



Energy Equity Resources

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Energy Equity Resources (AS) Limited

**Presentation to SPEE – London Chapter**  
***PRMS Applications Guidelines Document***  
***PRMS - AG Overview***

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*Geological Society, London*  
*8 May, 2012*

Society of Petroleum Engineers



# PRMS

# PRMS

- Introduction
- PRMS Overview
  - PRMS Document
  - Classification Matrix
  - Major Principles
  - Definitions
  - High Level Guidelines
- Conclusion



# What is PRMS?

PRMS is a framework for classifying and categorizing estimates of petroleum reserves and resources.

PRMS provides an industry consensus on basic principles and high level guidelines, that if adopted, will improve internal assessment consistency ... *and help companies manage their business.*

## What PRMS is not?

PRMS was not written as a set of public disclosure rules – issuers should continue to consult those rules established under the applicable regulations.

# The PRMS Document

## Discussion of Principles

- Section 1. Basic Principles & Definitions**
- Section 2. Classification and Categorization Guidelines**
- Section 3. Evaluation and Reporting Guidelines.**
- Section 4. Estimating Recoverable Quantities**

*23 pages*

## Resource Definitions & Guidelines

- Table I: Classes & Sub-classes***
- Table II: Resource Status Modifiers***
- Table III: Category Definitions & Guidelines***

*6 pages*

## Auxiliary Definitions

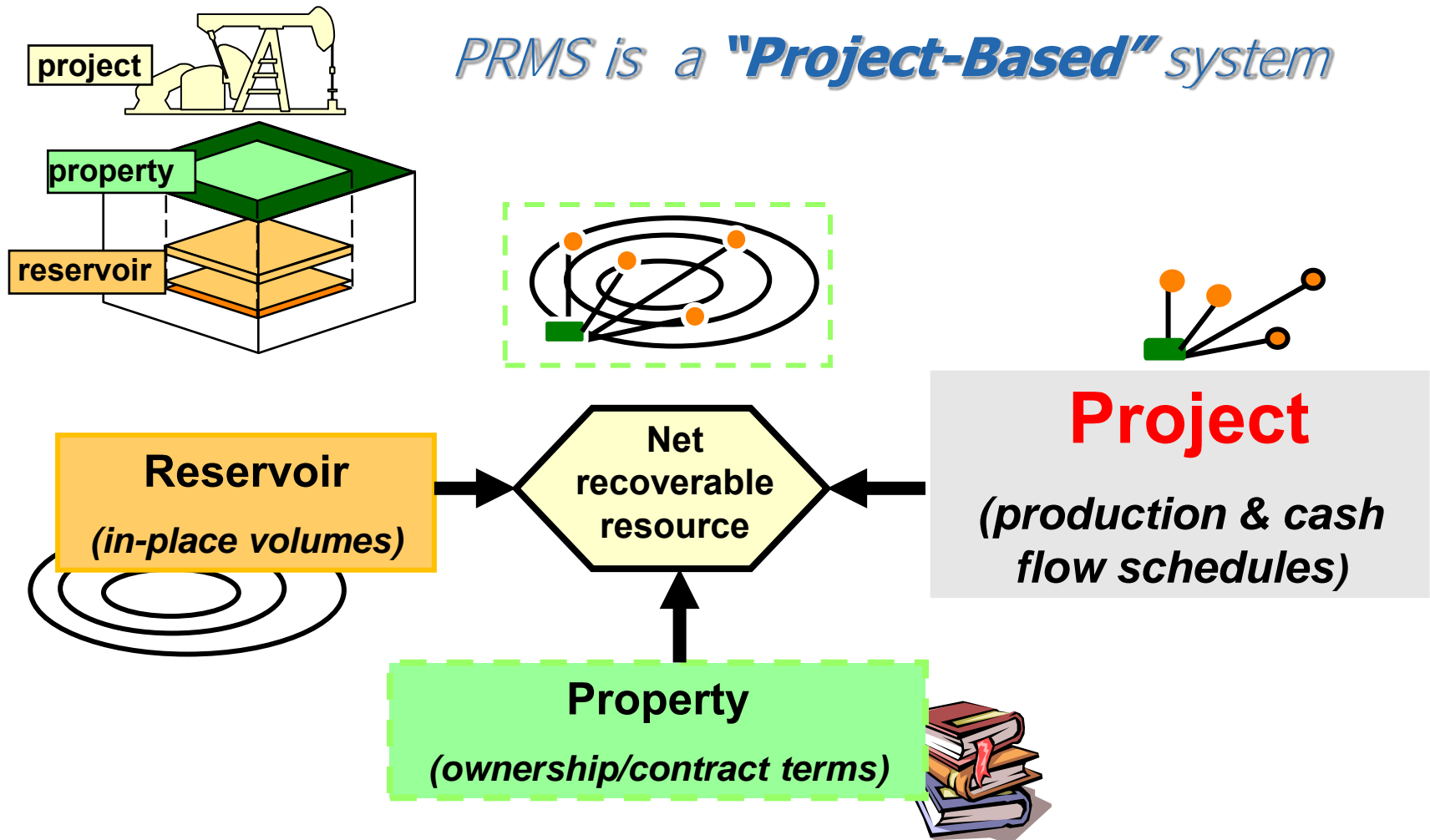
- Appendix A: Glossary**

*20 pages*

# PRMS - Major Principles

1. The System is **"Project–Based"**.
2. Classification is based on project's **chance of commerciality**.  
Categorization is based on **recoverable uncertainty**.
3. Base case uses evaluator's **forecast of future conditions**.
4. Provides more **granularity for project management**.
5. Estimates based on **deterministic and/or probabilistic** methods.
6. Applies to both conventional and **unconventional resources**.
7. Reserves /resources are estimated in terms of the **sales products**.

# PRMS Overview



# A Project is Where “Rock Meets Iron”

## The key is to map data relationships!

One project may be applied to more than one reservoir.

One reservoir may be subjected to more than one project (simultaneously or in sequence).

One project and/or reservoir may span several properties.

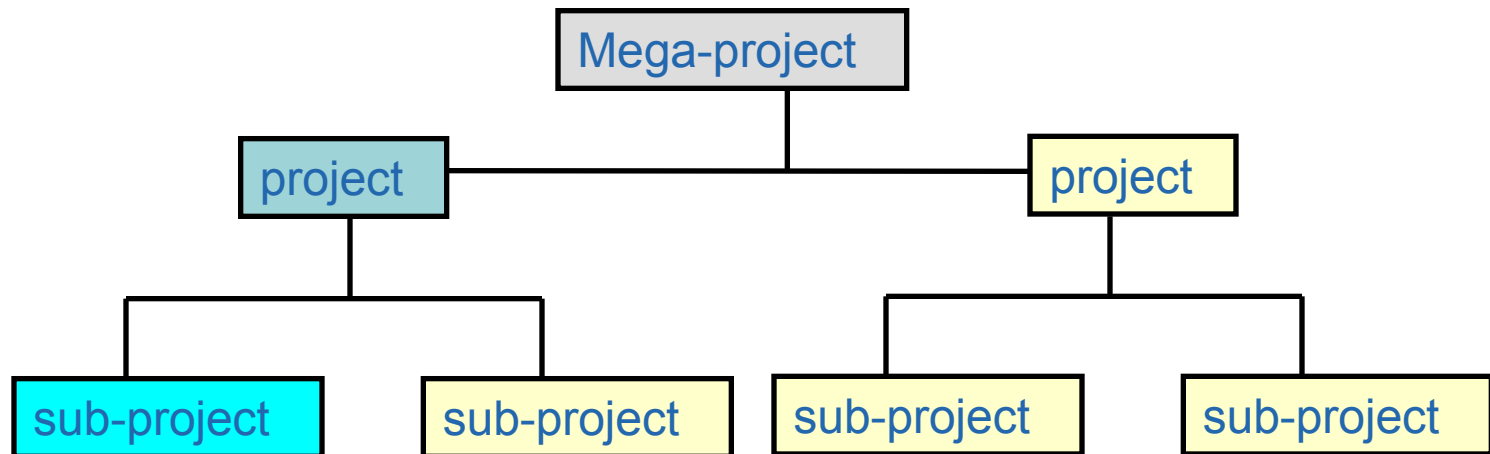
One property may contain several projects and/or reservoirs.

Recoverable (sales) quantities are associated with a project.



