Recovery Act Site Characterization Projects

February 3, 2010

Characterization of the Triassic Newark Basin of Southeastern New York /Northern New Jersey

Daniel Collins & Philip Papadeas - Sandia Technologies, LLC

John Conrad & Chris Brown – Conrad Geoscience Corp.

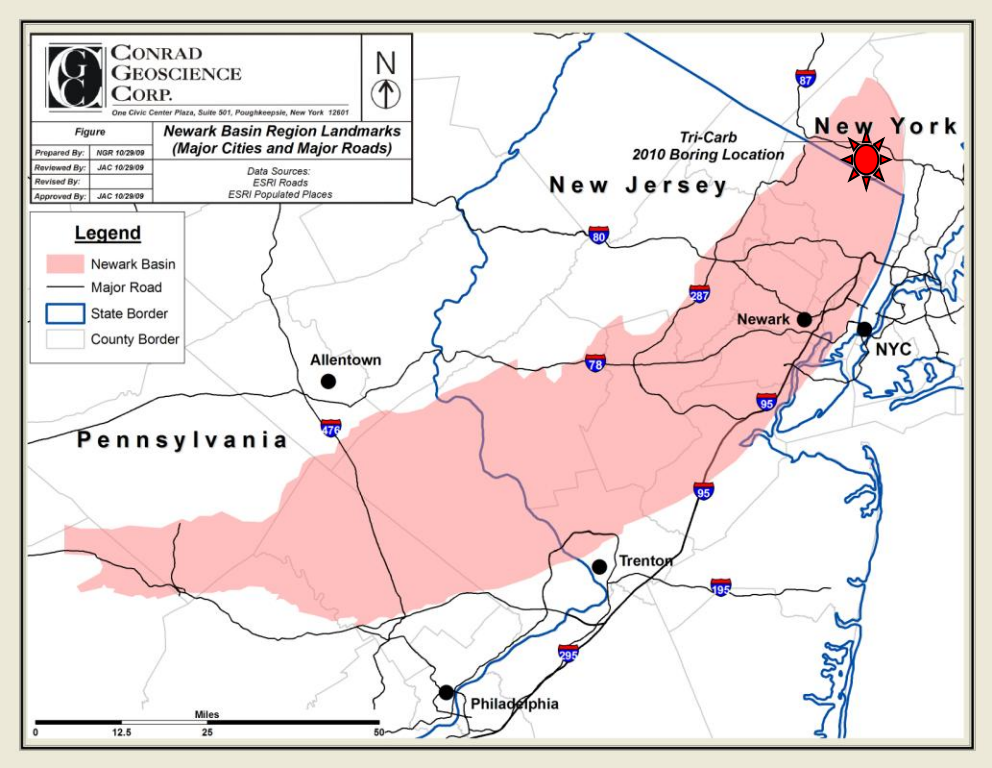
February 3 – 4, 2010 • National Energy Technology Laboratory • Pittsburgh, Pennsylvania

Sandia Technologies, LLC

CONRAD GEOSCIENCE CORP.
One Civic Center Plaza, Suite
501 Poughkeepsie, NY 12601

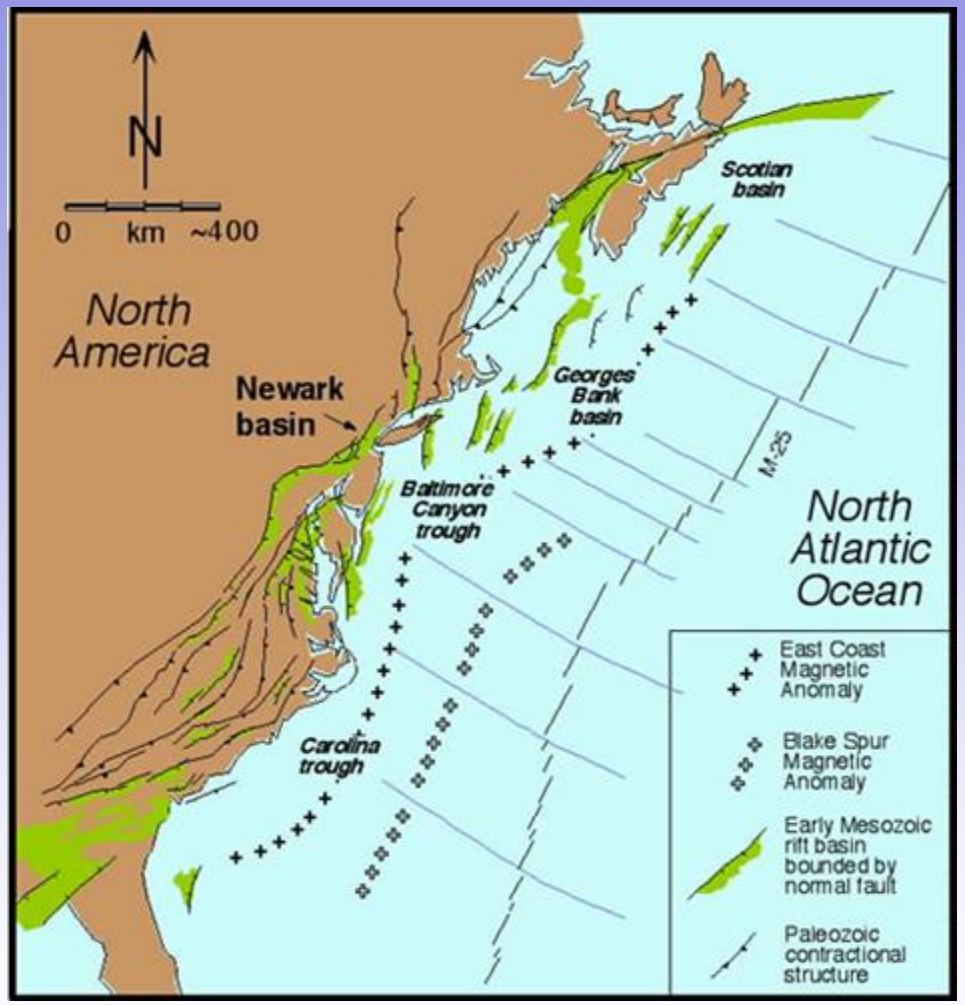
- **Acknowledgment**: This material is based upon work supported by the Department of Energy [National Energy Technology Laboratory] under Award Number DE-FE0002352 and the New York State Energy Research & Development Authority.

Physiogeographic Setting of the Newark Basin



- Newark Basin stretches from Rockland County, New York, southwest across northern New Jersey, and into southeastern Pennsylvania (140 miles long by 32 miles wide)
- Geographic extent ~ 2,700 square miles
- Merges into the Gettysburg Basin
- The Newark Basin is in close proximity to large population areas and a heavily industrialized section of the country (28 MM tons/year CO_2 in closest NY/NJ counties)
- Other potential geologic sequestration options are either offshore or well inland west of the Allegheny Front

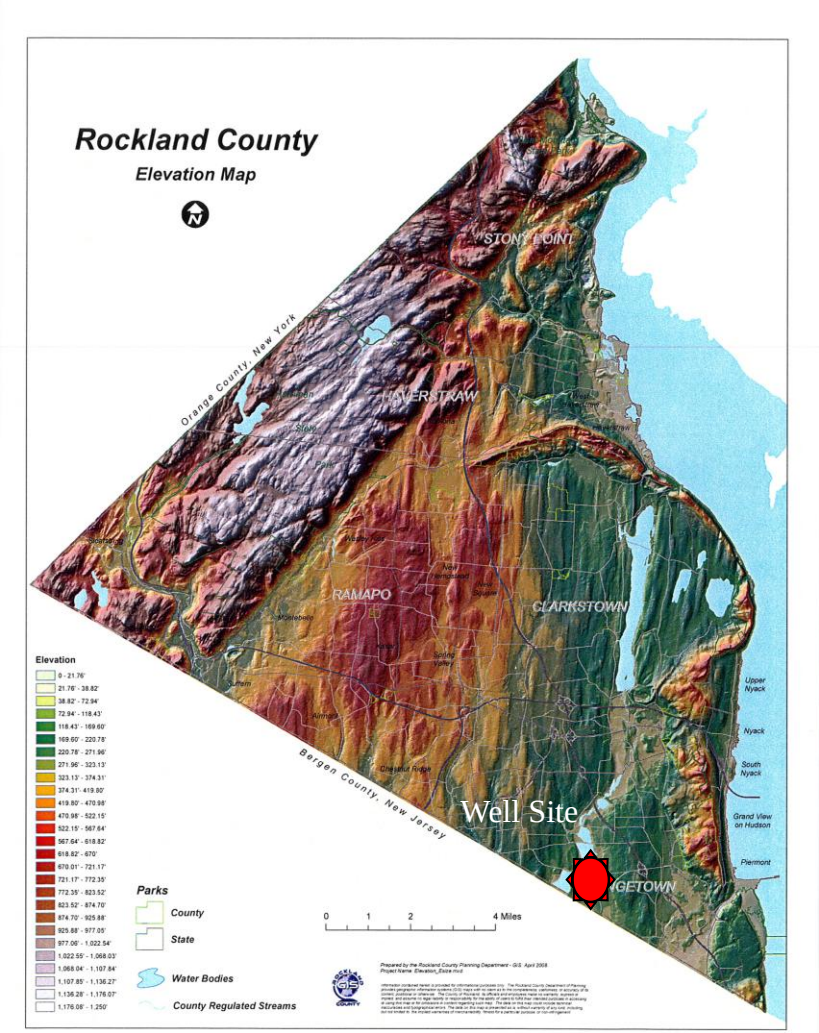
One of a Series of Basins along Eastern North America



