Evaluating Coalbed Methane Plays in Frontier Areas — From Example from Southern Africa*

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Abstract

Increasing global energy demands make the exploration for coalbed methane (CBM) plays in frontier areas attractive. CBM can be used as a feedstock to generate power and manufacture alternative products such as diesel (gas-to-liquids), liquid natural gas, and fertilizer. Challenges to economic development of CBM resources in remote areas of the world include undeveloped markets, distance to markets, and lack of infrastructure.

The four stages in the evaluation of a CBM project follow:
1. Formulate a strategic plan to define the objectives and duration of the project.
2. Conduct a feasibility study to analyze the economic and market potential of the project and determine appropriate production methods.
3. Initiate an exploratory drilling program to identify contingent resources and "sweet spots" for pilot wells.
4. Prepare a reserve estimate report based on production from the pilot wells to obtain financing for project development.

The relatively unexplored Kalahari Basin in southern Africa has all of the prerequisites for a giant CBM play. Permo-Triassic (Gondwana) coal-bearing strata of the Karoo Supergroup underlie 60 percent of Botswana. Coal and organic-rich shale intervals are as much as 100 meters thick at depths between 300 and 1000 meters. Impermeable massive calcareous mudstone seals overlie the coal-bearing rocks throughout the basin. Estimated gas-in-place in the central part of the basin is as much as 196 TCF. These conditions suggest that the area has enormous economic potential.

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AAPG 10 June 2009

Rick Hildebrand, Michele Bishop, Mark Cronshaw

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Outline

- **Introduction**
  - Frontier Area
  - Coalbed Methane
- Project Stages
- Summary

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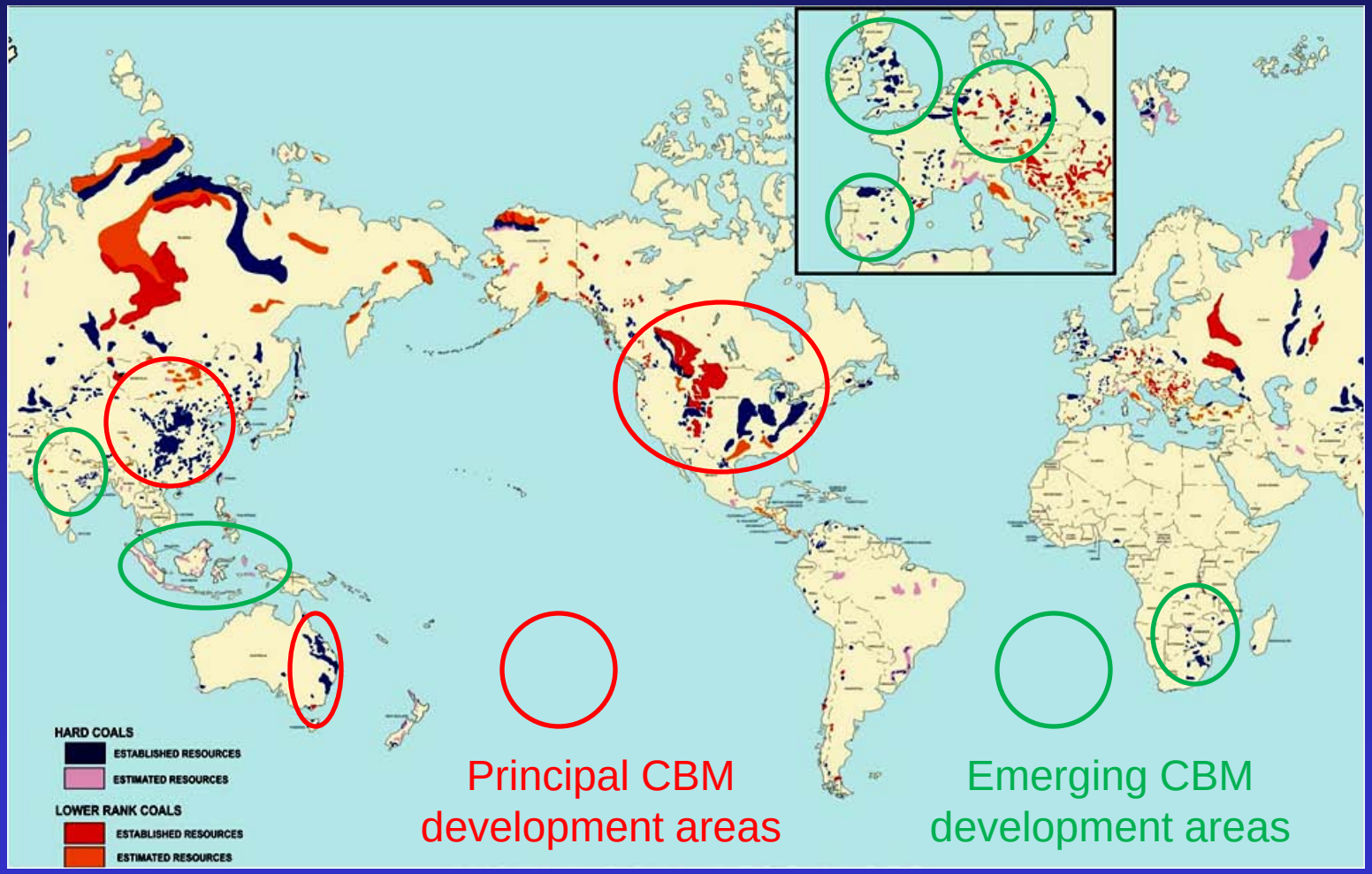
Frontier Area Defined

A frontier area is an area or basin in which exploration activities have been limited and a large proportion of resources present are categorized as undiscovered

Location of World Coal Deposits



Modified from iueassociation.org

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Coalbed Methane – CBM

- a.k.a. CBNG, CSM, CSG, CMM
- CH_4 most abundant gas
- Reservoir is also source
- Continuous accumulation
- Typically water saturated