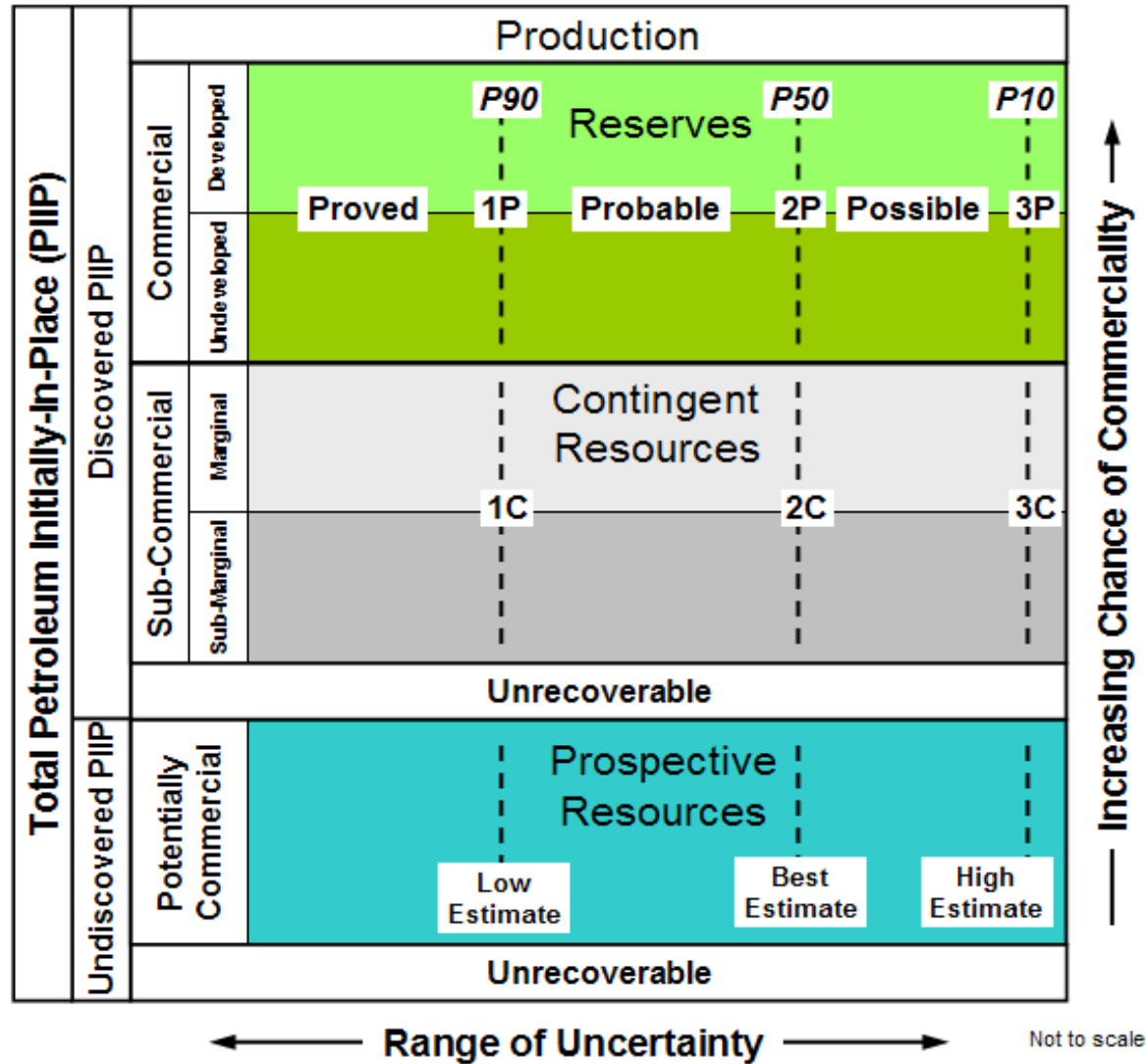
# Deciding “What is the Project”

A project is defined by the evaluator as the level at which cash flows are tracked to assess economic performance and management **makes an investment decision** .

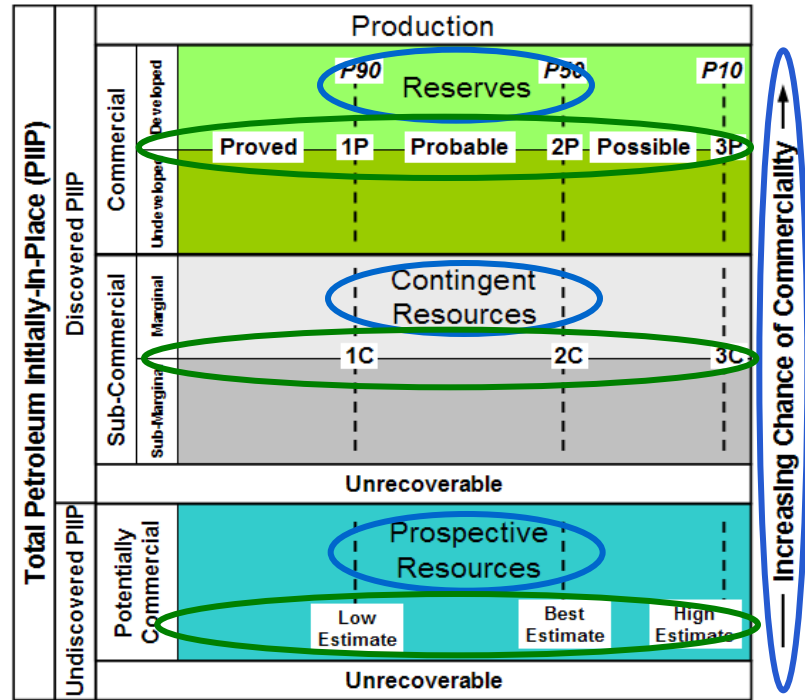


**Project is the level at which we define the risks and uncertainties.**  
**It is where we integrate commercial and technical uncertainties.**

# PRMS - Classification Matrix



# PRMS – Integrates Project Classification and the Range in Estimated Volumes by Assignment of Uncertainty Categories

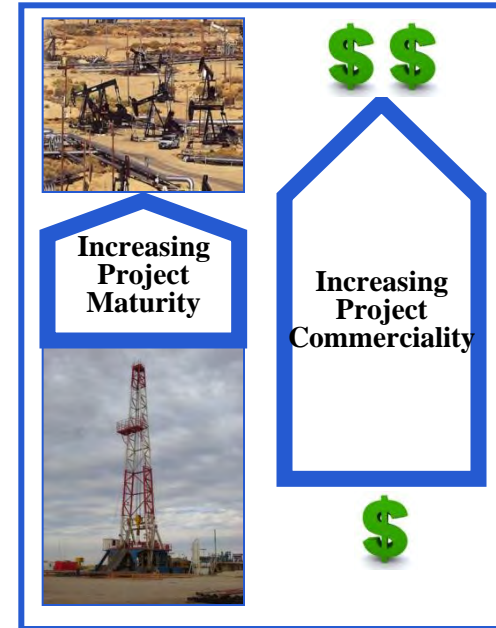


**CATEGORIZE**

Volumes

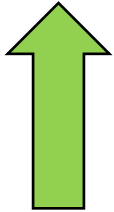
**Classify**

Projects



Represent Project Maturity & Commerciality  
By Assigning Volumes to Classes

# PRMS - Definitions



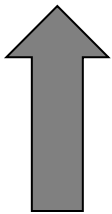
**RESERVES** are those quantities of petroleum anticipated to be commercially recoverable by application of development projects to known accumulations from a given date forward under defined conditions.

**Reserves must further satisfy four criteria: they must be discovered, recoverable, commercial, and remaining (as of the evaluation date) based on the development project(s) applied.**

Reserves are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by development and production status (developed or undeveloped).

# PRMS - Definitions

**CONTINGENT RESOURCES** are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from known accumulations, but the applied project(s) are **not yet considered mature enough for commercial development** due to one or more contingencies.



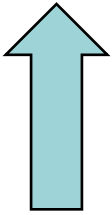
Contingent Resources may include, for example, projects for which there are currently no viable markets, or where commercial recovery is dependent on technology under development, or where evaluation of the accumulation is insufficient to clearly assess commerciality.

Contingent Resources are further categorized in accordance with the level of certainty associated with the estimates and may be sub-classified based on project maturity and/or characterized by their economic status (marginal or sub-marginal).

# PRMS - Definitions

**PROSPECTIVE RESOURCES** are those quantities of petroleum estimated, as of a given date, to be potentially recoverable from undiscovered accumulations by application of future development projects.

**Prospective Resources have both an associated chance of discovery and a chance of development.**



Prospective Resources are further subdivided in accordance with the level of certainty associated with recoverable estimates assuming their discovery and development and may be sub-classified based on project maturity.

# PRMS – High level Guidelines

- There should be at least a 90% probability (P90) that the quantities actually recovered will equal or exceed the low estimate.

- There should be at least a 50% probability (P50) that the quantities actually recovered will equal or exceed the best estimate.



- There should be at least a 10% probability (P10) that the quantities actually recovered will equal or exceed the high estimate.

