Shell's In-situ Conversion Process

National Academy of Sciences Earth Resources Committee

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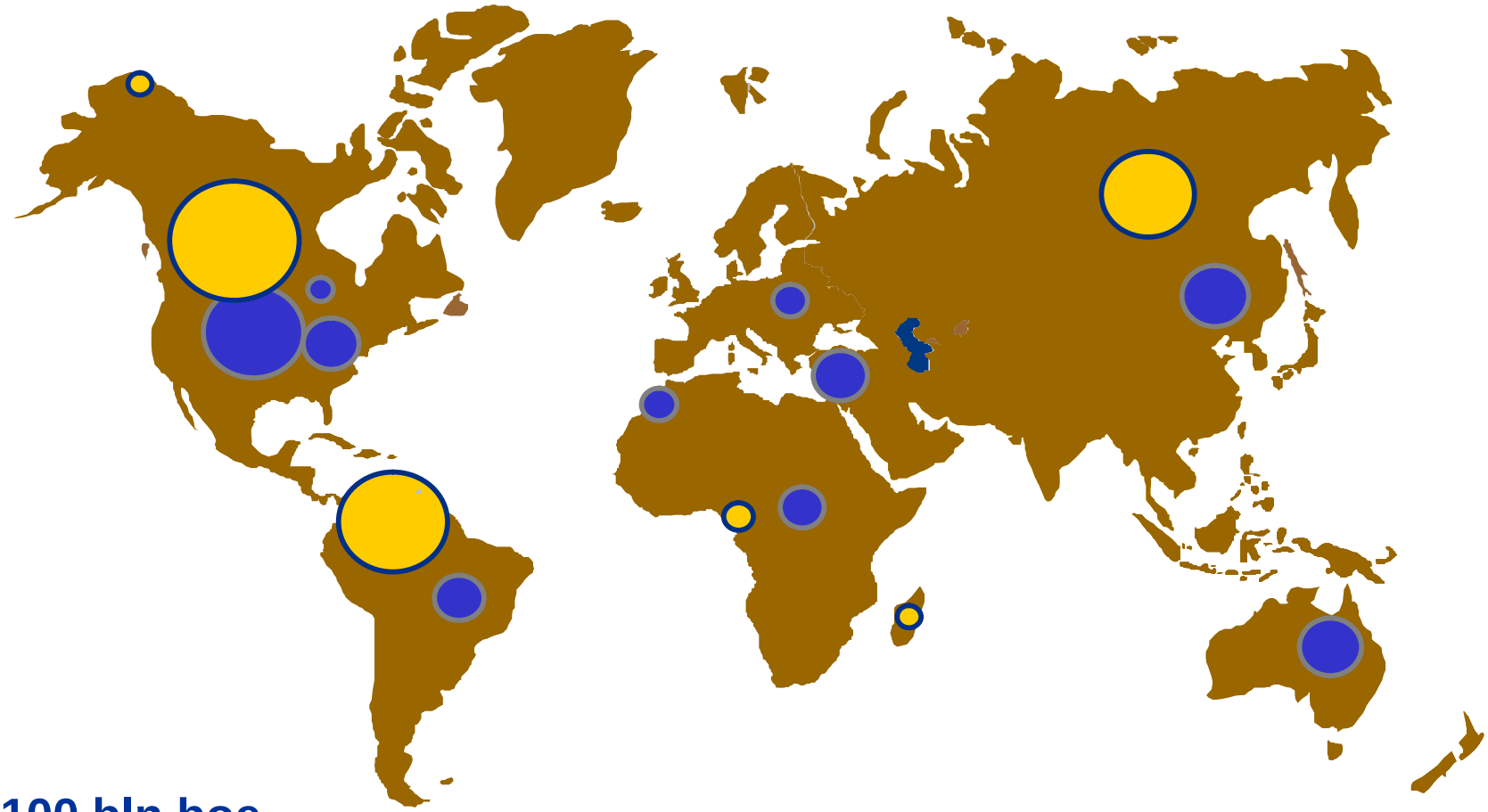
In-situ Conversion Processes

Shell Exploration & Production

Unconventionals Potential



100 bln boe

extra-heavy oil & bitumen

oil shale

In-Situ Conversion Process (ICP)

What is it?

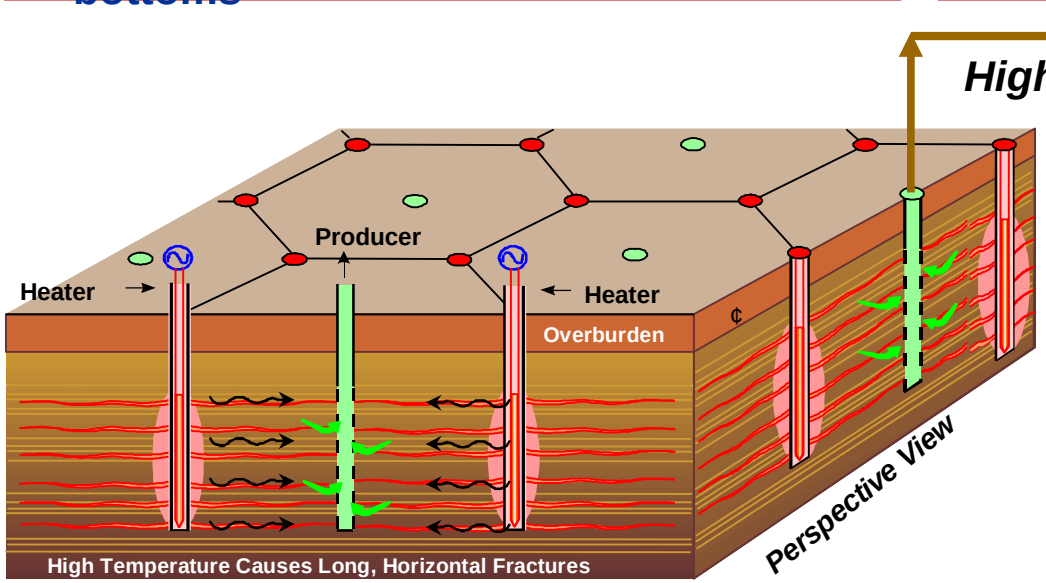
- **Enhancement of natural maturation of kerogen by *slow* heating**
- **Results in:**
  - **thermal cracking**
  - **in-situ hydrogenation**
  - **high sweep vapor phase production**
  - **high API oil**
  - **N, S, O content vary with resource**
- **Average temperature limited to boiling point of diesel, i.e. essentially no bottoms**

How is it done?

