

PENNSYLVANIA GEOLOGY & ECONOMICS



PA LAND TRUST ASSOCIATION

NATURAL GAS CONFERENCE

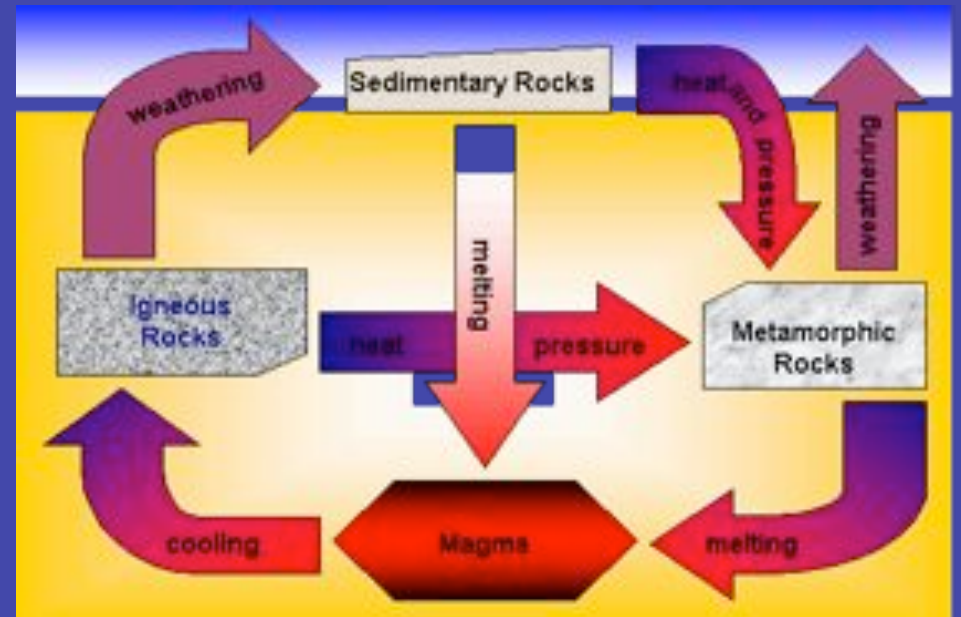
Thursday, June 19, 2008

GEOLOGY 101: *THE BASICS*

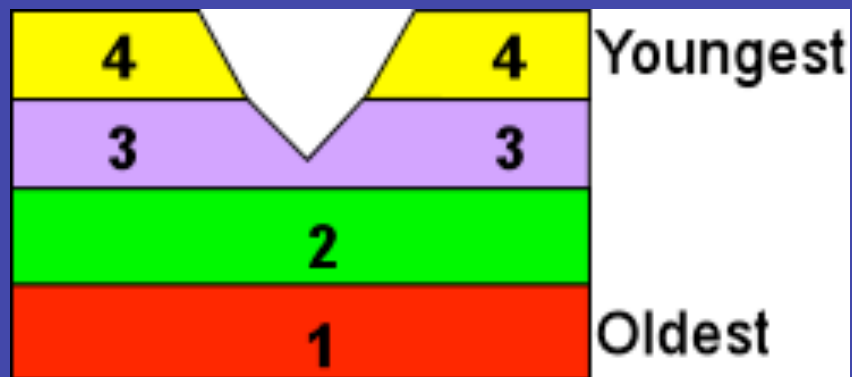
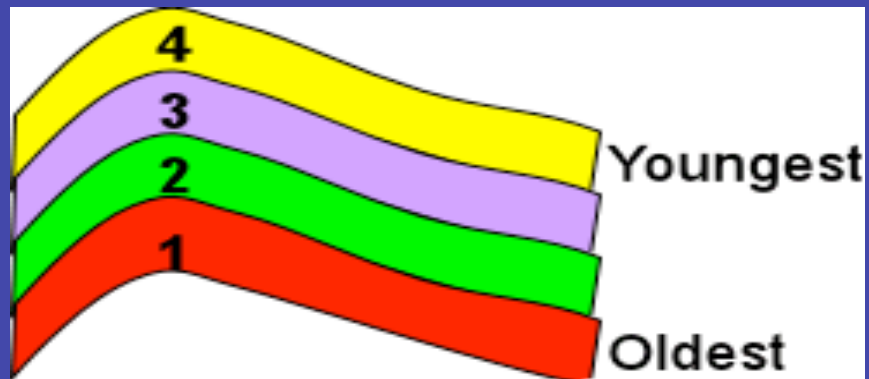
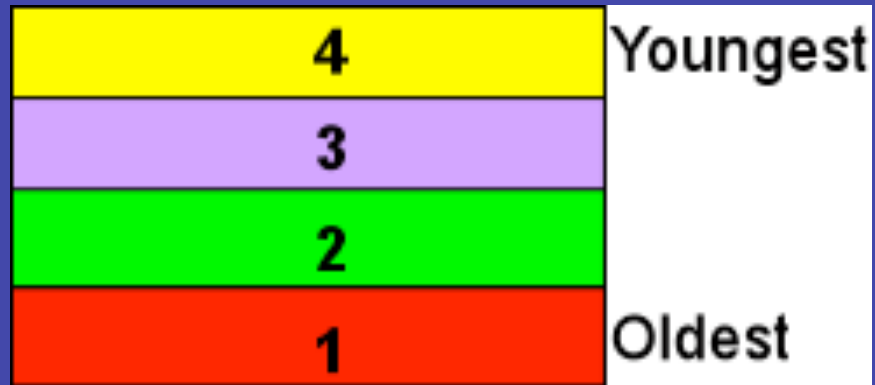
- THREE ROCK TYPES

SEDIMENTARY, IGNEOUS, METAMORPHIC

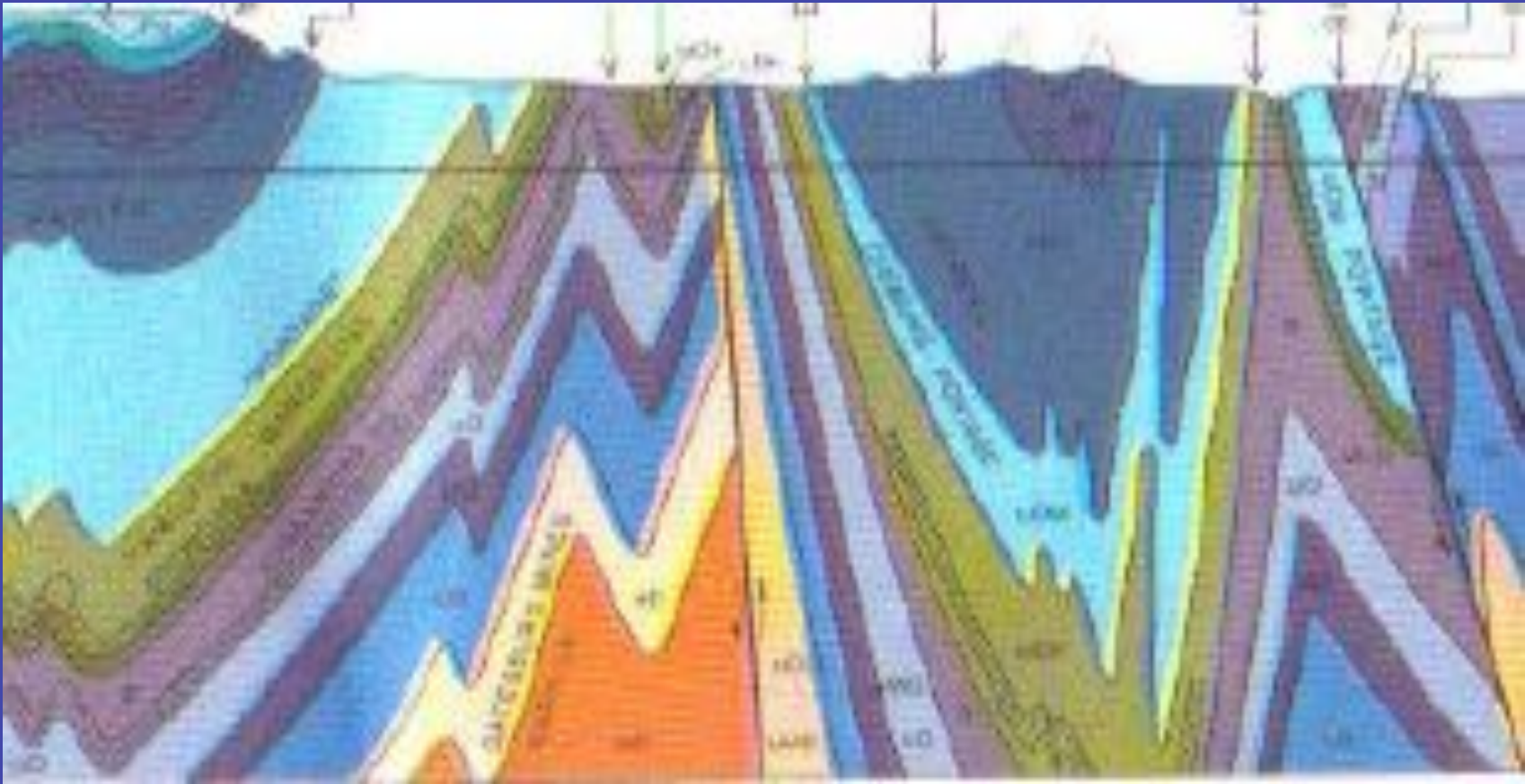
- WEATHERING & EROSION
- HEAT, PRESSURE, & TIME
- LAW OF SUPERPOSITION
- LAW OF HORIZONTALITY
- LAW OF LATERAL CONTINUITY



GEOLOGY 101: *THE BASICS*

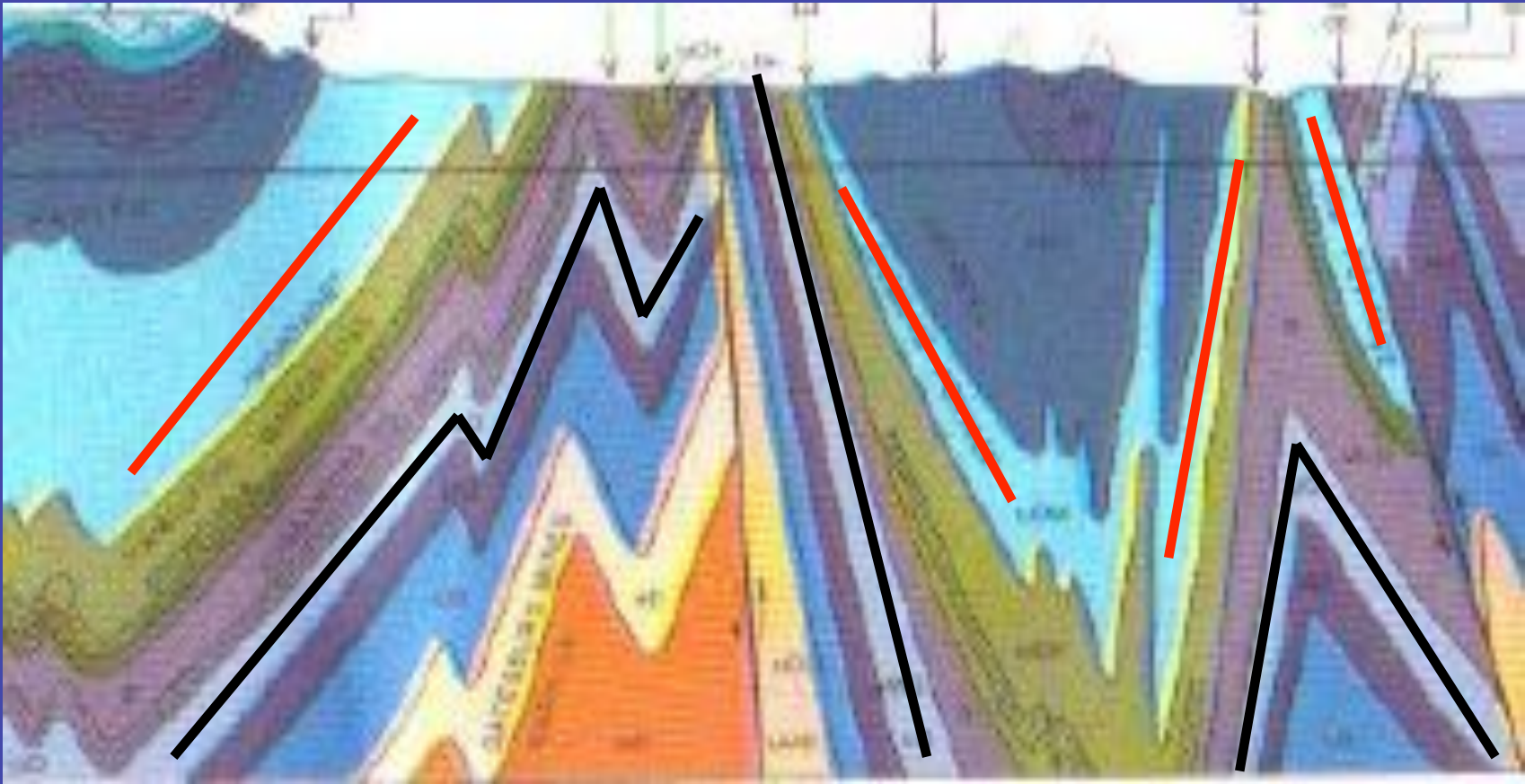


GEOLOGY 101: *THE BASICS*



Beneath PA-Turnpike, Near Bedford

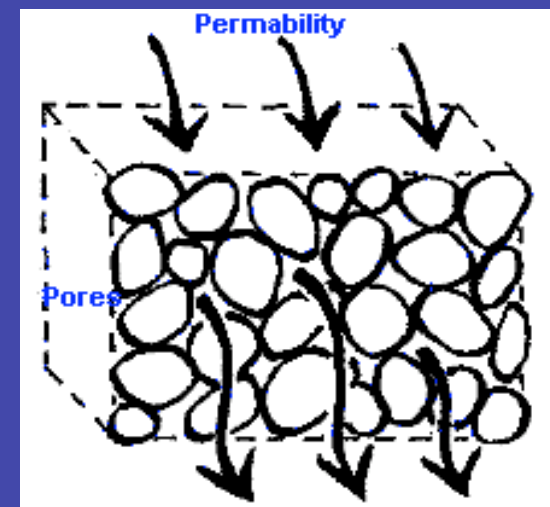
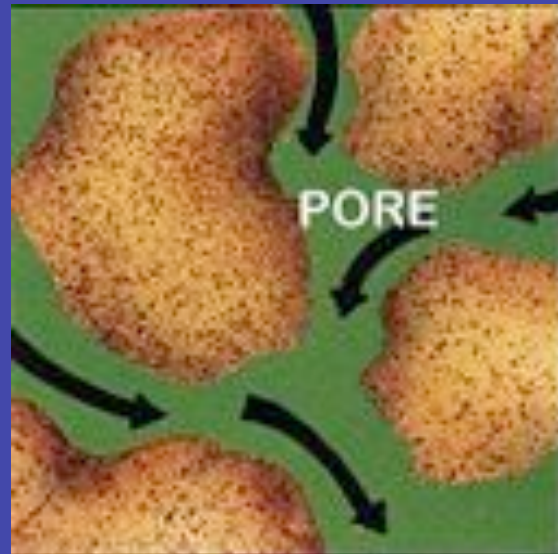
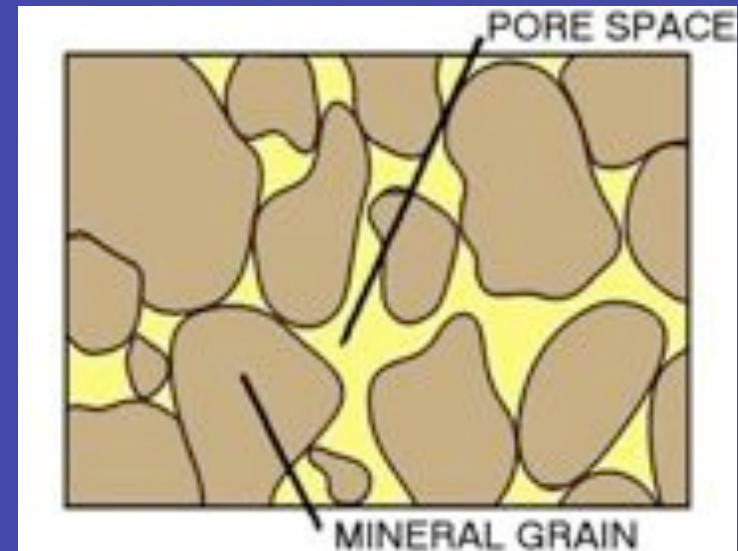
GEOLOGY 101: *THE BASICS*