- Includes both "exposed" and "buried" basins of Jurassic-Triassic Age (Newark Basin is exposed) and offshore basins
- Formed by the "breakup" & separation of North/South America from Europe and Africa
- Basins generally set up by a border fault (western)
- Sediment infilled the basin from adjoining areas

Withjack et al., 1998

Newark Basin in Rockland County, New York

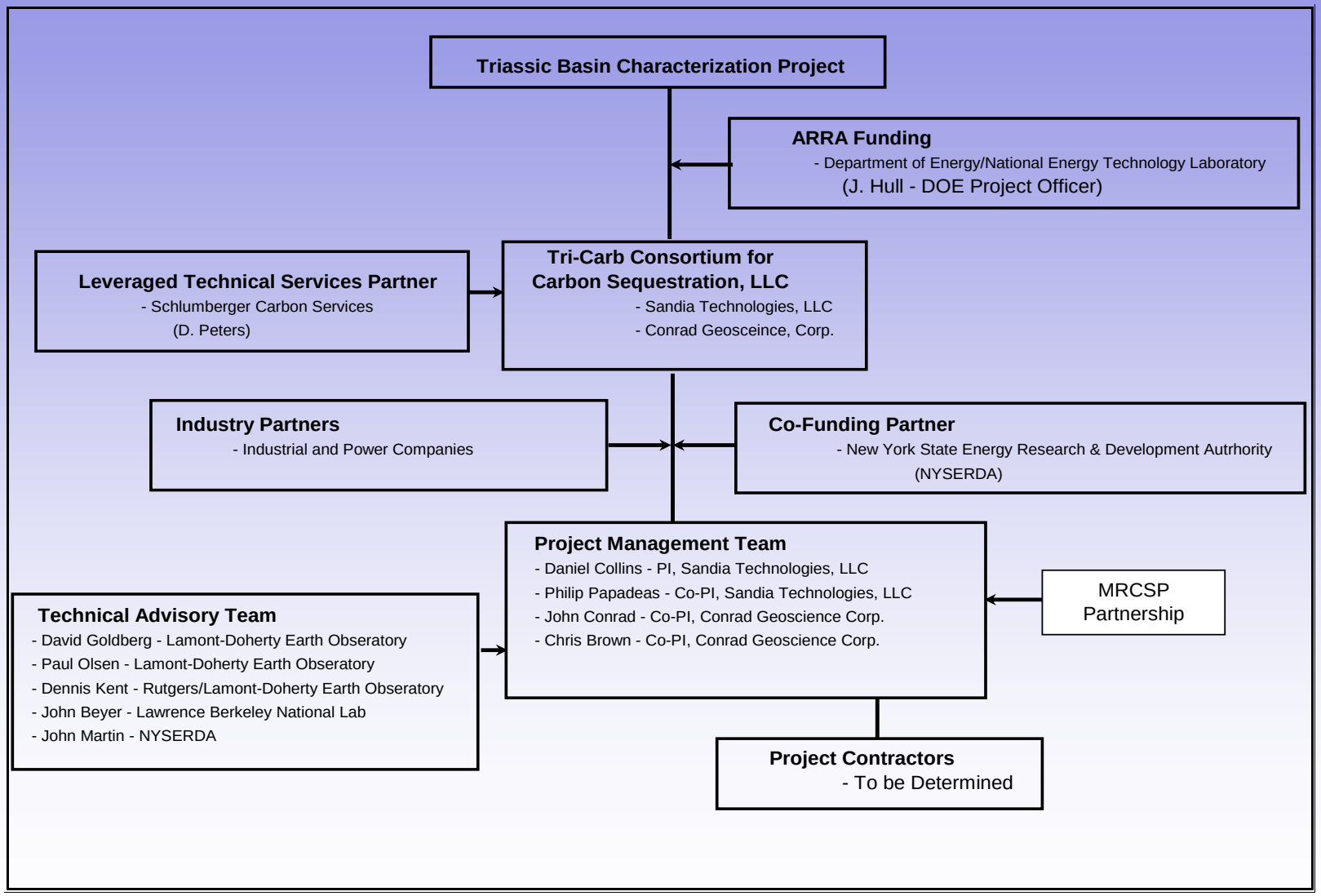


- Ramapo Fault forms the western border fault, running southwest to northeast
- Palisades Sill crops out along the western side of the Hudson River of New York and New Jersey, close to the eastern margin of the basin
- General dip is to the west-northwest, towards the border fault (~10 to 15 degrees). Expect a south-southwestern component of dip into the basin as well at the project site.

Project Team

- Tricarb Consortium for Carbon Sequestration, LLC to lead the effort (Sandia Technologies, LLC and Conrad Geoscience Corp.)
- Leveraged Technical Services Partner – Schlumberger Carbon Services
- Lawrence Berkeley National Laboratory (Federally Funded Research and Development Center (FFRDC)) to provide geochemical modeling
- Lamont-Doherty Earth Observatory – Expertise in the Newark Basin (Newark Basin Coring Project)
- Co-Funding Partner – New York State Energy Research & Development Authority (NYSERDA)

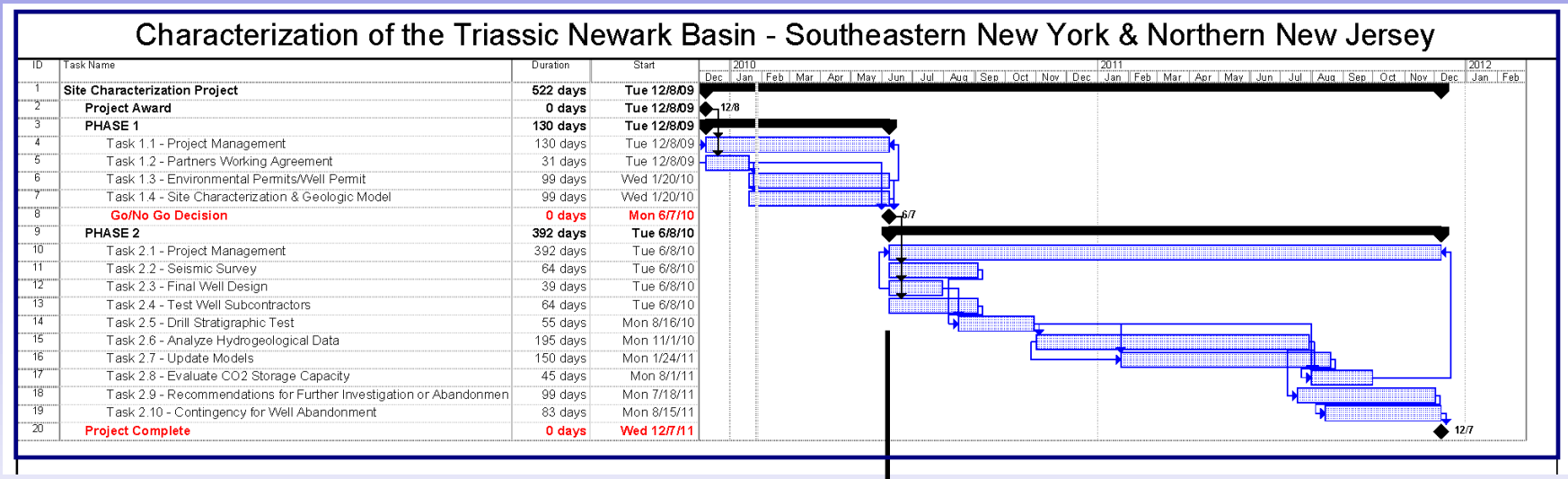
Project Organization



Project Objectives

- Demonstrate that geologic sequestration of CO_2 offers an effective and viable large-scale mitigation approach to managing greenhouse gas emissions from industrial sources in the northeastern United States; and
- Create meaningful near-term and long-term employment, building and initiating the foundation for a CCS industry using the Newark Basin geologic formations

Project Schedule



Phase 1 | Phase 2 →

Phase 1 - Pre-Operational Site Characterization and Permitting

- Task 1.1 – Project Management & Planning
- Task 1.2 – Finalize Agreements
- Task 1.3 – Obtain Environmental Permits & Well Drilling Approval
- Task 1.4 – Compile Existing Data & Develop Geological Model