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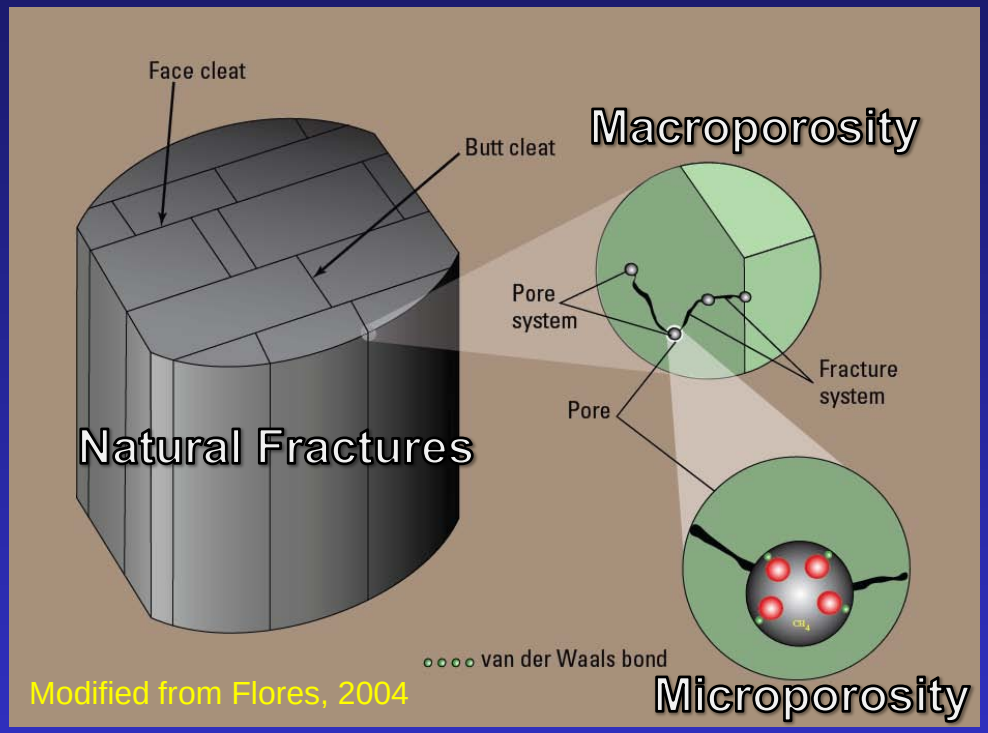
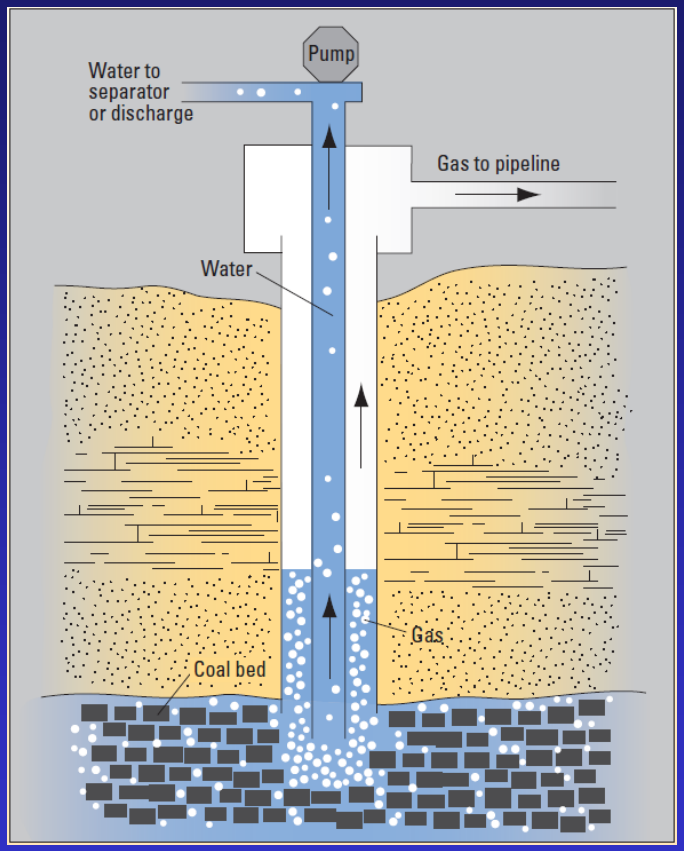
CBM Reservoir Characteristics



Modified from Flores, 2004



From USGS Fact Sheet FS-158-02, 2002

Dual Porosity Reservoir System

Primary
Diffusion

→

Secondary
Darcy flow

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Potential Project Stages

1. Enthusiasm
2. Disillusionment
3. Panic
4. Search for the Guilty
5. Punishment of the Innocent
6. Praise and Glory for the Non-participants

3rd Party Advice

Feasibility Study

Resource Estimate

Market Identification

Economics

Geologic Confirmation

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Outline

Preferred

- Introduction
- **Project Stages**
  1. Strategic Planning
  2. Feasibility Study
  3. Exploratory Drilling
  4. Reserve Estimation
- Summary

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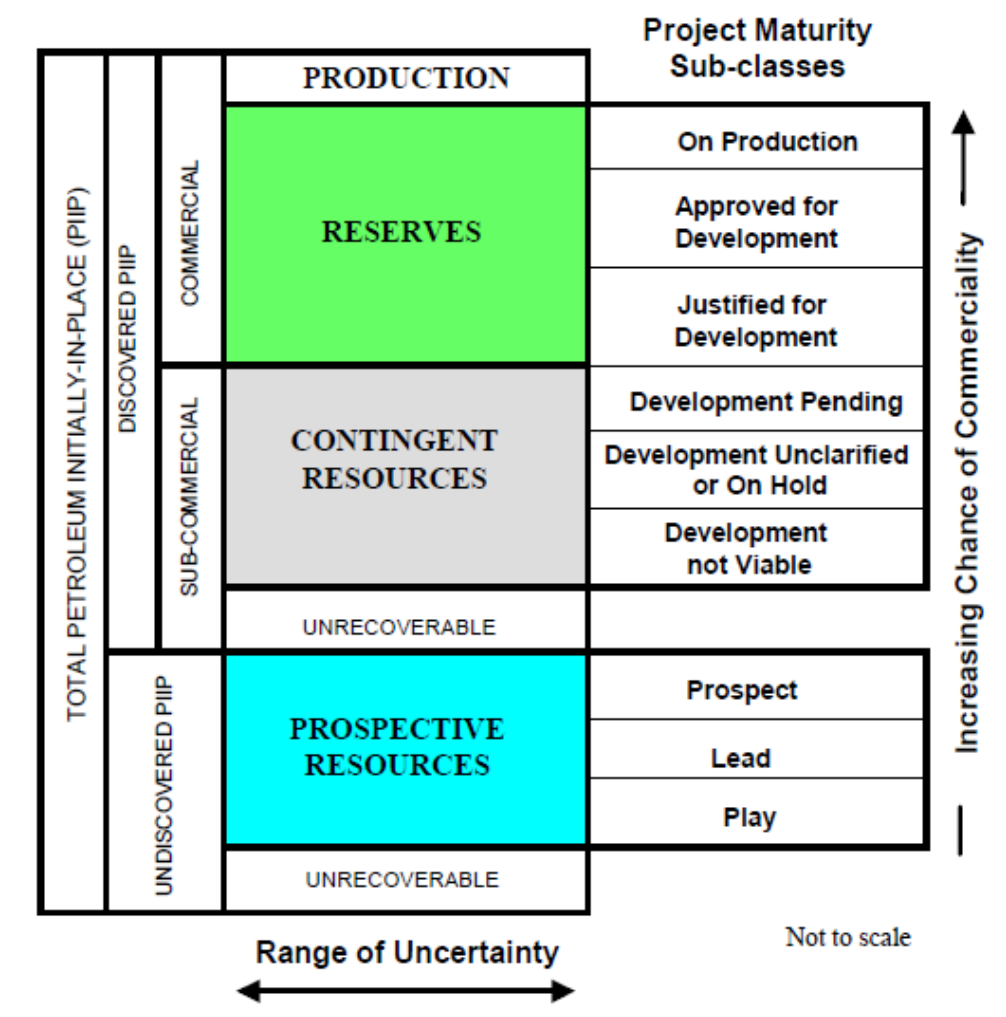
PROJECT STAGES