- **Electric resistance or, potentially, gas heaters**
- **Underground conductive heat transport**

Potential resource applications:

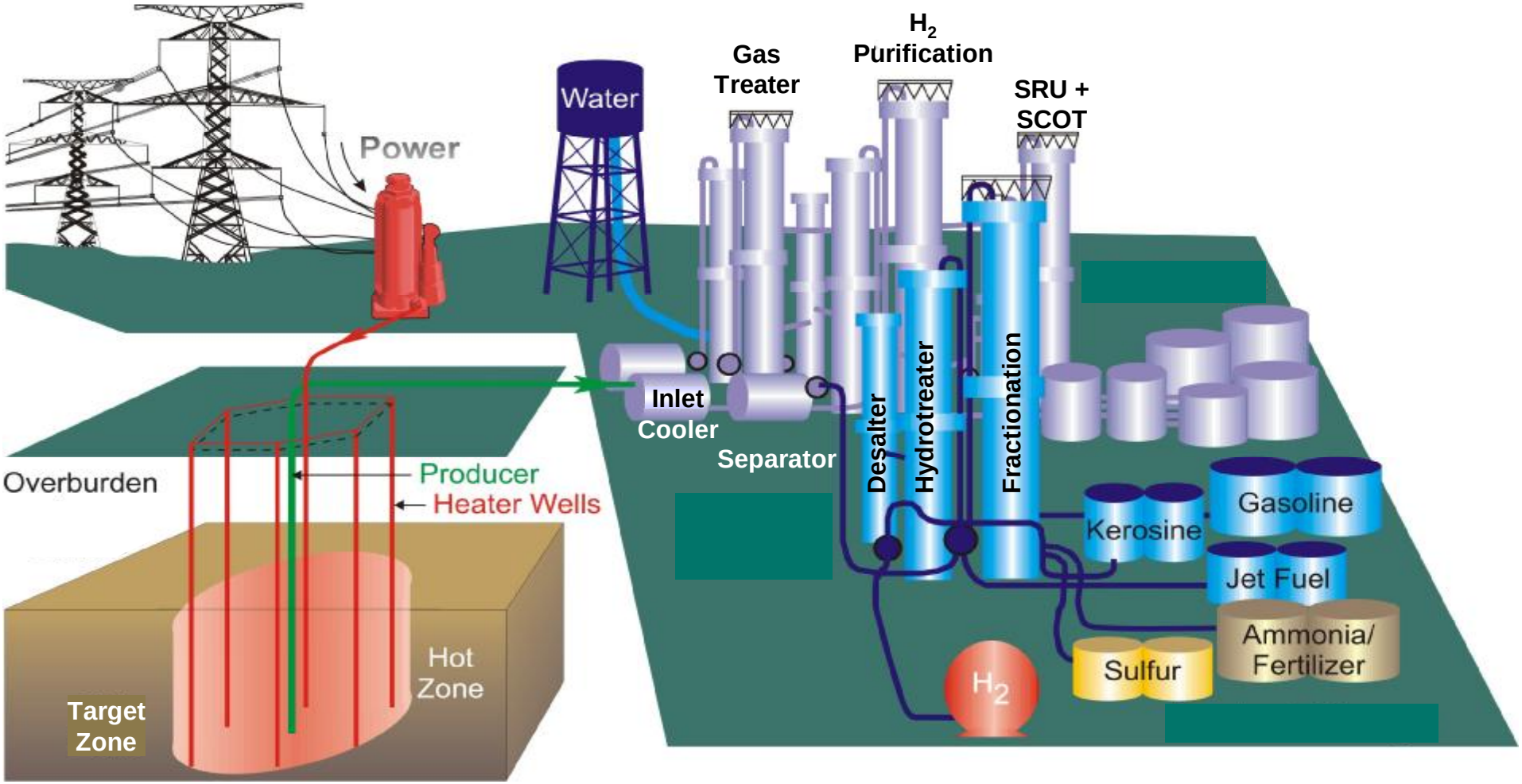
- **Oil Shale**
- **Heavy Oil / Bitumen**
- **Coal**



High Value Products

- **Naphtha**
- **Jet**
- **Diesel**
- **Nat. Gas**
- **Hydrogen**
- **Chem. Feed**
- **Heat**