Task 1.3 Obtain Environmental Permits & Well Drilling Approval

- New York State Department of Environmental Conservation (NYSDEC) – Stratigraphic Test Well
- Local Approvals/Permitting
- State Environmental Quality Review (SEQRA)
  - Prefer a Type II Action (cite Section 617.5(15), which applies to minor, temporary uses of land having negligible or no permanent impact on the environment; and Section 617.5(18), which applies to information collection, including basic data collection and research, including subsurface investigations)
  - Or Negative Declaration from the Town (which would involve completing an Environmental Assessment Form & a noise study)

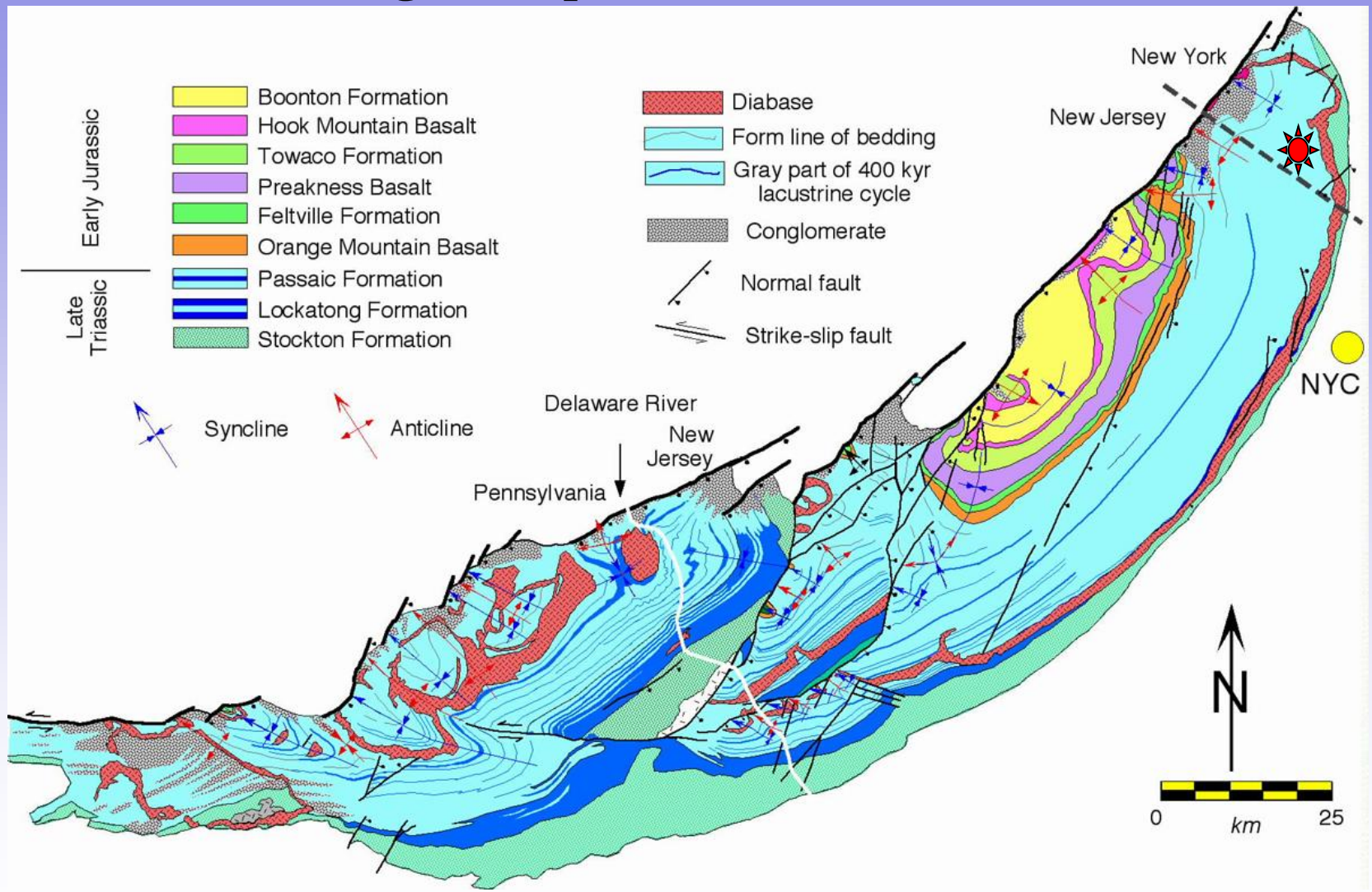
Task 1.4 – Compile Existing Data & Develop Geological Model

- Analyze Existing Data
- Develop GIS Database
- Develop Conceptual Geologic Model
- Review Conceptual Model
- Produce 3-D Model Framework

Sources of Existing Basin Data

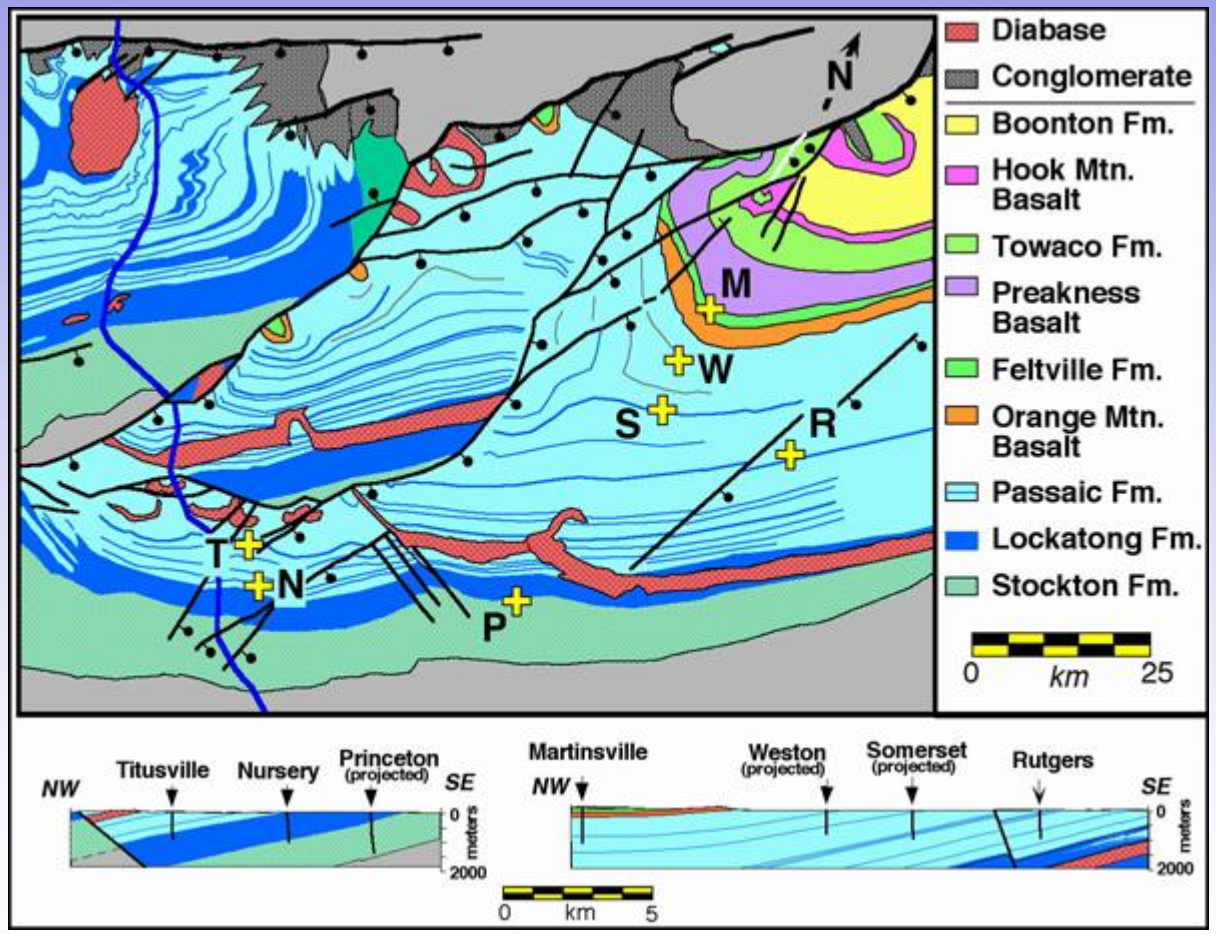
- Newark Basin Coring Project (7 wells with 20,000 feet of core)
- Outcrop Areas
- Studies where Basin formations are freshwater aquifers
- Superfund sites where Basin formations are contaminated
- Oil & gas exploration wells (Pennsylvania)
- Geophysical data (seismic, gravity, magnetics)