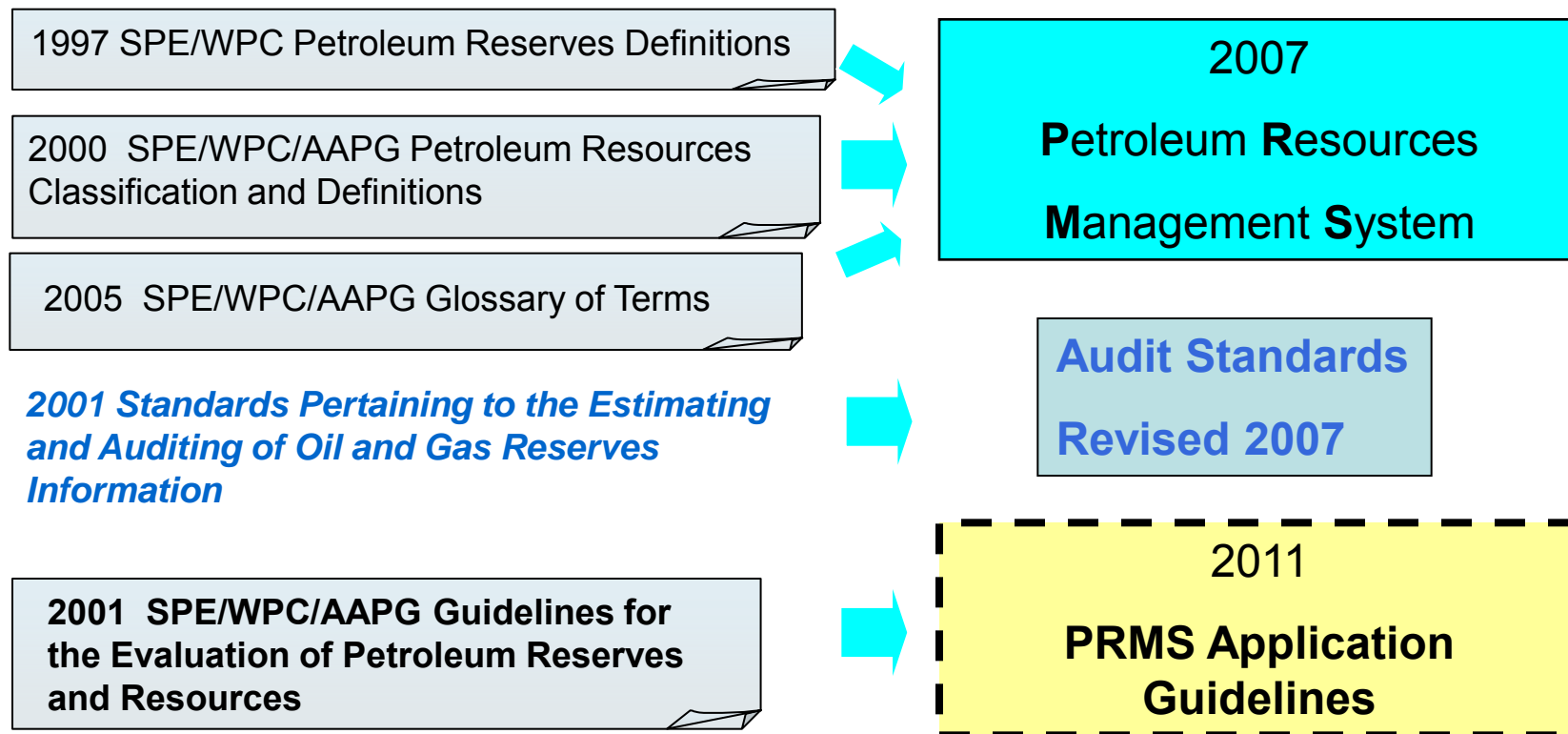
These same approaches to describing uncertainty may be applied to Reserves, Contingent Resources, and Prospective Resources.

While there may be significant risk that sub-commercial and undiscovered accumulations will not achieve commercial production, it is useful to consider the range of potentially recoverable quantities **independently** of such a risk or consideration of the resource class to which the quantities will be assigned.

# PRMS – Building on Success



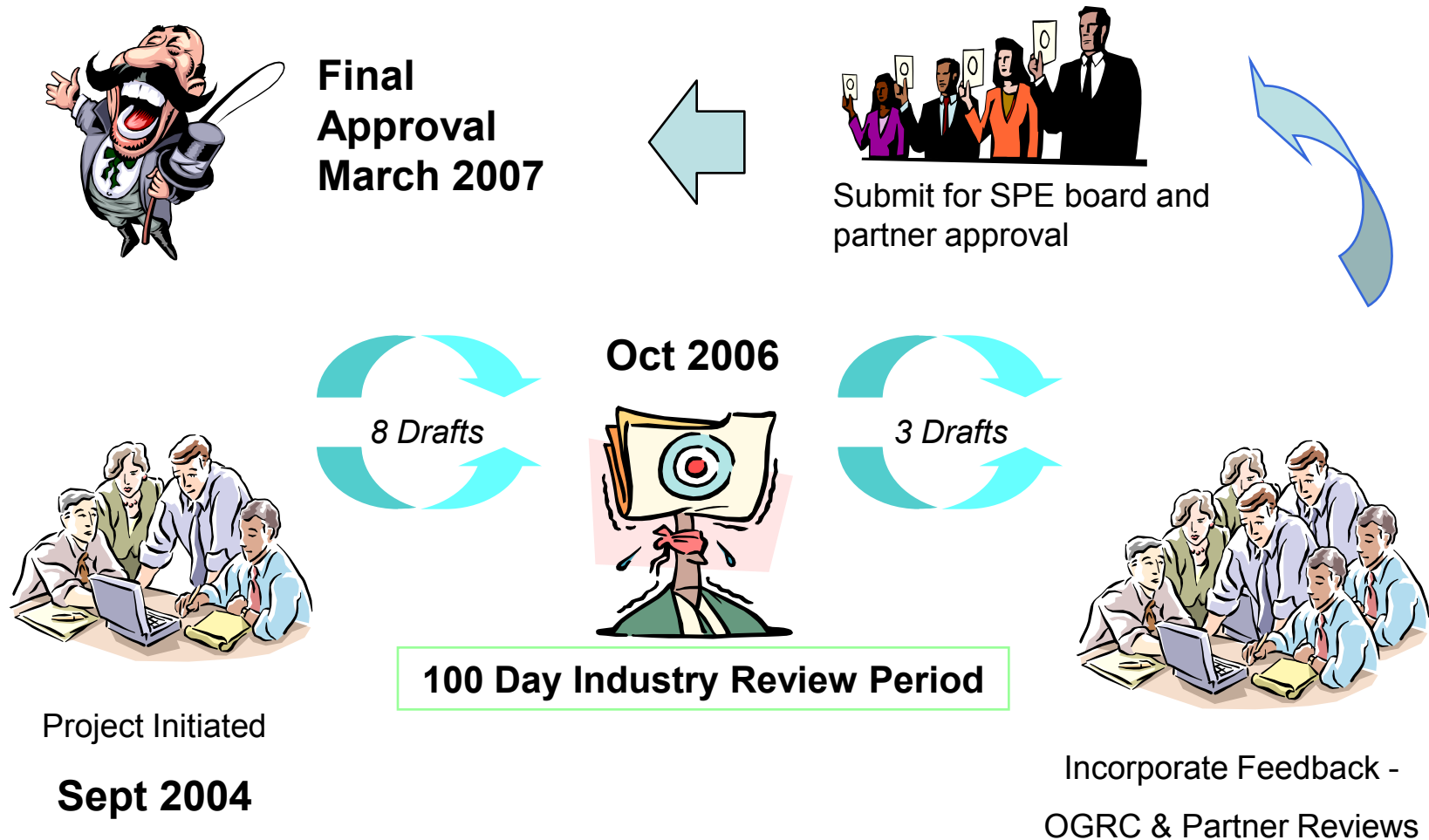
(see SPE 114162 for history)



**Consolidate, build on, update, and replace prior guidance**



# PRMS Development Timeline



# PRMS Official Reference (www.spe.org)



The screenshot shows the SPE International website. The header includes the SPE logo and the text "Society of Petroleum Engineers". Below the header, there are navigation tabs for "SPE Links" and "Industry Resources". The "Industry Resources" tab is selected, and a sub-menu is visible with "Petroleum Reserves Definitions" highlighted. The main content area is divided into three columns: "Sites", "Special Topics", and "SPE Disciplines". The "Special Topics" column lists "Petroleum Reserves Definitions", "Research Tools and Calculators", "Research & Development", "Carbon Capture and Sequestration", and "More Industry Topics...". The "SPE Disciplines" column lists "Drilling and completions", "Health, safety, security, environment and social responsibility", "Management and information", "Production and operations", "Projects, facilities and construction", and "Reservoir description and dynamics". Below the navigation tabs, there is a sidebar with links to "Industry Home", "Research & Development", "Reserves Definitions", and "Reserves Committee". The main content area features the title "Petroleum Reserves & Resources Definitions" and a section titled "Petroleum Resources Management System". This section states that the system was approved by the SPE Board in March 2007 and was developed by an international group of reserves evaluation experts. It also mentions that the system was endorsed by the World Petroleum Council, the American Association of Petroleum Geologists, the Society of Petroleum Evaluation Engineers, and the Society of Exploration Geophysicists. A link is provided to "Learn about the process" and another link to "read a quick overview of the PRMS for non-technical users". To the right of the main content, there is a section titled "Other Committees" which lists the "Joint Committee on Reserves Evaluator Training (JCORET)" and the "Oil & Gas Reserves Committee".

**SPE International** Society of Petroleum Engineers

SPE Links ▾ Industry Resources ▴

**Sites**

- › OnePetro
- › Bookstore
- › E&P Glossary
- › Energy4Me
- › Technical Interest Groups

**Special Topics**

- › **Petroleum Reserves Definitions**
- › Research Tools and Calculators
- › Research & Development
- › Carbon Capture and Sequestration
- › More Industry Topics...

