Seismic Expression of Potential Trenton – Black River Dolomite Reservoirs in the Eastern Midcontinent

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Acknowledgements

• **Companies**
  - BP Exploration Company Ltd.
  - Conoco Inc.
  - ChevronTexaco Corp.
  - SEISCO Inc.
  - Seitel Inc.

• **Colleagues**
  - Mark Baranoski, Ohio Division of Geology
  - Dave Harris, Kentucky Geological Survey
  - Jesse Kincheloe, Consultant
  - John Rupp, Indiana Geological Survey
  - Josh Stark, Continental Resources of Illinois Inc.
  - Carl Steffensen, BP Exploration Company Ltd.
  - Larry Wickstrom, Ohio Division of Geology
  - Tina White, Kentucky Geological Survey
Outline

- Hydrothermal dolomite development
- Hydrothermal dolomite: its expression on seismic data
- Space creation and synclinal mechanisms
- Hydrothermal dolomite chimneys
- Examples of potential hydrothermal dolomites as seen on seismic profiles
Potential Trenton-Black River Dolomite Reservoirs:

**Hydrothermal Dolomite Development**

- **Apparent requirements:**
  - High-temperature mineralizing fluids
  - Low pressure (thermobaric)
  - Focused flow through fractures
- **The replacement of calcite results in a volume decrease**
  - Porosity increases 13% in dolomite
  - Formation of collapse breccias
  - Sag in overlying formations
- **Reservoir development**
- **Seismic expression:** narrow synclines or sags

Whitish-blue dolomite crystals have replaced the pink-stained calcite.
Potential Trenton-Black River Dolomite Reservoirs: 

Seismic Expression of Dolomites

- Direct detection of dolomite is difficult
  - Same acoustic impedance as limestone
  - Secondary porosity: invisible with P-wave data
- Sags or synclines above
- Internal reflector changes
- Recognition of faults
- Disruption of lower events
  - including basement offsets

Stop 2: The “Light Bulb” Structure
Potential Trenton-Black River Dolomite Reservoirs:

Space Creation and Proposed Synclinal Mechanisms

- Meteoric Karst
- Evaporite Solution
- Hydrothermal Dissolution (HT “Karst”)
- Extensional Faults
- Transtensional (Wrench) Faults

All create space

Especially if listric

from Davies, 2000
Potential Trenton-Black River Dolomite Reservoirs:

Hydrothermal Dolomite Pipes or “Chimneys”

- Equidimensional deposits
- Fault-controlled HTD breccia “chimney” in the Knox
- Central Tennessee Lead District
- Breccia in hanging wall
- Cambrian sandstone hydrothermal aquifer?

From Tedesco, 1998 as modified by Davies, 2000
Potential Trenton-Black River Dolomite Reservoirs:

**Hydrothermal Dolomite “Chimneys”**

- Vertical HTD chimneys in stratiform dolomite
- Middle Cambrian
- West face of Mount Wapta, southeastern BC, Canada
- ~2000 ft face

*From Davies, 2002*
Potential Trenton-Black River Dolomite Reservoirs:

Mile-High, Hydrothermal Dolomite Breccia “Chimneys”

- Burkesville-Cumberland City, Ky., area
- Knox Zn-Pb mineralization
- Illustrates: character change
  - Except for Precambrian and Cambrian, reflector-character change is unclear
- Faulting
  - Body edges
  - Basement
- Eastern chimney is questionable

from Tedesco, 1998, in Davies, 2000
Potential Trenton-Black River Dolomite Reservoirs:

“Linear” Mineralization Zones along Wrench Faults

- Pb-Zn zone in Ireland
- Note the location of mineralization
  - not present along entire wrench zone
  - present only in dilational jog
  - parallel to the principal compressional stress axis
- Same principle applies to oil and gas reservoirs

from Davies, 2000
Potential Trenton-Black River Dolomite Reservoirs:

Location of Potential Hydrothermal Dolomites

- Proterozoic and Cambrian Provinces
  - ECRB: East Continent Rift Basin
  - EB: English Basin
  - HTB: Hoosier Thrust Belt
  - LH: Louisville High
  - RCG: Rough Creek Graben
  - RT: Rome Trough
Sags in the Knox, High Bridge, and Lexington Dolomite reservoirs associated with Paleozoic carbonates?

No. 1. West Flank of the Louisville Uplift

Dolomite reservoirs associated with Paleozoic carbonates?
No. 2. East Continent Rift Basin, Central Kentucky

Sags parallel Knox surface: Dolomitization of Knox and High Bridge?
Flat above the T-BR (Lexington-High Bridge)
No. 3. Potential Trenton-Black River Dolomite Reservoirs: Bardstown Monocline, Central Kentucky

- Bardstown Monocline
  - formed by wrench faulting
  - At surface: 115 ft of down-to-west displacement in Upper Ordovician and Silurian rocks
  - At Precambrian unconformity
    - Much larger: 1,100 ft of down-to-west displacement
- Several potential gas targets
- Mesoproterozoic unit 4
  - Depth: 6,000 feet
- Pre-Knox Cambrian
  - Depth: 4,500 ft
- Shallower: wrench-fault-associated Trenton-Black River dolomites(?)
  - Depth: 1,500 ft
- Area largely undrilled
No. 4. Potential Trenton-Black River Dolomite Reservoirs:

Western Rome Trough, Southeast Kentucky

- Rockcastle River Fault Zone
- Irvine-Paint Creek Fault Zone
- Kentucky River Fault Zone

- Post Conasauga
- Conasauga
- Rome

Grenville Basement

Scale:
- 10 Km
- 10 Miles
Shallow production
Undrilled play in Rome Trough
Rome Trough formed by Cambrian extension
In Alleghanian(?) reactivation, contractional or transpressional faulting created:
- Rockcastle River Uplift
- Faulted anticline in Rome Trough
  - Top of Rome is < 8,000 ft
Shallower: wrench-fault-associated Trenton-Black River dolomite(?) reservoirs: Raccoon Mountain Field
Sags in High Bridge and Lexington

- Sags in and at edge of Pennyrile Fault Zone