Geologic Map of the Newark Basin



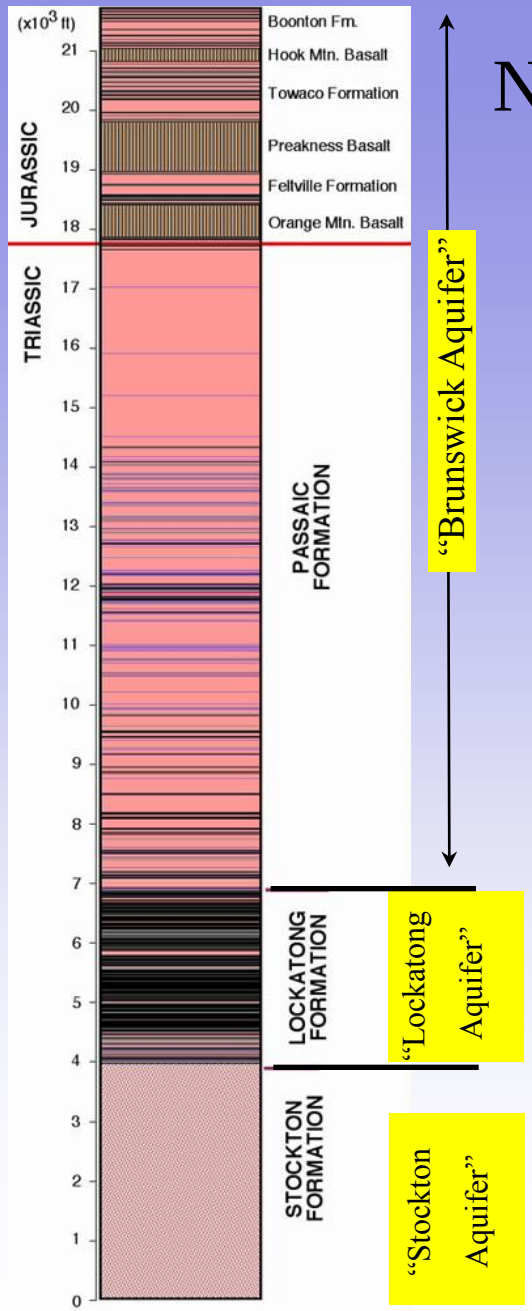
from Schlische (1992) and Olsen et al. (1996).

Newark Basin Coring Project



- 7 wells spaced laterally to see the vertical section
- Top & bottom overlap of wells allows for a correlation and building a “continuous” geologic section
- Limited penetration of the basal Stockton Formation

Newark Basin Stratigraphy

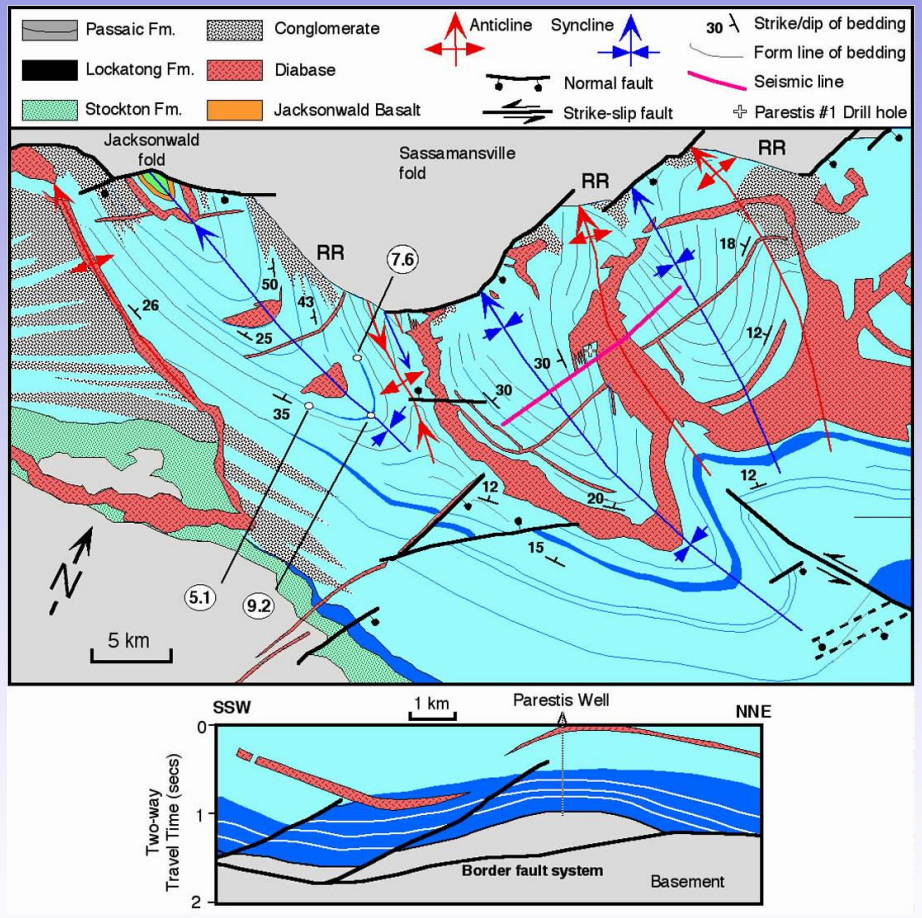


Playa lake and mudbank shales of the Passaic Fm provide secondary "seal" cap – up to 10,000 feet thick

Deep lake and mudflat shales of the Lockatong Fm provide primary "seal" cap – up to 3,000 feet thick

Target is fluvial-alluvial sandstones of the Stockton Fm – up to 6,000 feet thick (or more along border fault)

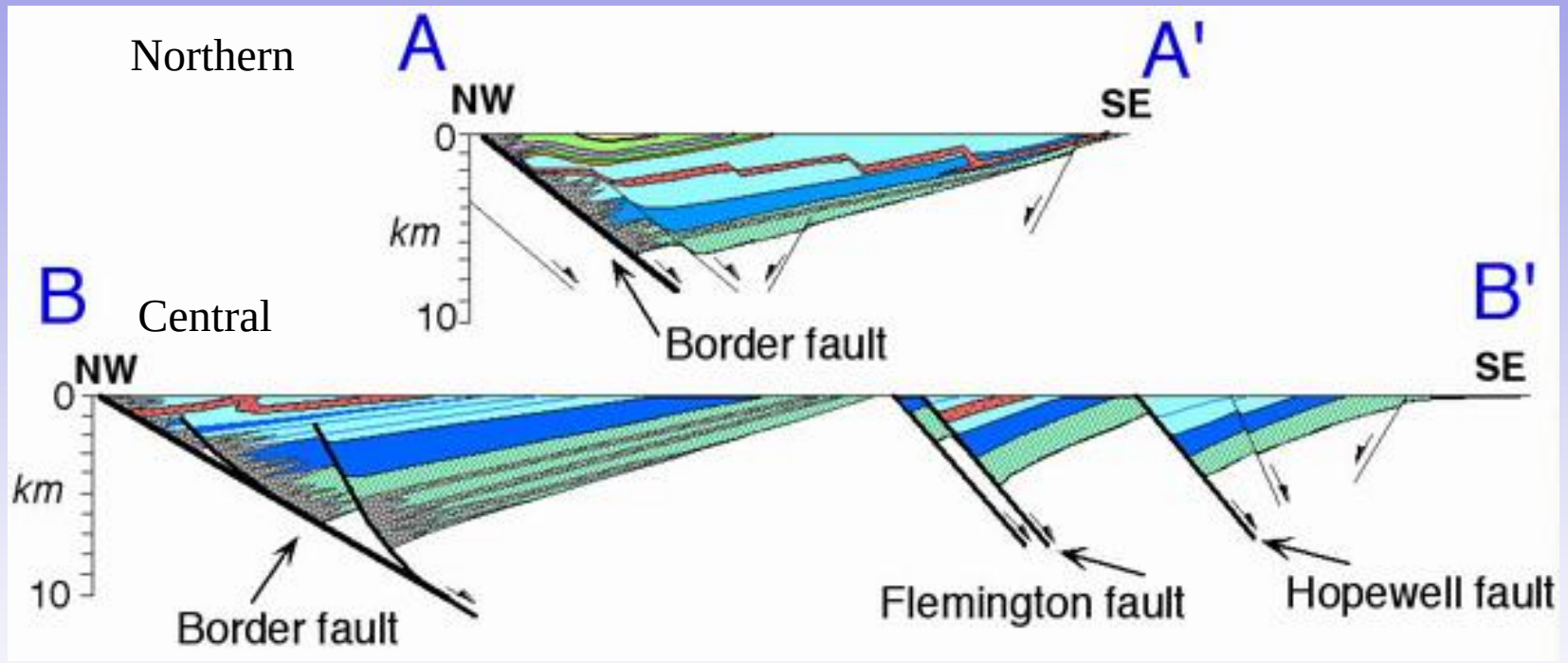
Structures Known to Occur in the Basin



- Structures could be used to “contain” injected CO2 versus injection into regional dip w/o structural containment which would rely on hydrodynamic and/or geochemical trapping
- Smaller plume size imprint in the basin