Beneath PA-Turnpike, Near Bedford

GEOLOGY 101: *SEDIMENTARY ROCKS*

- COMPACTION, CEMENTATION, & LITHIFICATION
- POROSITY
- PERMEABILITY
- RESERVOIR REQUIREMENTS



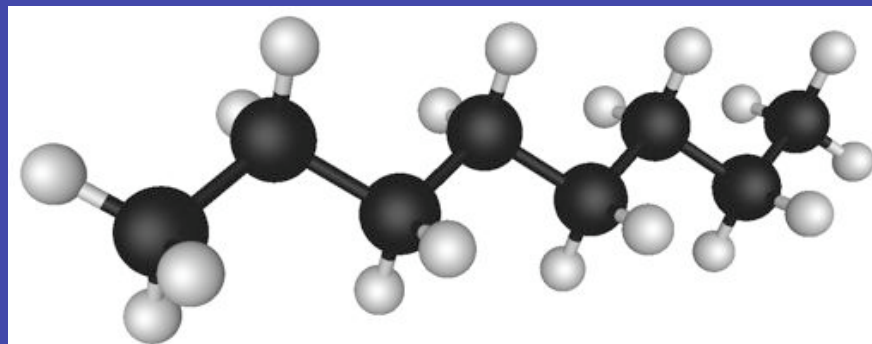
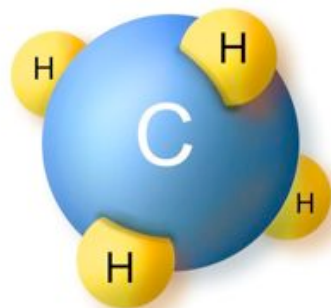
GEOLOGY 101: *PETROLEUM*

- KNOWN AS HYDROCARBONS
- FORMATION

BIOGENIC vs. THERMOGENIC vs. ABIOGENIC

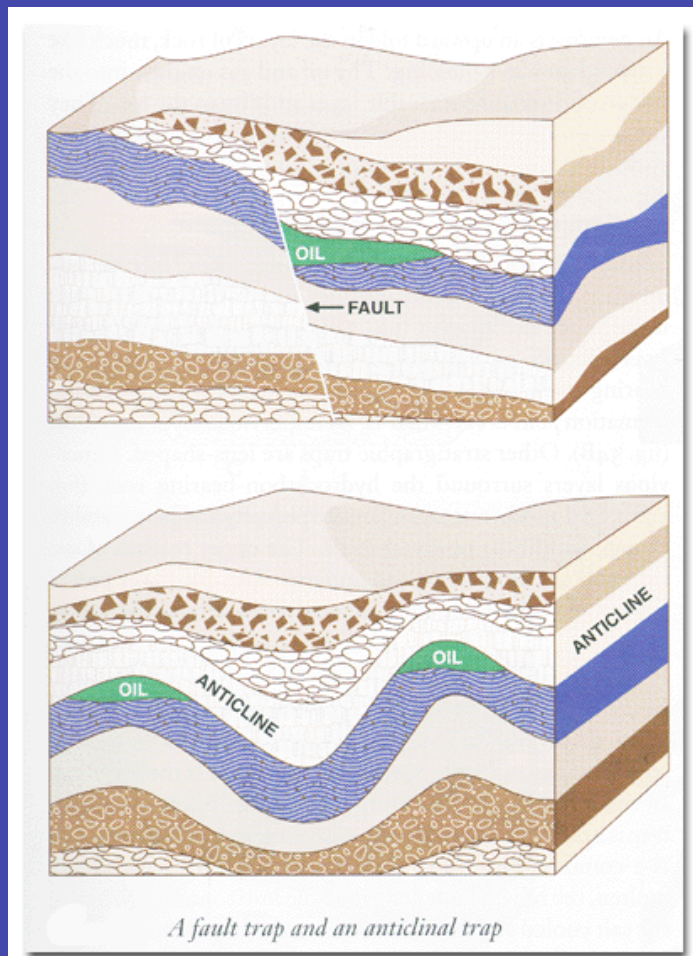
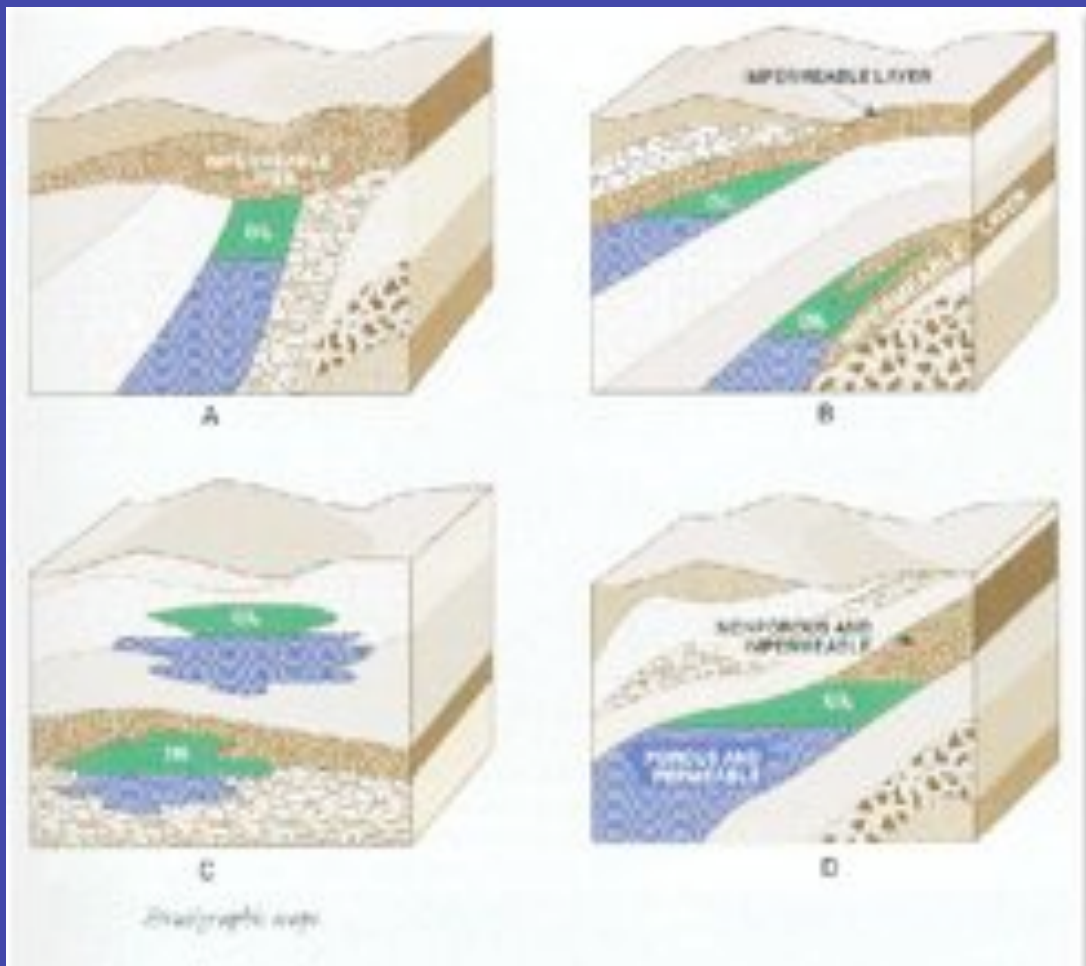
- OIL & NATURAL GAS