From Petroleum Resources Management System, 2007 (www.spe.org)

MILESTONES

London, New York, Toronto Financial Institutions for Development

3RD PARTY INDEPENDENT EVALUATION OF DRILLING RESULTS

Exploratory Drilling

Raise Money for Exploration

3RD PARTY ADVICE

Seed Money
Potential & Enthusiasm
Idea

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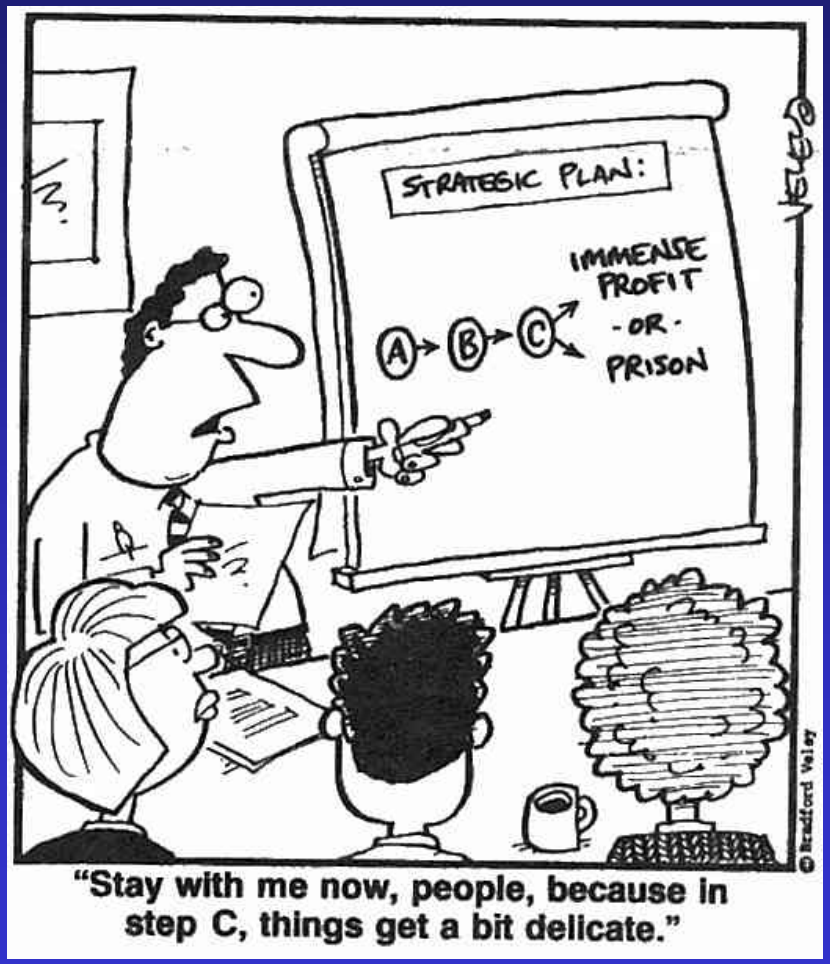
Project Stages

1. Strategic Planning



"Stay with me now, people, because in step C, things get a bit delicate."

Idea

Potential

Enthusiasm

Seed Money

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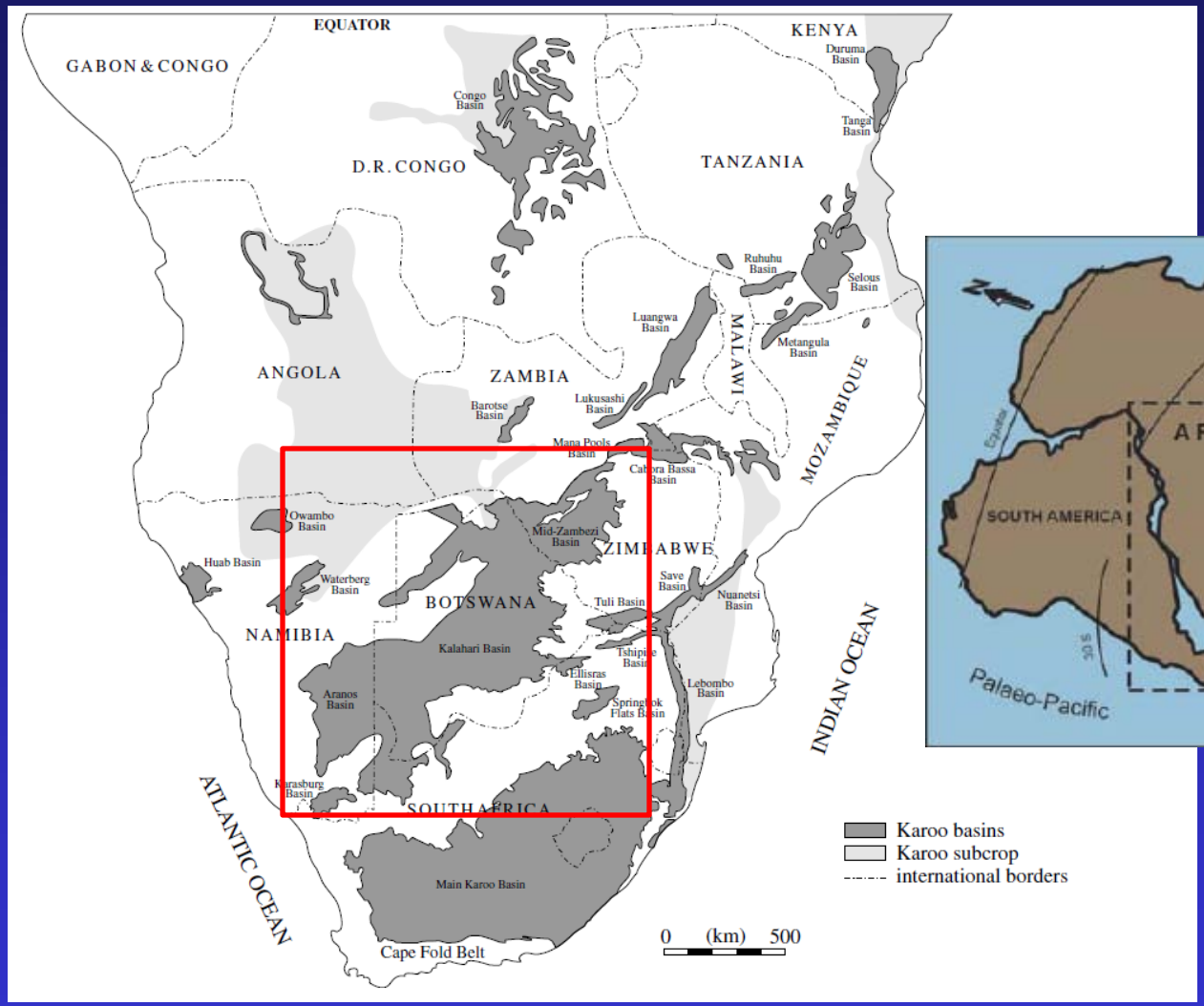
Sedimentary Basins in Southern Africa