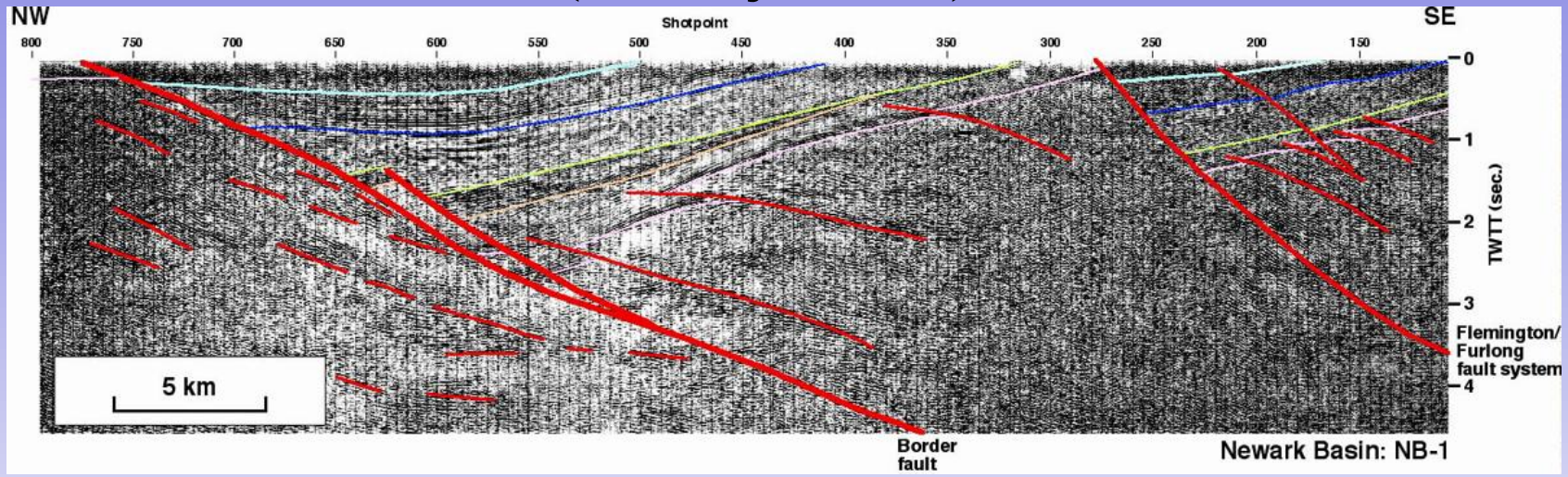
Modified from Schlische (1992) and Reynolds (1994).

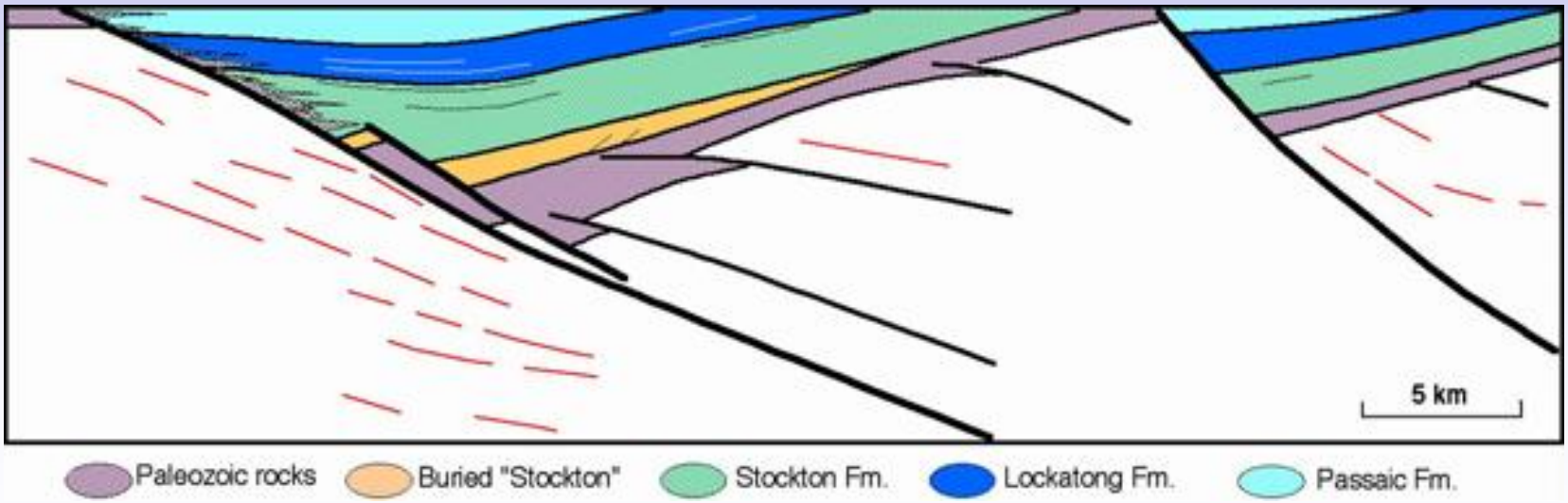
General Basin Cross Sections – New Jersey



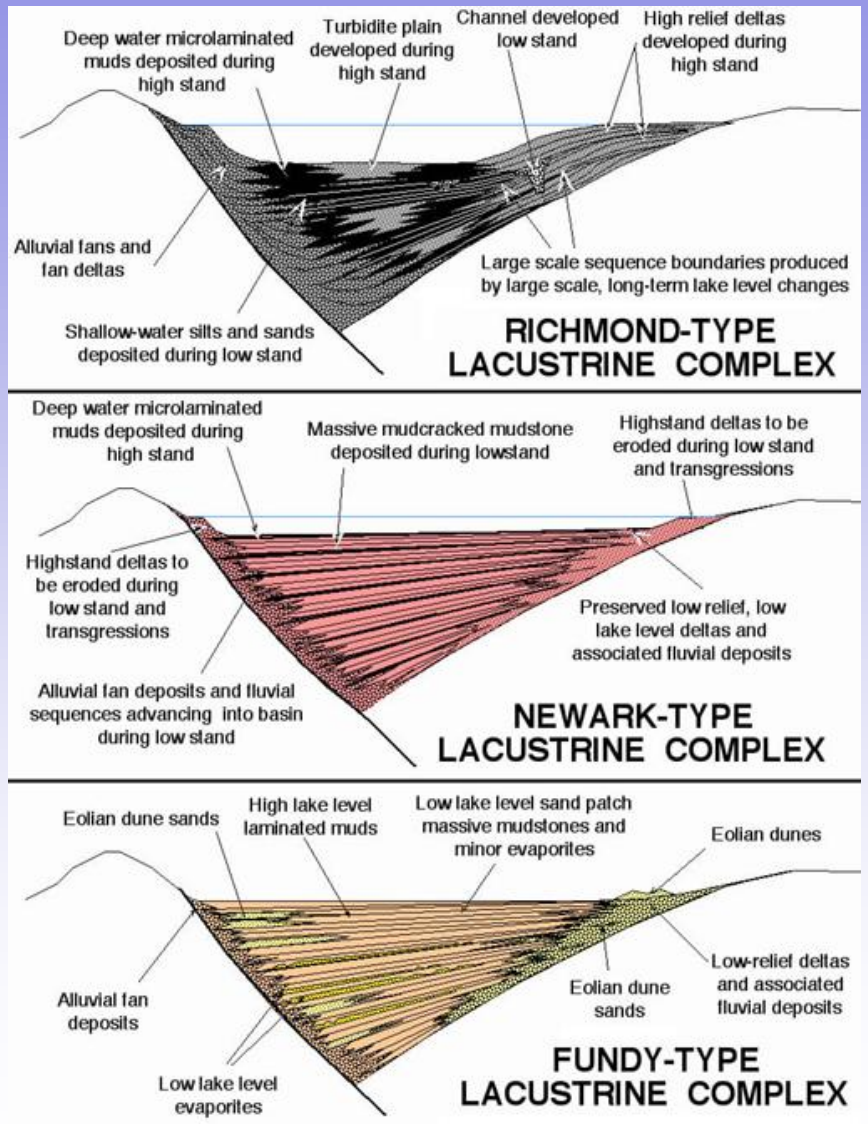
Modified from Schlische (1992)

Newark Basin Cross Section – Seismic Data – NB-1 (Pennsylvania)