DEPTH, PRESSURE, TEMPERATURE,
ORIGINAL MATERIALS

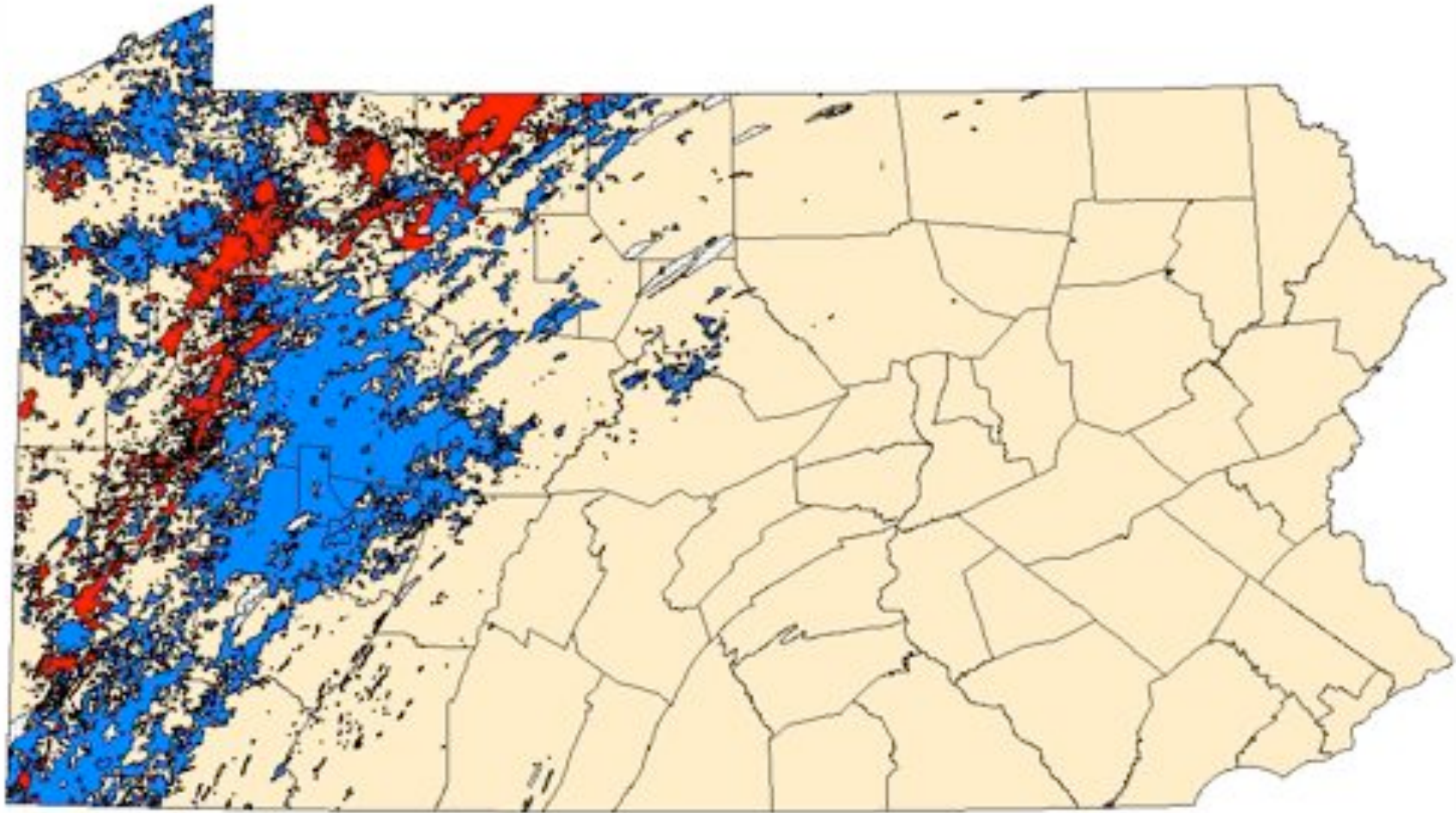


GEOLOGY 101: *CREATING A GAS FIELD*

- SOURCE, RESERVOIR, & TRAP
- STRATIGRAPHIC vs. STRUCTURAL



PENNSYLVANIA OIL & GAS FIELDS

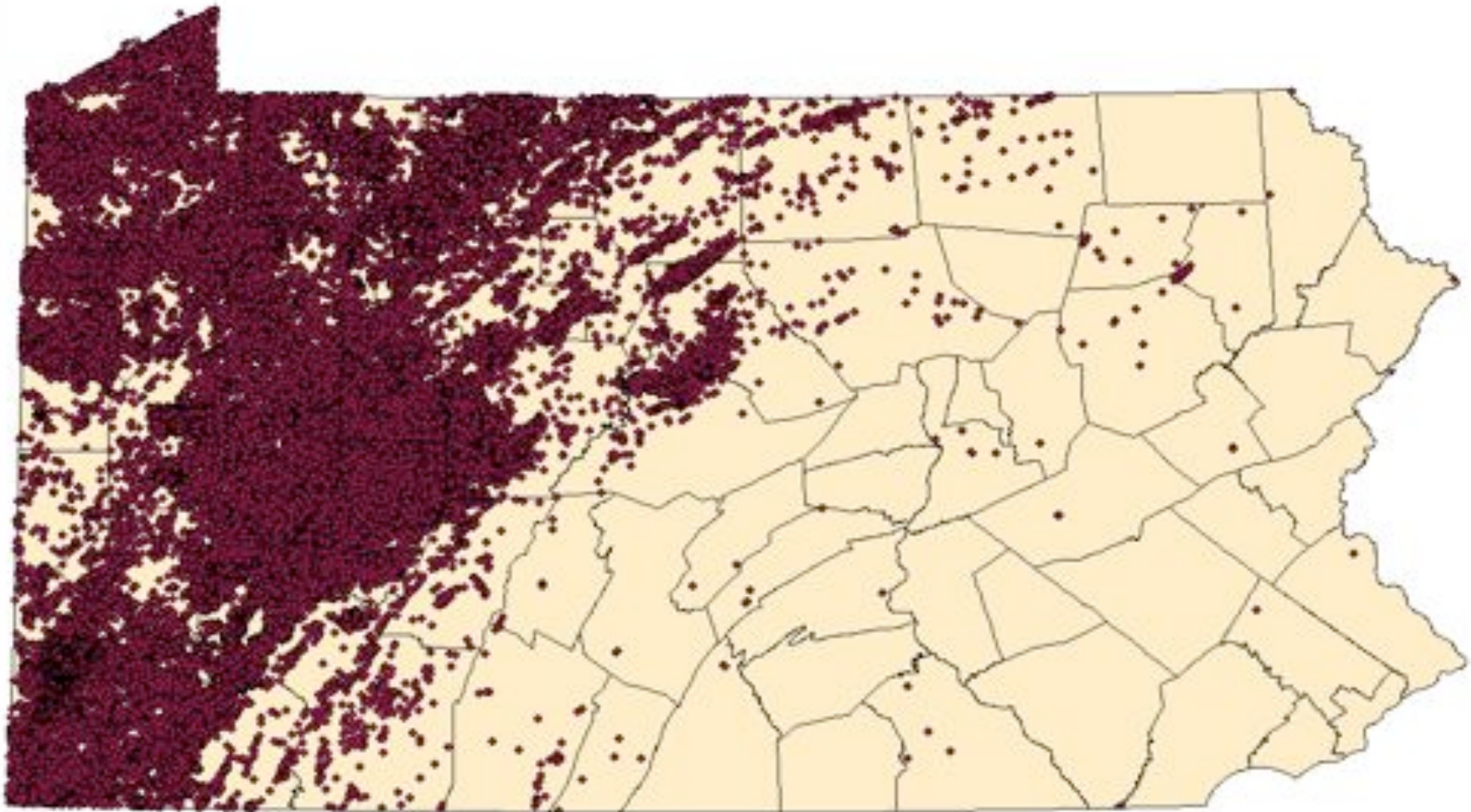


Oil Field

Natural Gas Storage Field

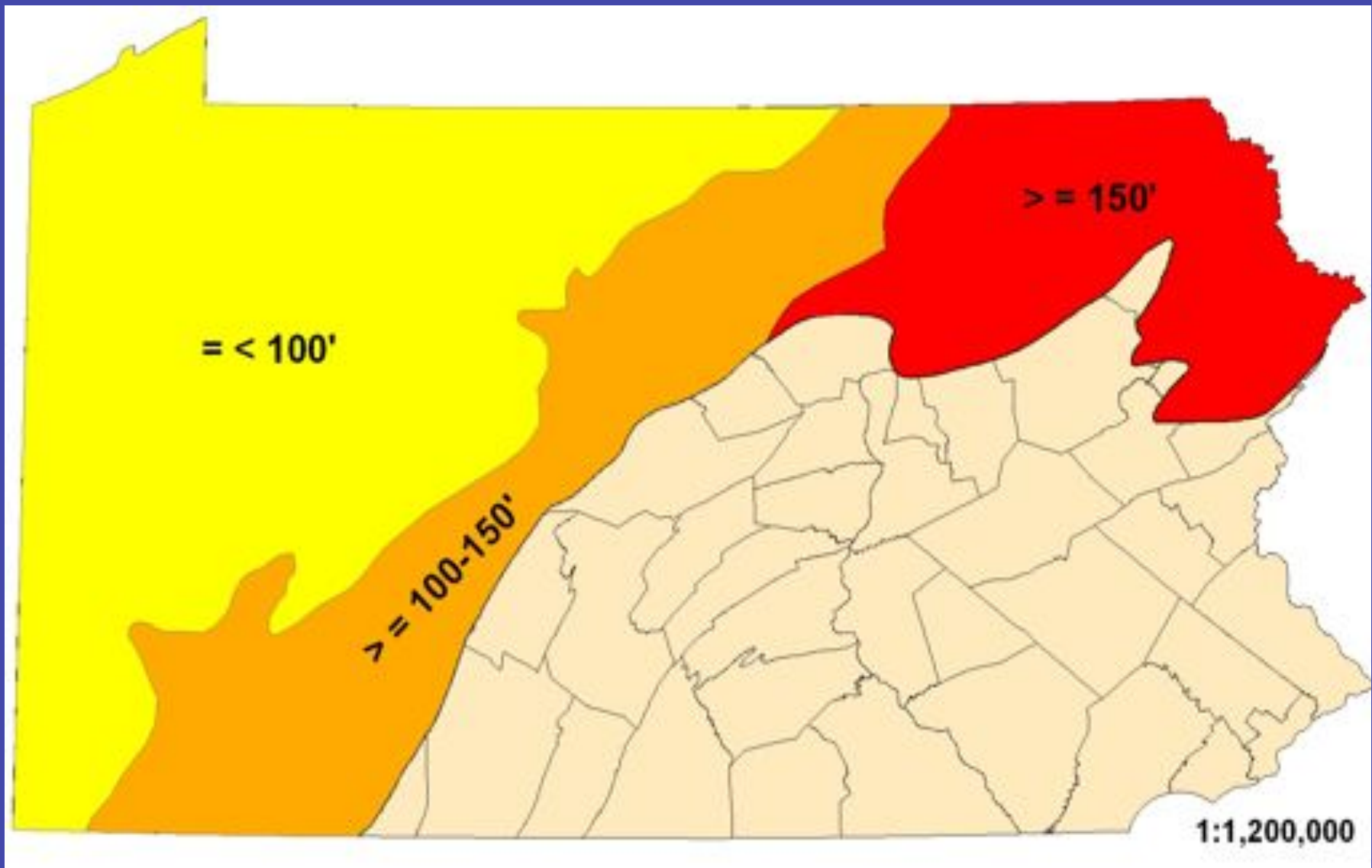
Natural Gas Field

PENNSYLVANIA DOCUMENTED OIL & GAS WELLS



Total Wells Represented Above: 135,322

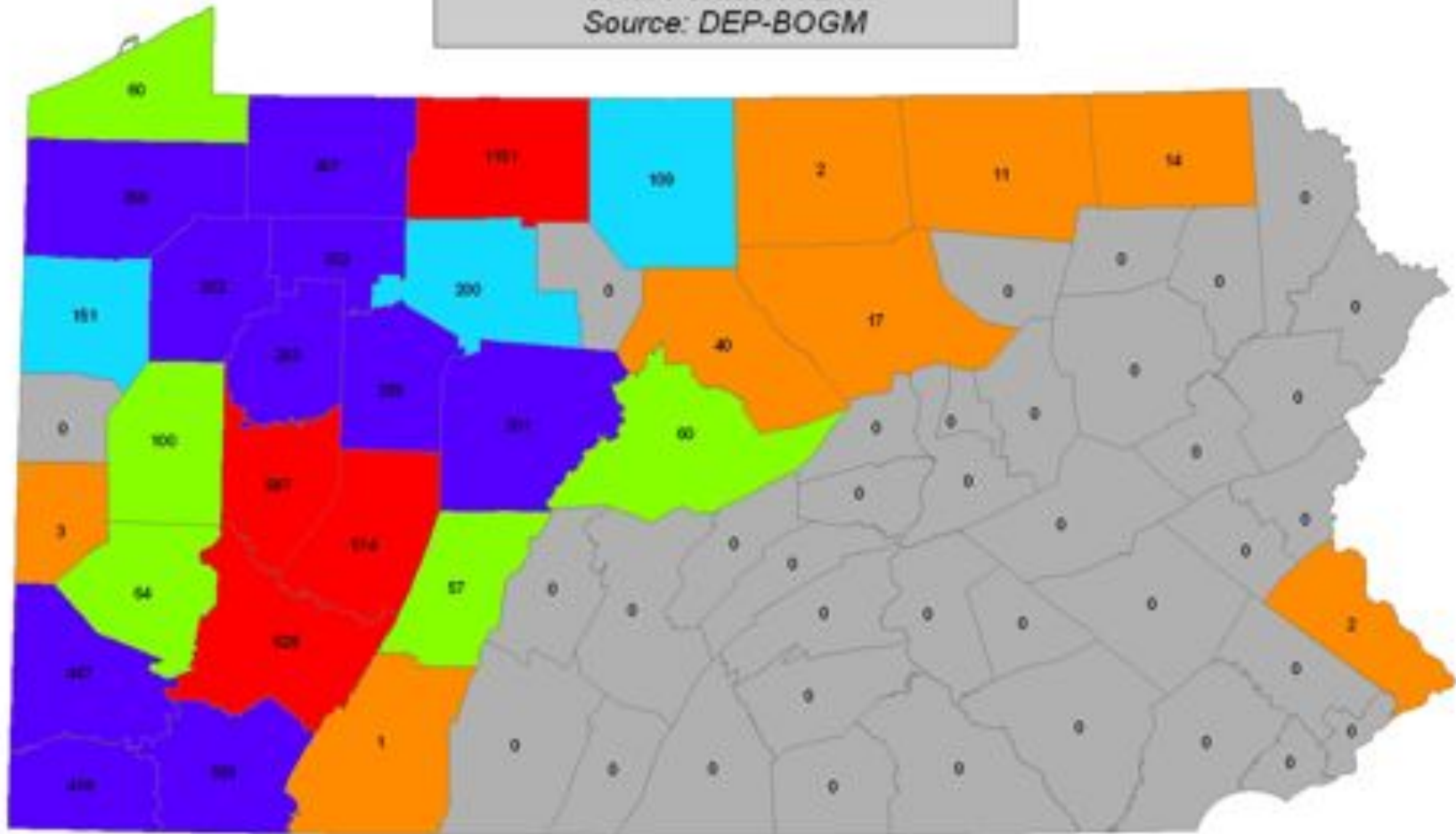
POTENTIAL MARCELLUS SHALE "Fields"



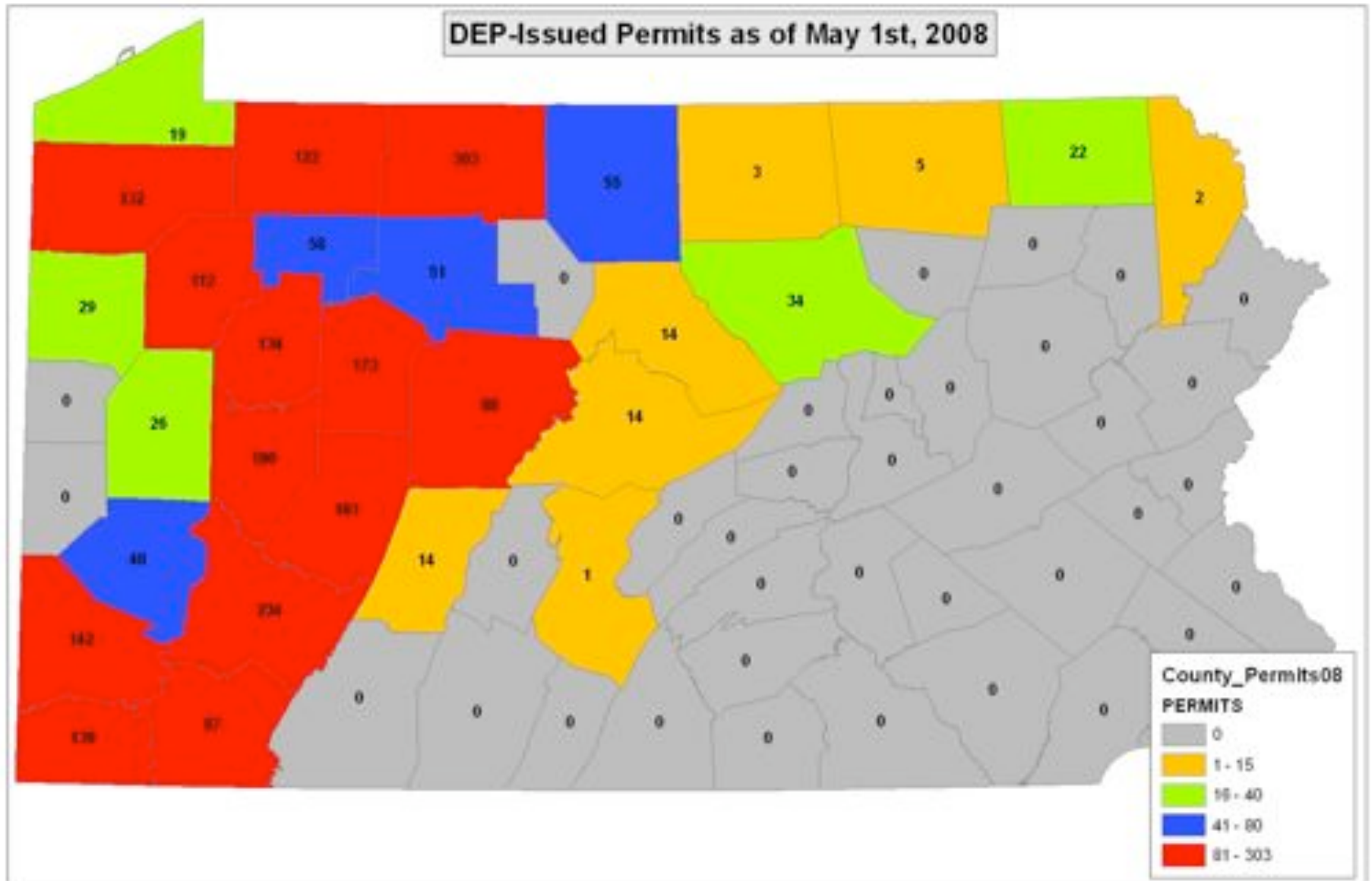
GROSSLY GENERALIZED THICKNESS CARTOON

DEP ISSUED WELL PERMITS - 2007

PERMITS ISSUED BY COUNTY IN 2007
Total Permits: 7241
Source: DEP-BOGM



DEP ISSUED WELL PERMITS – *thru APRIL 2008*



THE THREE DISTINCT PHASES OF NATURAL GAS DEVELOPMENT

- LEASING & ACQUISITION
- EXPLORATION & SCIENCE
- DEVELOPMENT & RETURN



*Sediment Core
Michaux State Forest*

*TRACT 285 #1 WELL
TD: 19,365'
PLUGGED TO: 13,120'*



Grugan Gas Field

RISK & NATURAL GAS RESERVE ESTIMATES

- RESERVES, CONTINGENT RESOURCES, PROSPECTIVE RESOURCES
- PROVED, PROBABLE, POSSIBLE
- SANDSTONES, SILTSTONES, LIMESTONES, DOLOMITES
- ORGANIC SHALES - *MARCELLUS*
- ENGELDER & LASH – 168 > 500 Tcf: *50 Tcf Tech Recv.*
- USGS – 20 > 50 Tcf: *2 Tcf Tech Recv.*
- *YOU DECIDE.....*



MARKETING THE NATURL GAS RESOURCE

- EAST COAST NATURAL GAS MARKET
- PIPELINE INFRASTRUCTURE – Gathering, Marketing, Transmission
- CAPTURE, COMPRESSION, CAPACITY
- CURRENT NEEDS → NON-TRADITIONAL AREAS



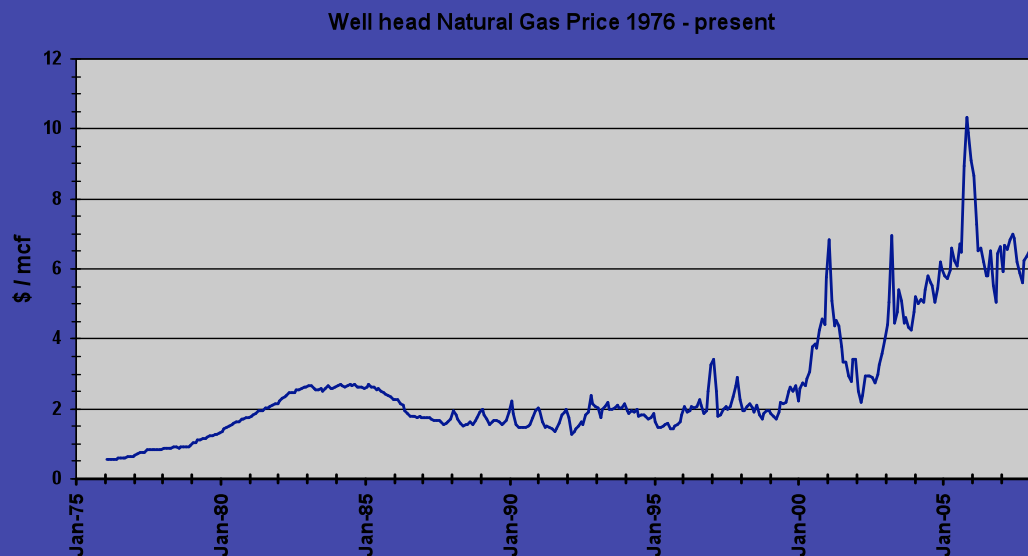
VALUING THE NATURAL GAS RESOURCE

- LEASING ECONOMICS → *Bonus, Royalty, Manpower*
- EXPLORATION / DEVELOPMENT ECONOMICS