From Scheffler, 2004

From Catuneanu and others, 2005

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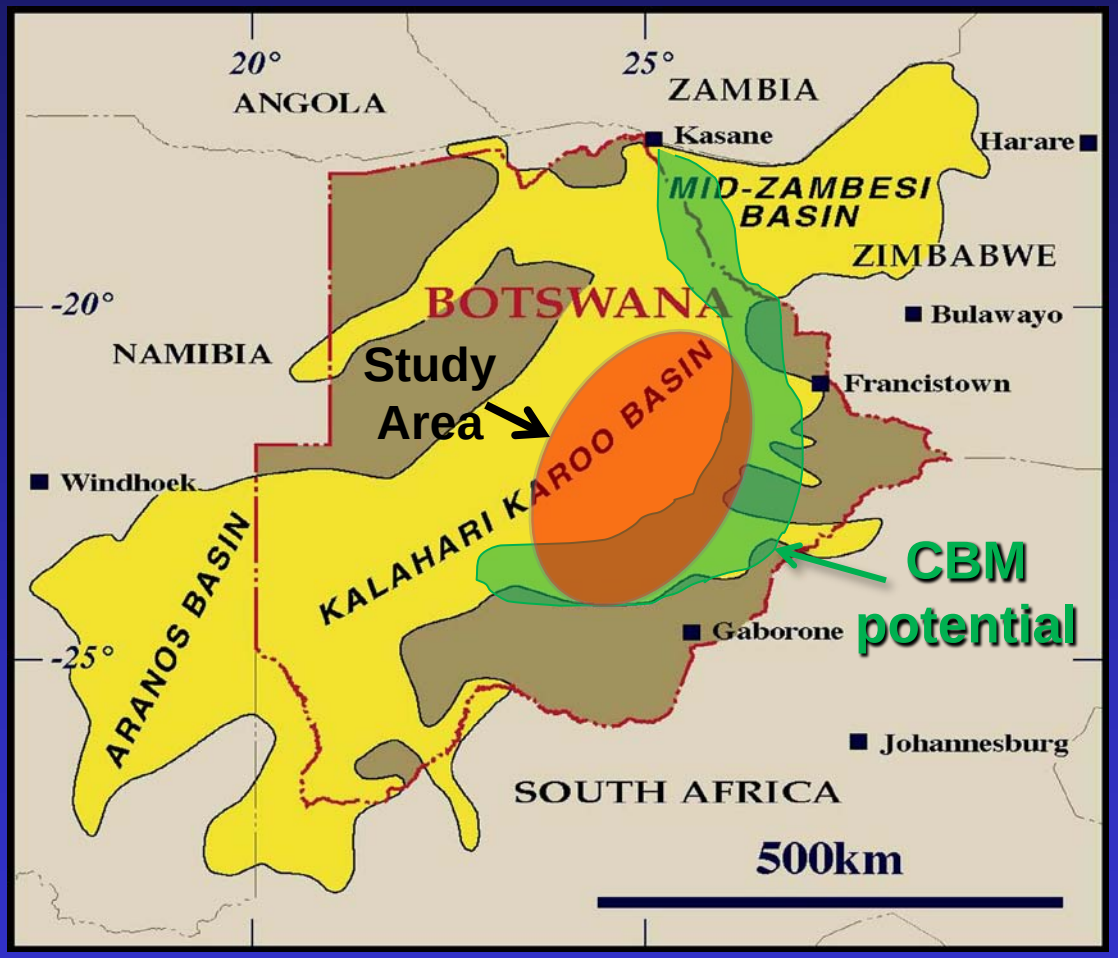
Estimate Prospective Resources



Modified From Scales, 2006

CBM Study Results

Exploration 2001-2003

41,459 km^2 Study Area

Four Boreholes Tested

Reservoir thickness: ≤ 80 m

Reservoir ≤ 30% coal

Gas Content: 50-100 scf/ton (as-received)

Estimated GIP

- 60 Tcf (coal)
- 136 Tcf (carb. shale)
- 196 Tcf total

Data from Botswana DGS (www.gov.bw)

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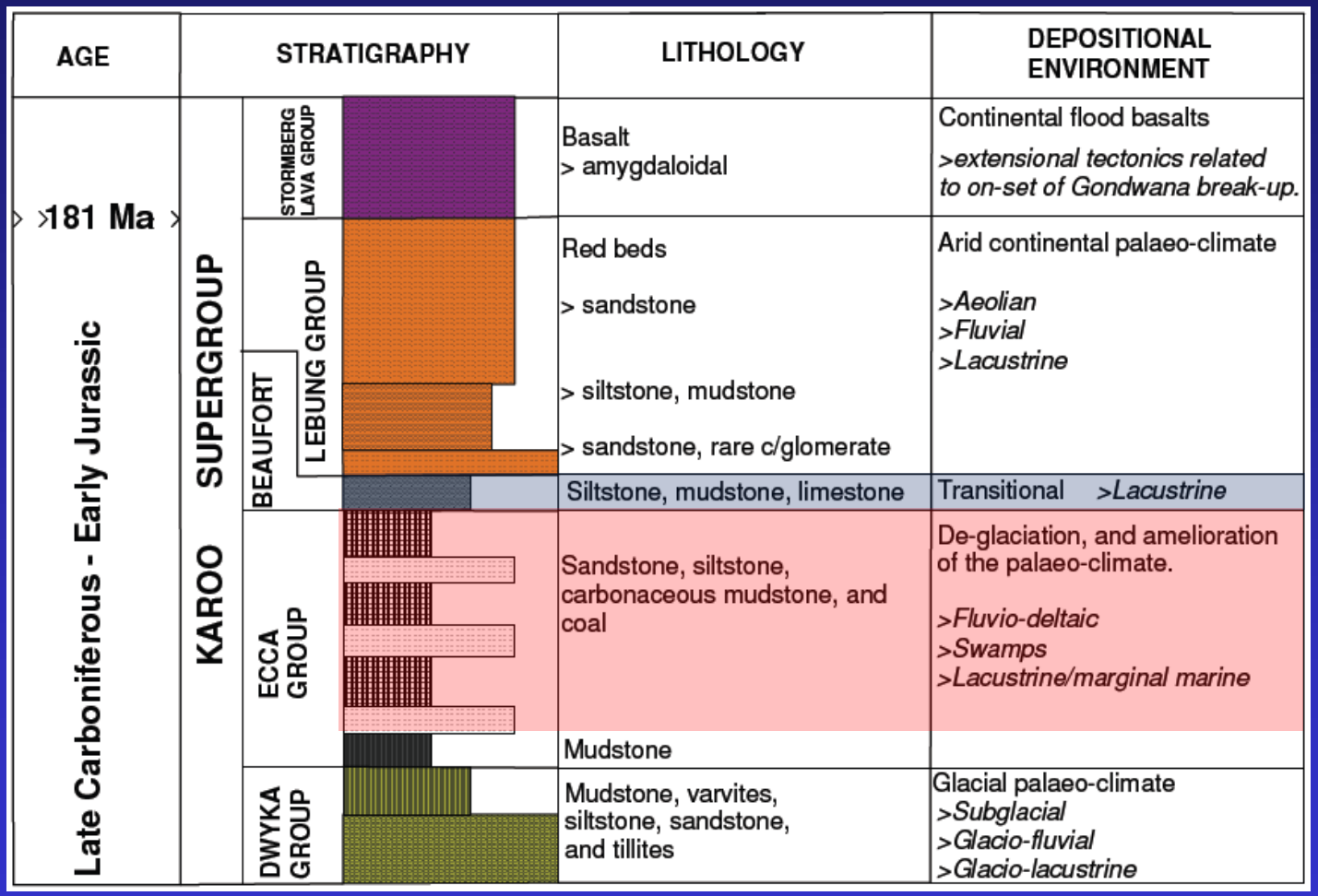
Lithostratigraphy and Paleoenvironments, Karoo Supergroup, Kalahari Basin



