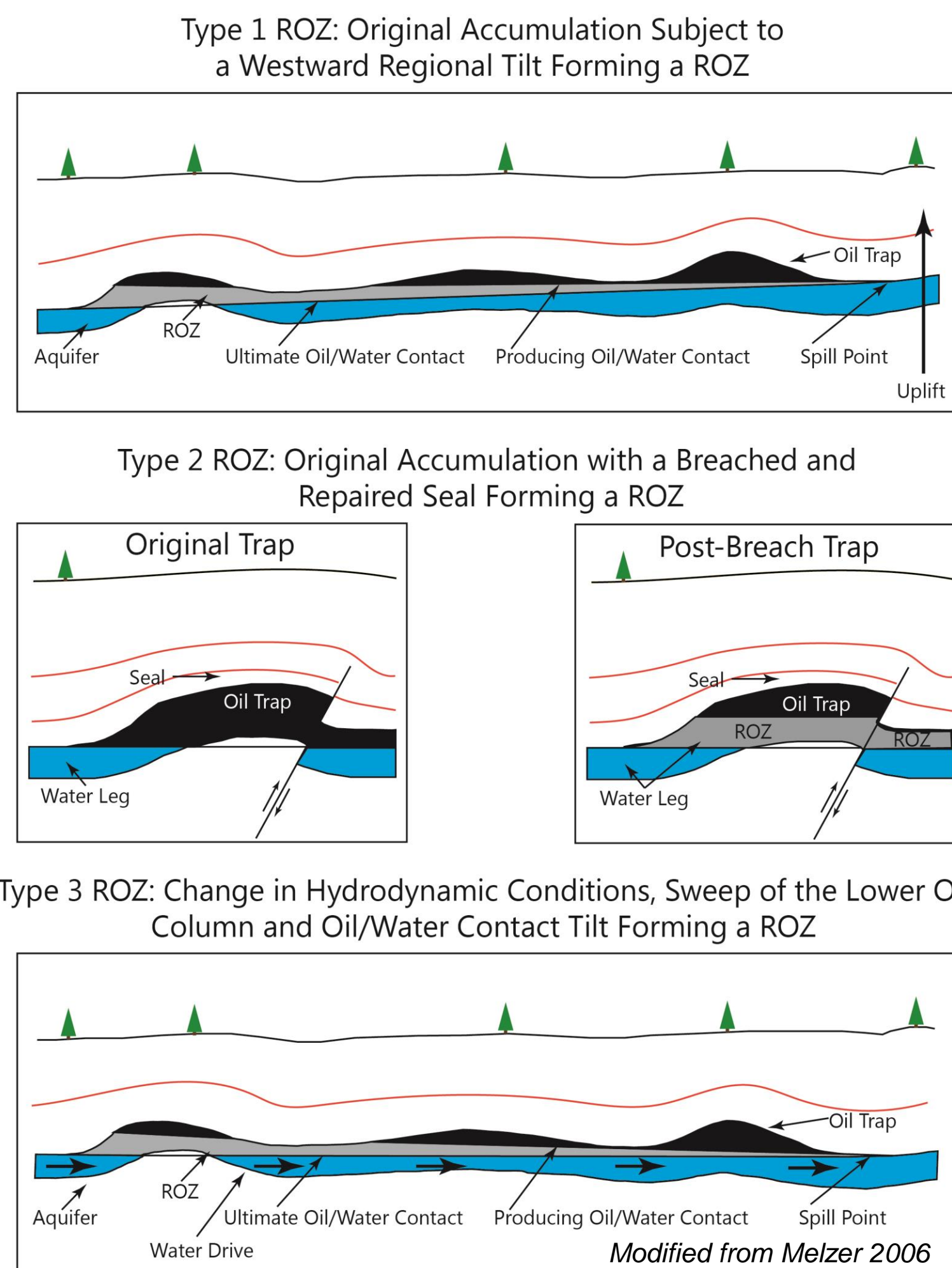
Map of Cypress Sandstone depositional facies and productive areas

- If a ROZ exists, how did it form and what are the geologic consequences of its formation?