D&C Costs, Equipment, Infrastructure

- ENERGY NEEDS → *Yesterday, Today, & Tomorrow*

Example: October 2005, October 2006, March 2008



Department of Conservation & Natural Resources
Bureau of Forestry

Oil & Gas Program

DCNR Legal Mandates

- **Conservation and Natural Resources Act 1995**
 - 302(a)(6) Authorizes DCNR to make and execute leases for mining or removal of valuable material from State Forests.
 - 302(b)(10) Empowers DCNR to lease State Forest for underground storage of natural gas
- **Act 1955-256** Established “Oil and Gas Fund.” Royalties and rents to be used by DCNR for conservation, recreation, and flood control

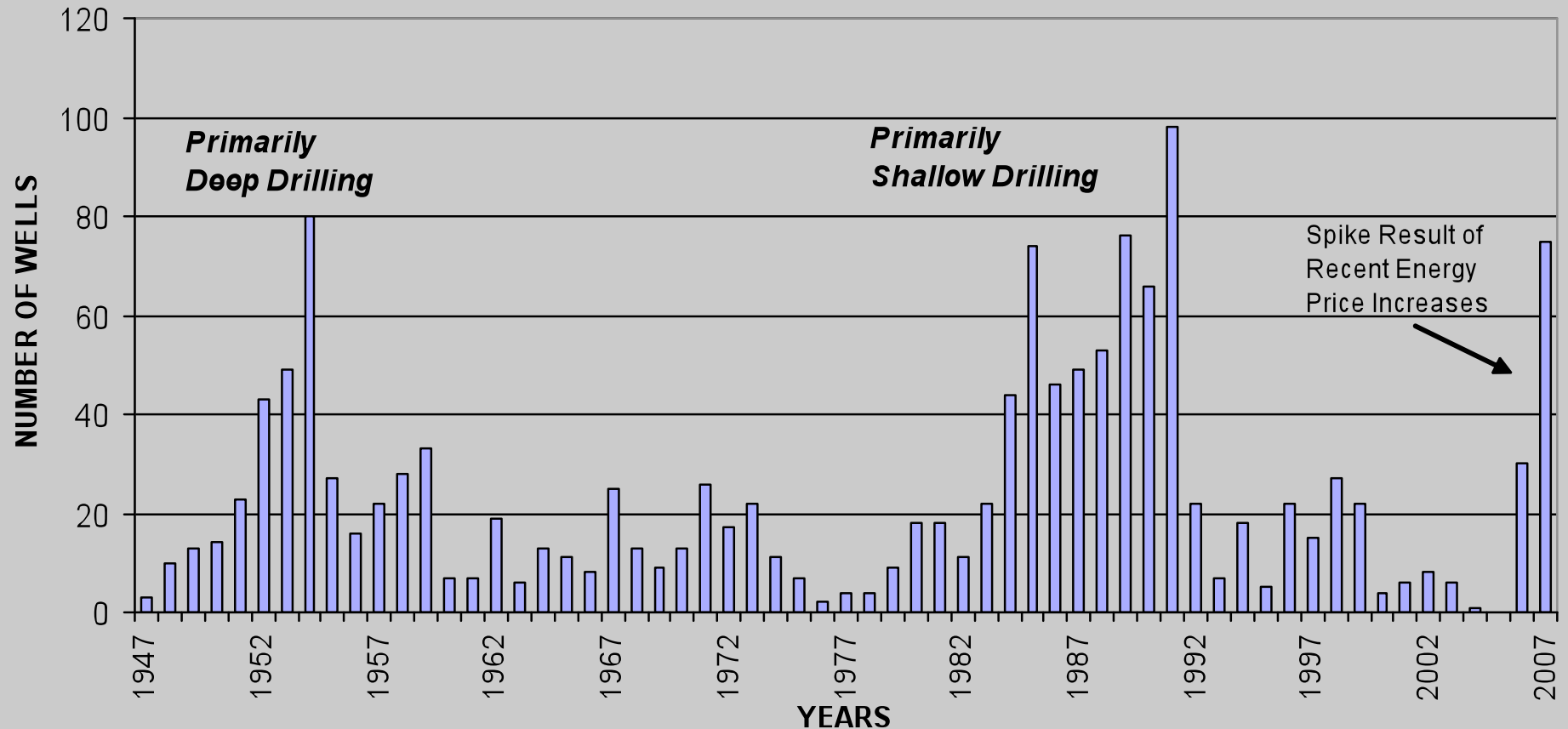
Bureau of Forestry Mission

The mission of the Bureau of Forestry is to ensure the long-term health, viability and productivity of the Commonwealth's forests and to conserve native wild plants.

The Bureau will accomplish this mission by:

Managing State Forests under sound ecosystem management, to retain their wild character and maintain biological diversity while providing pure water, opportunities for low density recreation, habitats for forest plants and animals, sustained yields of quality timber, ***and environmentally sound utilization of mineral resources.***

Gas Wells Drilled on State Forest Land Through a Commonwealth Lease Agreement 1947-2007



1,437 wells in 60 years

OIL & NATURAL GAS PROGRAM

- OIL & GAS LEASE FUND (1955) – *Rents, Royalties, Associated Fees*
- OVER \$153 MM GENERATED
- USES OF O&G LEASE FUND
Parks, State Forest Land, Pine Creek Trail

*26 State
Subsurface Rights,*



OIL & NATURAL GAS PROGRAM

- DCNR OWNS 85% STATE FORESTS *fee simple*
- CURRENTLY 99 ACTIVE LEASES on 270,609 acres
- GAS STORAGE LEASES on 69,983 acres
- 650 ROYALTY PRODUCING GAS WELLS
- \$4.4 MM REVENUE – 2007 (O&G Lease Fund)



OIL & NATURAL GAS PROGRAM

- DCNR LEASE AGREEMENT
- SURFACE USE AGREEMENT (*Severed Ownership*)
- SURETY BONDS
- COMPREHENSIVE OVERSIGHT
- WELL LOCATION APPROVALS
- TIMBER DAMAGES
- PLUGGING CLAUSE



OIL & NATURAL GAS PROGRAM

- OIL & GAS WEBSITE

http://www.dcnr.state.pa.us/forestry/oil_gas.aspx

- FORESTRY DOCUMENTATION

<http://www.dcnr.state.pa.us/sfrmp/documents.aspx>

MINERALS SECTION

MAIN # 717-787-4835

Nathan Bennett: 717-783-7940

nabennett@state.pa.us



OGM Activity & Development on State Game Lands

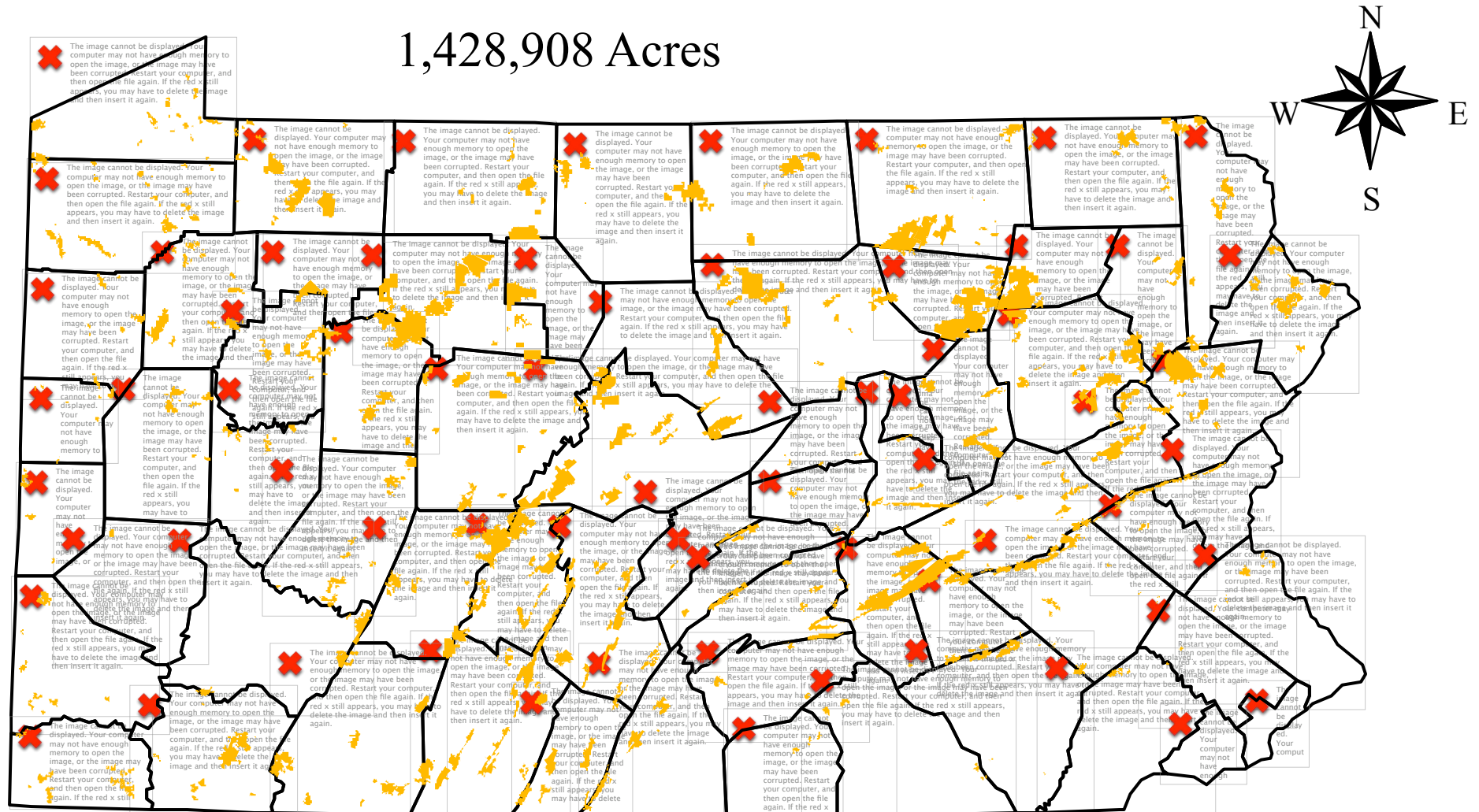
**Michael DiMatteo, Chief
Oil/Gas & Mineral Development
Division of Environmental Planning & Habitat
Protection**



June 19, 2008

PENNSYLVANIA STATE GAME LANDS

1,428,908 Acres



Title 34 Game and Wildlife Code

- Chapter 7 – Subchapter B
 - **722 Use of Property**
 - (B) Permits Licenses Leases The Commission may issue permits, licenses and enter into leases for uses of its lands as it deems in the best interest of the commission at such charge as it deems reasonable



Title 34 Game and Wildlife Code

- **Chapter 7 – Subchapter B**
 - **723 Exchange or Sale**
 - **The Commission may, by resolution adopted by a majority of the members present and voting at a public meeting:**
 - **(1) Authorize the exchange of any lands acquired in return for lands having an equal or greater value when the exchange is in the best interest of the Commission.**
 - **(2) Exchange timber, minerals, oil or gas to which the commission holds title for suitable lands having an equal or greater value.**



Title 34 Game and Wildlife Code

- Chapter 7 – Subchapter B
 - **724 Disposition of timber, minerals and other products**
 - The commission may dispose of by lease, sale, or otherwise, timber, buildings, other appurtenances, minerals, oil, gas, or rights therein, including natural gas storage, or any other product, on or under lands to which it has title.



Title 34 Game and Wildlife Code

- Chapter 7 – Subchapter B
 - 726 Leases
 - Notwithstanding any other provision of the law, the director, with the approval of the commission, may lease any land or interest in land over which the commission exercises title or control for a term not to exceed 25 years when the commission determines the lease will promote public hunting or furtaking or benefit the game or wildlife resource or will otherwise further the interests of the commission



Leasing Policy

- Bid Process
- Land Exchange
- Sole Source lease due to circumstances

BID PROCESS

- Oil/Gas company nominates Gameland
- PGC determines OGM ownership - prepares map
- Questionnaire sent to Regional Office
- Regional Office comment, review and recommendation.
- Comments reviewed and any wildlife habitat and environmental concerns addressed.
- If all concerns are met Bid package can be initiated
- If all concerns not met- then further discussions occur and decision is made whether to proceed or to not proceed any further.

Bid Process (cont.)

- If bid process continues, a comprehensive review is completed to delineate critical and unique habitat areas, no drilling areas, and well spacing distance.
- Lease bid map prepared.
- Site specific drilling and development restrictions established to include:
 - Reclamation and revegetation plans
 - Land rental requirements
 - Assigned acreage for producing wells

Bid Process (cont.)

- Formally notify Commissioners
- Written public notice and bid advertisement in two local papers
Personal bid invitations sent to most probable bidders
- Bids received and opened
- Highest bidder recommended for Commission approval and lease award

Bid Process (cont.)

- Leasing Action approved by Commissioners
- Lease terms and conditions approved by Chief Counsel and State Attorney General
- Bond collected and held for term of lease
- Meeting with Lessee to review all terms and conditions.
- Periodic field review and audit by PGC.

Land-Lease Exchange

- Land exchange provided land has equal or greater value.
- Opportunity to offset “***Temporary Loss***”
- Exchange rate of 3 to 1 ie: Hunters get 3 acres of land in exchange for **each** acre leased.



Lease Value towards Land

- Bonus \$/acre
- Well location Fees
- Surface support value (6% f.o.b. pit price)
- *Coal or Mineral value (6% f.o.b. pit price)*
 - *If all upfront as a LAND exchange*

Land Value towards Lease

- Habitat values (thermal cover, wetlands, species diversity , hunting opportunity, T/E species, streams, soils, etc.)
- Indentures, Interiors, Additional Public Access Needs, Stand alone parcel, *OGM under current State Game Lands surface previously excepted out*
- PGC assesses land value upfront
 - Comparable sales values for local real estate
 - Other related OGM values
 - Total PGC value credit towards advanced surface damage royalties or timber surface damages (single stumpage)

Sole Source Lease Action due to Circumstances

- Oil/gas drilling on private reserves encroaching on PGC owned reserves
- Coal mining on adjacent lands presents opportunity to complete reclamation projects on Gamelands through leasing.
- Potential Lessee owns the land, or can cause to have PGC designated land conveyed

Goals & Strategic Objectives

- **Maintain & improve wildlife habitat**
- **Land acquisition & Habitat Enhancement**
- **Promote natural resource recovery on Game Lands**
- **Ensure wildlife habitat impacts are considered during regulatory permit review**
- **Monitor wildlife mitigation plans & critical habitat**
- **Develop sustainable funding sources thru OGM recovery, compliance, and damage assessment**
- **Protect & Conserve wildlife species of special concern**

RESOURCE RECOVERY QUESTIONNAIRE

PURPOSE

- Information Gathering
- Assessment
- Pros & Cons of proposed activity
- **REGION / FIELD INPUT**

Resource Recovery Quest.