**SPE Disciplines**

- › Drilling and completions
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- › Reservoir description and dynamics

› Industry Home

› Research & Development

› Reserves Definitions

› Reserves Committee

## Petroleum Reserves & Resources Definitions

### Petroleum Resources Management System

Approved by the SPE Board in March 2007, this system for defining reserves and resources was developed by an international group of reserves evaluation experts and endorsed by the World Petroleum Council, the American Association of Petroleum Geologists, the Society of Petroleum Evaluation Engineers, and the Society of Exploration Geophysicists. [Learn about the process](#) by which the new definitions were developed or read a [quick overview](#) of the PRMS for non-technical users.

#### Other Committees

- Joint Committee on Reserves Evaluator Training (JCORET)
- Oil & Gas Reserves Committee

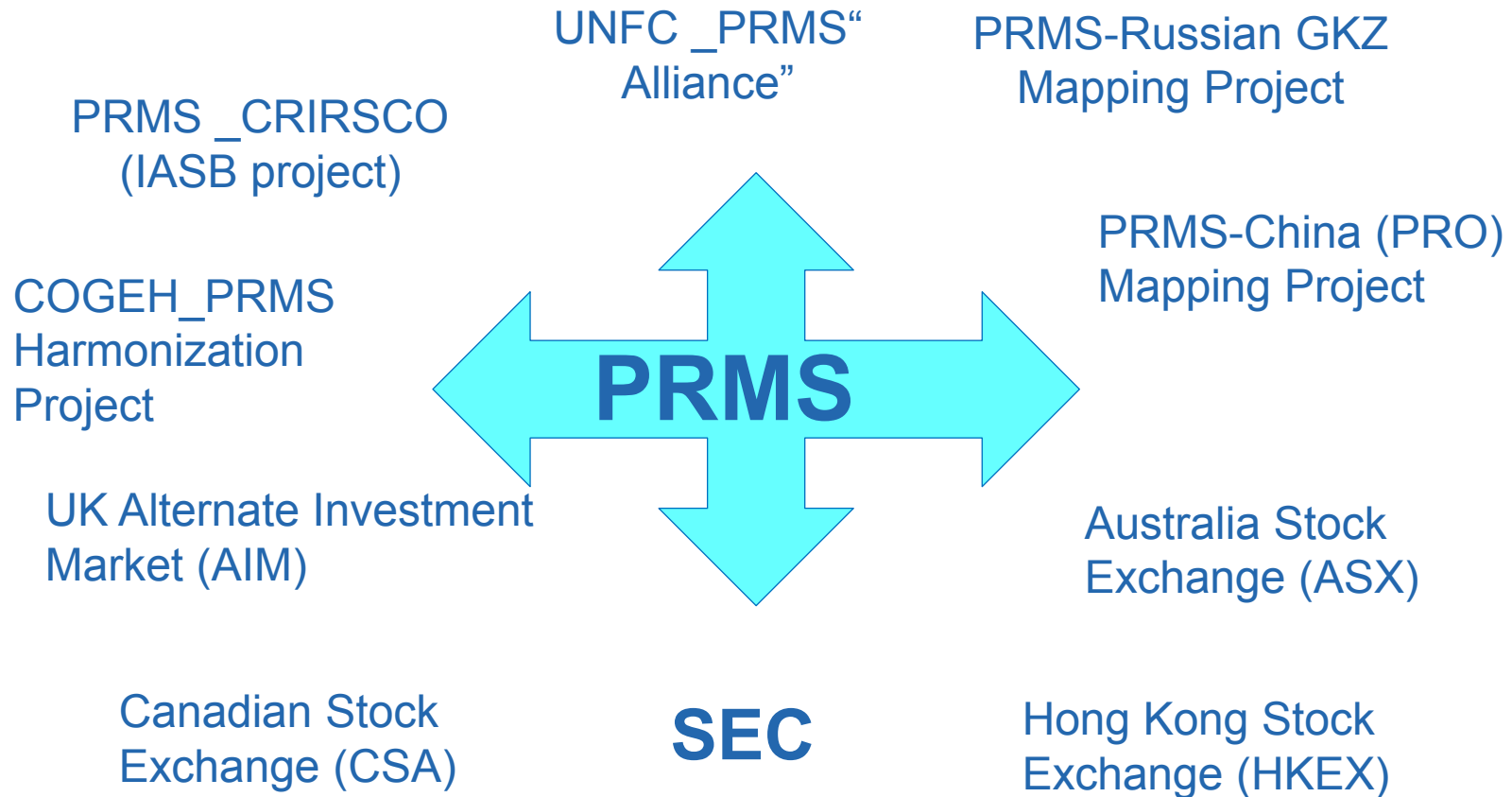
Also See:

**Mapping of Reserves Definitions**

**Estimating and Auditing Standards for Reserves**

**Historical Archives**

# Industry Consolidation Around PRMS



# PRMS - AG

# Presentation Outline

- Introduction
- Tenets and Objectives
- AG Development
- PRMS-AG History
- Implementation
- Closing Remarks



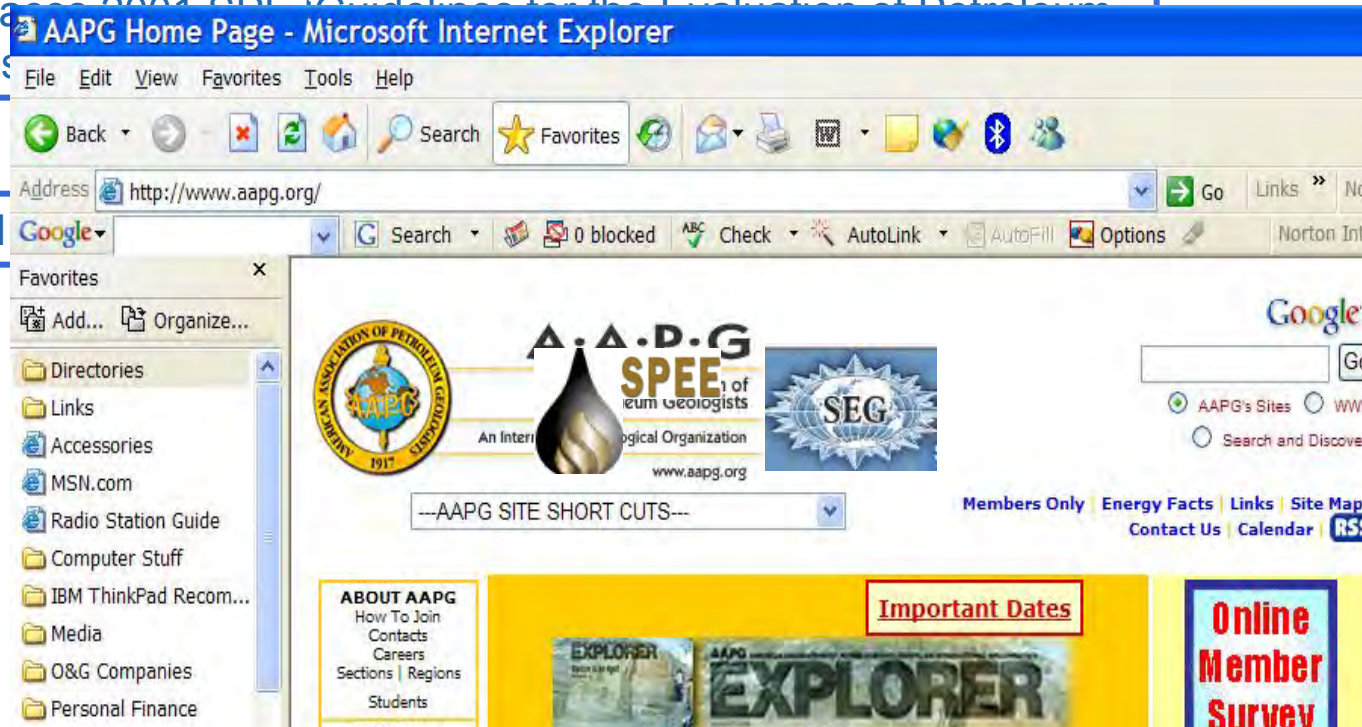
# Applications Guidelines

April 2007 – November 2011

1 Goal: To provide supplemental guidance on application of PRMS classification to Reserves and Resource Evaluations

2 Updated and replaced 2004 SPE Guidelines for the Evaluation of Petroleum Reserves and Resources

3 Jointly sponsored



# Stakeholders



All stakeholders require complete, **consistent** and reliable information on future production and associated cash flow estimates through full life recovery.

# AG – Fundamental Tenets

## Agreed at 2009 OGRC Meeting in New Orleans

- Main purpose
  - Provide real-world guidance on the application of PRMS
  - Does not contradict or change PRMS
- Concise
  - Not intended to be a manual on petroleum engineering or earth sciences.
- Broad-based
  - Inclusive architecture that accommodates different regulatory systems and commonly applied accounting systems.
    - Does not provide advice on SEC/ASC booking.
    - Does not promote a single financial accounting system.