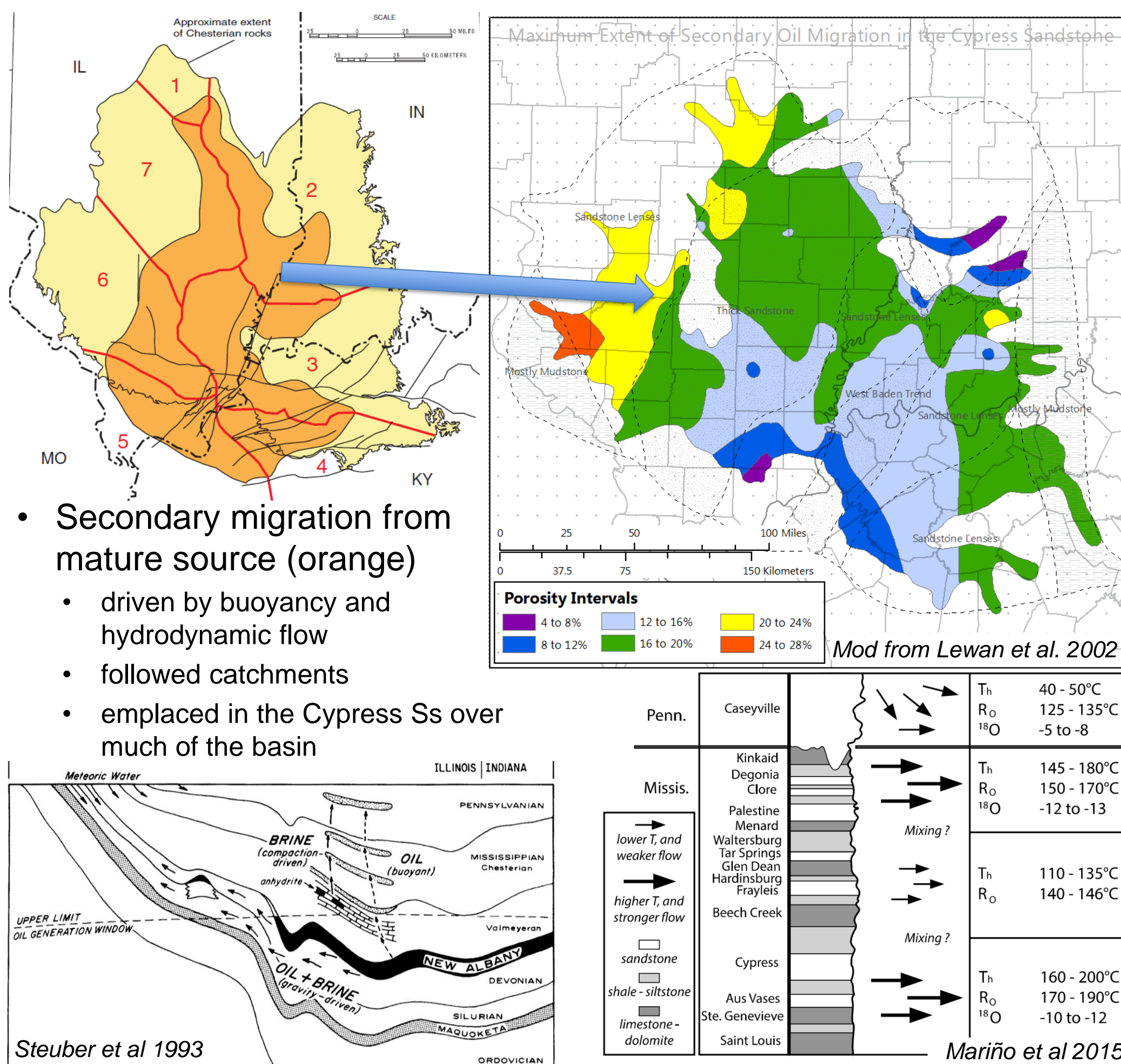
Right: Diagram of events in the Illinois Basin petroleum system (from Lewan 2002)