- Harrisburg will provide map depicting:
 - SGL boundary
 - OGM ownership
 - Proposed lease area(s)
 - NWI wetlands & Hydric Soils
 - Wild Trout Streams & Chap 93 designations
 - EV, HQ, CWF, WWF
 - Species of special concern and Buffer area
 - Existing well locations – coal mines, highwalls etc

Resource Recovery Questionnaire

- Current and historic drilling activity
- Assessments, surveys academic research etc...
- Wetlands
- Critical & unique Habitats
- Wildlife propagation areas
- Wild or Scenic Rivers, historical sites, regional trails, or public recreation areas
- suspected or confirmed species of special concern and/or their habitats
- public or private water supplies

MINERAL OWNER VS Surface Owner

- Mineral owner (or lessee) has implied right to use the surface as reasonably necessary for mineral exploration and production
- If you do not own the oil and gas under your land, you cannot prevent the mineral owner's reasonable access for development and production
- Landowner has right to protection from unreasonable encroachment or damage

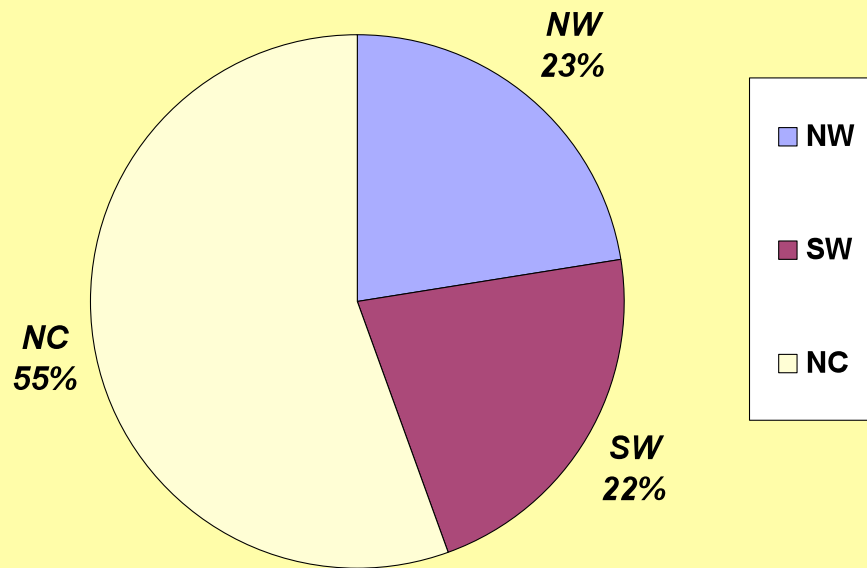
Severed mineral interest

- Severed mineral interest: the mineral estate is separate from the surface estate
- Mineral estate is generally dominant to the surface estate

OGM activity on SGL

- 77,256 acres leased
- 117 leases
- 319 wells on PGC leases
- 2,610 Total oil/gas wells on SGL

New wells per Region
2006-2007-2008



*PGC well permits
2006-2008*

total wells	479
NW	108
SW	105
NC	266

OGM activity on SGL

Gas Activities & Impacts

Surface Use Activities

Access roads

(permanent vs. temporary)

- Exploratory drilling
- Haulroads
(OGM related, timber related)
- Maintenance & Service roads
- Private access roads
(individual dwelling)
- Public access roads
(park, other State Agency, etc.)

Surface Use Activities (cont.)

Seismic geophysical lines

Coal gob vent holes and air shafts

Passive treatment systems and watershed
abatement projects

Electric transmission lines

Oil/Gas pipelines

Gas Compressor stations

Sewer lines

Water lines (private vs. public)



OGM Well Coordination

- Plat received in Harrisburg
- Review Ownership
- PNDI
- Review Wetlands/ Stream uses Chap 93
- Send email & memo to Region with map

Region Coordination

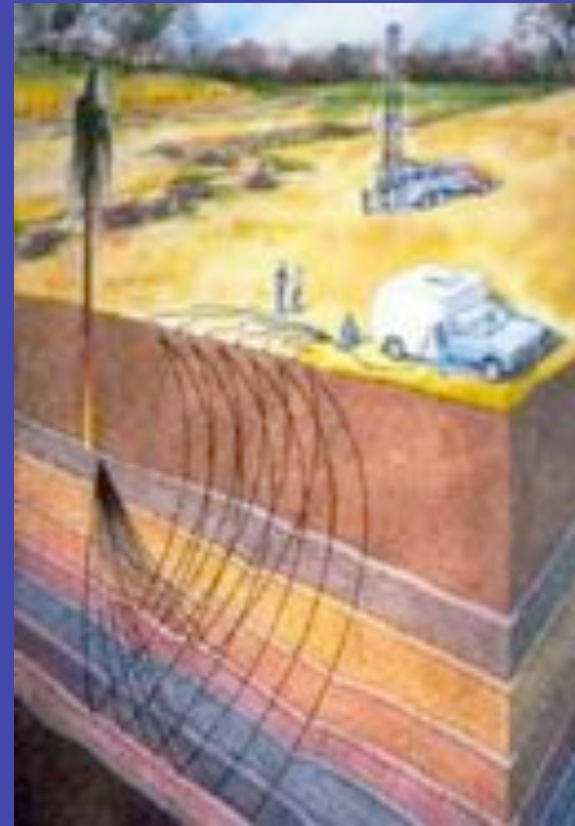
- Land Manager/Forester meet with company
- Field Review well location, access road, pipeline
- Tally surface / timber damage
- Send invoice to Company
- Send copy to Harrisburg
- Monitor development activity

Surface Damage

- Operator can make reasonable use of the surface for the purpose of exploring, drilling, operating for, use water, build roads lay pipe, Must compensate surface owner for damages to growing crops and timber,
- Well Location fee

Exploration

- SEISMIC 2D OR 3D SHOOT
- USUALLY ALLOWED FOR IN LEASE TERMS
- REQUIRES PERMIT



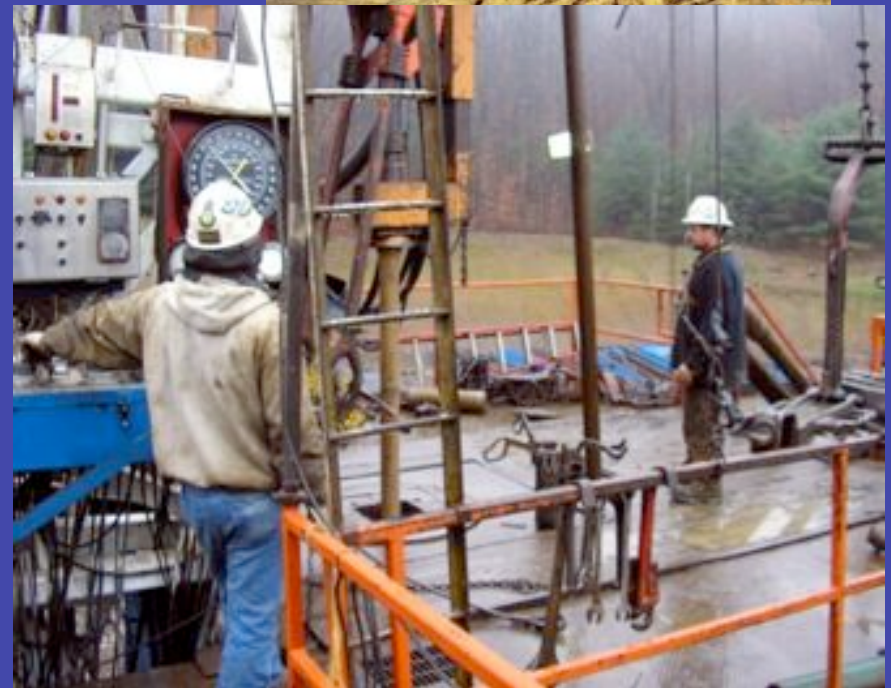


WELL SITE DEVELOPMENT

LANDOWNER NOTIFICATION-PLAT
LOCATION APPROVAL
TIMBER ASSESMENT
CLEARING / GRUBBING
E&S CONTROLS
SLUSH PIT
GRADE / LEVEL SITE
for RIG



Well Drilling







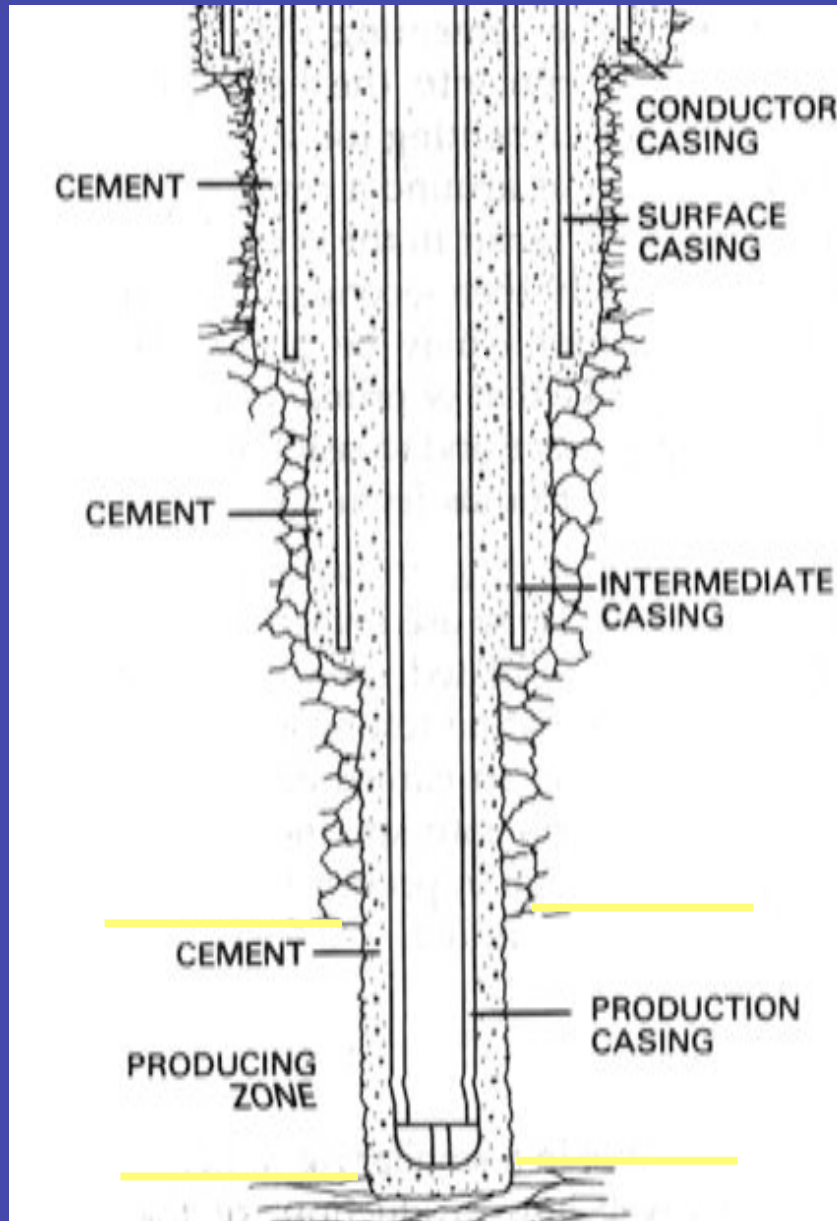




Completion Steps

- **Casing and cementing** - stabilize the hole
- **Perforations** - allow oil, gas to enter the well
- **Stimulation** - increase production
- **Equipment** - determined by well conditions

Well Casing



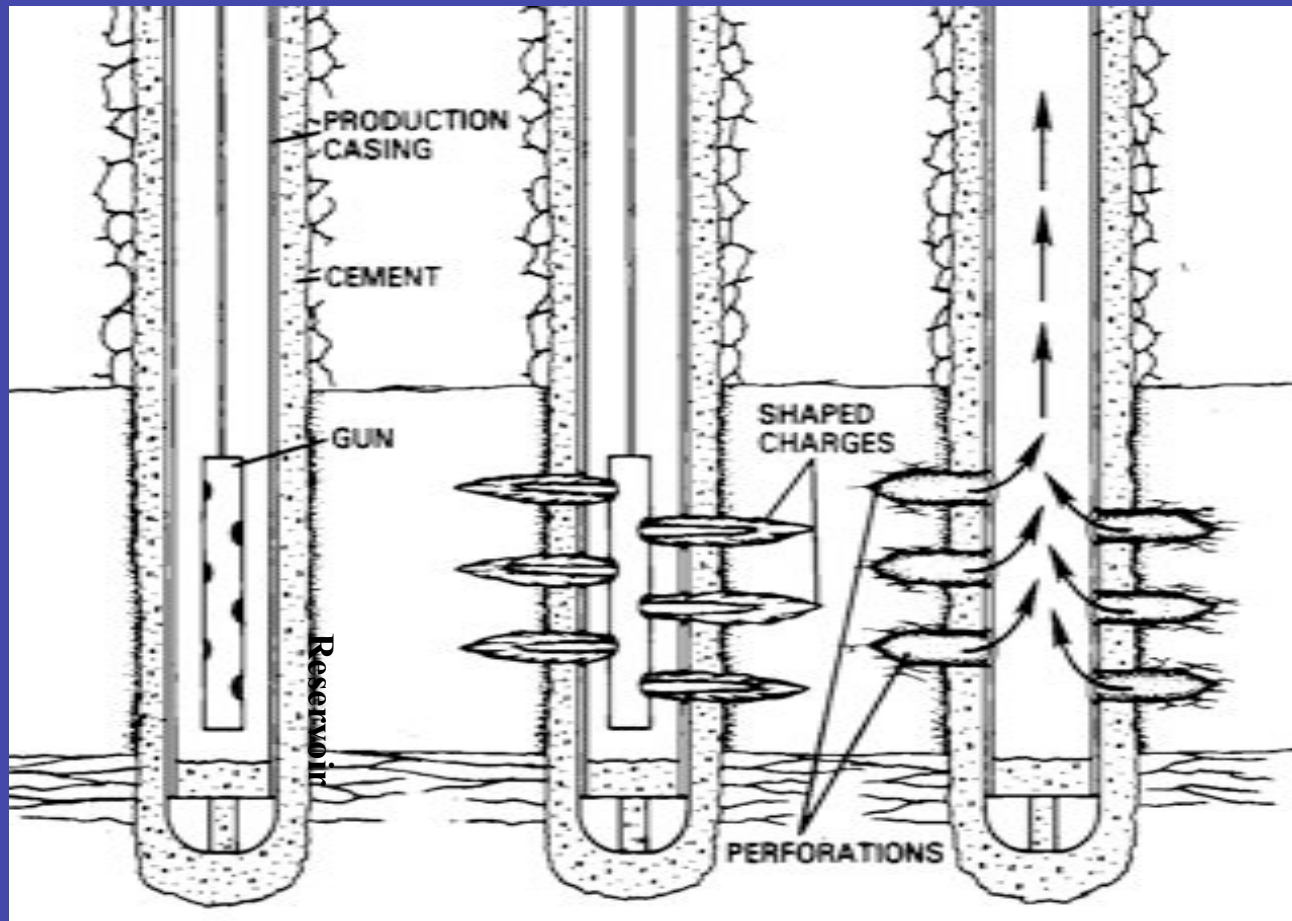
Conductor, surface, intermediate, and production casing cemented in well.

Well Fracing

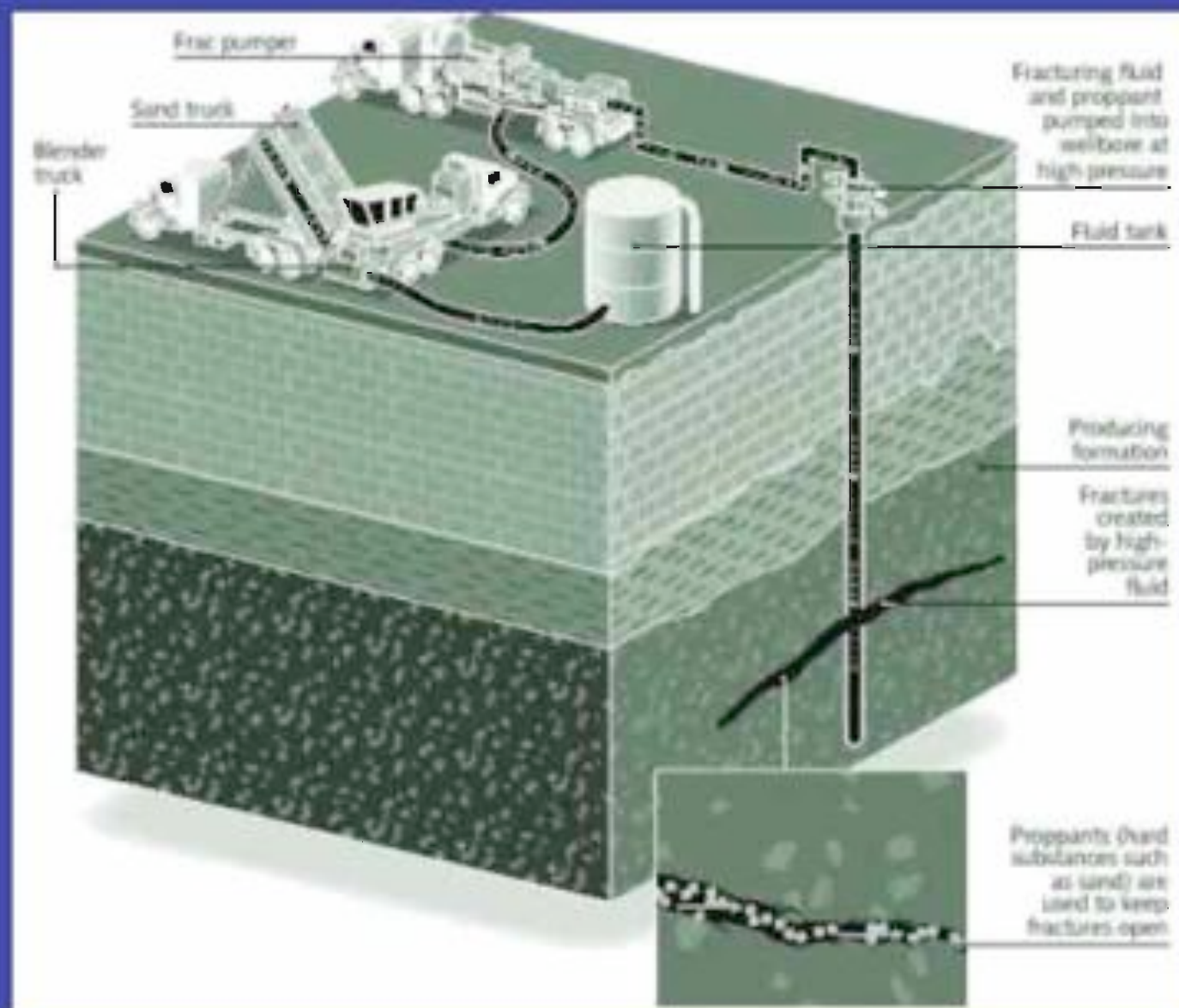
- Artificial way to enhance permeability
- Pumping sand, water, polymers, gels, foams into formation under high pressure
- Liquid is then pulled out of well bore leaving sand in place
- Sand fills fractures and provides flow path for gas to well bore



Perforating the Casing



A perforating gun OR Shape Charges are used to create holes in the casing and cement to allow fluids or gas to enter the well.

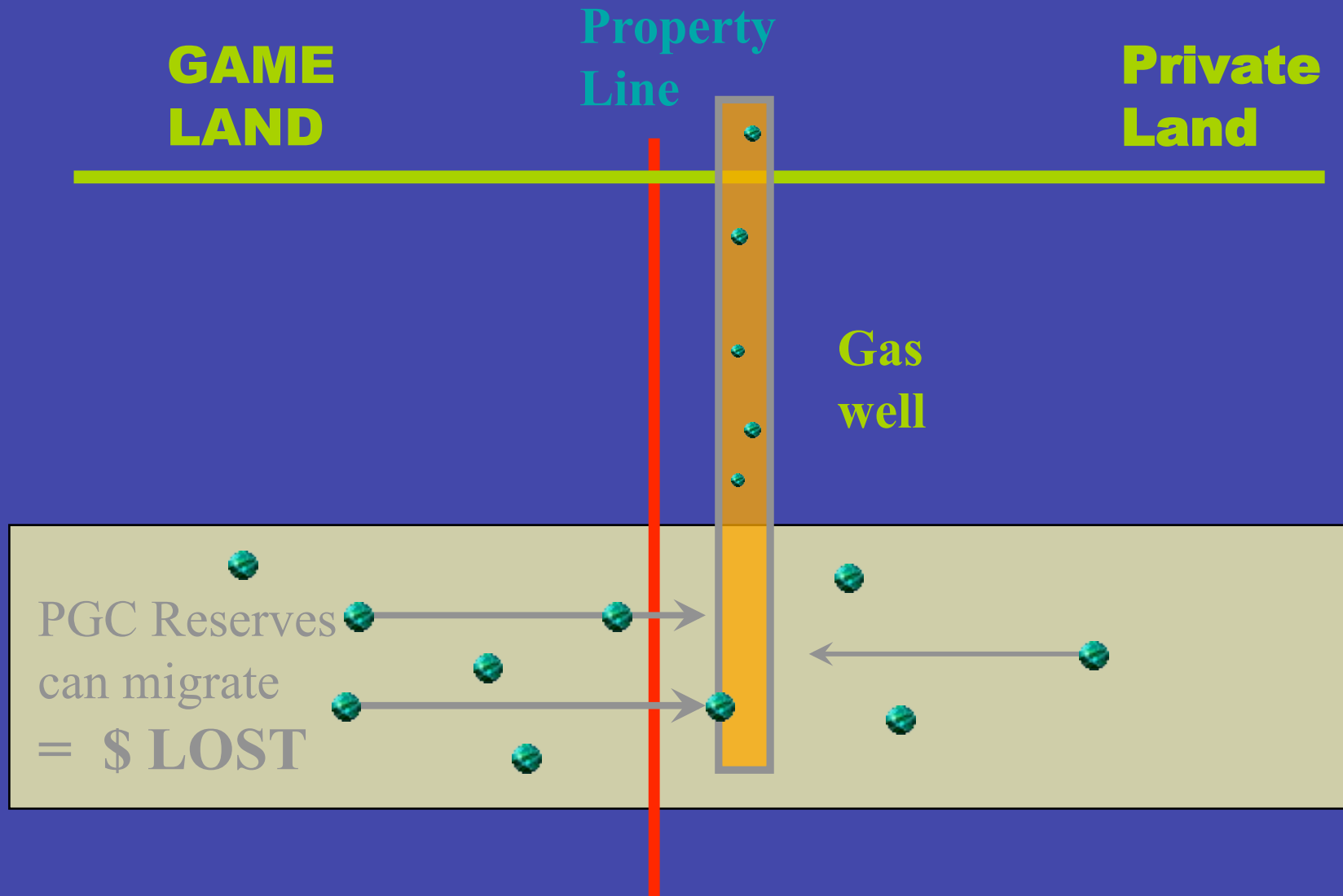




Rule of Capture

- **The Rule Of Capture:** one who captures the resource has ownership and therefore there is no liability for capturing oil and gas that drains from another's lands
- Under the classic rule of capture, a landowner has only one option when someone is draining oil and gas from beneath his property: drill his own offset well to intercept the flow.

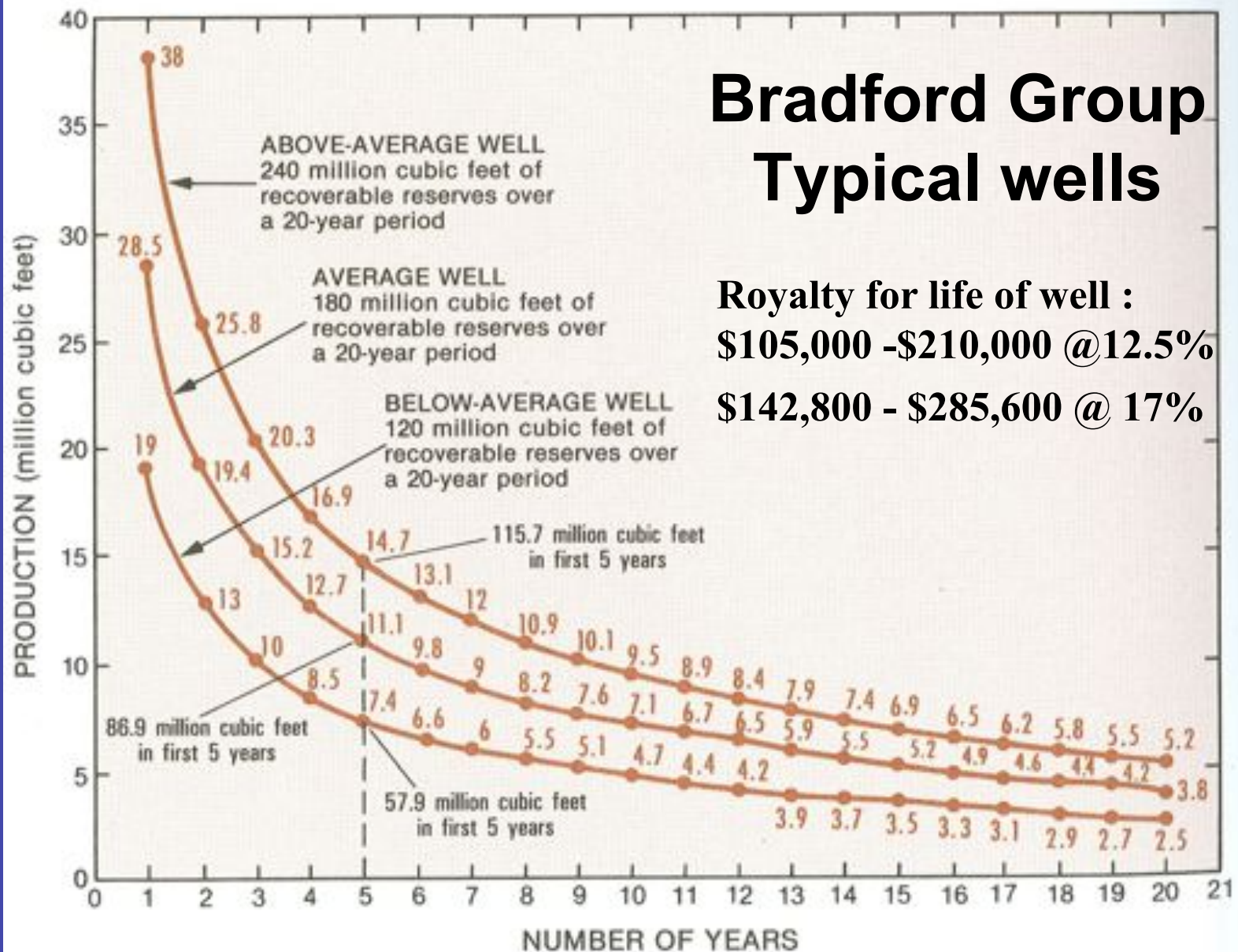
Rule of Capture



How much gas can a well
produce?

Bradford Group Typical wells

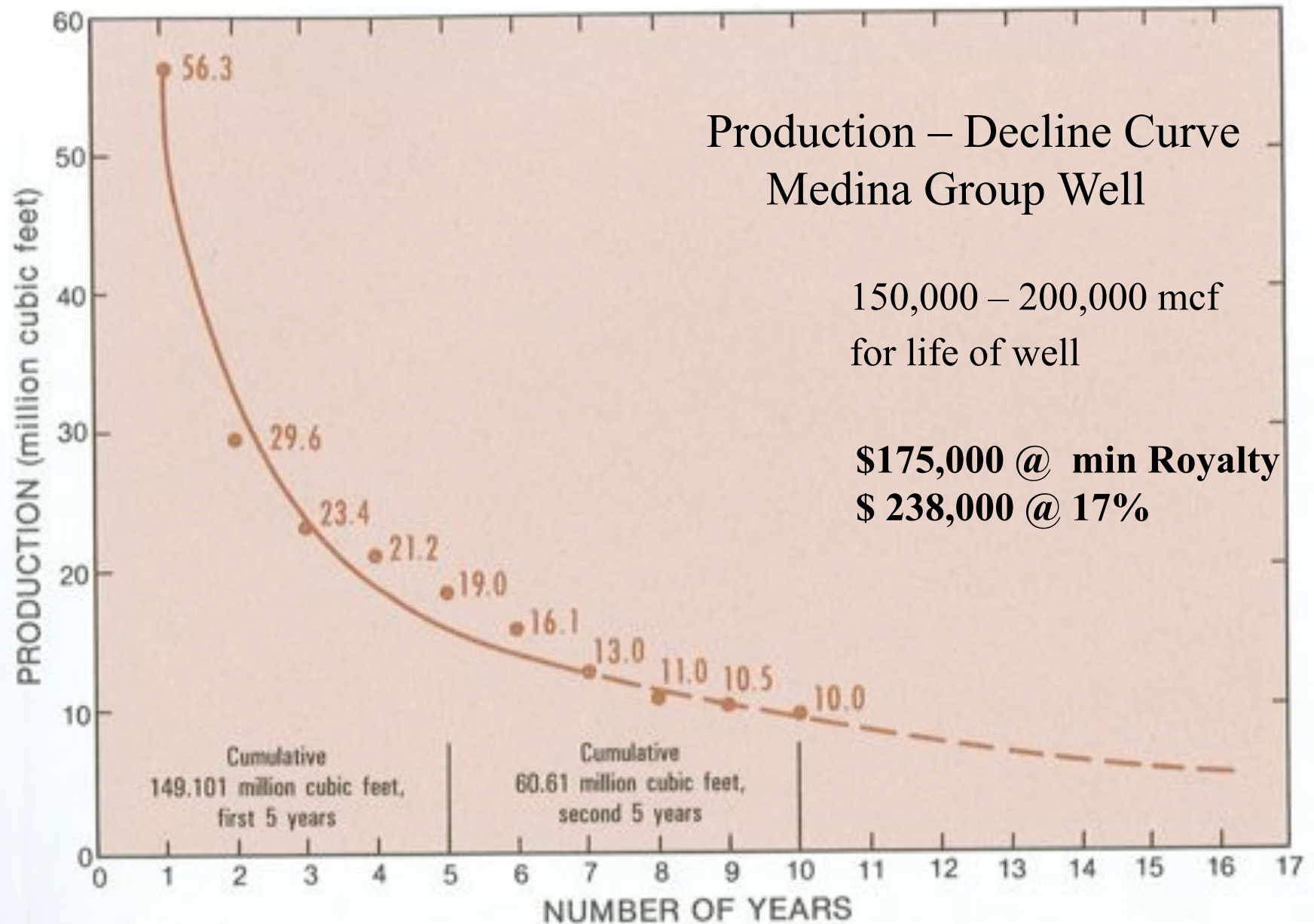
Royalty for life of well :
\$105,000 - \$210,000 @12.5%
\$142,800 - \$285,600 @ 17%



Production – Decline Curve Medina Group Well

150,000 – 200,000 mcf
for life of well

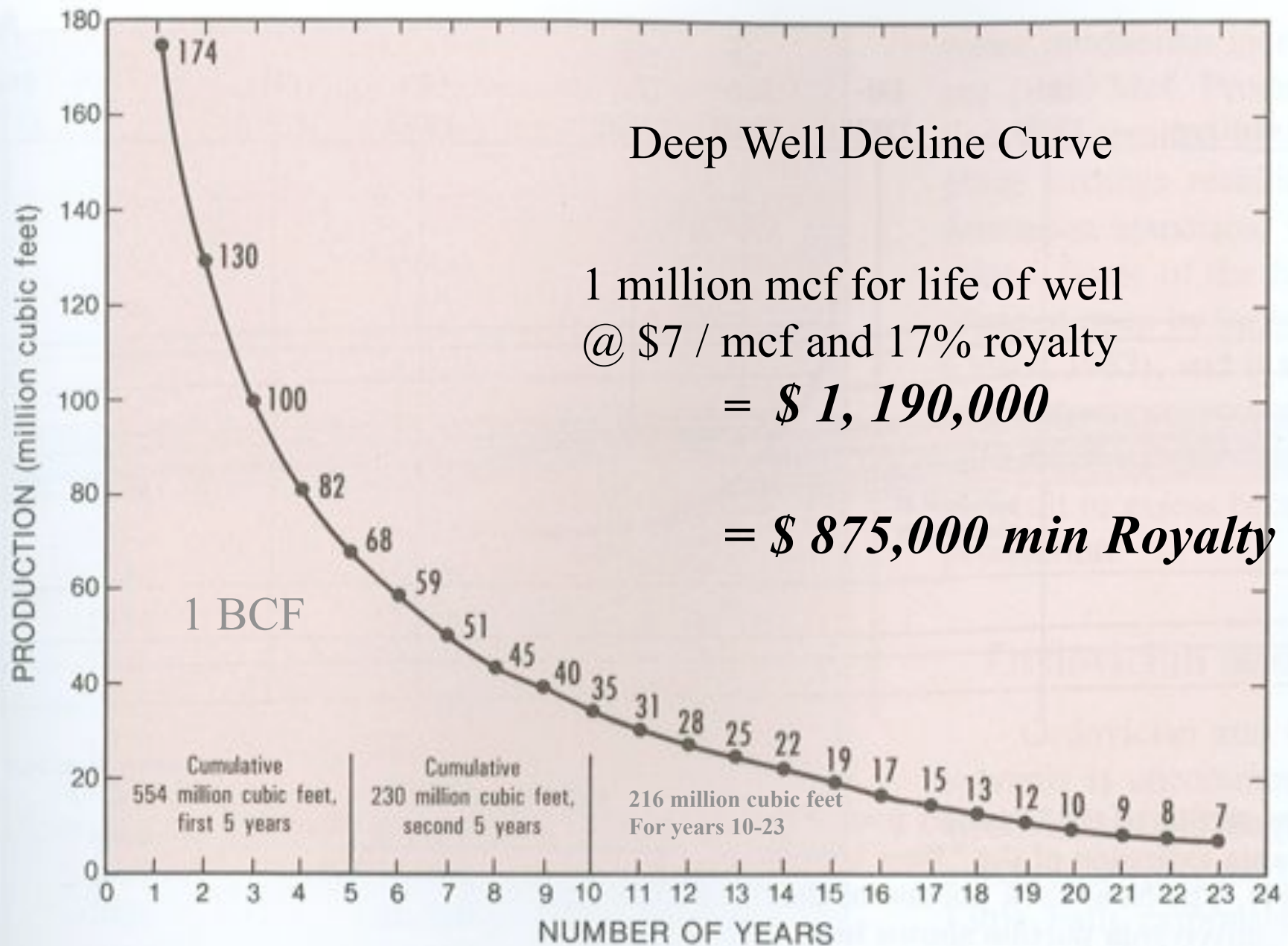
\$175,000 @ min Royalty
\$ 238,000 @ 17%



Deep Well Decline Curve

1 million mcf for life of well
@ \$7 / mcf and 17% royalty
= **\$ 1,190,000**

= **\$ 875,000 min Royalty**



ENVIRONMENTAL IMPACTS

- WATER USE
- TAILINGS AND DISPOSAL
- HAZARDOUS WASTE COLLECTION / DISPOSAL
- ROADS
- PIPELINES
- INVASIVE SPECIES

WATER USE

- DRILLING PROCESS USES 50,000 – 70,000 GALLONS WATER
- FRACING USES MUCH GREATER AMOUNTS UP TO 1MILLION GALLONS / STAGE
- SRBC/DRBC WITHDRAW & CONSUMPTIVE USE PERMITS

TAILINGS AND DISPOSAL



ROADS & PIPELINES

- LOCATION APPROVAL BY PGC
- MUST FOLLOW BMPS / E&S CONTROL PLAN
- OBTAIN STREAM CROSSING/ ENCROACHMENT PERMITS



Roads & Pipelines



SITE RESTORATION

- 9 months after completion of the well
 - PGC – seed mix rec plan for each site
 - Site Restoration Report
-
- 9 months after plugging the well
 - Well Plugging report

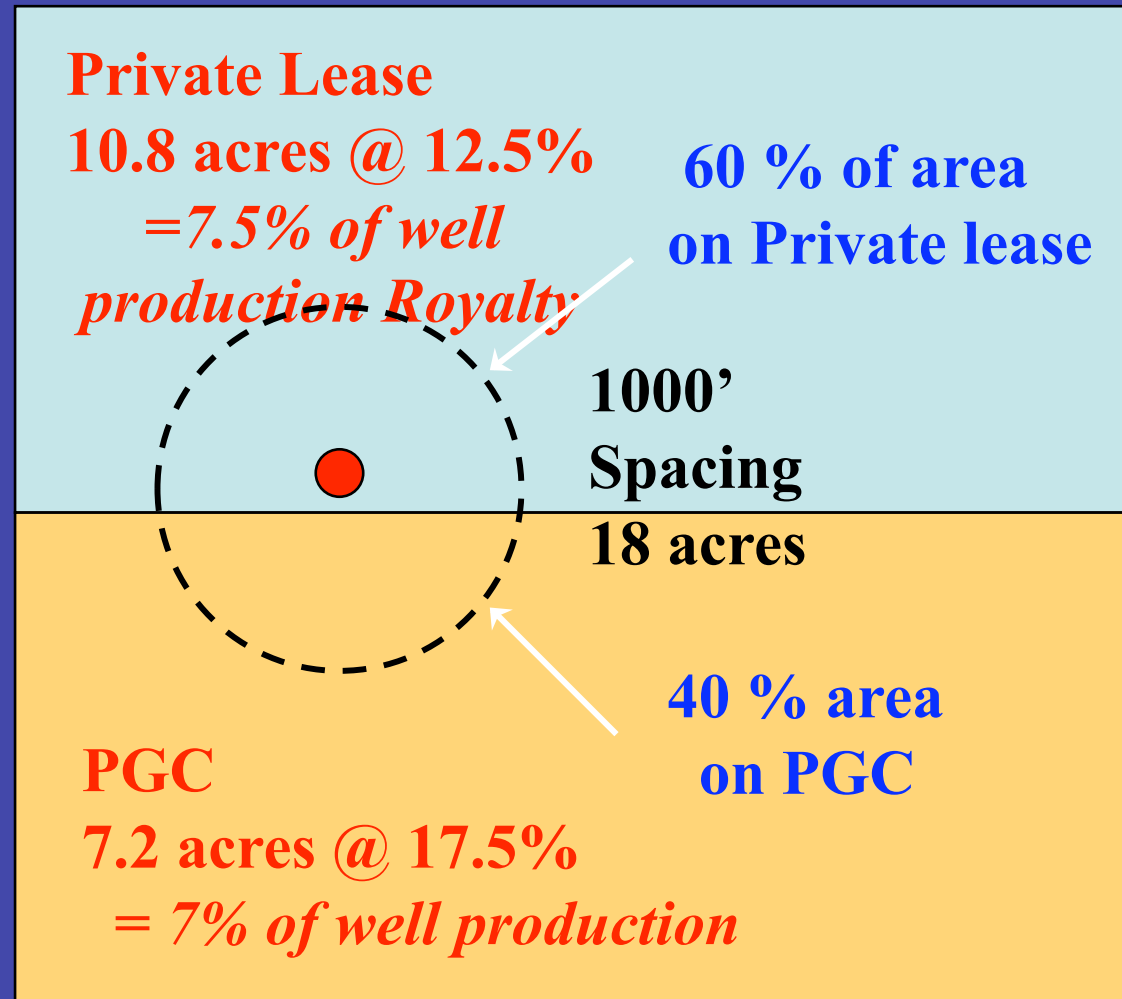
WELL SPACING

Density regulations

Distance regulations

provides for minimum distances
between wells and for minimum
distances between wells and boundary
lines

Unitization / Pooling















































The MARCELLUS SHALE

- **Black, Organic Rich Shale**
- **Middle Devonian-aged, Moderate Depth**
(Btw Shallow UD Sands and LD Oriskany Ss)
- **Present Throughout PA, Thickest in East,
Fractured, Nano-Darcy Permeability**
- **Continuous resource / Resource Play / Source
Rocks as Reservoirs**



The MARCELLUS SHALE

- **Known about for Decades**
- **Completion Technology Play**

Fracturing Technology, Drilling Techniques

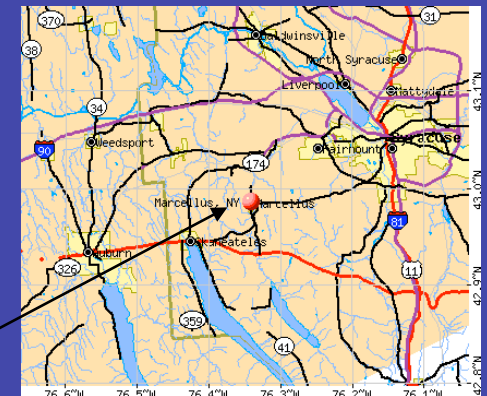
- **Estimated 200 + TCF, 1200 miles Long**
- **Still “Unknown”**
- **Range Res., Atlas, Chief, Chesapeake, Cabot**



