CO_2 Sequestration: Geology and Serious Volume Issues

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Bill Shefchik

Associate Geologist

Burns & McDonnell

Engineering Company

Founded 1898

Geological Reservoirs

- It all came out of the earth;
- Concept:
  - → Put it back into the earth

Volume Issues

Serious Volume Issues

- 750 MW Reference Plant
  - Supercritical Pulverized Coal
  - Annual CO_2 Output: 5 Million Tons
- Dissolved CO_2 Model

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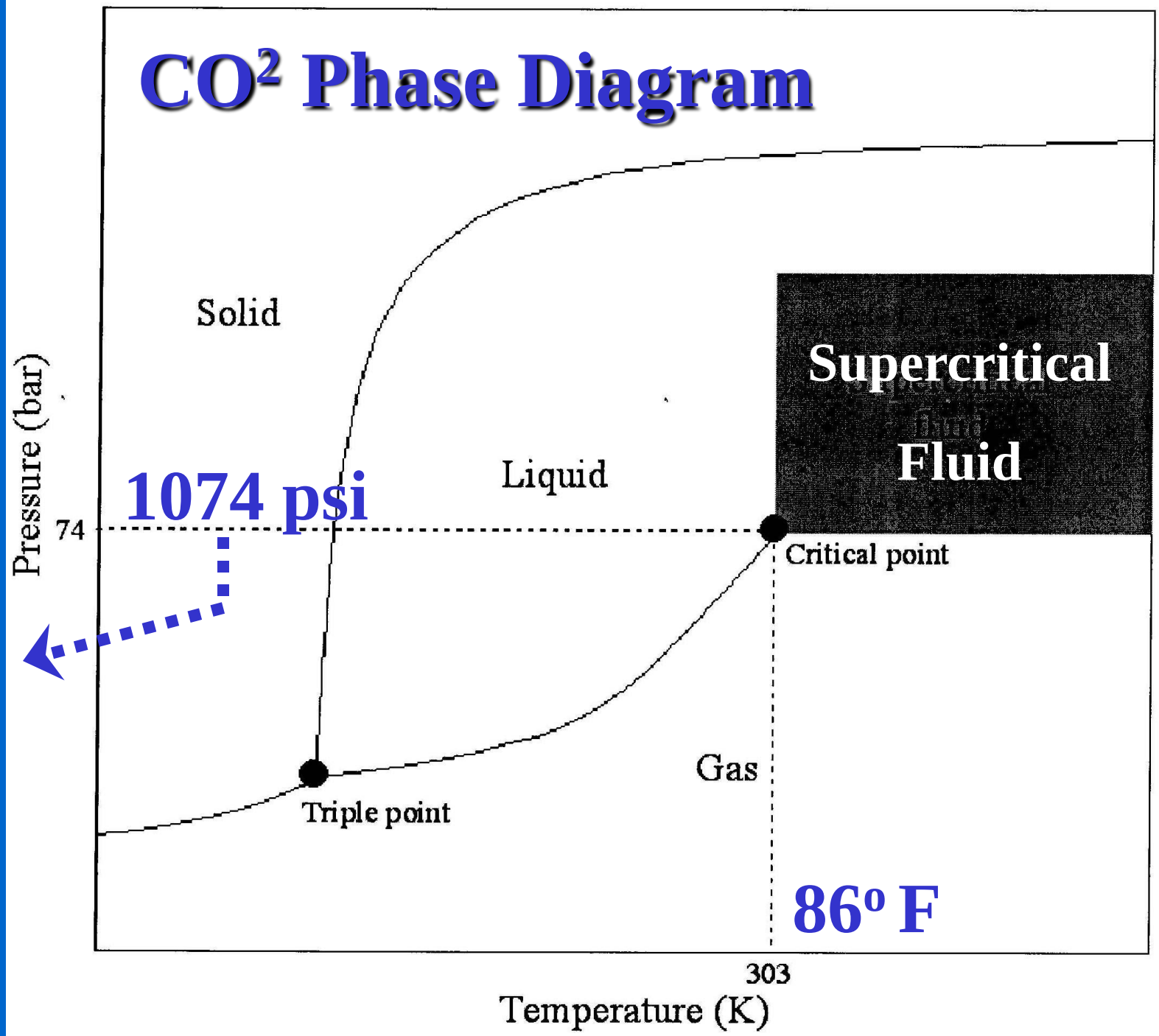
CO^2 Phase Diagram