# AG Objectives

To ensure an effective document consistent with the original purpose and guidance of 2007 PRMS and SPE Governance

*Build on 2001 Guidelines ... update ... replace*

## Reserves and Resources.

- Technology update
- Review of strengths and weakness of methods
- Add chapters:
  - ✓ Unconventional resource evaluation
  - ✓ Deterministic Procedures
  - ✓ Seismic Applications

## Provide additional guidance to users of PRMS.

- linkage to a project level assessment process
- Examples

# AG Project Leadership

Original Applications Document Subcommittee members:

- Satinder Purewal - EERas (Chair)\*
- Delores Hinkle - Marathon
- Bernard Seiller - TOTAL
- Stuart Filler - SWN\*\*
- Stefan Choquette - CVX (Consultant)
- Yasin Senturk - Saudi Aramco

\*ex SHELL \*\* ex DEVON

# AG - Governance

Transparent process – ensure broad industry input

- Editing strategy to reduce endorsement issues: Reviewed and revised twice by editing teams with members representing OGRC, AAPG, SPEE, WPC, and SEG.
- Reviewed and edited by SPE staff for format and style consistency.
- Public Review- Posted for 90 days on [www.SPE.org](http://www.SPE.org) with an invitation for submission of comments
- Submitted for endorsement by sponsoring organizations (SPE, AAPG, SPEE, WPC, and SEG) early July (45 Days)

# PRMS - AG Development Planning



## Look Back

Review Previous Guidance (2001).

- ❖ What works OK?
- ❖ Where are the problems?



## Look Around

- ❖ What else is out there?
- ❖ Look for best practices.



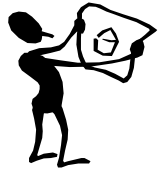
## Look Ahead

The business is changing!

- ❖ Unconventional Resources
- ❖ New Technology
- ❖ New arrangements: PSC's, RSC's, ...
- ❖ More guidance needed

# AG History – From Start to Finish

2007



- Significant progress with TOR & TOC
- Decision to seek industry examples delayed the project to mid-2008

2008

- Authors sought; uncertainty on COGEH; what to include on unconventionalals?

2009



- Most chapters written – time line/work plan agreed (OGRC-ATCE)
- Chapter editing & Steering committees. Some 40+ SME's.

2010

- Draft posted on SPE website December 2010 for comments
- Include comments received

2011



- Finalization with SPE OGRC, SPE board and sister societies
- Publish November 2011!

Chapter 1	Introduction
Chapter 2	Petroleum Resources Definitions, Classification, and Categorization Guidelines
Chapter 3	Seismic Applications
Chapter 4	Assessment of Petroleum Reserves using Deterministic Procedures
Chapter 5	Probabilistic Reserves Estimation
Chapter 6	Aggregation of Reserves
Chapter 7	Evaluation of Petroleum Reserves and Resources
Chapter 8	Unconventional Reserves Estimation
Chapter 9	Production Measurement and Operational Issues
Chapter 10	Reserves Entitlement and Recognition
'Reference Terms'	

# Chapter Reviewers

Broad X-section from Industry

- Steering Committee: Purewal\*/Choquette/Gold/Mallon
- Ch 1: Tenzer\*/Hinkle
- Ch 2: Harrell\*/Lee/Martinez
- Ch 3: Ritter\*/Withers/Marion/Scott/Shang
- Ch 4: Etherington\*/Adams/Gold
- Ch 5: Seager\*/Purewal/MacMaster/Schuenemayer
- Ch6: Seager\*/Purewal/Brown/Schuenemayer
- Ch 7: Etherington\*/Adams/Choquette/Filler
- Ch 8: Chan\*/Sistrunk/Scott/Jenkins/Lapointe
- Ch 9: Scholnberger\*/Purewal/Gold
- Ch 10: Young\*/Filler
- Reference Terms: Scott\*/Brown

\* Chair

Plus Corbeil/McCants and many more .....

Society of Petroleum Engineers



# Future Updates to PRMS and AG

- Making a list for PRMS and PRMS-AG
- Consider inclusion and recognition of 1U, 2U and 3U as alternative acronyms for Prospective Resources estimates of Low, Best and High (similar to 1P, 2P, 3P and 1C, 2C and 3C)
- Clarify maturity sub-classes:
  - “On Production” means Developed
  - “Approved for Development” means Undeveloped i.e. post decision to invest
  - “Justified for Development” means Undeveloped i.e. post Field Development Plan (FDP)





# Increasing Global Awareness of PRMS-AG

- **2011**

- SPE/GKZ Reserves Workshop in Moscow, April 2011
- SPEE/AAPG/SPEE Symposium Reserves and Resource Estimation and Reporting in Houston, July 2011

- **2012 and Future**

- PRMS-AG ATW's

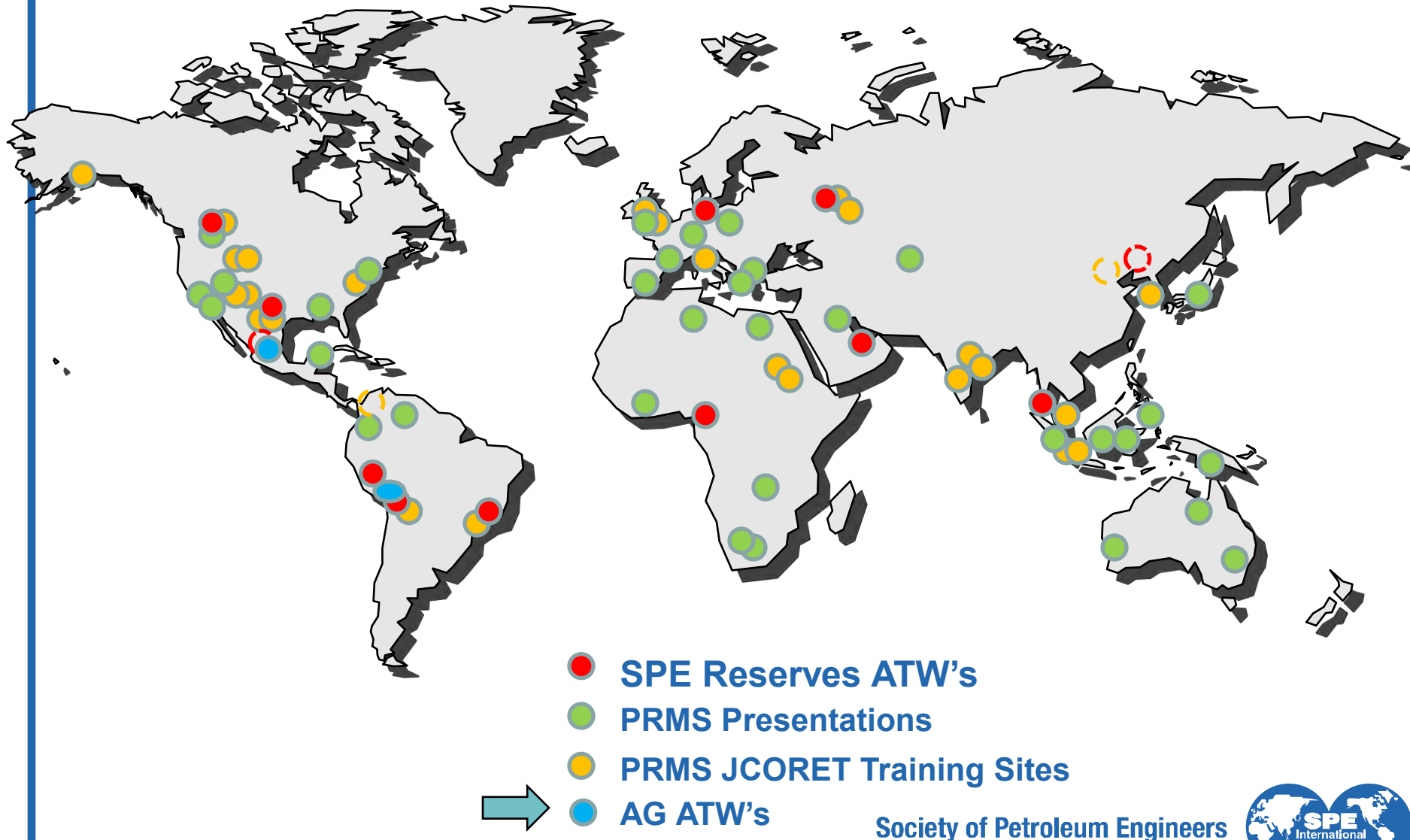
Peru 2012

Mexico 2012

Moscow 2013 (Conceptual stage) - Other areas of interest: Asia & Africa in newly emerging petroleum areas

- PRMS-AG paper at future ATCE 2012 & HEES 2012
- SPE Distinguished Lecturer for PRMS – AG
- Consider chapter authors to create JCORET courses

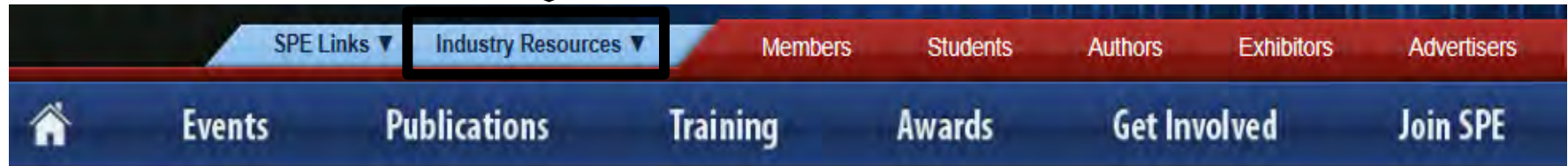
# PRMS and AG - Sharing the Vision Globally



Society of Petroleum Engineers



# PRMS AG Free Download (www.spe.org)



[Industry Home](#)

[Research & Development](#)

[Reserves Definitions](#)

[Reserves Committee](#)

## Petroleum Reserves & Resources Definitions



### New Reserves Classification Guidelines Available

The SPE Oil and Gas Reserves Committee (OGRC) recently released *Guidelines for Application of the Petroleum Resources Management System (PRMS)*. The new, 221-page document replaces the 2001 "Guidelines for Evaluation of Reserves and Resources" with expanded content that is updated to focus on using the 2007 PRMS to classify petroleum reserves and resources.