Modified From Modie, 2007

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Basin Analogue – Eastern Australia

Permian-Triassic Sediments

Sydney-Gunnedah Basin CBM Potential

~59,000 km^2 Area

Coal thickness: 32-230 m

Gas Content: 32-700 scf/ft (daf)

Estimated GIP: 139Tcf

Data from Scott and others, 2004

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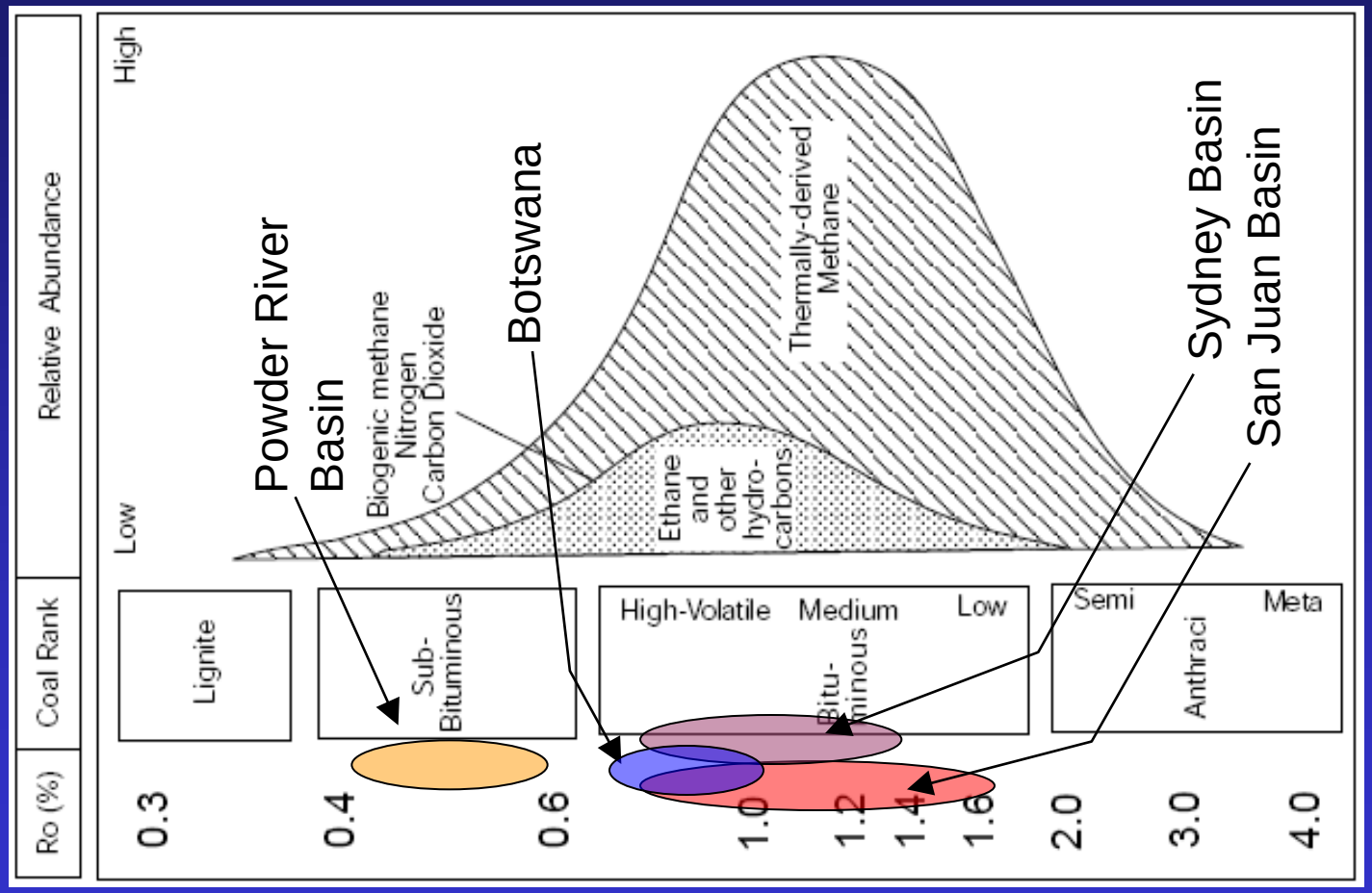
Hydrocarbons Generated During Coalification



Modified From Montgomery, 1999

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Project Stages

2. Feasibility Study

3rd Party Advice

What are the Markets?

Where are the Markets?

How do you Deliver?

Will it be Profitable?

Play Confirmation

Resource Estimate

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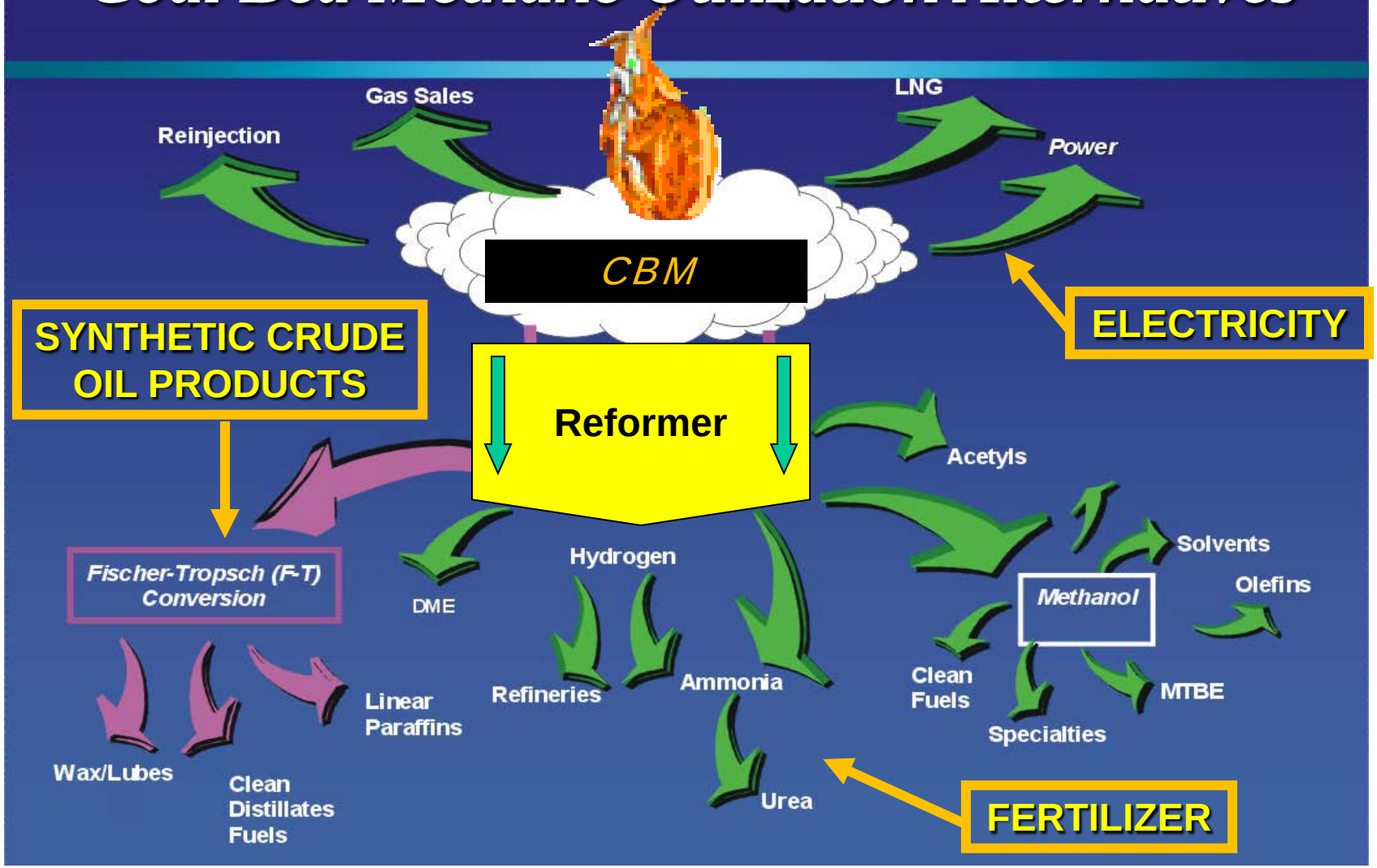
Coal Bed Methane Utilization Alternatives