@ 0.5 psi per foot of depth: 2,148 ft

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Serious Volume Issues

- Need Potential Reservoir Rock Where Sedimentary Strata are over 2,000 feet Thick
  - Significant Parts of the Country Have Shallow Basement Rock
  - No Potential Reservoirs at the Depths Required
- Within Regions of Thick Potential Reservoir Rock Strata, Traps must Be Defined and Proven
  - Equivalent to Proving Oil & Gas Reserves

Serious Volume Issues

- 750 MW Reference Plant
  - Supercritical Pulverized Coal
  - Annual CO_2 Output: 5 Million Tons
  - Assume 300-Foot Thick Sandstone Stratum at 4,000 Ft. TD

10 Year Output: 89 Mi ^{2} (10 X 10 Miles)

50 Year Output: 442 Mi ^{2} (21 X 21 Miles)

Serious Volume Issues

- 750 MW Reference Plant
  - Supercritical Pulverized Coal
  - Annual CO_2 Output: 5 Million Tons
  - Assume 300-Foot Thick Sandstone Stratum at 4,000 Ft. TD
  - Dissolved CO_2 Model

200 Year Output: 1,725 Mi ^{2}
(41 X 41 Miles)

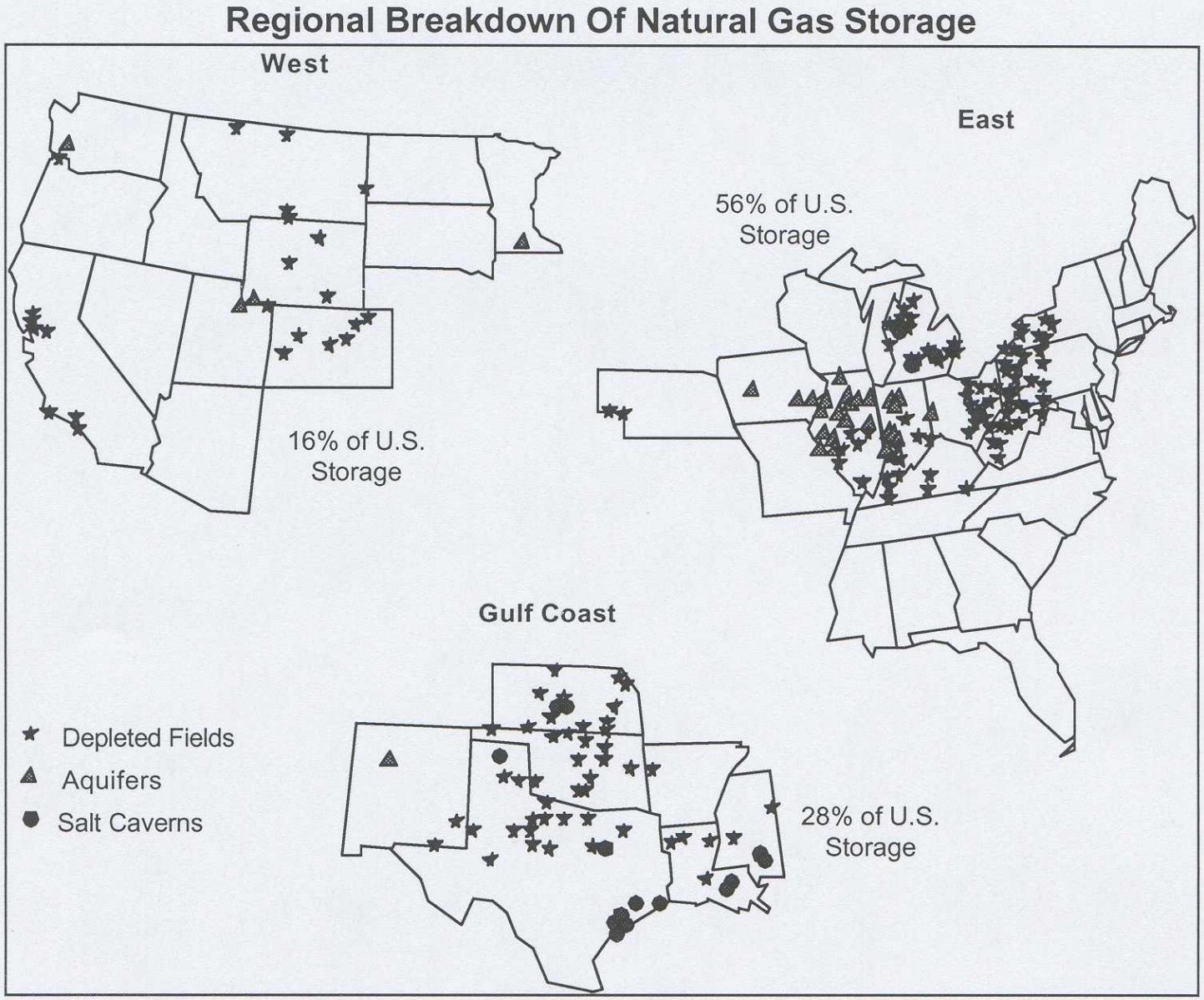
Serious Volume Issues

- 200 Year Output for Two 750 Plants:
  3,450 Mi2
  (59 X 59 Miles)
- Equivalent to a Class 18 Oil Field
  - (16,000 Million BOE +)

→ 20 each Class 18 Oil Fields in U.S.