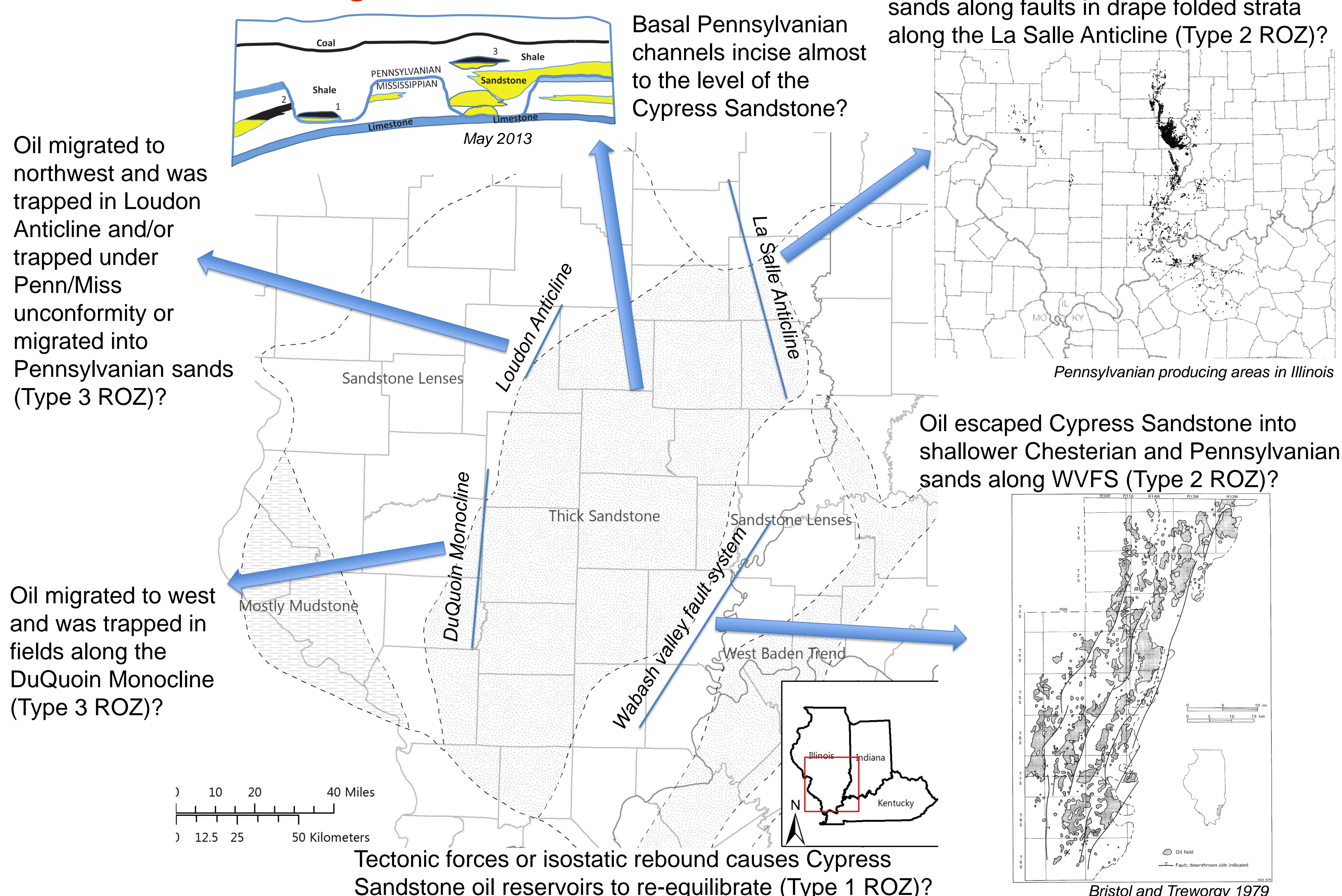
How ROZs Form



Petroleum Migration/Emplacement in the Cypress

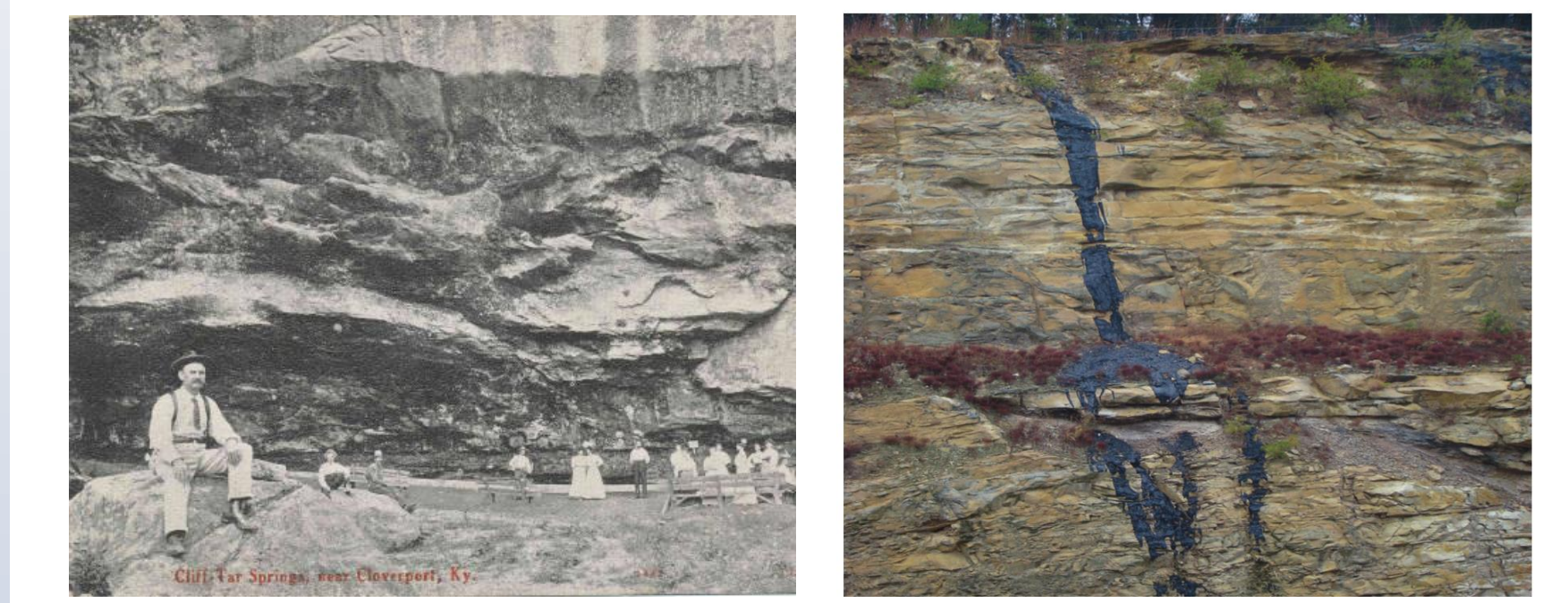


Potential ROZ Forming Mechanisms in the Illinois Basin



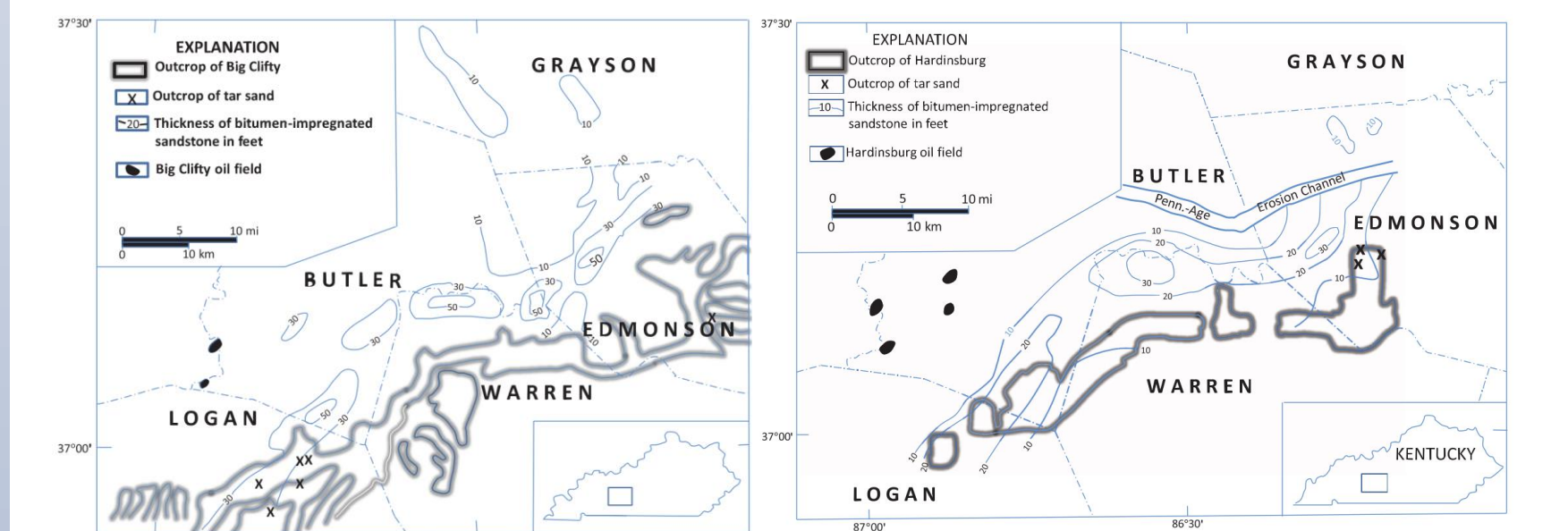
Indicators to Look For

- Residual oil saturation in outcrops; tar seeps



Tar Springs Sandstone, Kentucky Tar seep, Kentucky (May 2013)

- Heavy oil sands near outcrop belt



Maps of heavy oil deposits in sandstones above the Cypress Ss, Kentucky (May 2013)

- Geochemical and compositional evidence of biodegradation of Cypress Sandstone oils
 - Decrease in API Gravity and n-alkanes
 - Sterane and hopane biomarkers absent
- Evidence of compositional changes resulting from secondary migration through the Cypress Sandstone into overlying formations
- Evidence of petroleum trapped in fault sealing mineral cements
- Evidence that magnitude of tilt of oil-water contacts reflects tectonic or isostatic movements

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Acknowledgments

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