Oil Shale Development Concept



Engineering and Testing Facilities

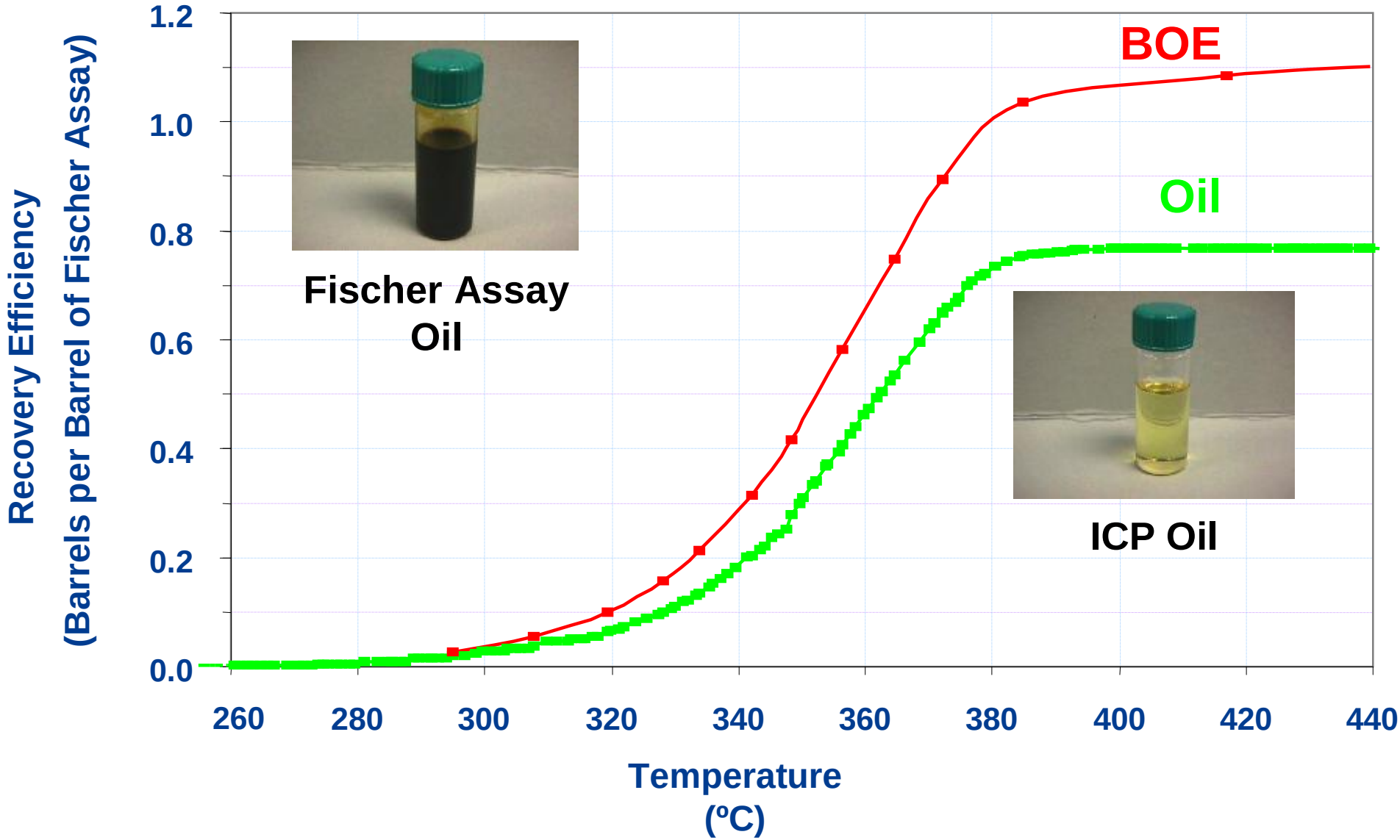
Peace River

Houston – Gasmer Site

Colorado Site

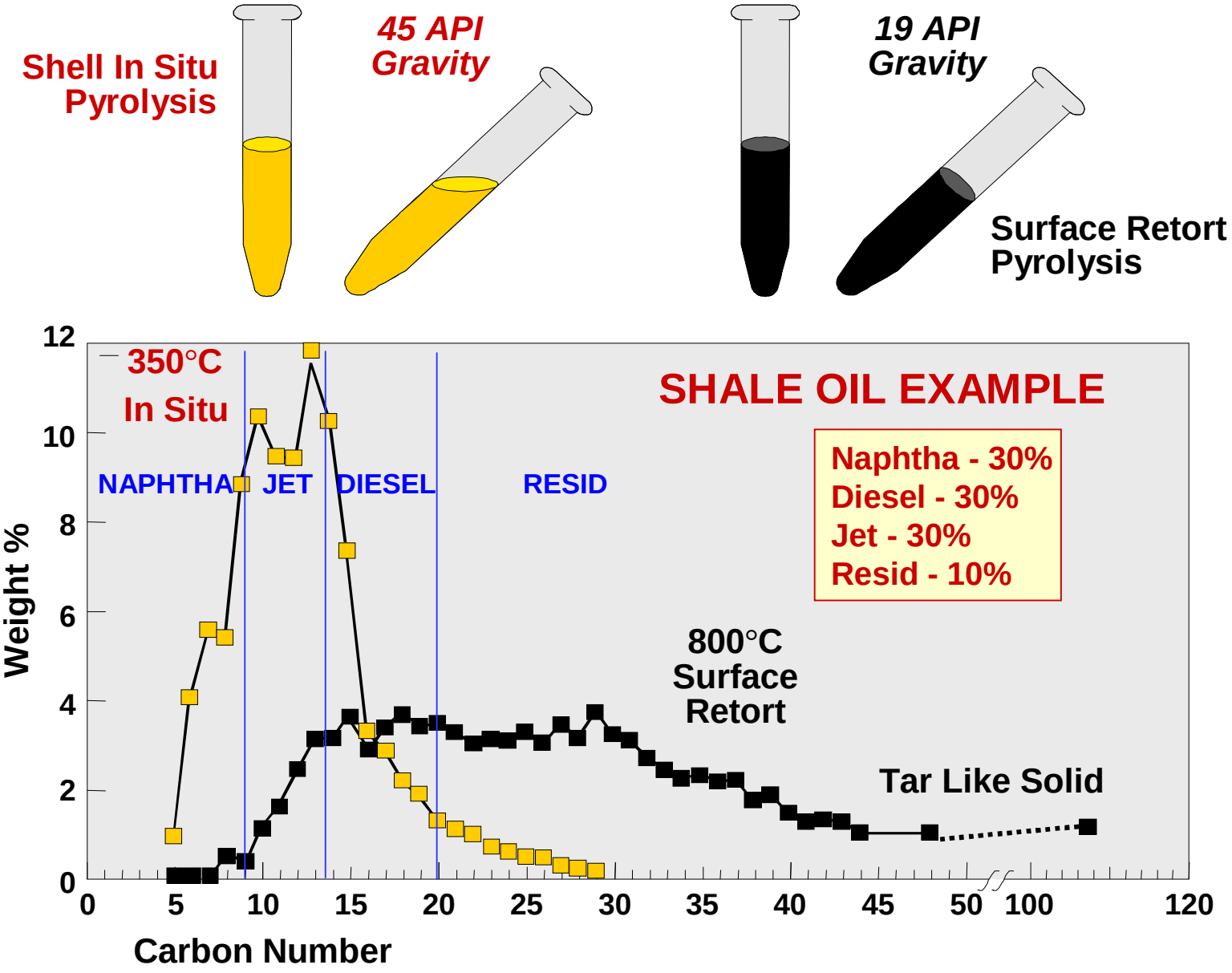
Houston – Woodcreek Site

Recovery Efficiency – Colorado Oil Shale Test

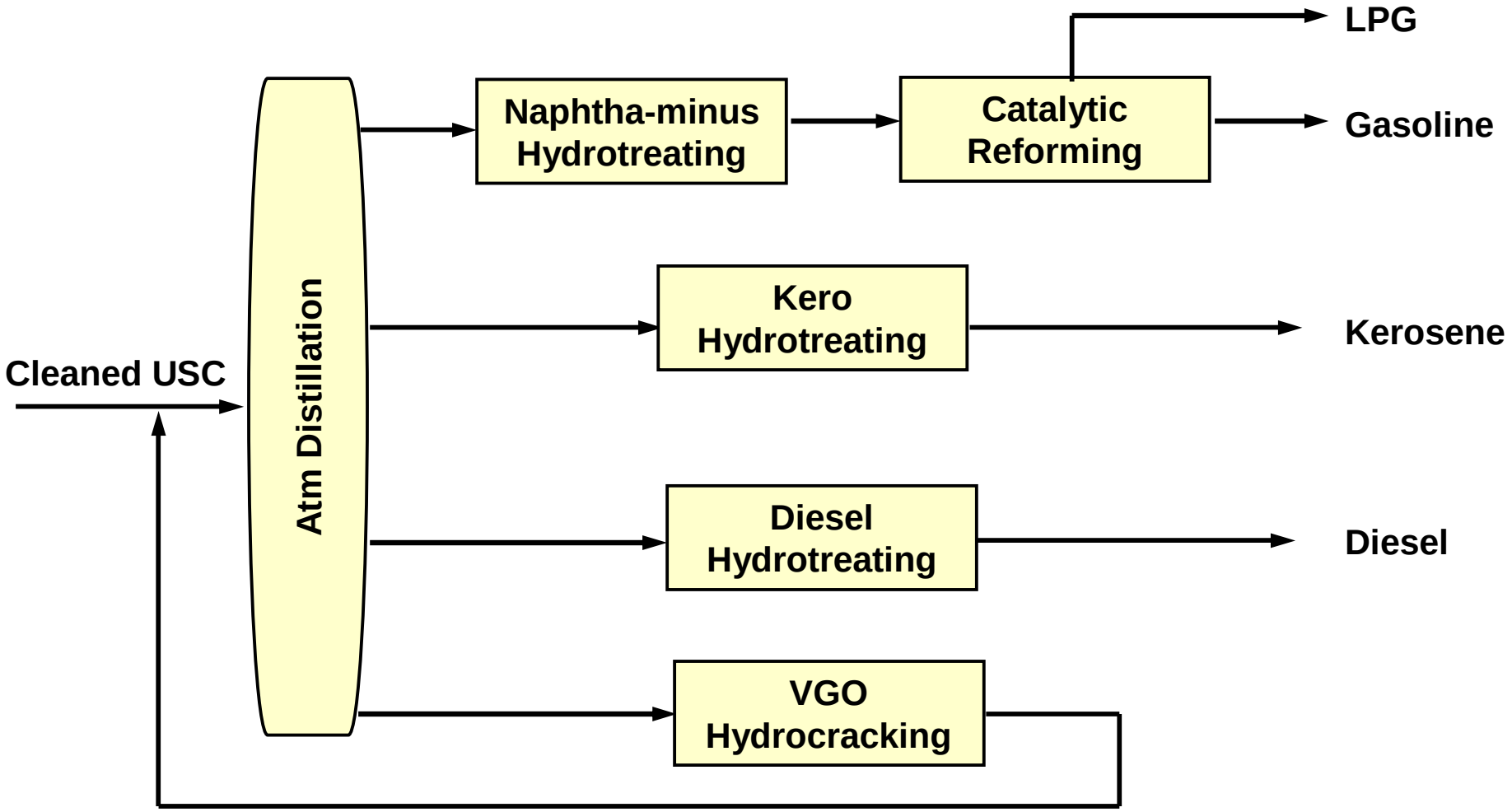


: deg C /day at 100 psig

Better Feedstock For Upgrading



Simplified Fractionation and Hydroprocessing Scheme



Advantages of In Situ Conversion

- In situ process: no mining
- Less water use than retort technology
- More oil and gas from smaller area
- Accesses deeper oil shale resources
- Uses entire resource column, not just rich layers
- Yields high quality transportation fuels