What are the Markets?

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CBM Market Alternatives

LNG Facility, Indonesia
(www.japanfocus.org)

Synfuels Plant, South Africa
(www.grinaker-lta.co.za)

Natural Gas for Domestic Use
(www.freefoto.com)

Gas-fired Combustion Turbine Generators, Wyoming
(www.basinelectric.com)

Fertilizer Complex, India
(www.linde-le.com)

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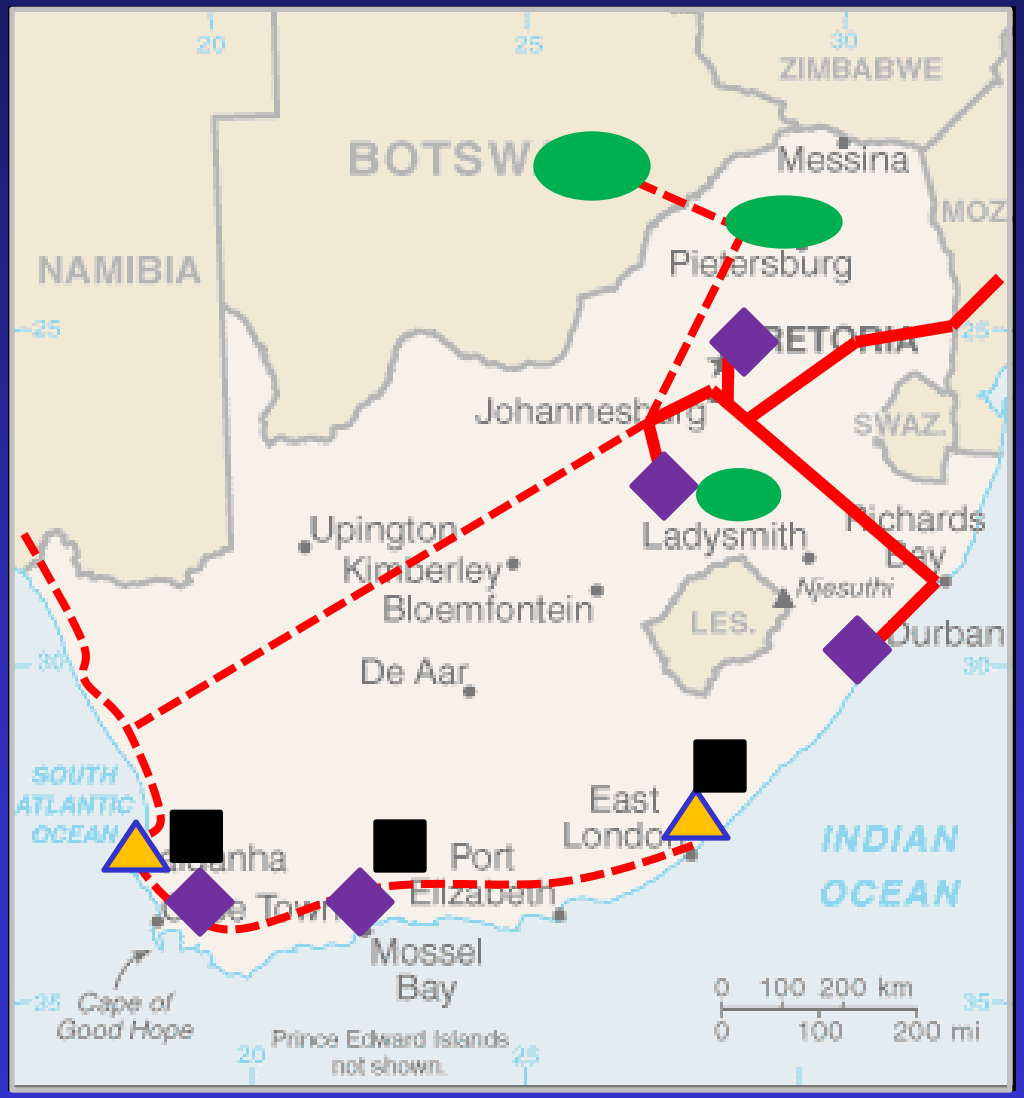
Potential CBM Markets in South Africa



Legend

- CBM play
- Existing gas pipeline
- Proposed gas pipeline
- Gas Turbine
- Refinery or chemical plant
- LNG Facility (New, Proposed)

Data from South Africa DME (2006) and iGas (2009)

Where are the Markets?

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CBM Delivery Alternatives

Gas Pipeline (www.un.org)

LNG Tanker (www.lngworldwide.com)

Electricity Transmission Lines
(GNU Photo)

LNG Truck (www.paccar.com)

How do you Deliver?

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Hypothetical CBM Economics

Scenario

- 200 miles from field to city
- Construct gas pipeline to city
- Construct city gas distribution system
- 1 million households

Numbers

- 80 MMCFD gas
- 330 wells
- Capital cost $million
  - Pipeline $100
  - Distribution $1,000
  - Wells $ 82
- Delivered cost of gas >$5.00 / MMBTU

Will it be Profitable?

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Project Costs


From DOE, 2002


From Barker and Tromp, 2006


www.uky.edu

"No matter how good a coal seam methane project is, it is very hard to fund and to bank a project that is going to be based solely on coal seam methane gas."

