Petroleum Resource Management System: What is it? Implications for Cooper Basin Un-conventional Resources

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Presentation to SA Roundtable

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Our Vision: To provide **reliable**, **relevant** information about oil and gas reserves and resources.

Our Mission: To provide **respected** scientific and economic guidance that enables clients to manage their oil and gas resources in the best possible manner.

Our Pillars: Knowledge, Integrity, and Service

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- Since its founding in 1936, D&M has completed more than 21,000 projects in more than 100 countries.
- D&M works with some of the world's best known oil and gas exploration companies, and all of the major national oil companies.
- Many of D&M's top ten clients have been clients for more than 30 years, a testimony to the service and value D&M provides.
- D&M maintains one of the largest consulting teams in the industry, with more than 160 petroleum industry scientists and economists on staff.

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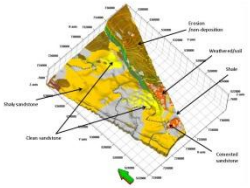
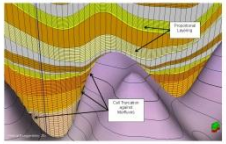
	Reservoir Simulation	**GeoScientific Studies**	**Engineering Studies**	**Contingent / Prospective Resources**
Technical Services				

MacNaughton
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D&M has made a commitment to work with Australian based companies

Santos Ltd.
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Norwest Energy
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AWE
Exoma Energy
Buru Energy
Woodside Energy, