

Geological Overview of Coalbed Methane

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What is Coalbed Methane?

Coalbed Methane (CBM) is an economic source of methane that is generated and stored in coalbeds

It occurs throughout the U.S. (and the world) and can be easily and cheaply recovered

History

Coalbed methane production began as a way to de-gas coal mines, keeping them safe from explosions

Since the early 1980's, production has steadily increased, and today CBM serves as an important clean-burning energy resource

CBM Generation

Coals are extremely rich source rocks for methane

Methane is generated by microbial (biogenic) or thermal (thermogenic) processes

Generation can occur throughout the burial history of the coal

CBM Storage

Much of the methane is physically sorbed onto the surfaces of the coal's microporosity

One gram of coal can have as much surface area as several football fields--so can hold large quantities of methane

Hydraulic pressure is the trapping mechanism

CLEATS

**Coal is very porous but has low permeability
(connected openings)**

**Most coals contain methane but cannot be
economically produced without the presence of
open natural fractures (CLEATS)**

**Cleats allow the desorbed gas to flow to the well
bore**

Cleats (cont.)

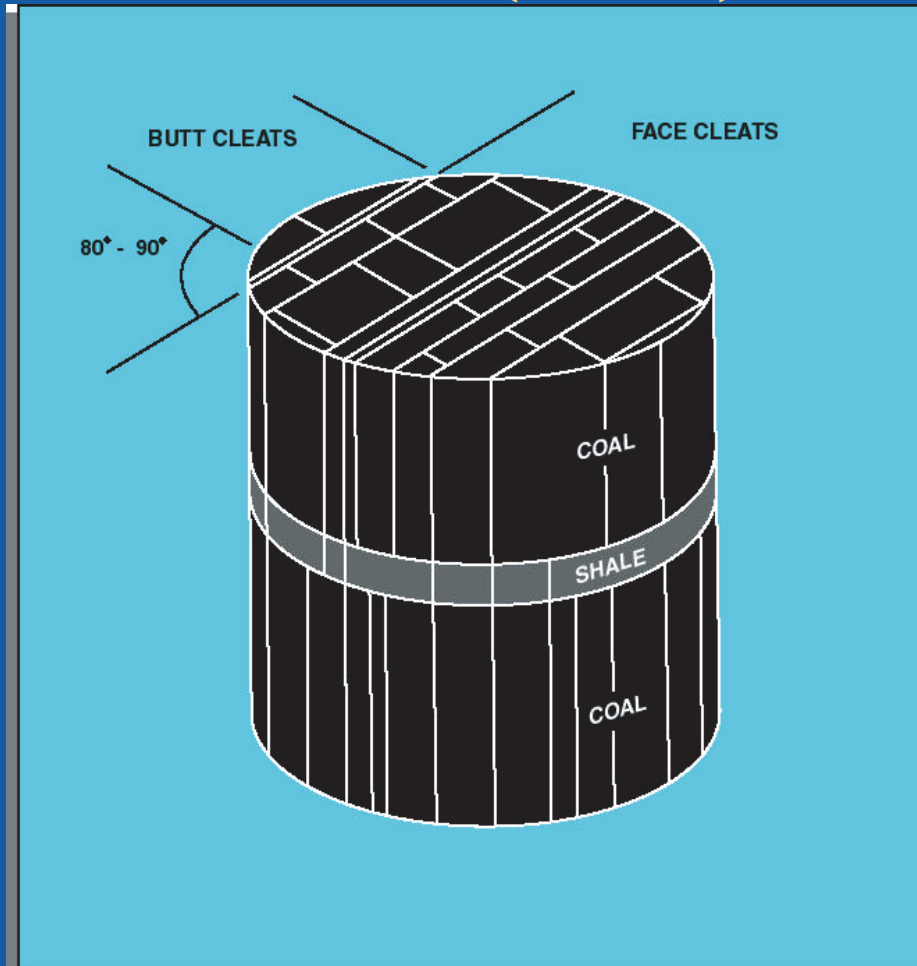


Diagram illustrating the relationship of cleats in coal and shale. The frequency of cleats is generally higher in coal than in the shale. Cleats provide the pathway for methane to move through the coal. From Rice and others (1993).

Cleats (cont.)

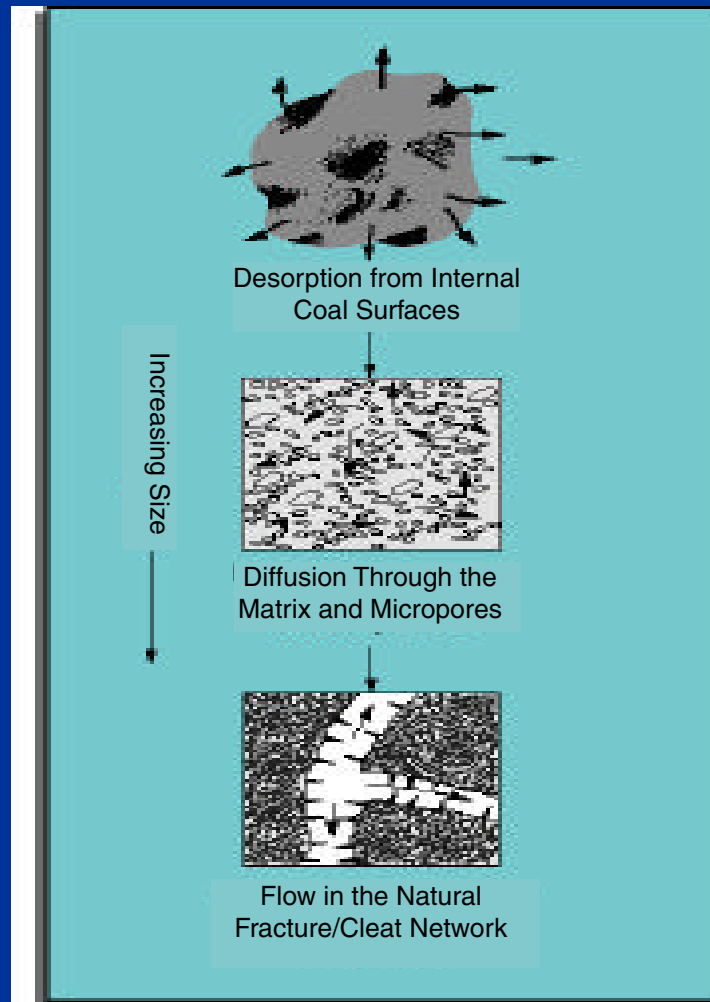


Illustration showing the movement of methane within a coal. First, methane desorption occurs within the micro-structure of the coal. Second, methane diffuses through the matrix and to the cleats. Third, methane flows through the cleats to the well bore. Modified from Kuuskraa and Brandenburg (1989)

CBM PRODUCTION

Methane will stay in a coalbed as long as the water table remains above the gas saturated coal

Gas is released from the coalbed when cleat pressure is reduced by dewatering

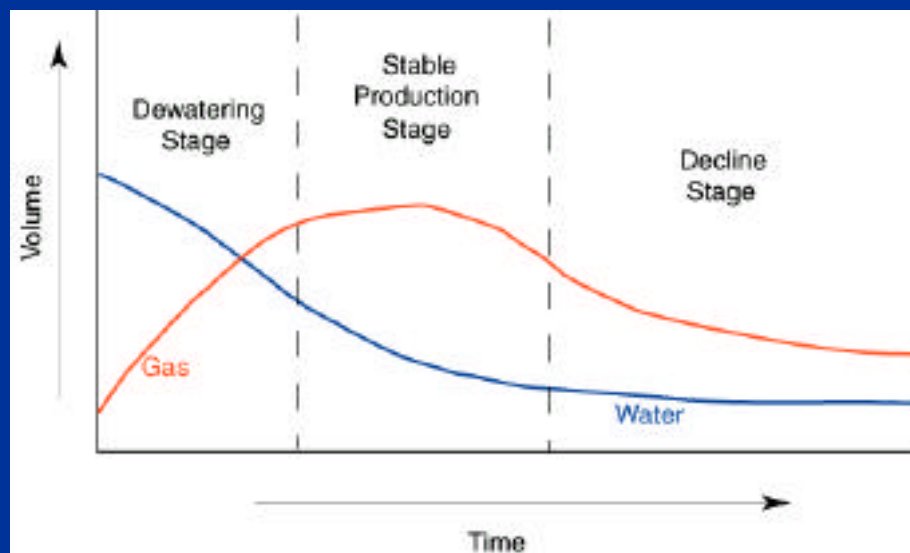
Some wells may never become economic if coals can't be dewatered

CBM PRODUCTION (cont.)

Generally, in conventional wells, gas production is highest early on, then declines through time. Water production generally increases through time

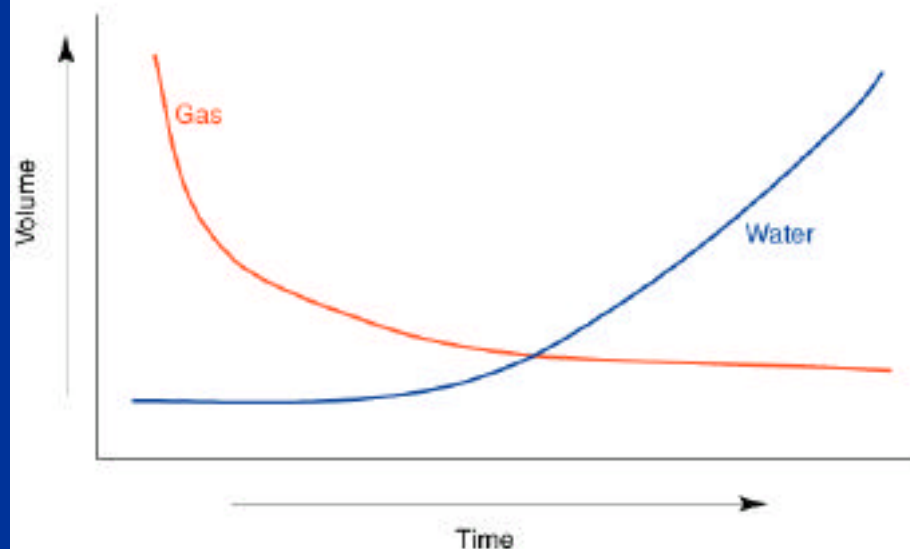
In CBM wells, water production is generally highest early on, then declines through time. Gas production increases with time-- providing the coals can be dewatered

Coalbed methane Production curves



Idealized coalbed methane production

Conventional gas Production curves



Idealized conventional gas production

Production scheme

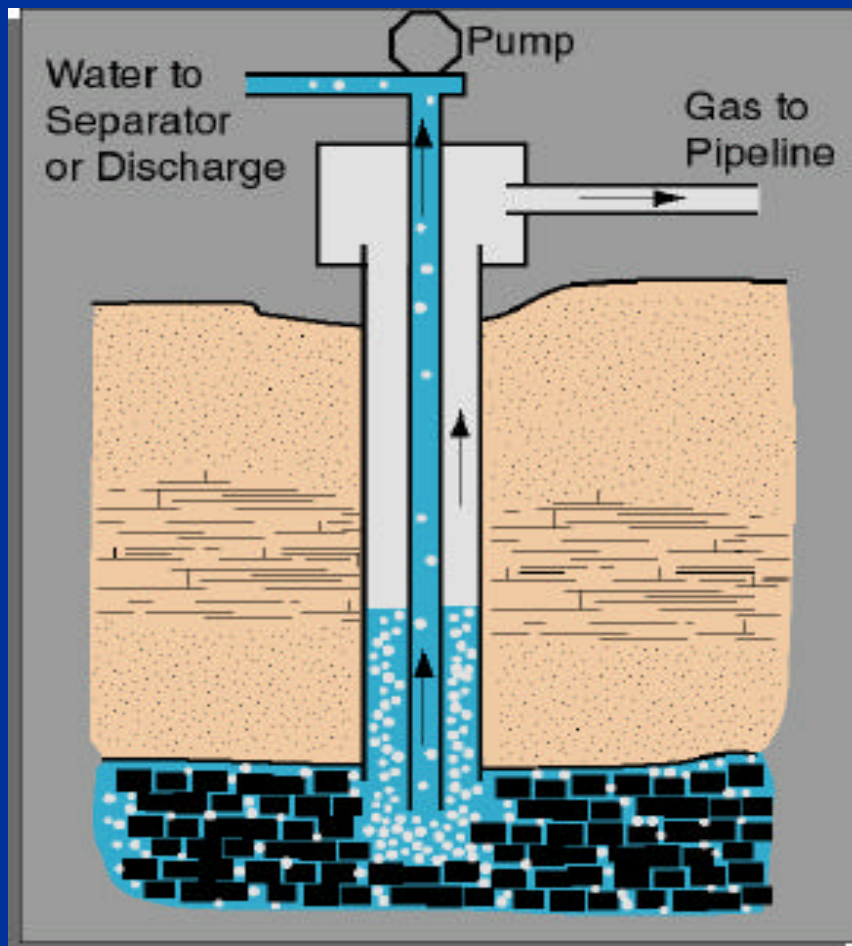


Diagram showing the production scheme of gas and water for a typical coalbed methane well.

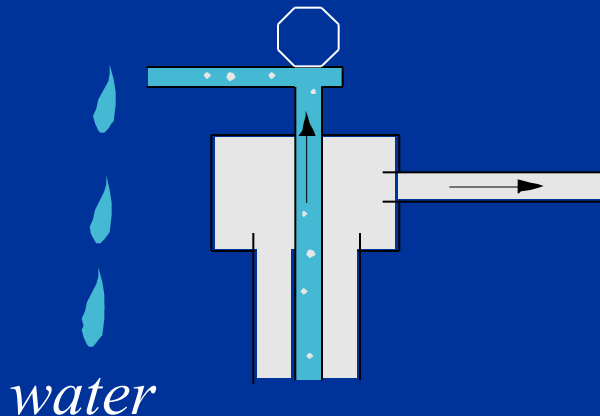
What to do with the co-produced water?

Discharge to Wetlands

Injection to
Groundwater aquifers

Discharge to
Streams/rivers

Deep injection
For disposal



Discharge to
Ponds/lakes

Discharge to
Evaporation pond

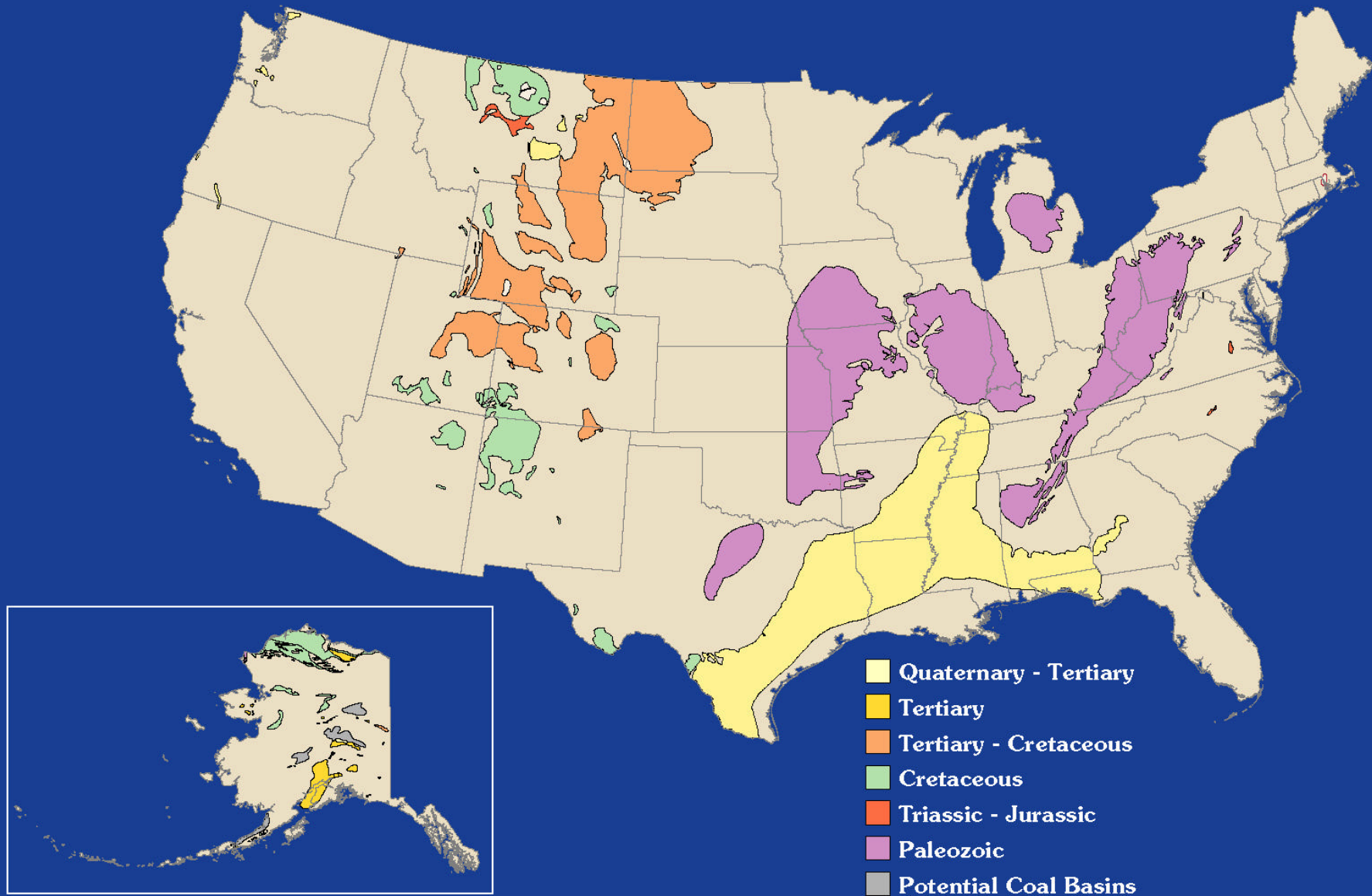
Evaporation Pond



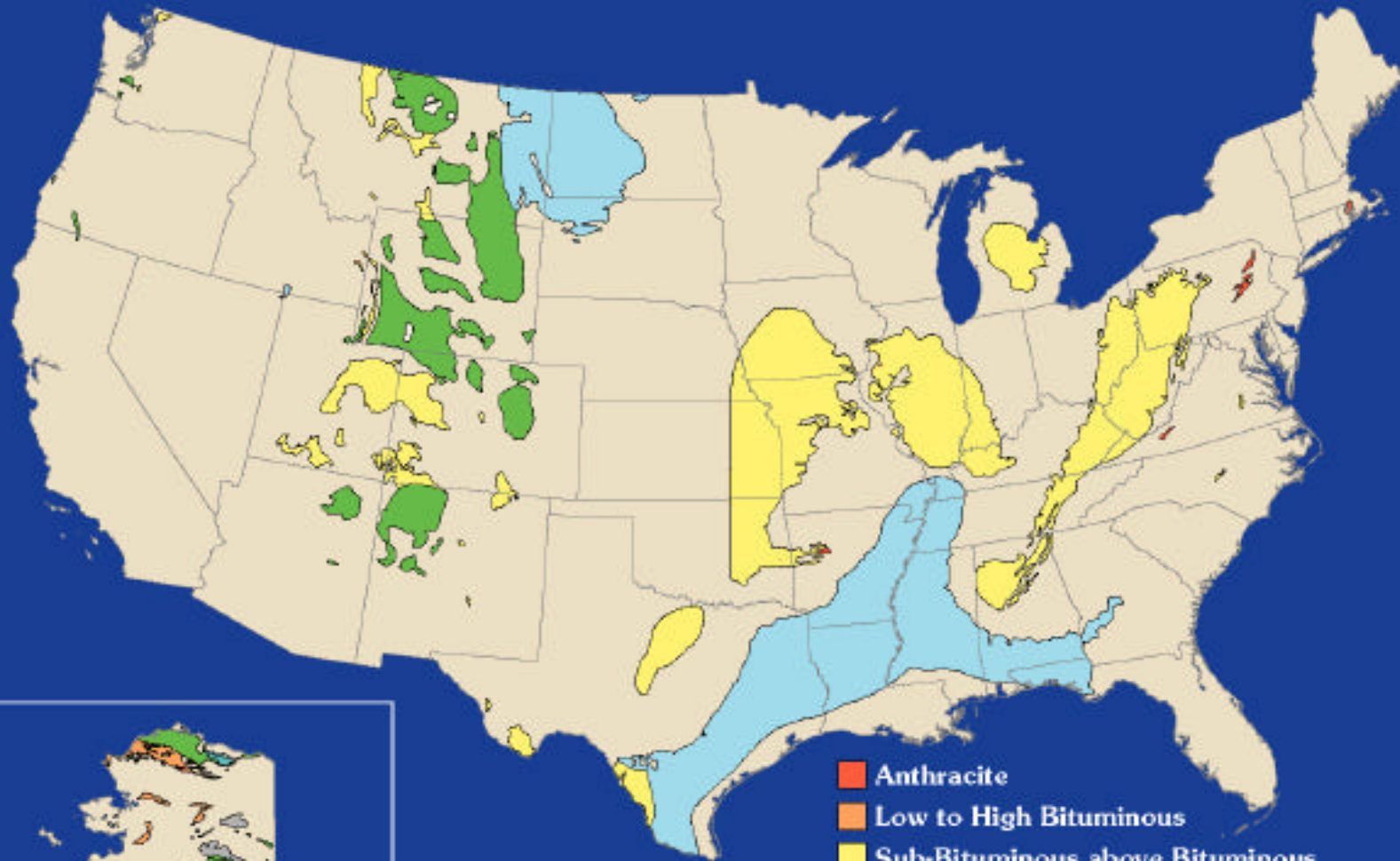
Potential Coalbed Methane Areas



General Age of Coal for Major Coalbed Methane Areas



General Rank of Coal for Major Coalbed Methane Areas



- Anthracite
 - Low to High Bituminous
 - Sub-Bituminous above Bituminous
 - Sub-Bituminous
 - Lignite above Sub-Bituminous
 - Lignite
 - Potential Coal Basins
- Gas Content Increasing

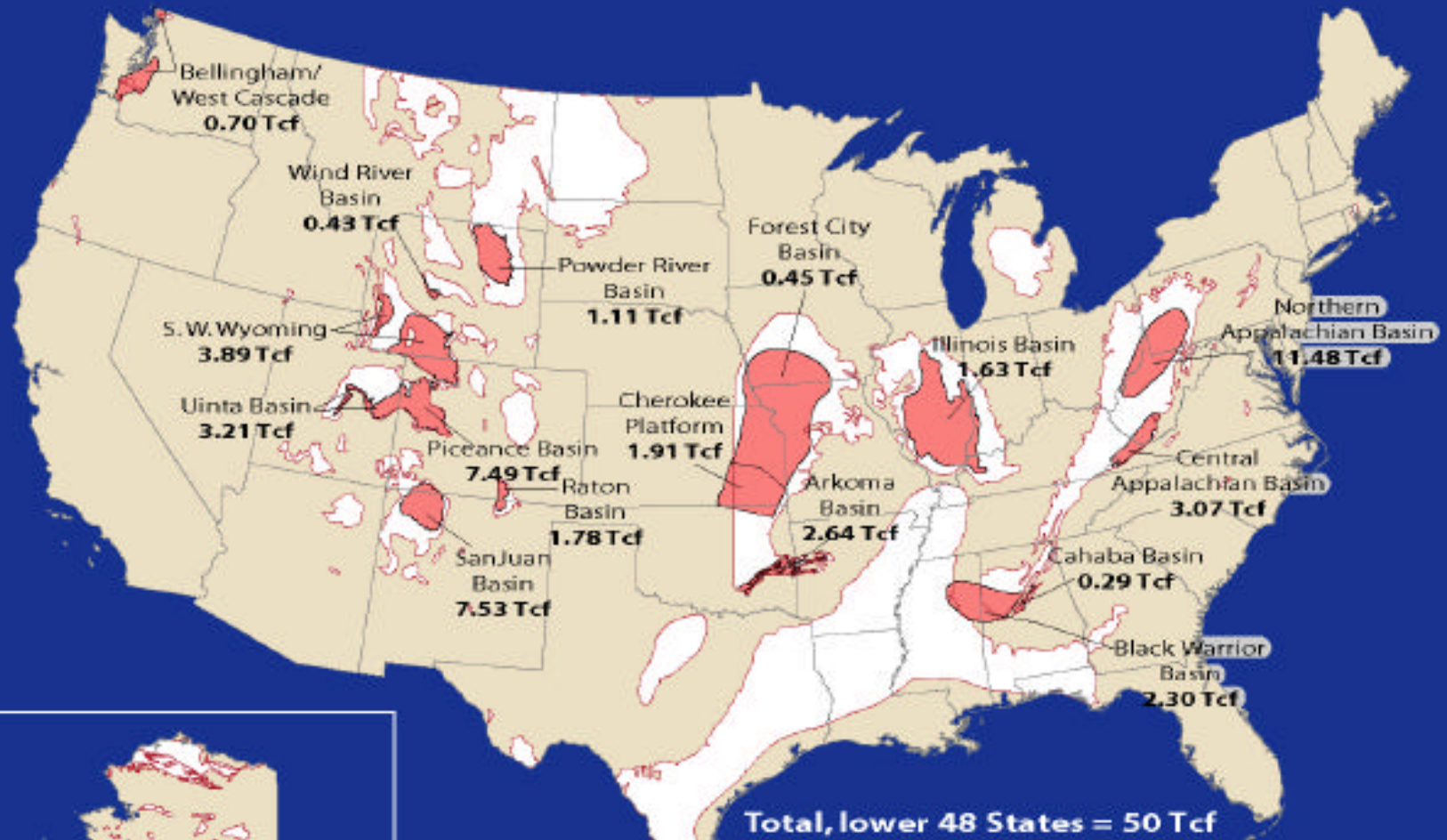
Potential Coalbed Methane Areas in Relation to Federal Lands



- Potential coalbed methane areas
- Federal lands (includes BIA, BLM, NPS, and USFS - generalized)

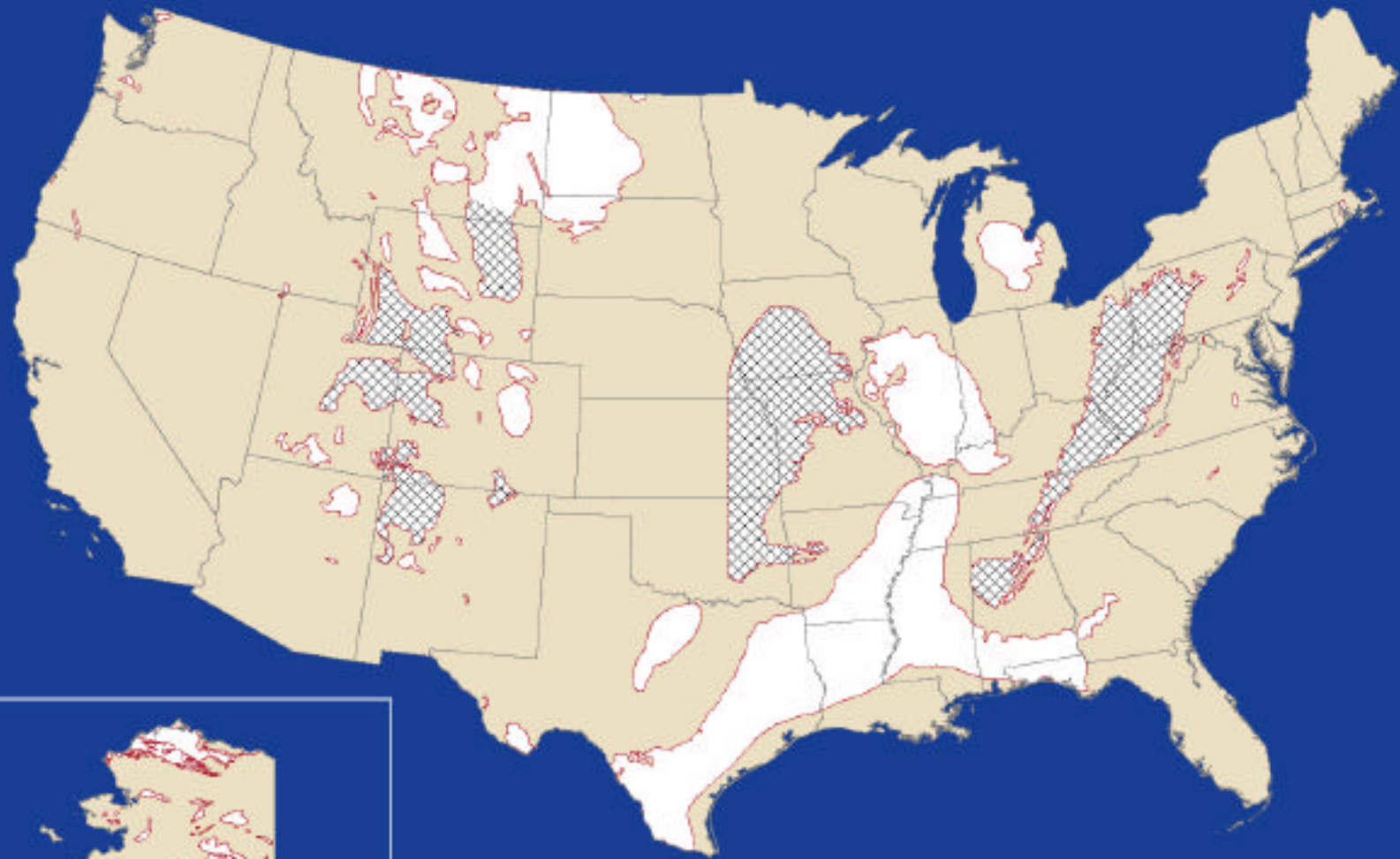
Coalbed Methane Plays Assessed by USGS in 1995

(technically recoverable, in trillion cubic feet)



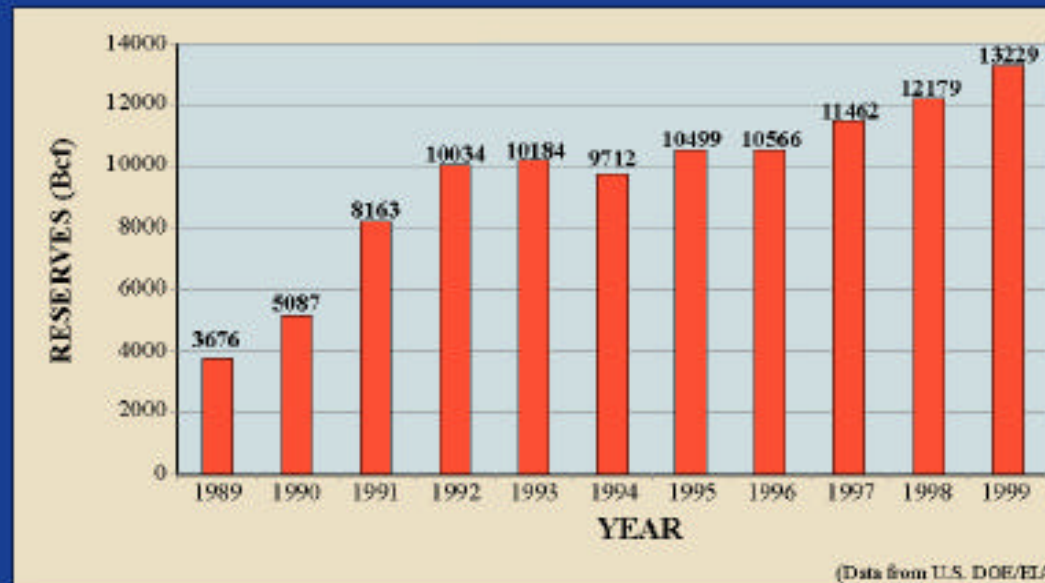
- Potential coalbed methane areas
- Coalbed methane plays assessed in 1995

Areas with Major Current Coalbed Methane Production

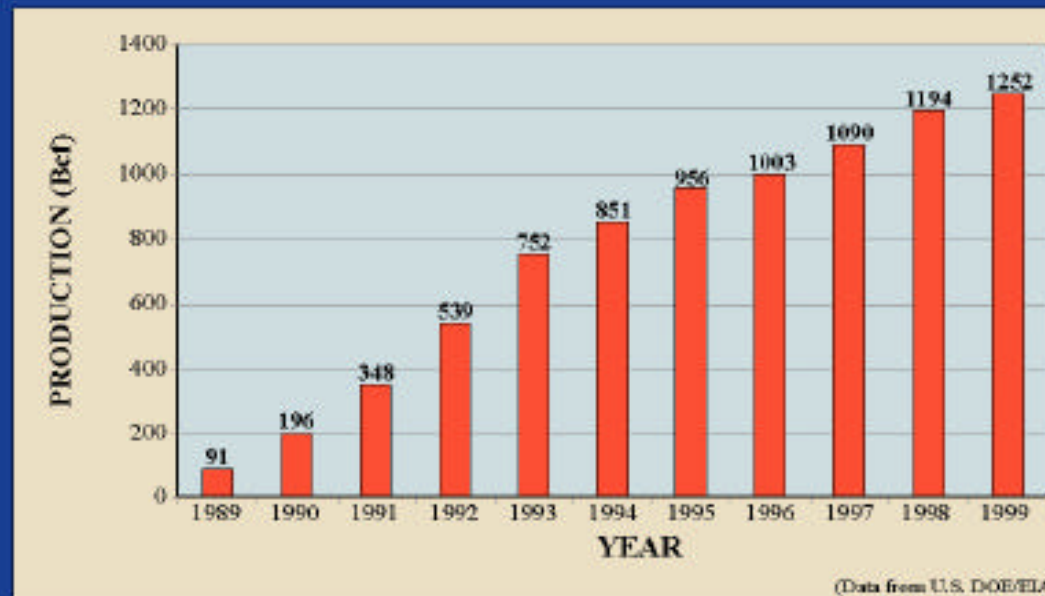


- Potential coalbed methane areas
- ▣ Areas of current production

U.S. Coalbed Methane Reserves, 1989 through 1999



U.S. Coalbed Methane Production, 1989 through 1999



1999 CBM Statistics

- **1265 CBM wells were drilled**
- **U.S. production was 1.25 Tcf**
- **CBM accounted for ~ 7.0% of natural gas production**
- **86% of CBM production is from Rocky Mountain states**

1999 CBM Milestones

- **San Juan Basin cumulative production exceeded 6 Tcf**
- **Black Warrior Basin cumulative production exceeded 1 Tcf**
- **8000 CBM producing wells in the U.S.**

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Federal land ownership categories were generalized from publically available digital data that can be found at the web site <http://www.nationalatlas.gov>. These data are part of The National Atlas of the United States of America provided by the U.S. Geological Survey.

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U.S. state boundaries were generalized from publically available digital data that can be found at the web site <http://www.nationalatlas.gov>. These data are part of The National Atlas of the United States of America provided by the U.S. Geological Survey.

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