Mr. Greg Martin, Managing Director, Australian Gas Light Company (AGL), 2001

The Simple Presence of a CBM deposit does not Ensure a Commercial Project

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Project Stages

3. Exploratory Drilling

Pending
Unclarified
Not Viable

From Stricker and others, 2006

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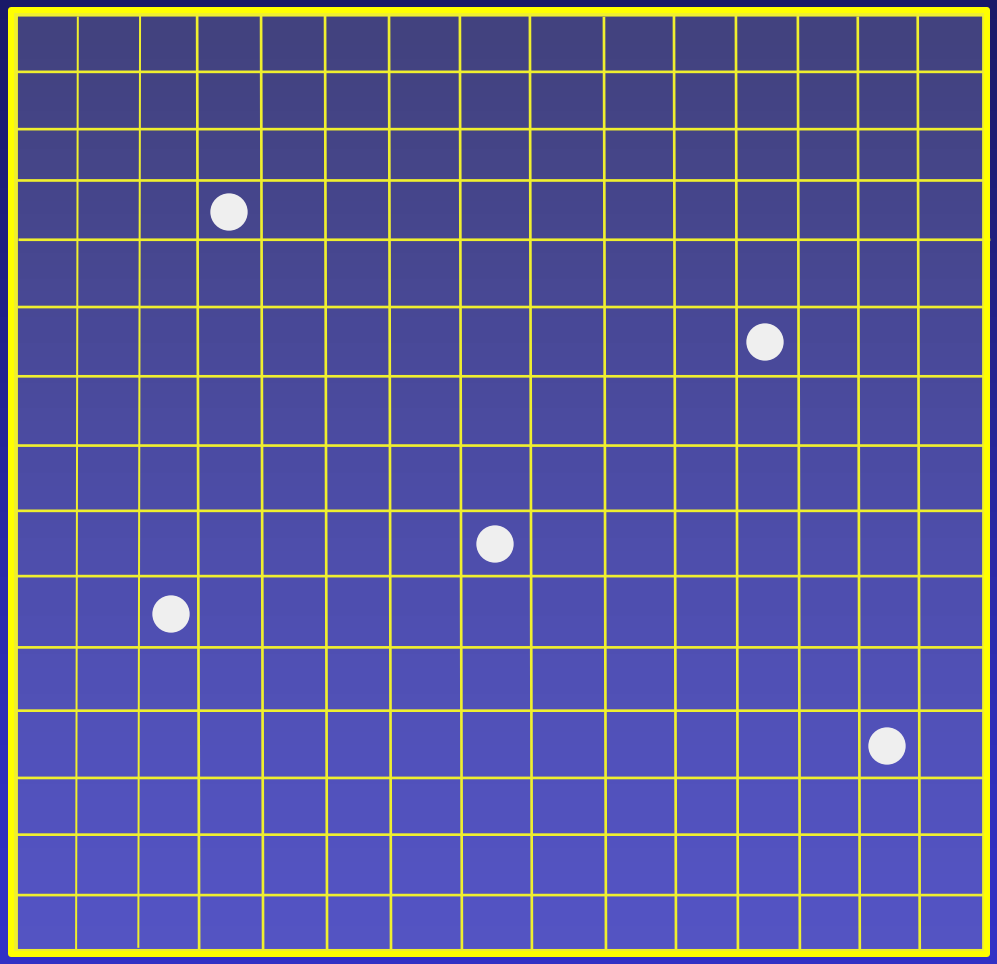
Estimate Contingent Resources



1 square = 160 acres (1/4 section)

Exploration/Appraisal Wells

Subsurface Data

- Reservoir depth(s)
- Reservoir thickness(es)
- Areal extent
- Lithologies

Samples for Analysis

- Gas content/composition
- Coal composition
- Mineralogy/petrophysics

Hydrology/Reservoir Properties

- Permeability
- Flow rates
- Water Quality

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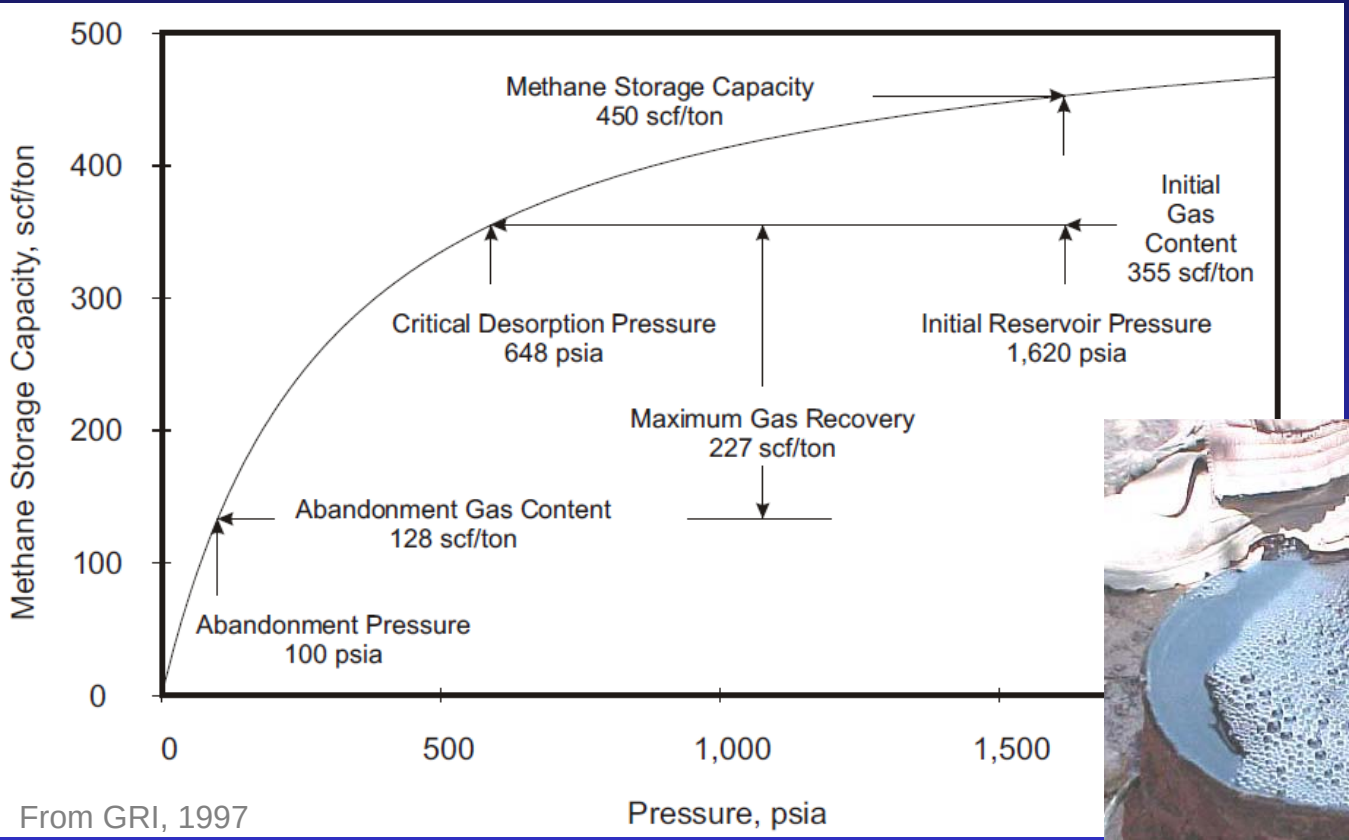
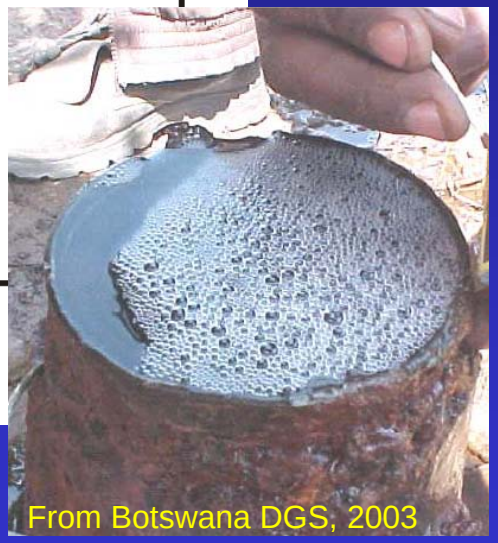
CBM Reservoir Saturation