Northwest Colorado

Completed Oil Shale ICP Field Tests

A. Colorado Oil Shale (1997/98)

- ü Test Recovery Efficiency: 60-70% liquid

B. Colorado Oil Shale 1999

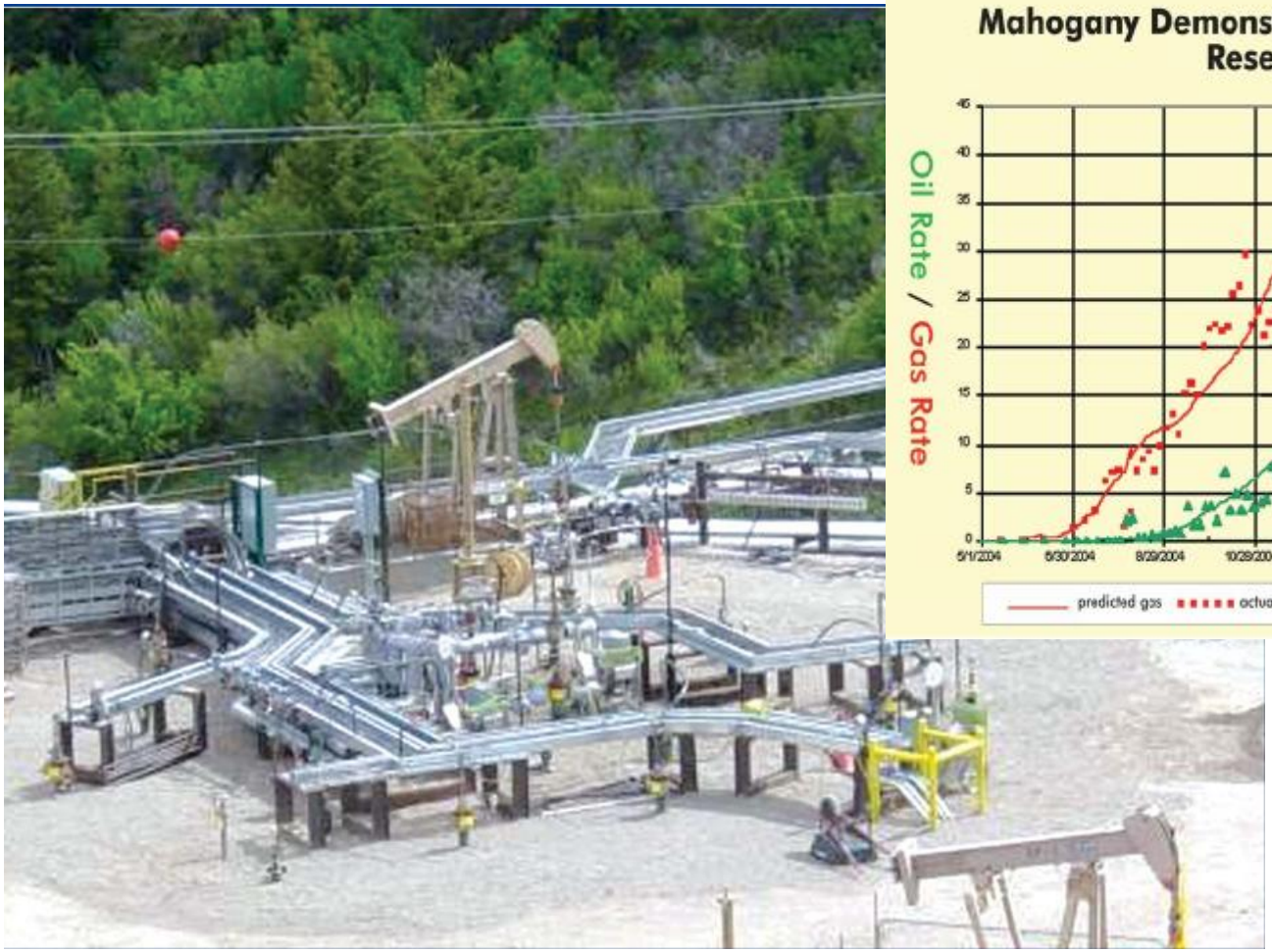
- ü Geomechanical models
- ü Heater development
- ü Product transport model

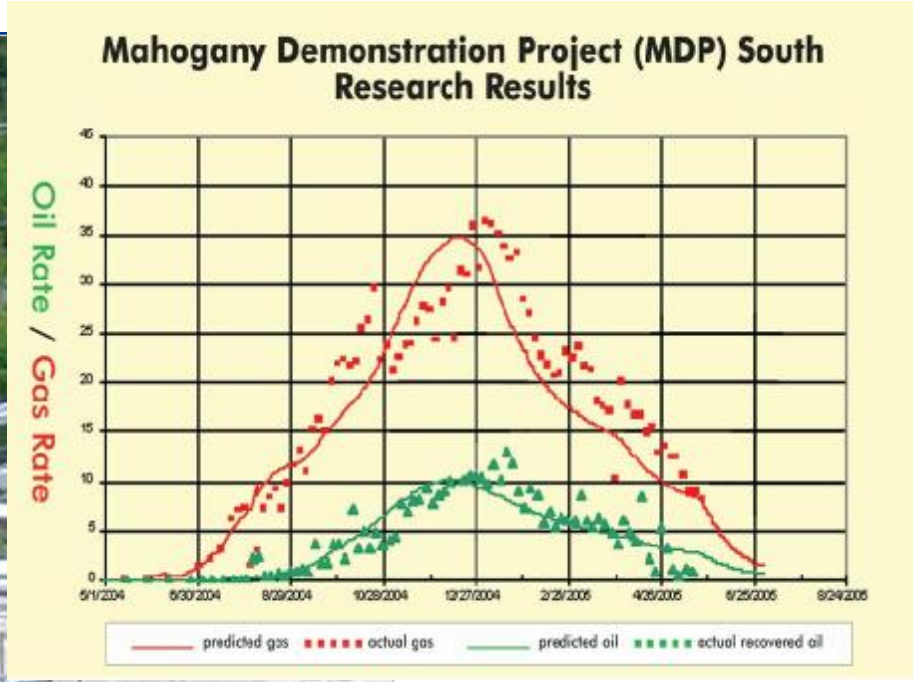
C. Colorado Oil Shale Containment Test 2001

- ü Containment
- ü Reclamation techniques

Colorado Research Facilities

Mahogany Demonstration Project (South)



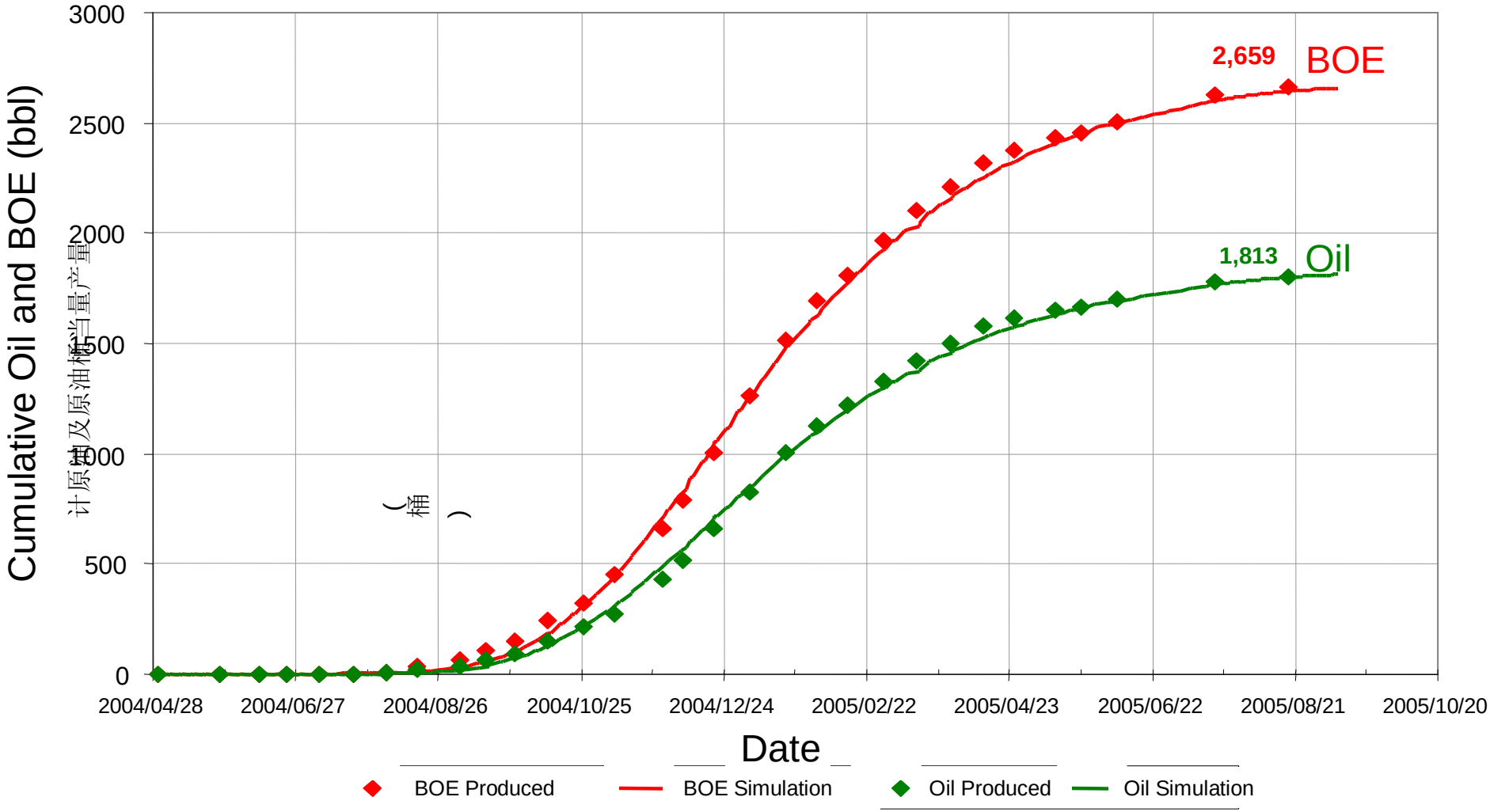


2003 – 2005

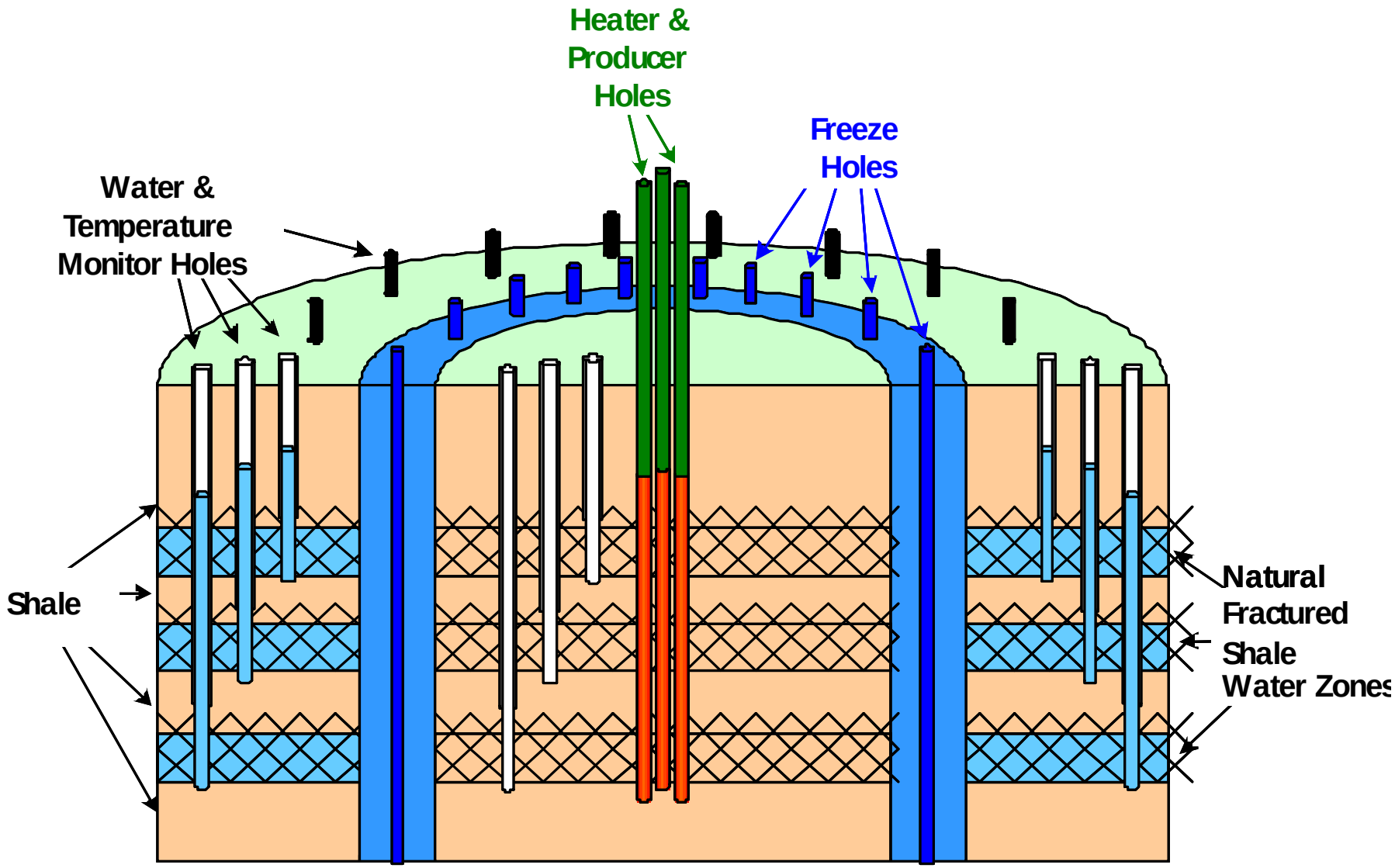
- ü **Recovery efficiency**
- ü **Product quality**
- ü **Energy balance**

- Oil used for processing studies, sample preparation and RefSim tuning
- Extrapolation to commercial reservoir model, further supported by lab scale tests

Field test oil and gas production (2004)



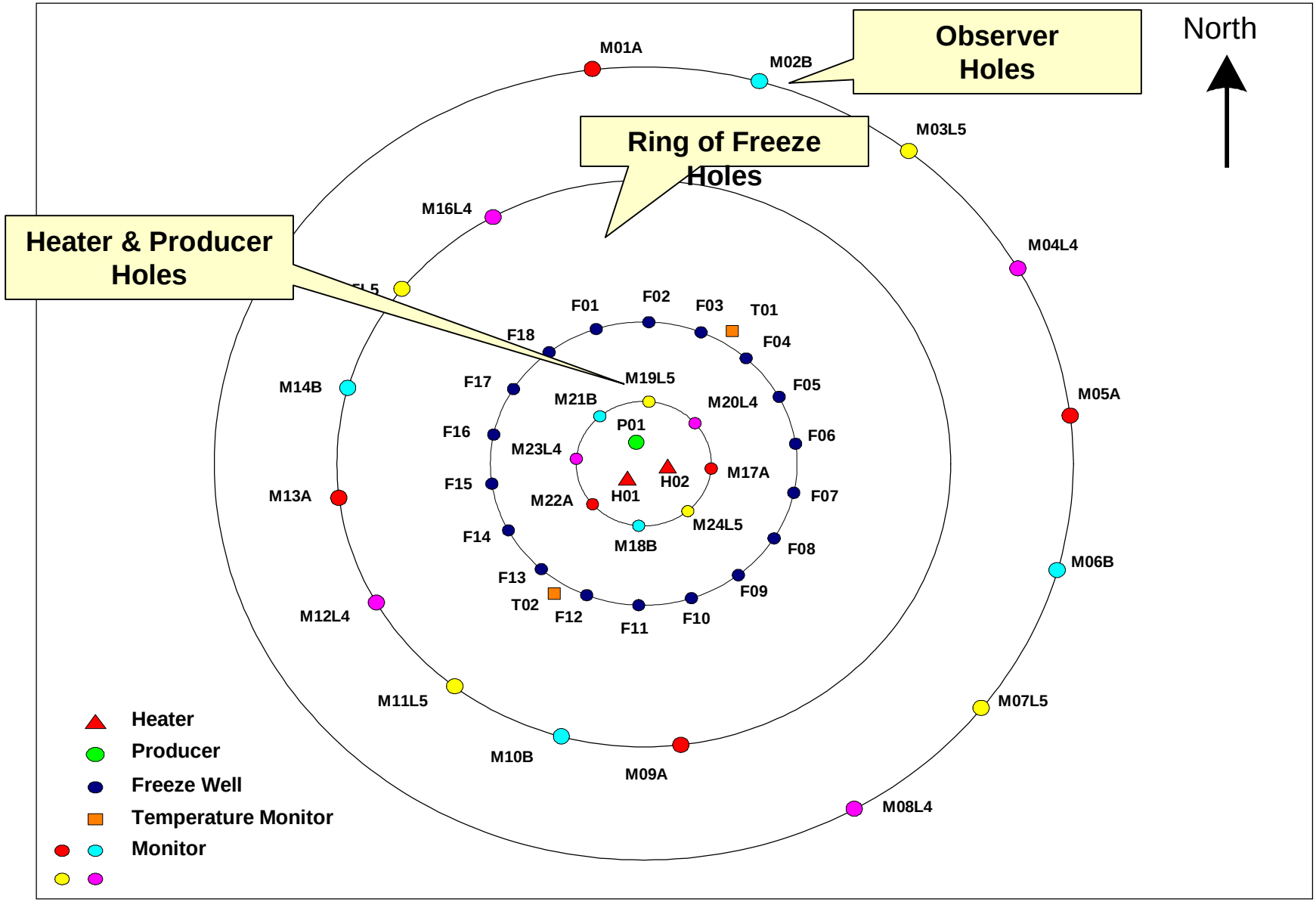
Freeze Wall Concept

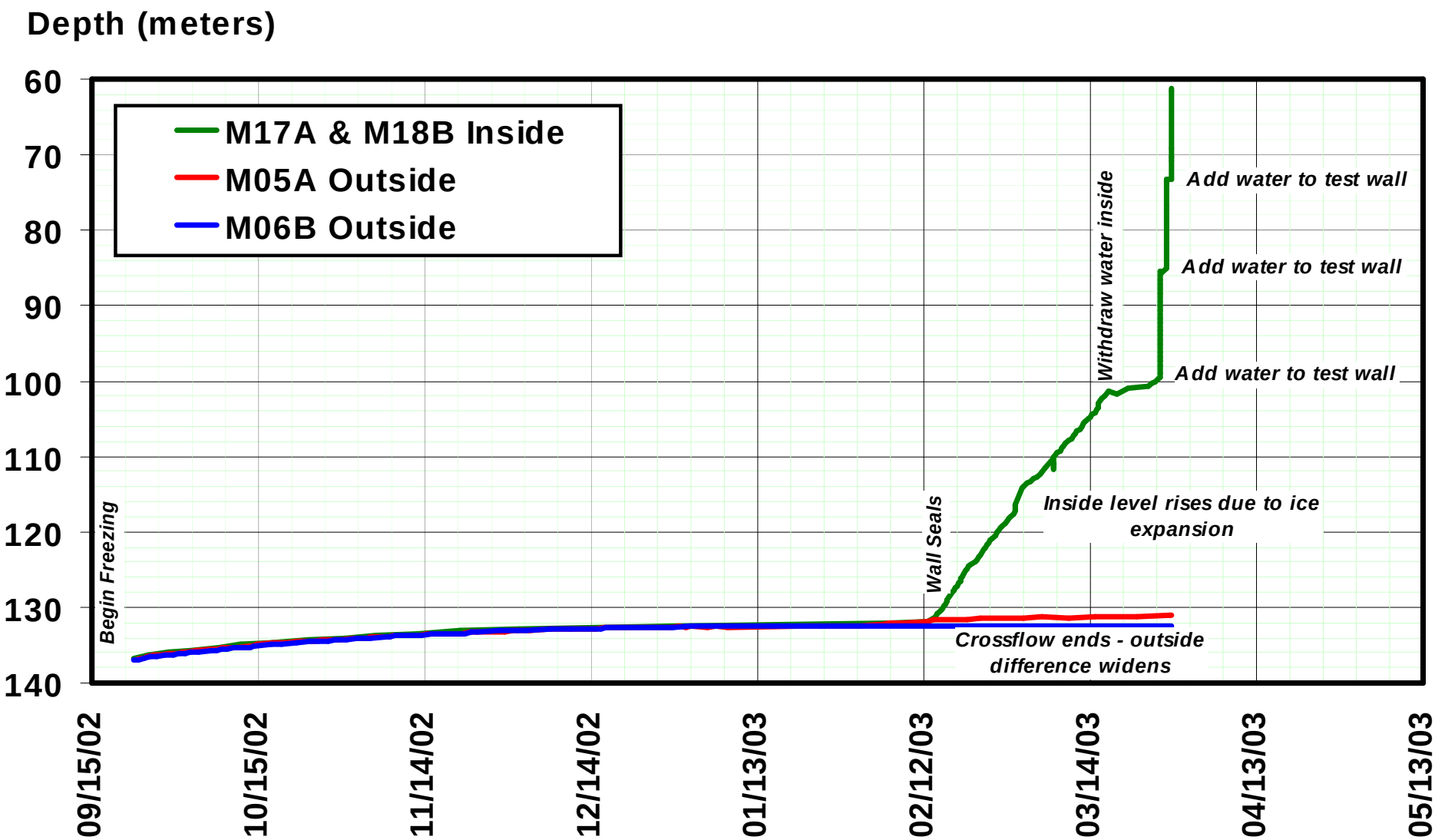


Mahogany Isolation Test (MIT) – 2001

- Small-scale, circular freeze wall test
- Conducted to determine whether a freeze wall keeps groundwater out of possible production zone

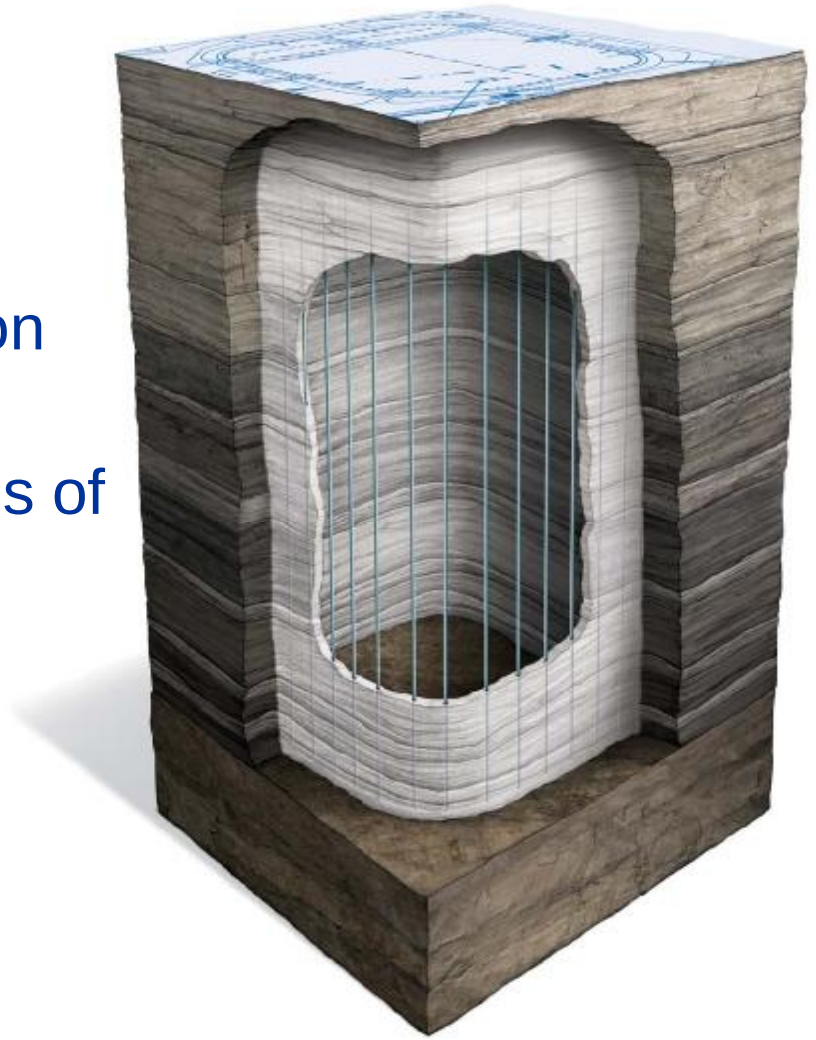
Mahogany Isolation Test (MIT) – 2001





Freeze Wall Test

- Freeze wall serves as an underground barrier to protect groundwater and isolate any proposed subsurface production areas
- Environmental test for purposes of groundwater protection
- Likely to be last major “show stopper”
- On Shell’s private land



Freeze Wall Test Site (2006)

Freeze Wall Test Site (2006)

Conclusions

- Oil shale is a strategic U.S. resource
- ICP technology has advanced dramatically since 1980, with over 200 Shell patents.
- We are very encouraged by research results, but further testing is still necessary before commercial investment decision – earliest around the end of the decade