The guidelines represent a collaboration of SPE, the American Association of Petroleum Geologists, the Society of Exploration Geophysicists, the Society of Petroleum Evaluation Engineers, and the World Petroleum Council. More than 40 subject-matter experts were involved in writing and review of the guidelines, headed by Satinder Purewal, chairman of the OGRC's Applications Document Subcommittee.

› **NEW:** [Guidelines for Application of the Petroleum Resources Management System](#)

### Other Committees

- [Joint Committee on Reserves Evaluator Training \(JCORET\)](#)
- [Oil & Gas Reserves Committee](#)

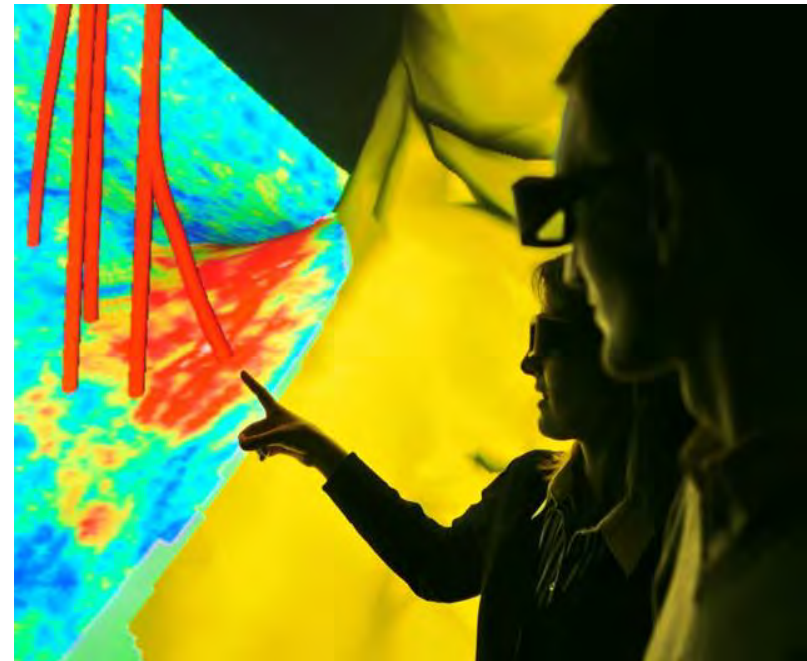
Society of Petroleum Engineers



# Selected AG updates: chapters 3 and 8

# PRMS-AG Guidance

- PRMS-AG Chapter 3: Seismic Applications
  - Provides guidance for use of seismic as part of **integrated analysis** for
    - Trap Geometry
      - Structural Definition, Faults, Fluid Contacts
    - Rock and Fluid Properties
      - Fluid Contacts, Reservoir Development
    - Flow Surveillance
      - Faults, Contact Movements
  - Dedicated sections on:
    - Seismic Uncertainties
    - Seismic Inversion



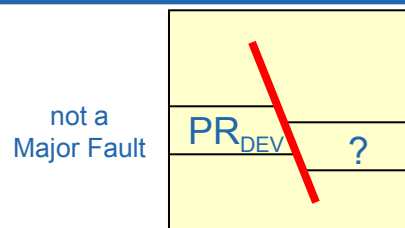
# PRMS-AG Guidance

- PRMS-AG Guidance on Trap Geometry: **Faults**
  - For fields interpreted to be faulted, it may be necessary to classify resource estimates differently for individual fault blocks.
  - Seismic amplitude anomalies may also be used to establish reservoir and fluid continuity across faulted reservoir provided that the following conditions are met:
    - Within the drilled fault block, well logs, pressure, and test data demonstrate a strong tie between the hydrocarbon-bearing reservoir and the seismic anomaly.
    - Fault throw is less than reservoir thickness over (part of) the hydrocarbon bearing section across the fault and the fault is not considered to be a major, potentially sealing, fault.
    - The seismic flat-spot or the seismic anomaly is spatially continuous and at the same depth across the fault.
  - If all these conditions are met, the presence of hydrocarbon in the adjacent fault block above the seismic flat-spot or seismic amplitude anomaly may be judged sufficiently robust to qualify the hydrocarbon volumes in the undrilled compartment as reserves.



# Considerations for Classification for unpenetrated fault blocks

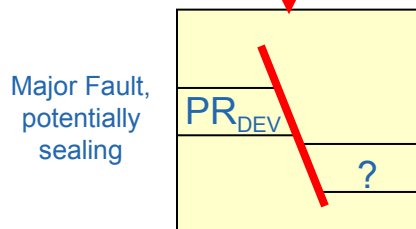
Step 2: Assess likelihood of economically producible reservoir in unpenetrated fault block



YES

START → Fault throw is less than reservoir thickness over (part of) the hydrocarbon bearing section across the fault

NO



**Prospective Resources**

## Data Sources to be looked at:

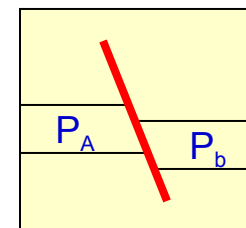
Reservoir Development Plan  
 Fault length/throw analysis  
 Fault juxtaposition analysis,  
 Structural setting & history  
 Allen-plots  
 Shale Gouge Ratio (SGR) analysis  
 Diagenesis  
 Pressure Data analysis  
 Well Test analysis  
 Geochem analysis  
**Seismic Evidence: (Offset, Attributes, Inversion, 4D-response)**  
 Production performance  
 Reservoir Simulation  
 Use of Analogues

The results of these various analyses should be internally consistent.

## Reserves, Contingent or Prospective Resources

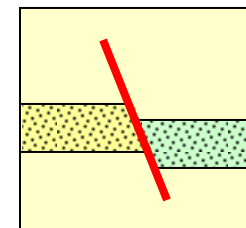
Depending on the outcome of the likelihood assessment of hydraulic communication across the fault, using all Geoscience and Engineering data

Pressure Regimes



$P_A \sim P_B$  ??

Reservoir Presence

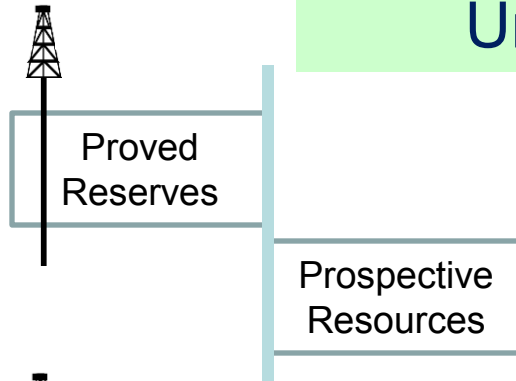


~ ??