Develop Conceptual Geologic Model



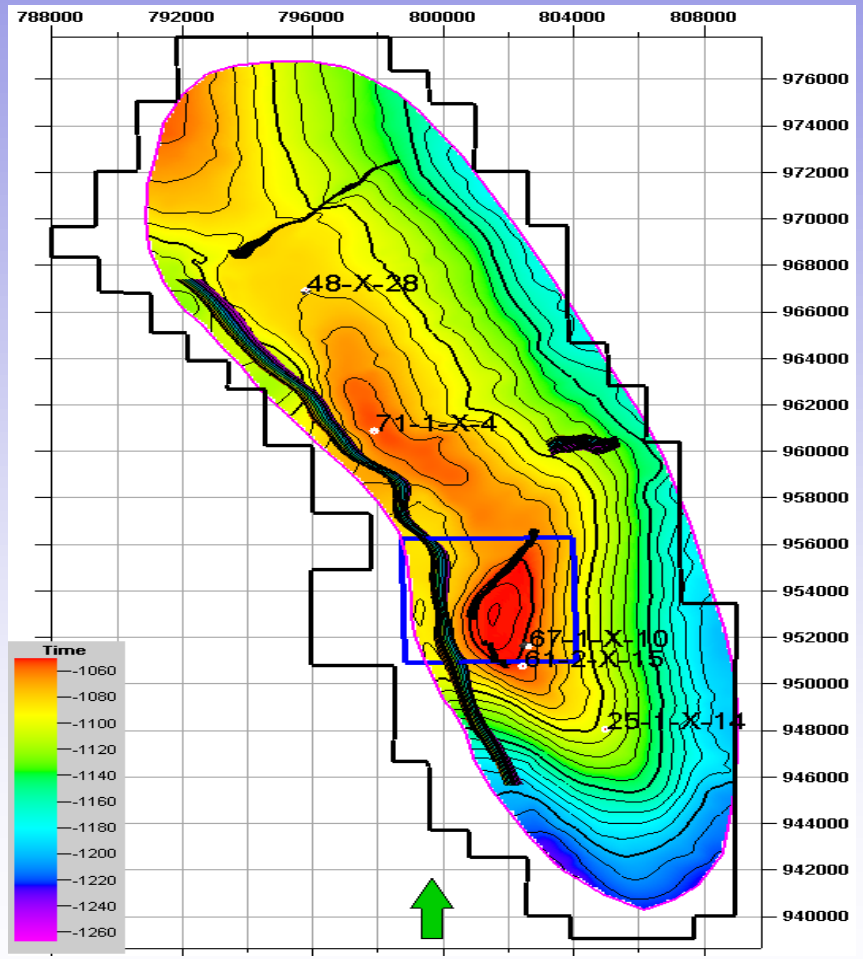
Wet Conditions

Wet& Arid Conditions

Arid Conditions

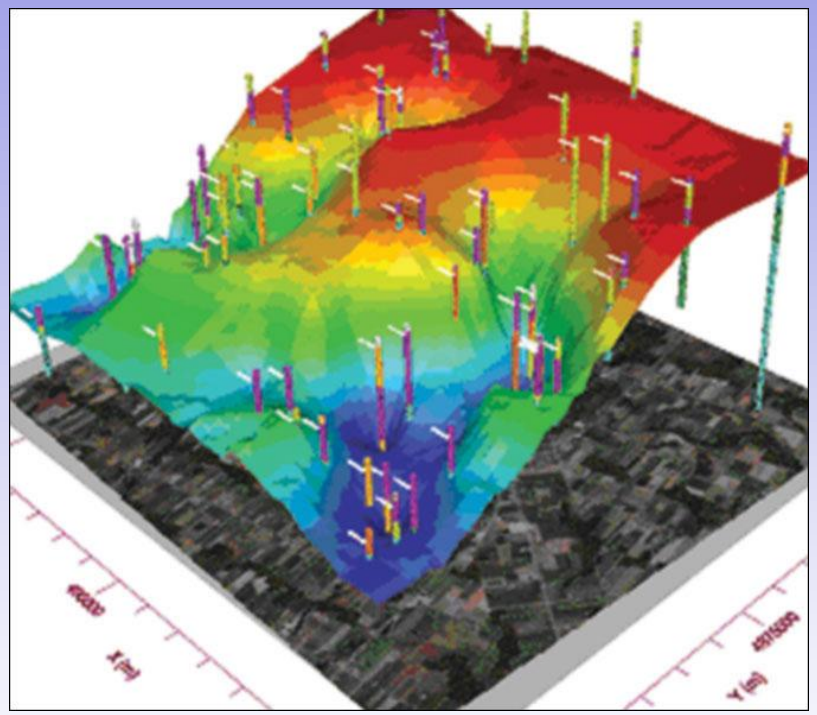
Modified from Olsen (1990).

Develop GIS Database



- Integrate stratigraphic, petrographic, structural, hydrologic, and water quality data into Geographic Information System (GIS) Database
- Allows for easy access by interested parties
- Shared with NATCARB & MRCSP

Produce 3-D Model Framework



- Develop model surrounding the stratigraphic test well site
- Use as illustrative tool for public outreach
- Basis for early-estimates of Co_2 storage capacity & modeling hypothetical injection scenarios

Key Phase I Deliverables

- Documentation that all permits/approvals secured and well drilling operations may proceed
- Topical report discussing the GIS Database, Conceptual Basin Model/3-D Visualization Model, and CO_2 Capacity Assessment

Go/No Go Decision Point – Proceed to Phase II?

- Permitting Hurdle
  - Have we secured all necessary permits/ authorizations to proceed with field operations?

- Technical Hurdle
  - Is there a technical finding from Phase 1 that warrants discontinuation of the project?

Phase 2 – Field Implementation & Data Analysis

- Task 2.1 – Project Management & Planning
- Task 2.2 – Seismic Survey
- Task 2.3 – Final Well Design
- Task 2.4 – Test Well Subcontractors
- Task 2.5 – Site Preparation, Drill and Acquire Hydrogeological Data at Deep Test Well

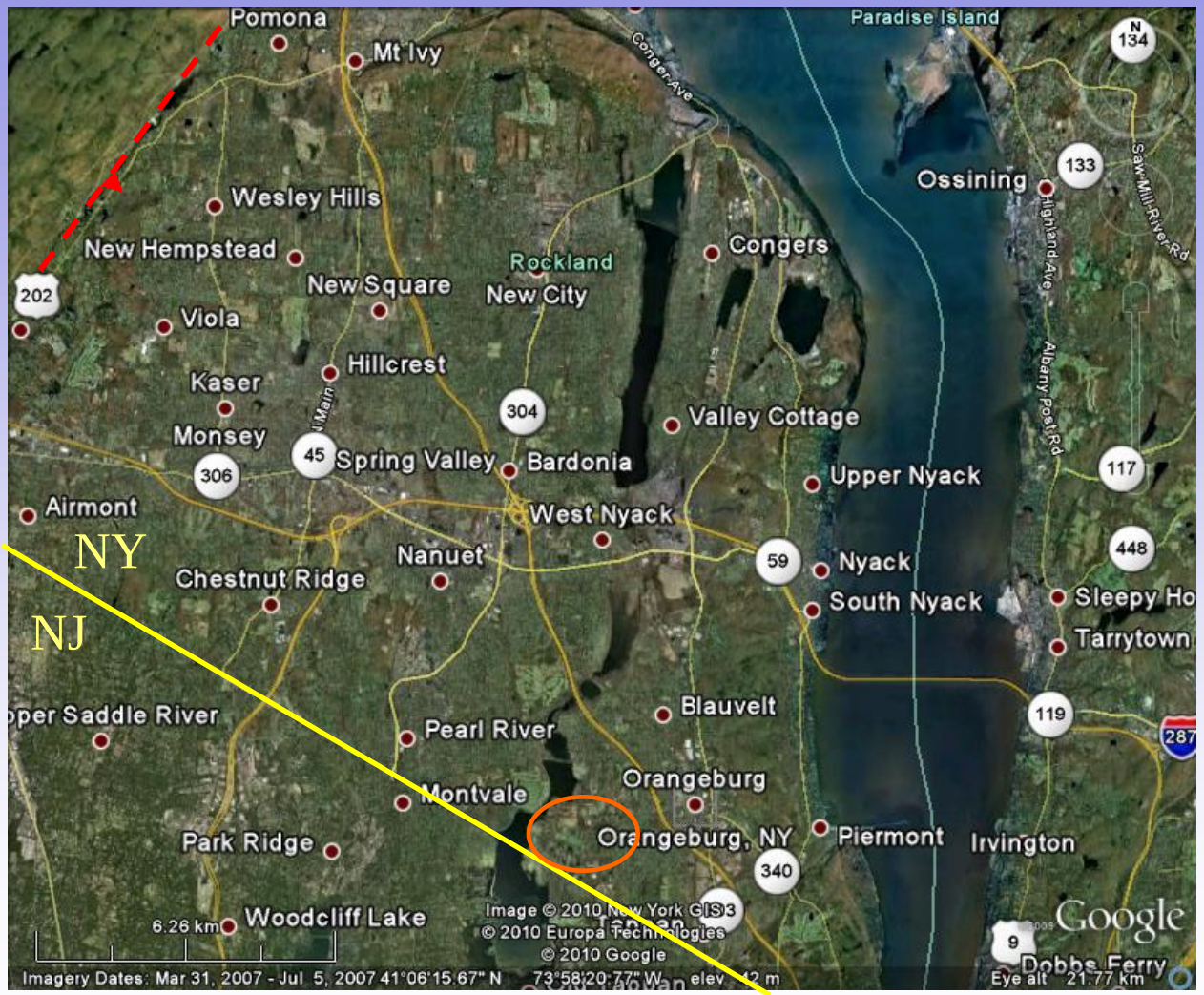
Phase 2 – Field Implementation & Data Analysis (Continued)