From GRI, 1997



From Botswana DGS, 2003

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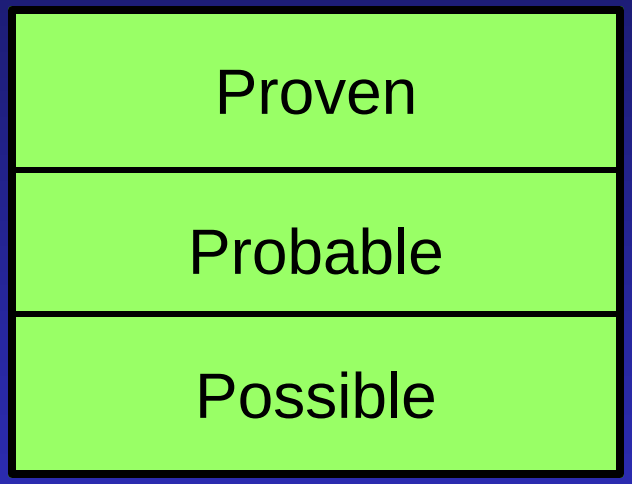
Project Stages

4. Reserve Estimation



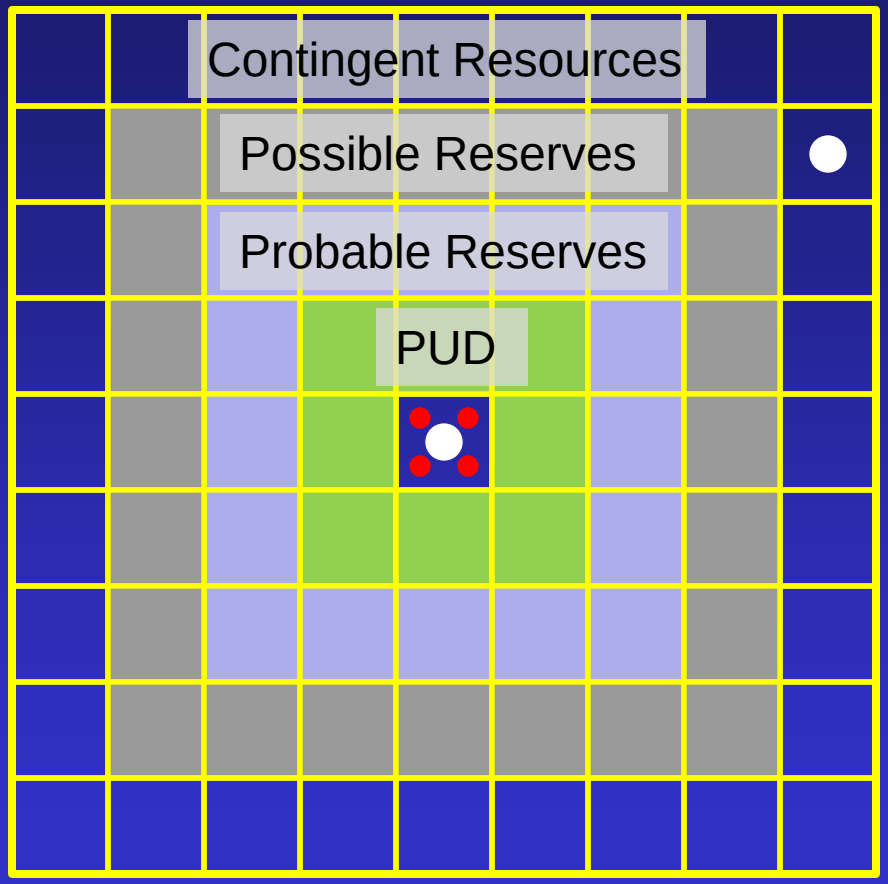
Development Financing

3RD PARTY INDEPENDENT EVALUATION OF DRILLING RESULTS

"… successful pilots or operating projects in the subject reservoir or successful projects in analogous reservoirs may be required to establish a distribution of recovery efficiencies for nonconventional accumulations."

From Petroleum Resources Management System, 2007 (www.spe.org)

Demonstrate Economic Gas Production and Reserve Base



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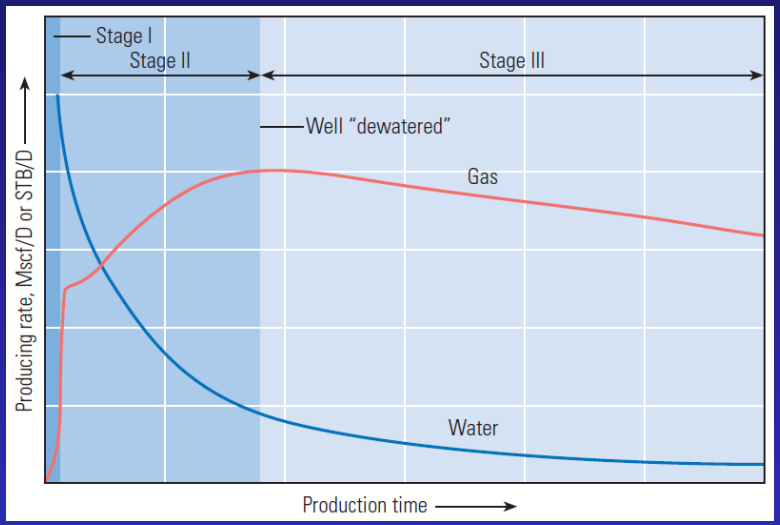

From Anderson and others, 2003

5-well Pilot Development (PDP)

- Reservoir communication
- Accelerated dewatering
- Production flow rates
- Well completion effectiveness

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Outline

- Introduction
- Project Stages
- **Summary**

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Summary

Strategic Planning

- Define team, product, market, infrastructure, duration

Feasibility Study

- Show economic viability (product, market, delivery)

Exploratory Drilling

- Improve economic aspects (gas content and production)

Reserve Estimation

- Establish reserve base, raise capital for development

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