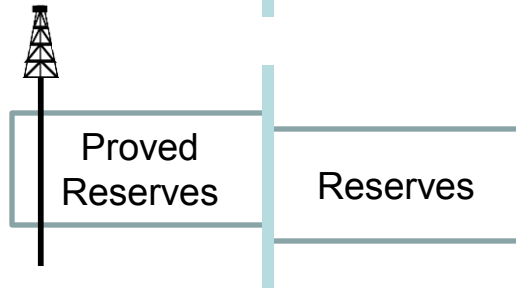
# Unpenetrated fault blocks scenarios

## Case 1



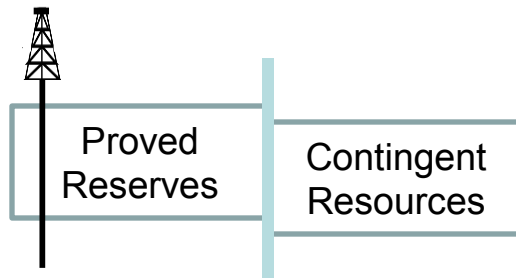
**Case 1:** Fault is sealing or offset > reservoir thickness

## Case 2



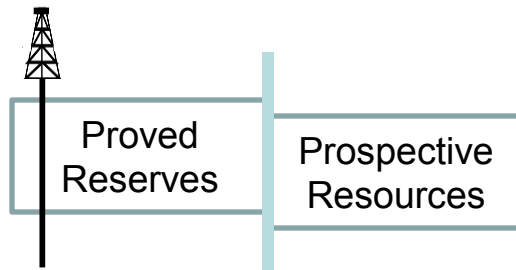
**Case 2:** Fault is non-sealing and offset < reservoir thickness, seismic & geology indicates continuity, well test data indicates extension of reservoir, good analogs available for continuity, development plan includes both fault blocks

## Case 3



**Case 3:** As case 2 but offset fault block not included in current development plan/project

## Case 4



**Case 4:** As case 3, but some questions about reservoir & hydrocarbons presence, fault is considered potentially sealing



# CBM

# Class Transition – Application to CBM

## Discovery

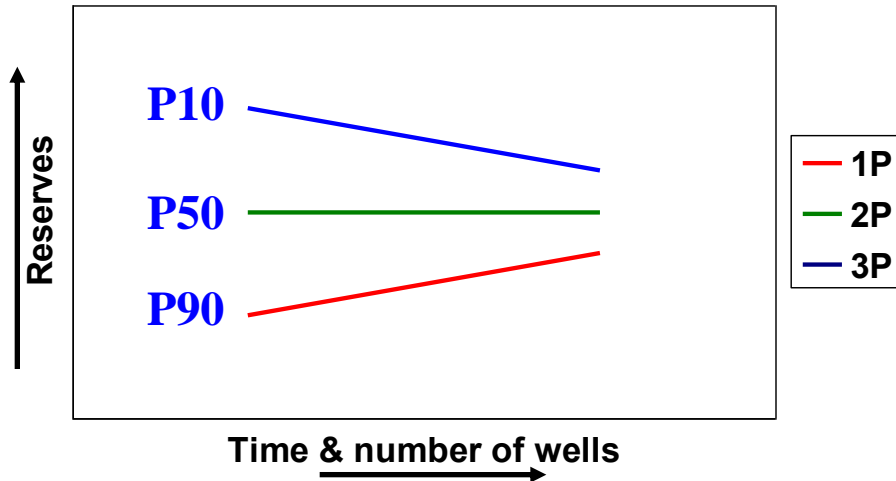
- Demonstrated by drilling, testing, sampling and/or logging:
- Hydrocarbon gas content (e.g. coal sample or gas flow)
- Coal thickness sufficient to establish the existence of a significant quantity of potentially moveable hydrocarbons
- data indicates sufficient permeability for flow within the coal seam

## ?? Commercial ??

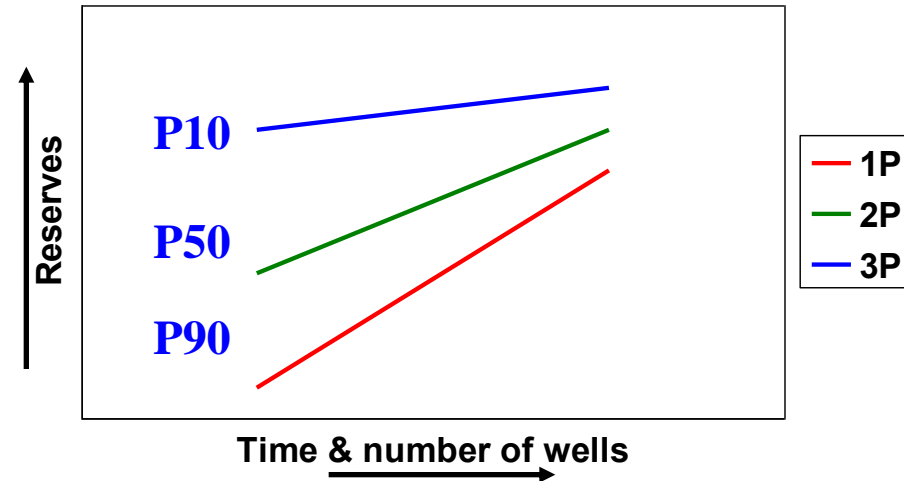
- Gas rates may as yet be undemonstrated or uneconomic
- Gas composition may or may not support marketability
- Location may be significant distance from existing well locations that have demonstrated commercial potential
- May be outside coal fairway or acceptable depth limits (typically 200 to 1000 m)
- May require as yet unproven well technology, (e.g. untried stimulation techniques or horizontal/multilateral wells)
- May be outside areas that can be accessed legally (e.g., protected land)
- Development plan immature or subeconomic
- Market not assured
- May require approvals.

# Australia CBM Reserves Growth Paradox

Conventional Petroleum



CSG

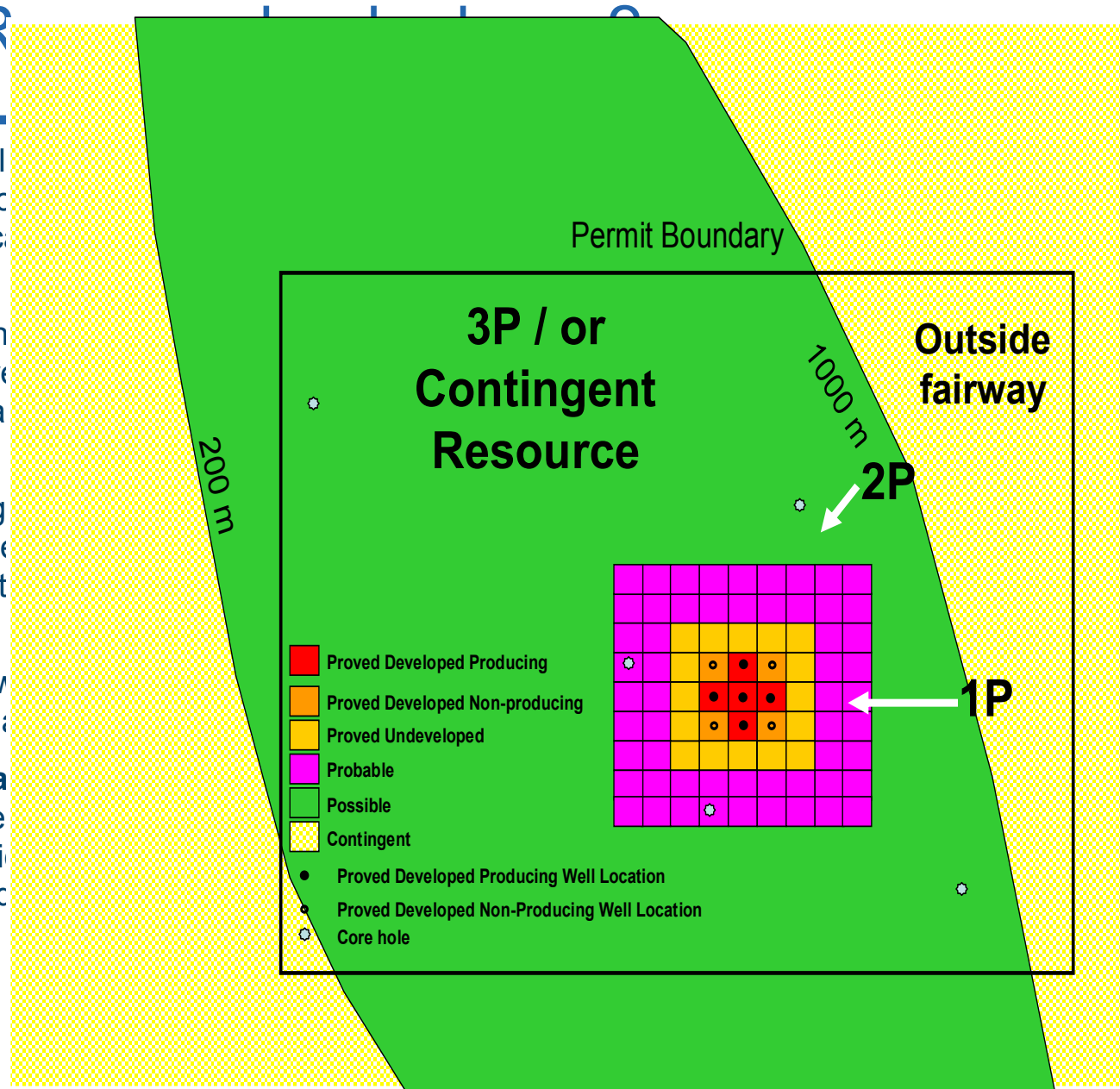


- Trends towards 2P
- Makes sense if 2P is roughly a P50 or 'equally likely' value

- Why?
  - Mixing Reserves & Contingent Resources
  - 1P and 2P underestimated
  - No range of recovery efficiency