MARCELLUS

Shale

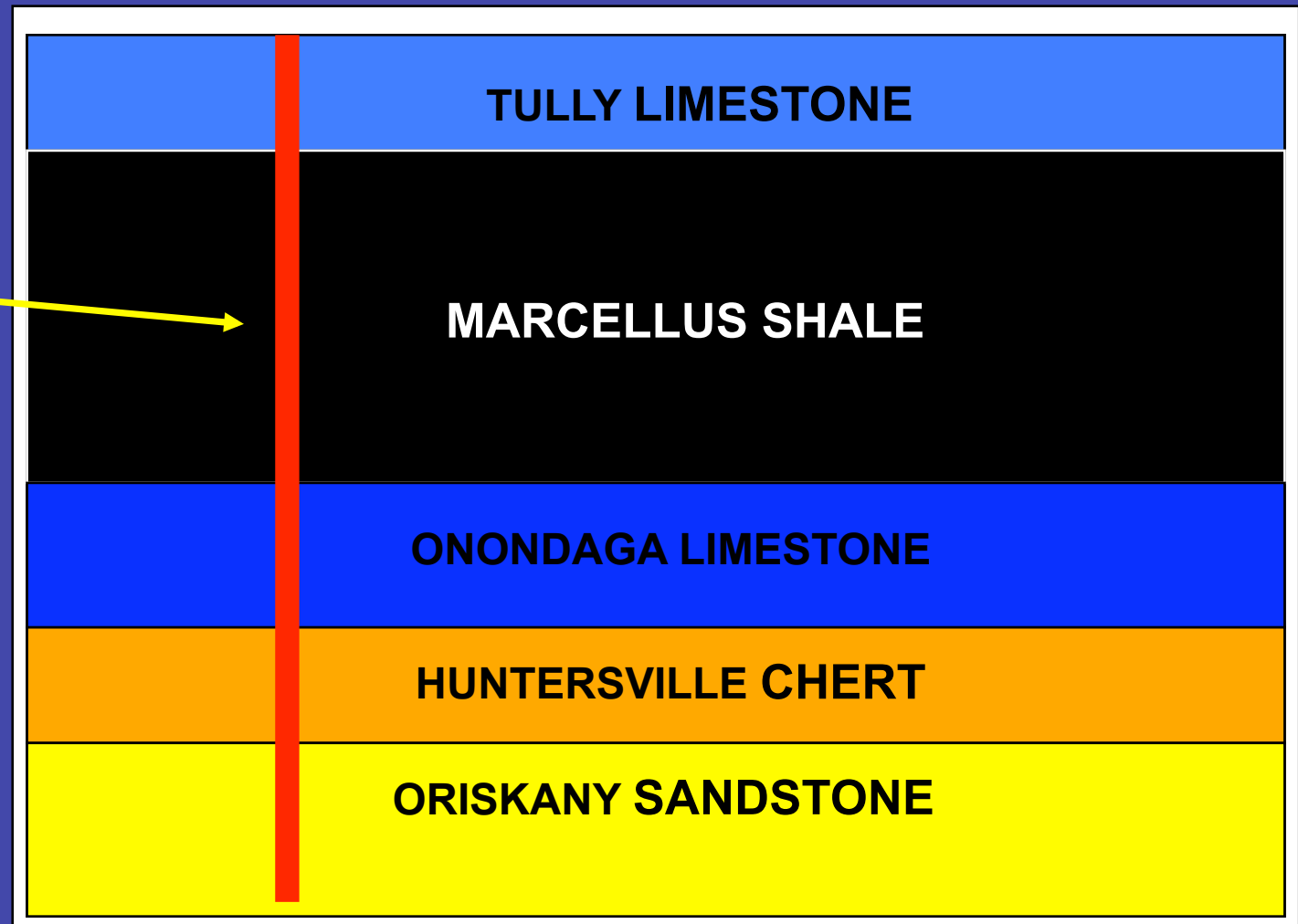
New York



THEORETICAL EXPLORATION CARTOON

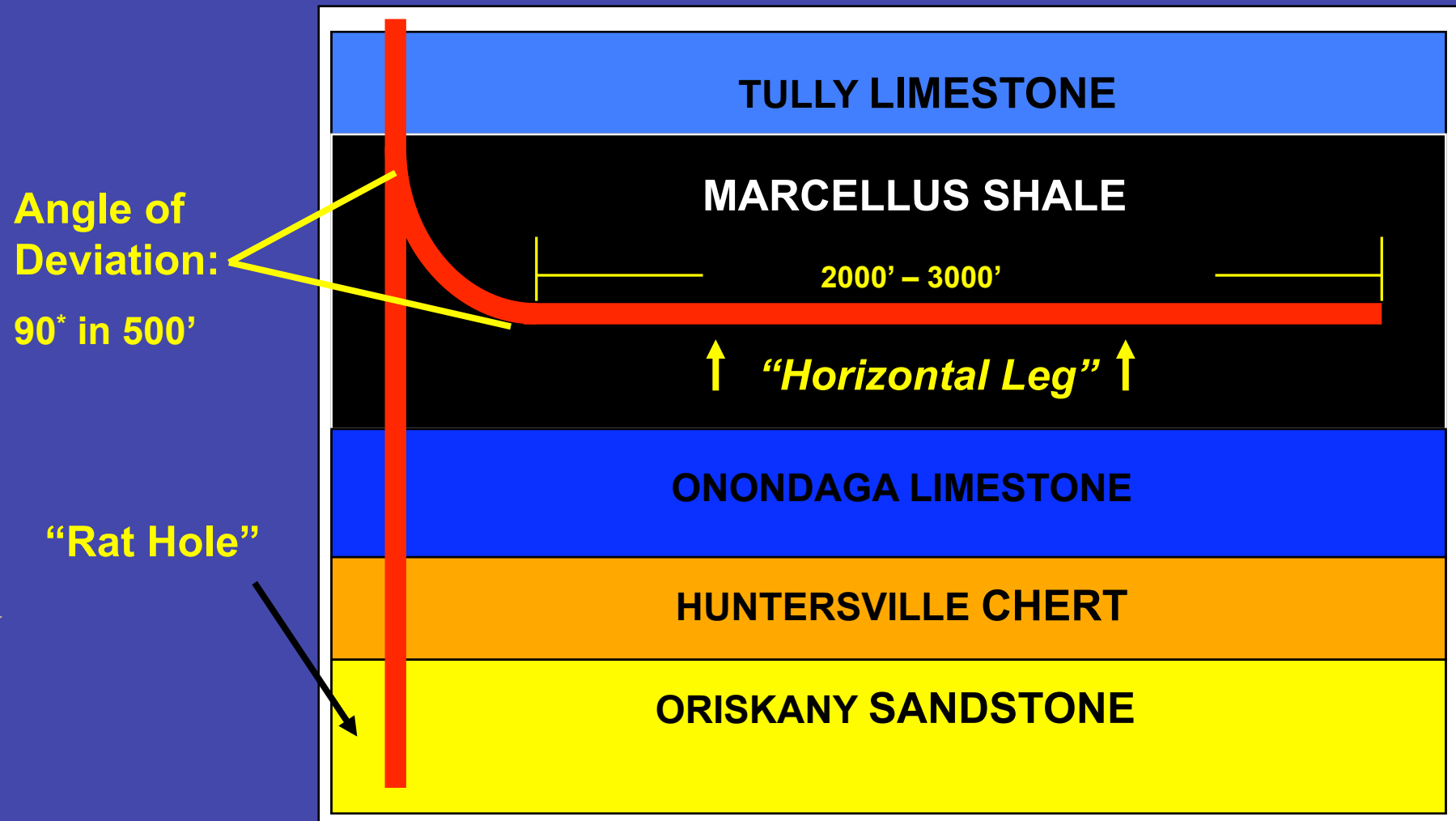
~ 6,000' DEEP, SOMEWHAT UNIFORM, 150' THICK or less

Vertical Well
Bore

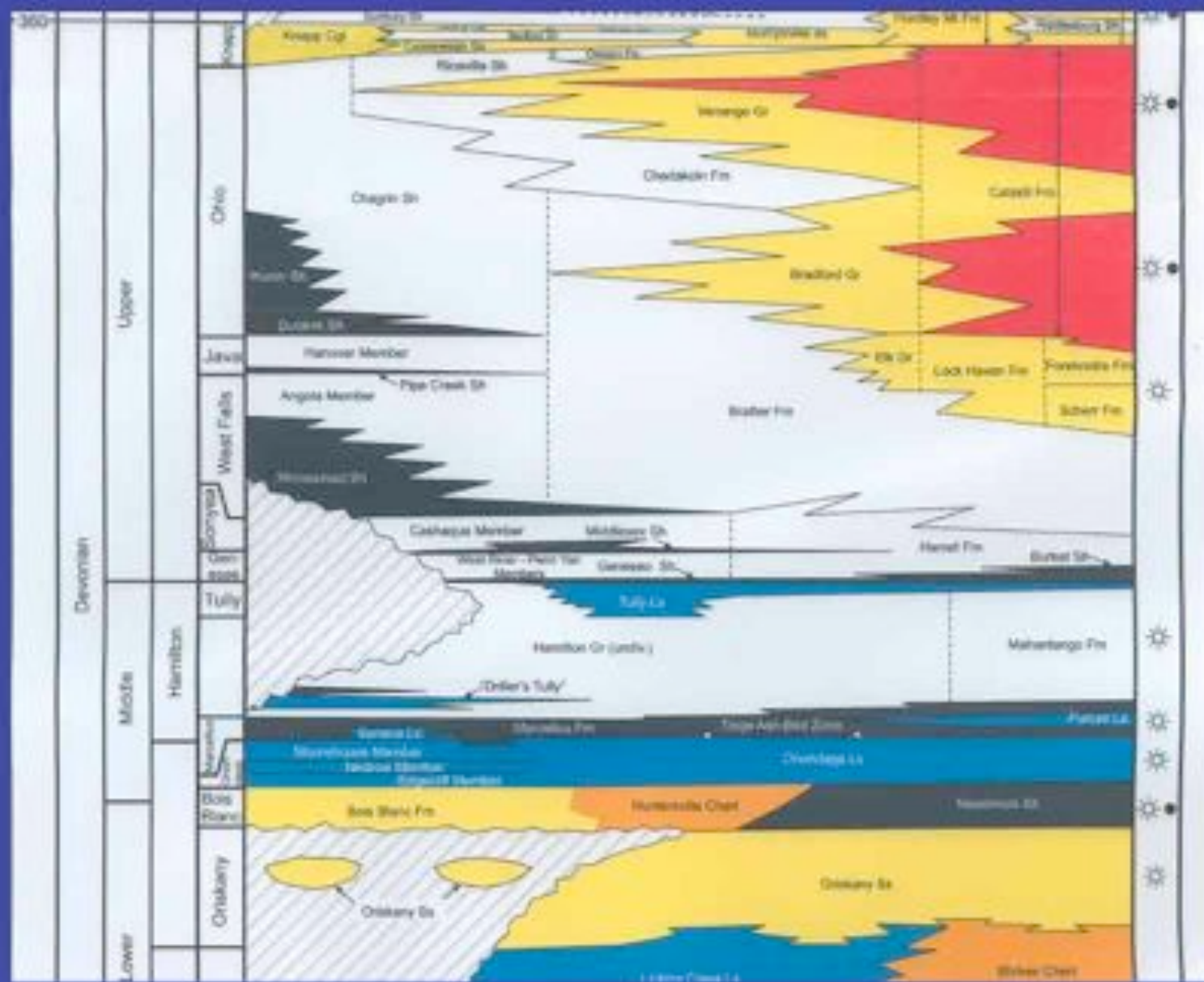


THEORETICAL EXPLORATION CARTOON

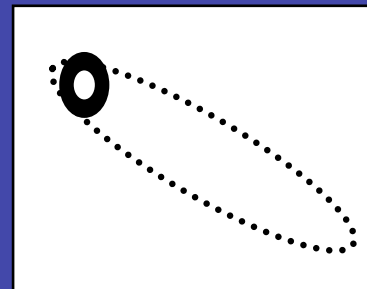
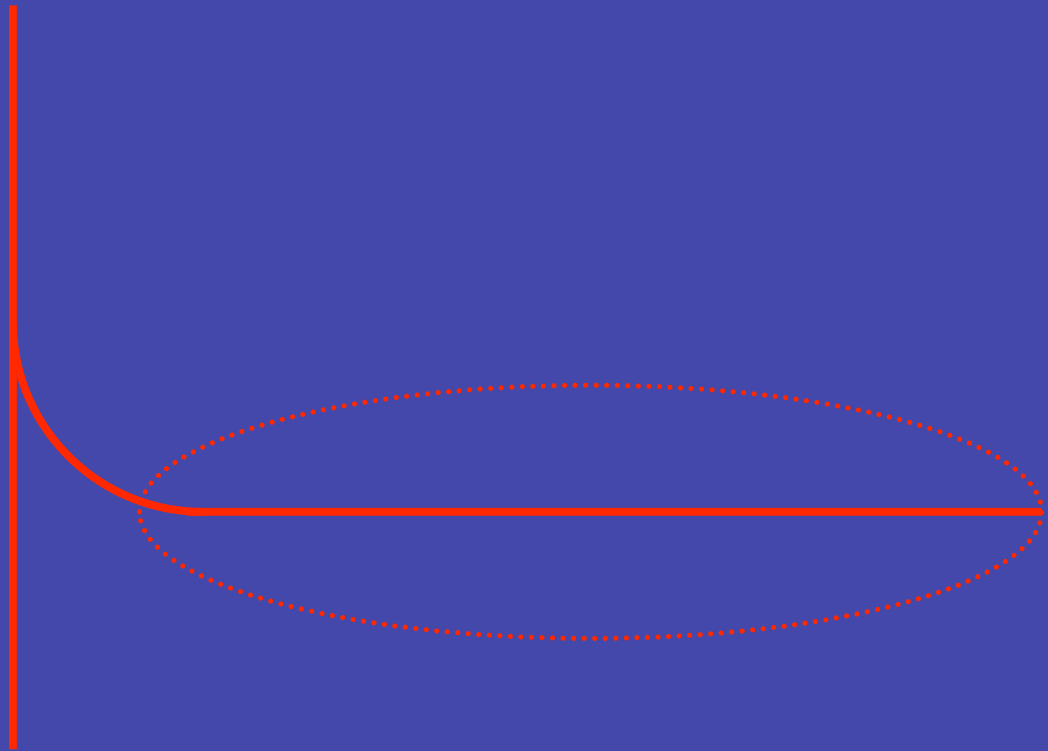
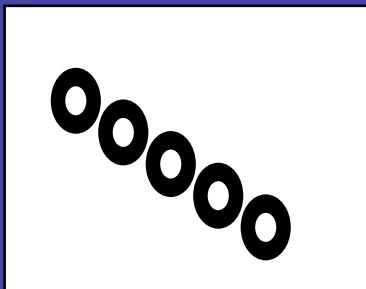
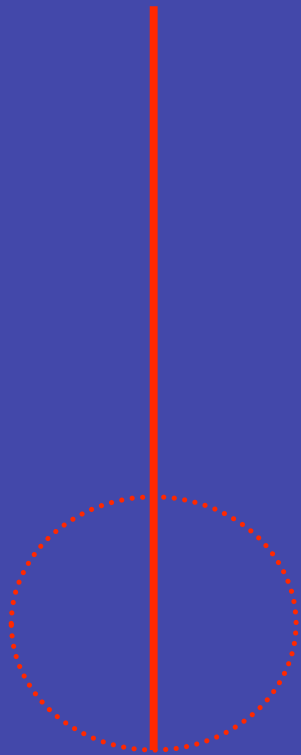
~ 6,000' DEEP, SOMEWHAT UNIFORM, 100' THICK or less



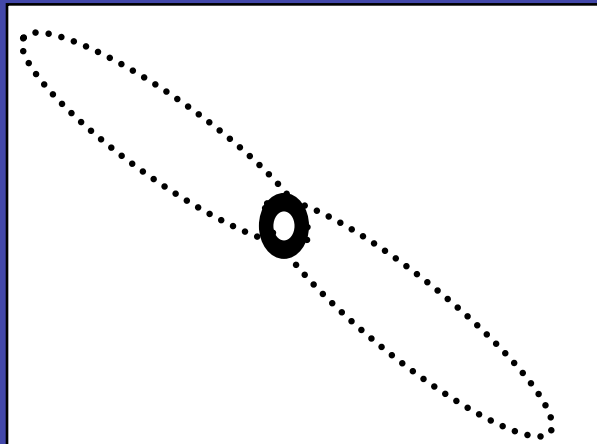
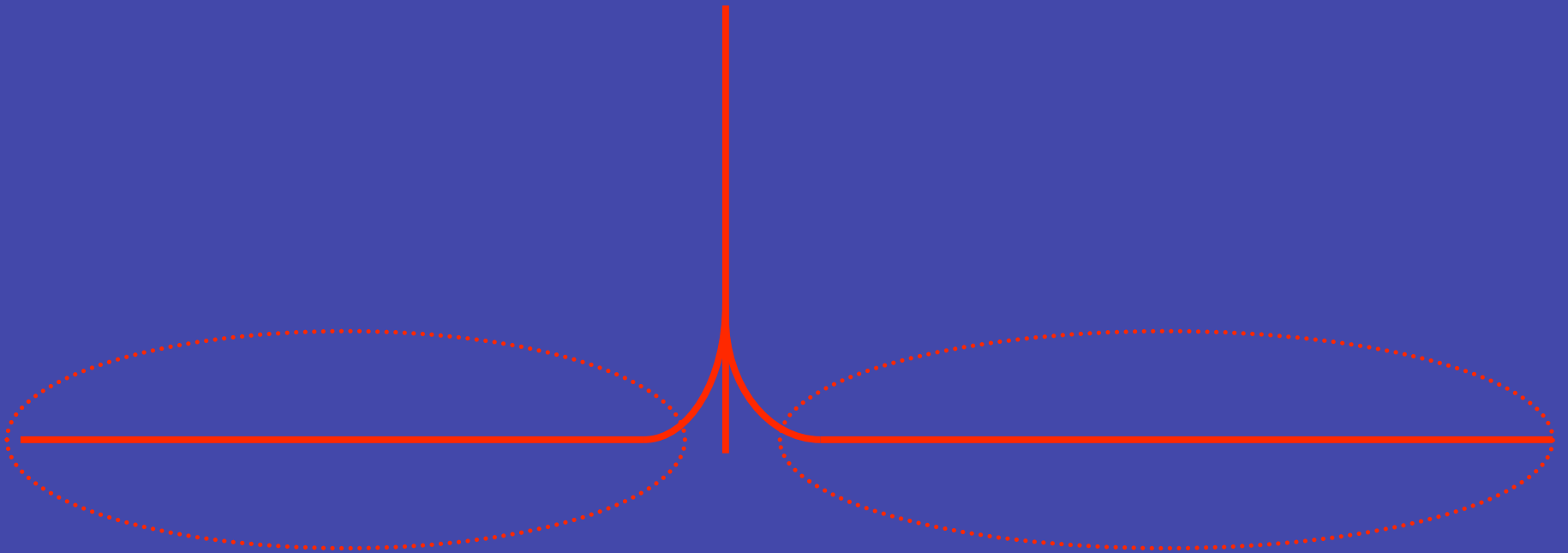




VERTICAL vs. HORIZONTAL DRILLING



RECENT HORIZONTAL TECHNIQUES



THEORETICAL COMPLETION TECHNIQUES



From the Air



From the Ground

From Below

- 1 MM gal H₂O
- Slickwater & Sand
- Increased Pumping Time, Multi Stage