→ 200 each 750 MW Reference Coal Plants in U.S.

Major Gas Storage Fields



Source: DOE.

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Volume Issues: Mitigating Factors

- Oil & Gas Need Source, Reservoir, and Trap
  - CO_2 Needs only Reservoir & Trap
- Mineralogical Changes due to CO_2
  - May Enhance Reservoir Permeability
  - Trap Rock Permeability likely unaffected
  - CO_2 may be adsorbed into mineral structure

CO_2: Safety Issues

- **Highly Toxic: Asphyxiant**
  - **Repcelak, Hungary, 1969**
    - **Carbolic Acid Plant**
    - **20-Ton Tank Rupture**
    - **Four Persons Dead**
    - **-108 Degrees F**
- **Corrosive**
- **Heavier than Air**

CO_2: Safety Issues

- Pipelines
- Tanks & Plant Infrastructure
- Well Casings and Seals ("Penetrations")
- Aquifer Leakage
- Trap Overspill

CO_2: Safety Issues

- All of These Factored Into Hutchinson, KS Gas Well Explosions, 2001; <u>but,</u> methane is:
  - Lighter than Air
  - Flammable
  - Stored At Lower Pressure

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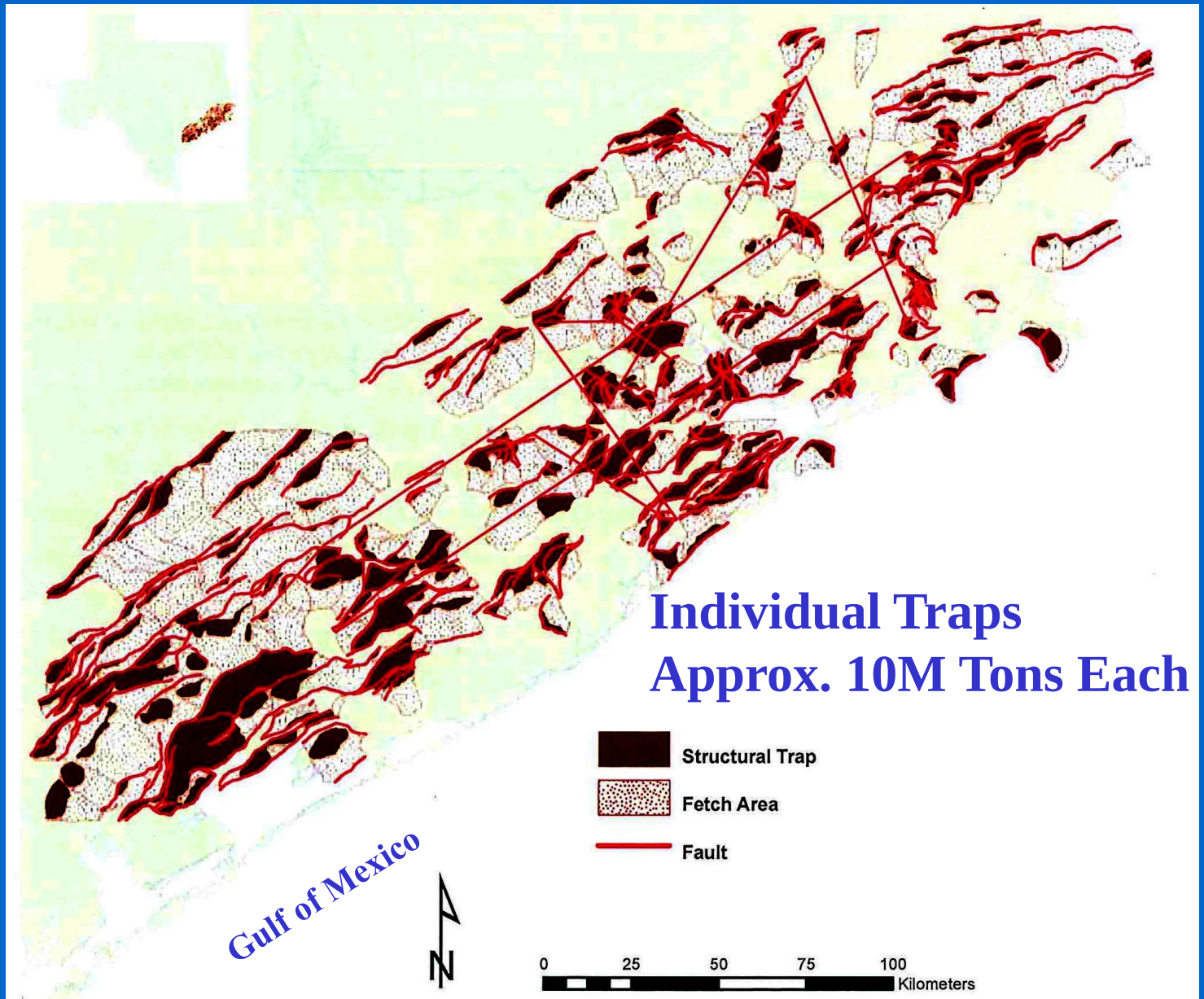
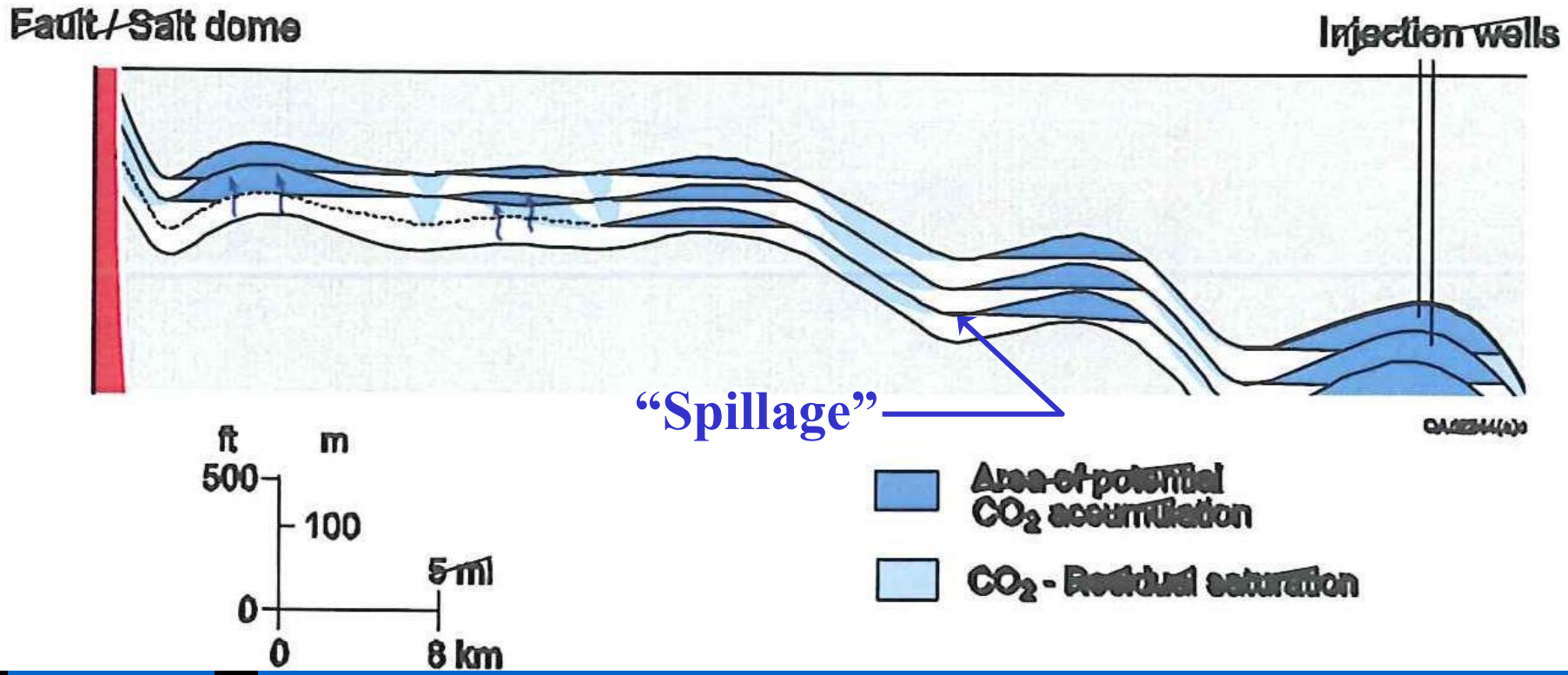
Even Under the Best of Conditions…
Texas Gulf Coast (Nicot, J-P., et al, 2006)