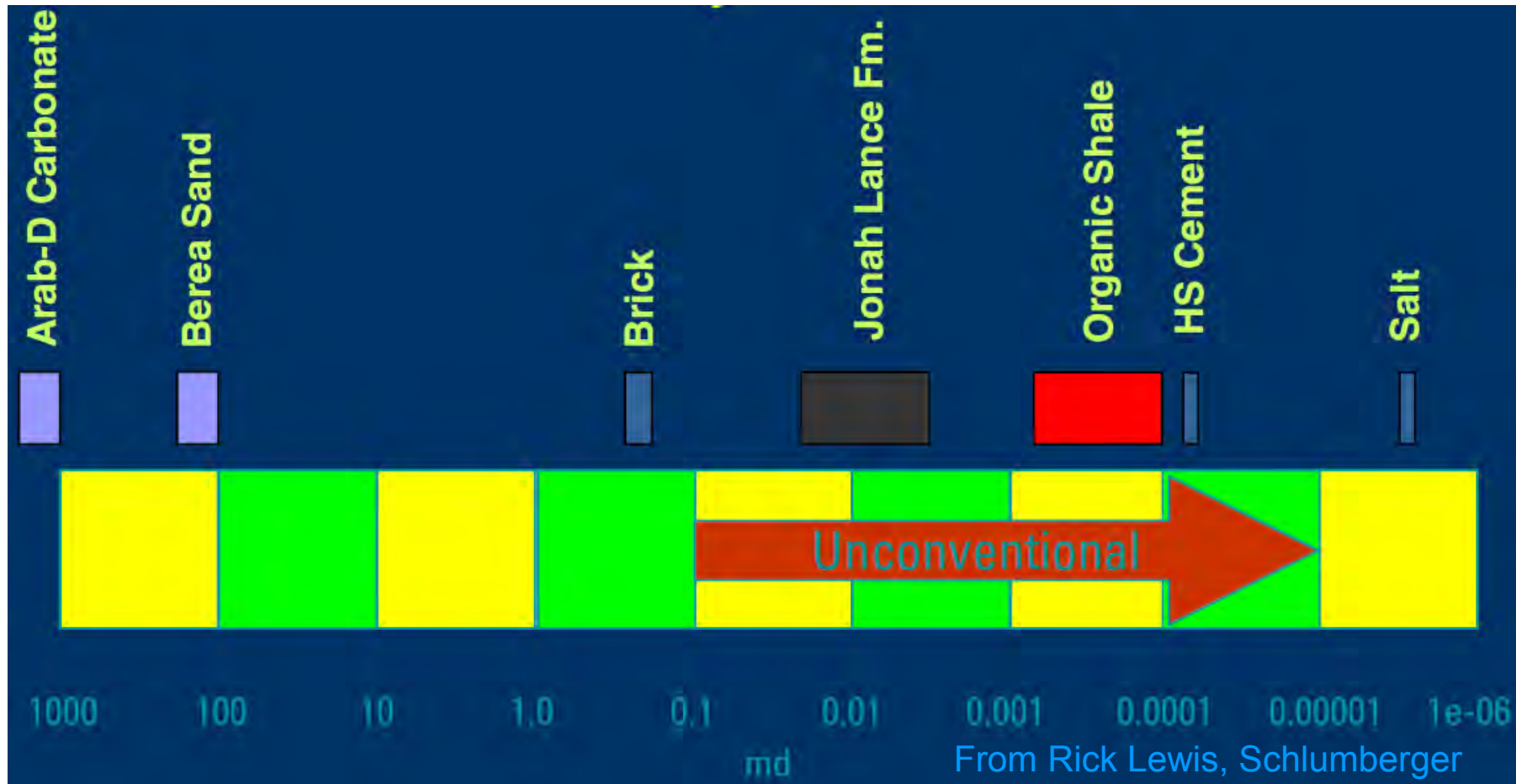
# How are CSG R

- **Proved developed:** Nominal area of a well, depends on completion properties and geology, typically 320 acres
- **Proved undeveloped:** within drainage radii from productive to 2 in high permeability area good continuity
- **Probable:** typically 2 drainage radii away from Proved, could be included in high permeability areas with good continuity
- **Possible:** 2 drainage radii away from Probable – or greater if data is available
- **“Bracketing” or “rubber-banding”** also used to enable areas between normal well spacing conventional wells to be categorised in a higher confidence resource class/category



# Shale gas

# Shale Permeability

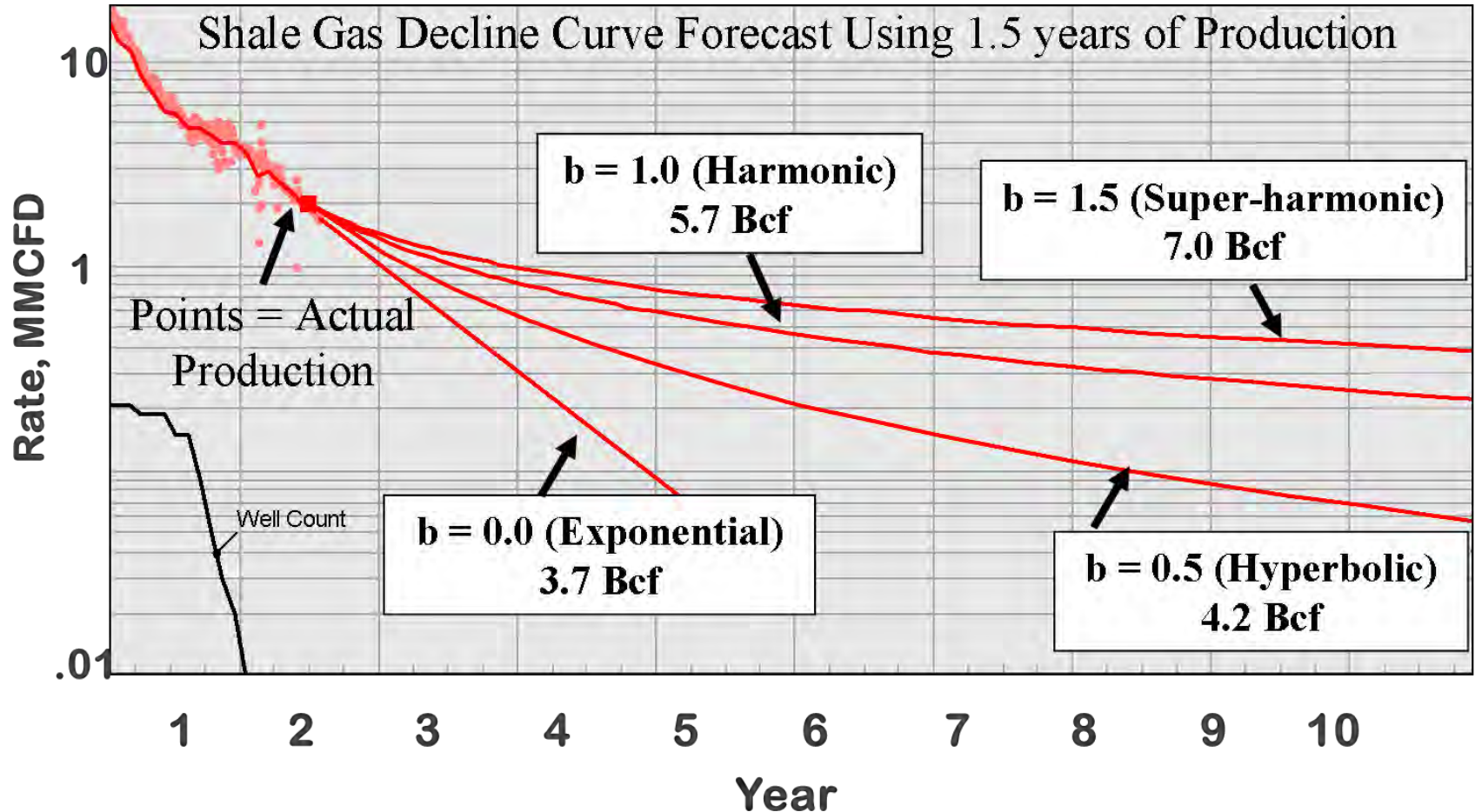


- Greater than high strength cement, but less than a brick!

# Forecasting Well Performance

- Rate-time relations (such as the Arps equation) are not accurate forecasting tools during the early years of production because wells are in transient flow and do not have a constant bottomhole pressure
- More sophisticated tools are therefore needed to more accurately forecast well performance

# Applying the Arps Equation



- Forecasting is highly uncertain if you only use rate data



# Classification of PUDs

- Requires reasonable certainty that these locations will be economic and that there is lateral continuity with drilled proved locations.
  - Lateral continuity is generally not a problem, unless the shale is cut by a fault, but the large variability in individual well IPs and EURs can make the assignment of PUDs problematic beyond one development spacing unit from a producing well.
  - In general, if there is consistency in IPs and EURs, then it seems reasonable to assign PUDs at a distance of 2 or perhaps 3 development spacings from these wells as long as these PUD locations are bounded by other PDP wells.

# Closing Remarks

- PRMS-AG took over 4 years to complete
- A quality document has been created with broad input from all stakeholders through an inclusive process
- PRMS - AG is an invaluable reference document with additional guidance to PRMS
- Finalized copy posted on SPE website
- Greater global awareness of PRMS-AG during 2012 /13 initiated

# Acknowledgements

- Shell, EER Limited
- John Etherington, HJ Kloosterman, Roberto Aguilera, Geoff Barker, Creties Jenkins
- PRMS AD Committee Members
- SPE OGRC Members
- Chapter Authors
- Chapter Editing Committee Members

# QUESTIONS & DISCUSSION