- Task 2.6 – Review and Analyze Hydrogeological Data and Prepare Reports
- Task 2.7 – Update Models
- Task 2.8 – Evaluate CO_2 Storage Capacity and Prepare Report
- Task 2.9 – Develop Recommendations for Further Investigation or Well Abandonment
- Task 2.10 – Contingency for Well Abandonment

Task 2.2 – Seismic Survey

- Plan includes two crossing 2-D seismic lines crossing at test site
- Each approximately 10 miles in length
- Palisades Sill may pose an “imaging” problem (i.e. want to “see” below the sill)
- Lack of nearby velocity information
- Field work will be in an urbanized environment

Site Located in an Urbanized Area



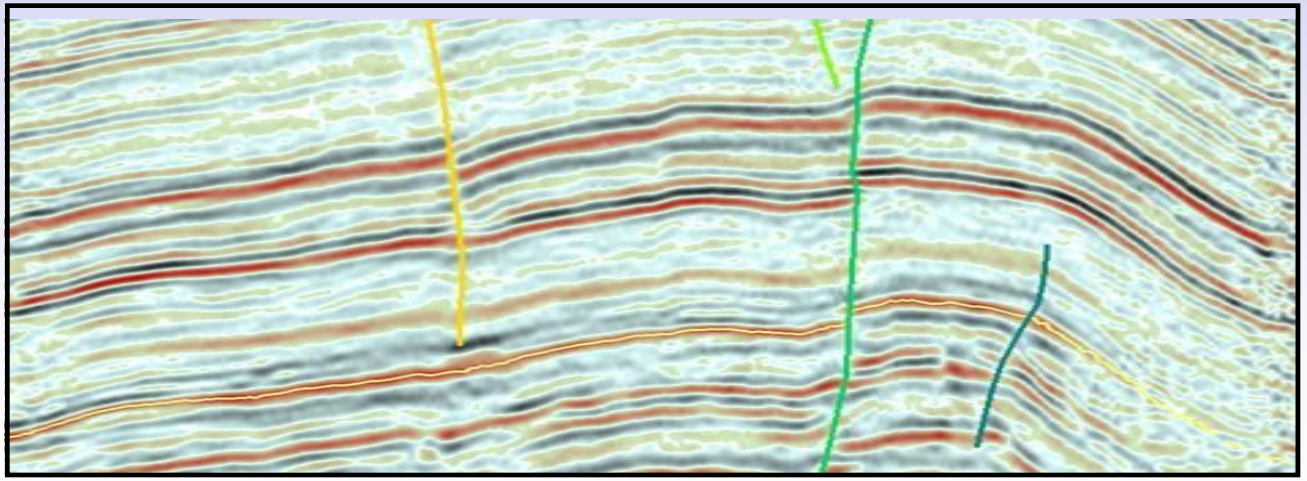
Geophysical Seismic Data – Urban Environment

Vibrating Truck – Sound Source

Receiver Geophones

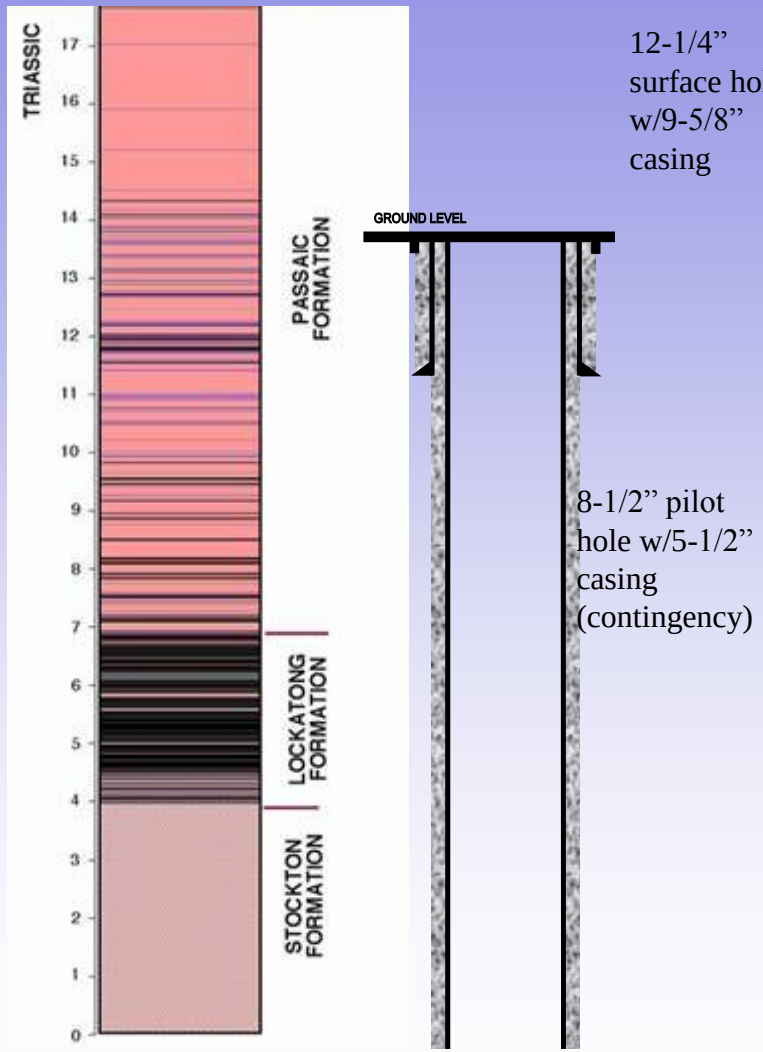
Distance

Depth



Task 2.3 – Final Well Design

Strategy is a Single Well to Sedimentary Basement



PTD Up to 8,000 feet

- Evaluate shallow groundwater zones
- Protect Underground Sources of Drinking Water behind Surface Casing
- 8-1/2-inch pilot hole to total depth, possible Paleozoic sediments below basin
- Maximize whole core in pilot hole to tie into Newark Basin Coring Project and calibrate logging suite
- Maximize open hole logging to provide "type log" suite
- Recover formation fluids to define hydrostratigraphy
- Potential aquifer tests to define transmissivity & flow characteristics (drill stem and/or pump tests)
- No Injection Planned!! (would need a UIC Permit)

Task 2.4 – Test Well Subcontractors

Screen & Qualify Test Well Subcontractors

- Identify technologies needed to meet project data objectives
- Screen universe of potential vendors that can provide services
- Down select vendors based on safety program/ performance/record
- Evaluate technologies/capabilities/experience and down select to “finalists”
- Rank finalists and select in consultation with DOE/NETL Project Manager

Task 2.5 – Site Preparation, Drill and Acquire Hydrogeological Data at Deep Test Well

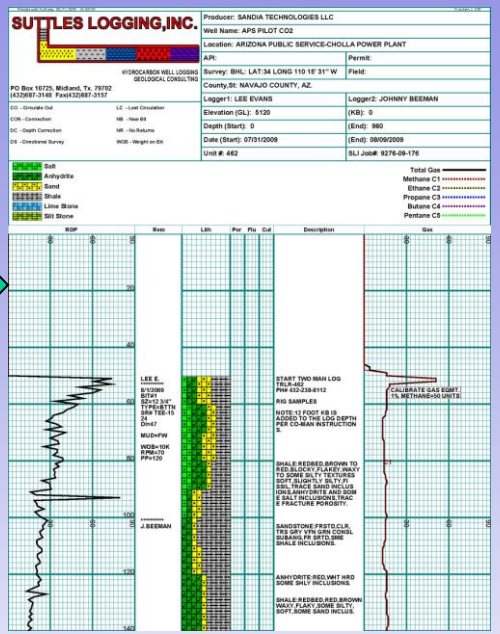
Drill Deep Stratigraphic Test Well

- Well Pad area is approximately 250 ft by 250 ft (less than 2 acres)
- Closed-loop system with decanting and solidification so all fluids/cuttings are contained and sent for offsite disposal
- Location returned to natural condition following well closure

Field Evaluation Methodologies

Whole Core

Well Cuttings Analysis



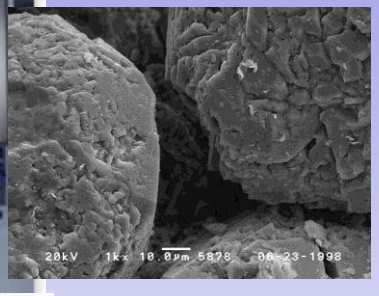
Open-hole Logging

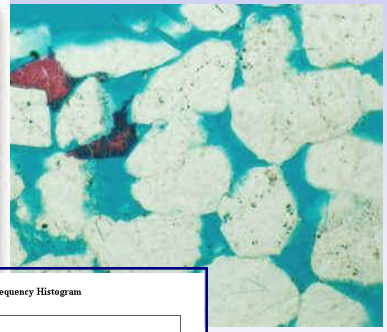
Fluids Recovery

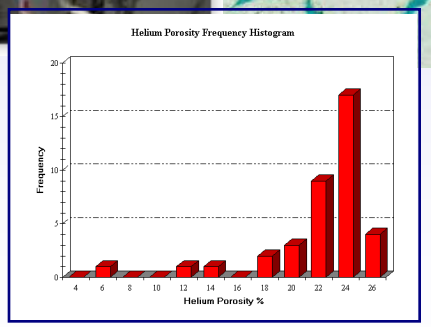
Task 2.6 – Review and Analyze Hydrogeological Data and Prepare Reports