Even Under the Best of Conditions… Texas Gulf Coast (Nicot, J-P., et al, 2006)

Generalized Geologic Cross Section



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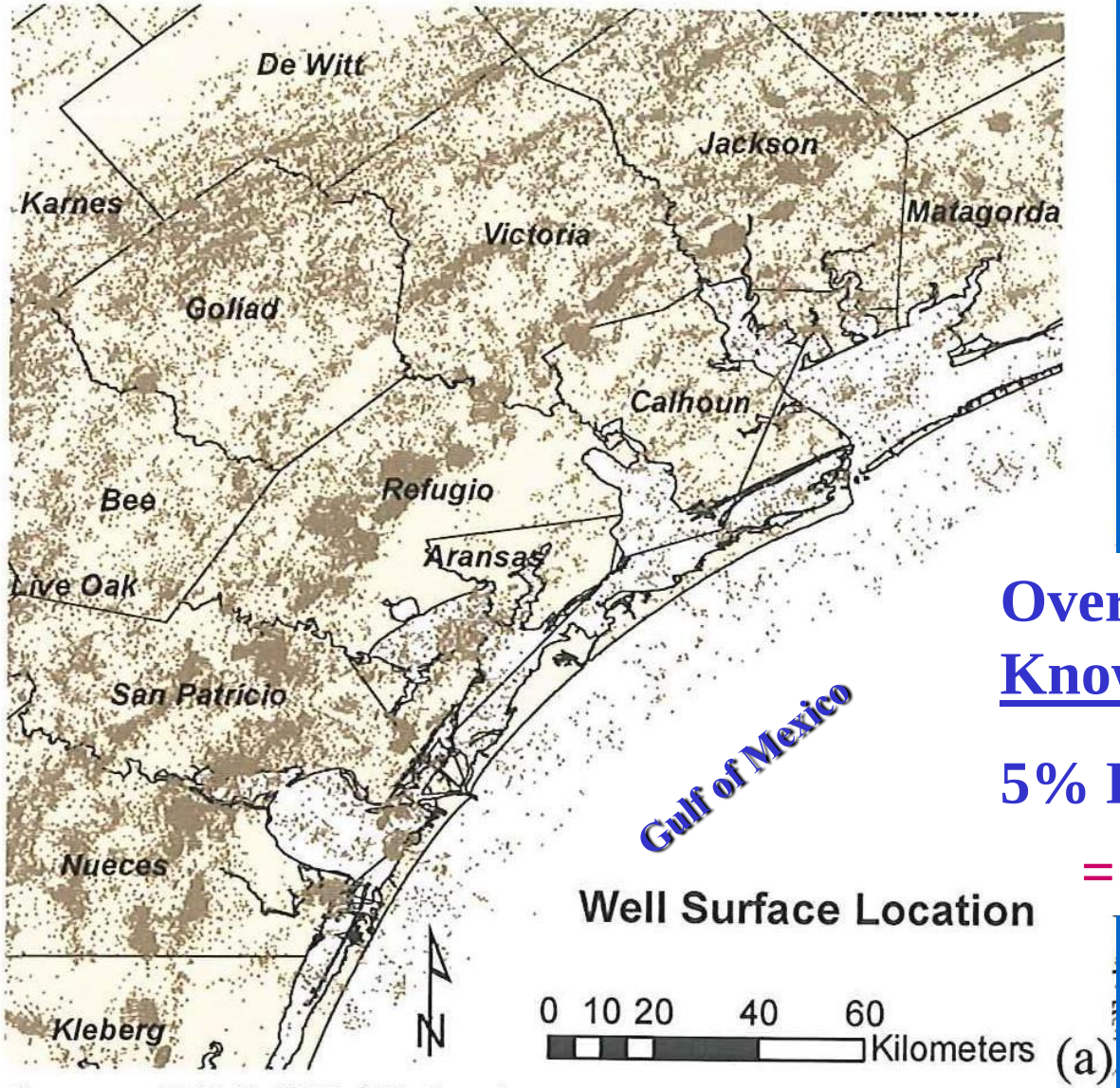

Source: RRC "Well" database

Over 140,000 Known Wells

5% Leakers?

= 7,000 +

CO_2: Safety Issues

- **Bhopal-Type Capability ?**
  - **1984**
  - **Methyl Isocyanate**
  - **Heavier than Air**
  - **Multiple, Linked Safety Issues**
  - **Over 7,000 Casualties**

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Questions