Analyze Hydrogeological Data

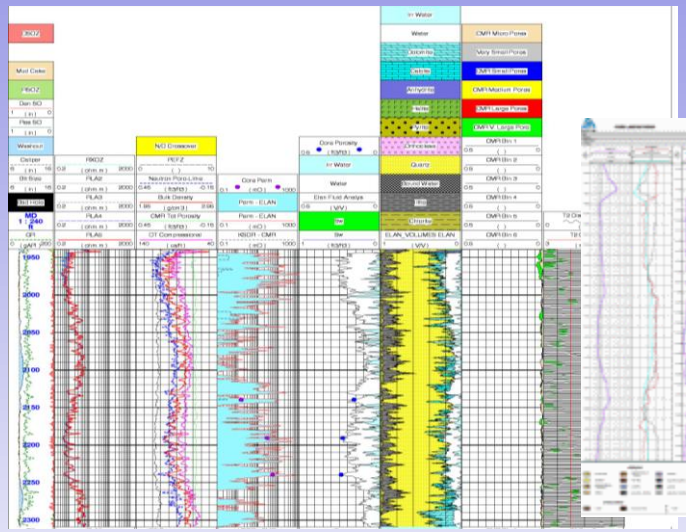
Core

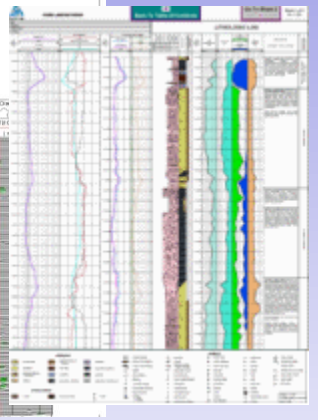




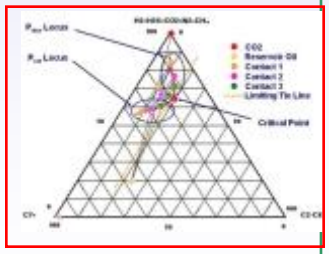


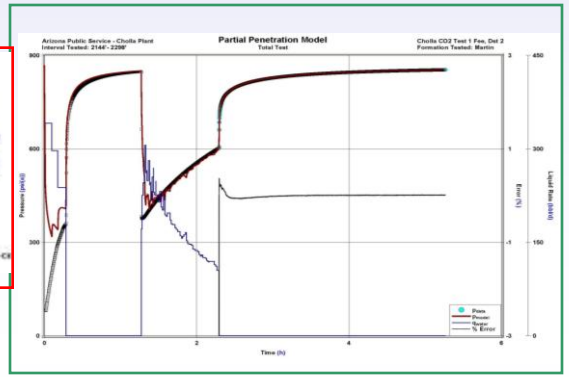
Well Log Analyses





Formation Fluid and Aquifer Properties





Task 2.7 – Update Models/
Task 2.8 – Evaluate CO_2 Storage Capacity

Reactive Transport

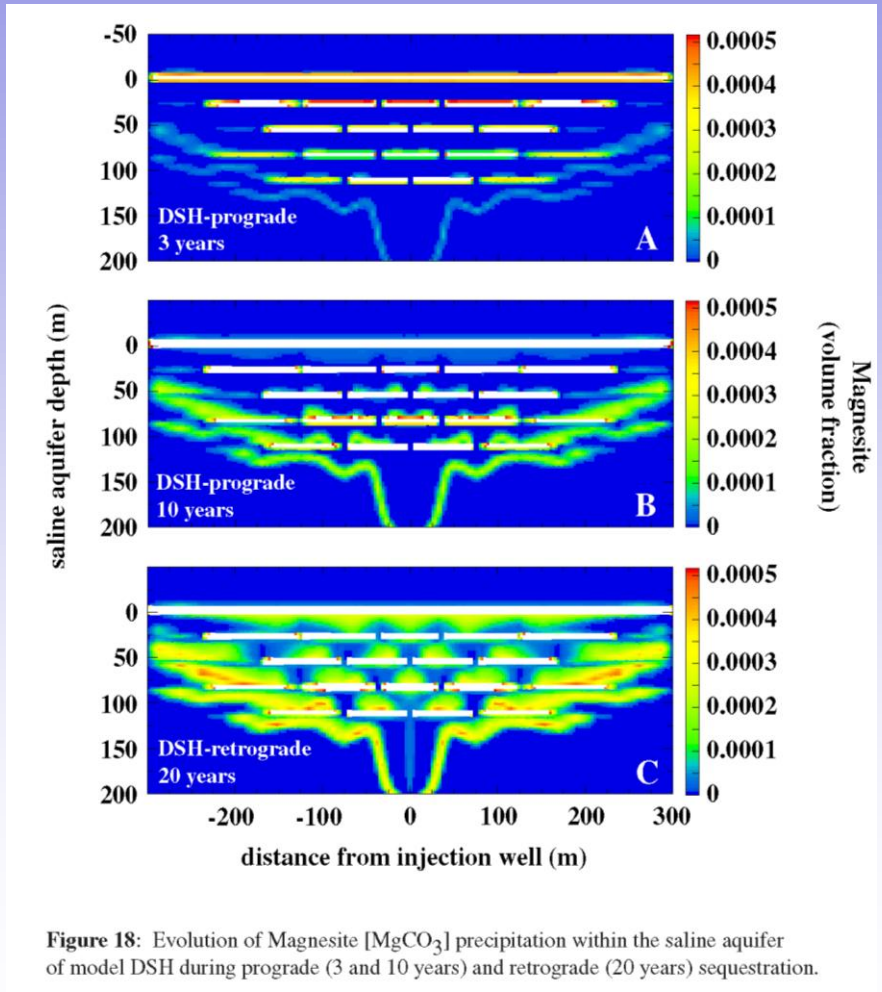
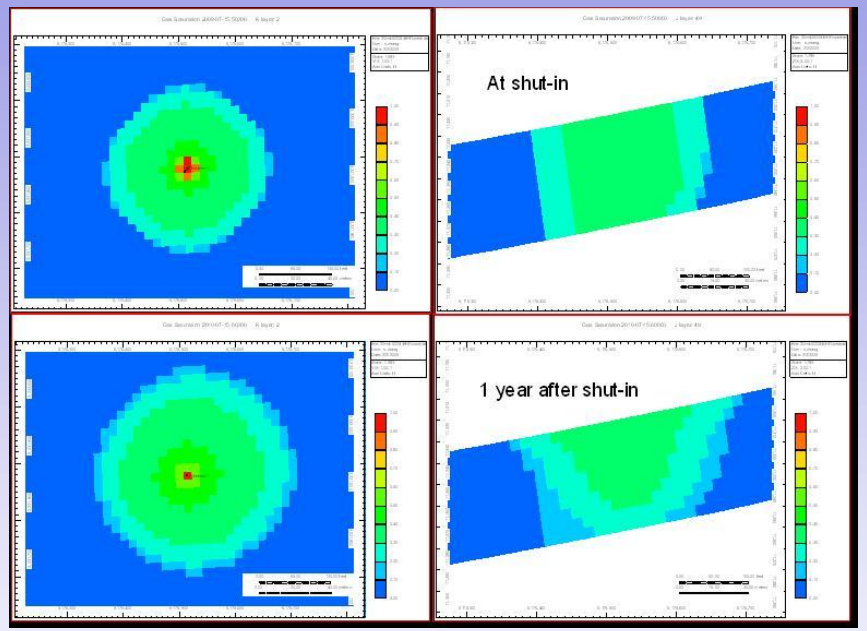


Figure 18: Evolution of Magnesite [$MgCO_3$] precipitation within the saline aquifer of model DSH during prograde (3 and 10 years) and retrograde (20 years) sequestration.

- Lawrence Berkeley to investigate interactions of CO_2 with rock matrix and formation fluids
- Assess rate of CO_2 dissolution into the formation brine and mineralization in the formation
- Prepare reactive transport and fate model (TOUGHREACT) for injected CO_2 into the Newark Basin

Task 2.7 – Update Models/
Task 2.8 – Evaluate CO_2 Storage Capacity

Flow Simulations



- Revaluate petrophysical properties used in Phase 1
- Perform basin-scale "what if" flow simulations at hypothetical point sources to assess response to industrial-scale injection scenarios
- Refined assessment of injection capacity for CO_2 in the Newark Basin

Phase II Deliverables

- Topical report and description of Seismic Survey
- Final Well Plans for site preparation, well installation, and testing
- Summary of Vendor Recommendations Report
- Relevant Properties of the Borehole and Target Formations Report
- CO_2 Storage Capacity Report
- Final Well Abandonment Plans for well closure and site restoration
- Well Closure & Site Restoration Report

Questions?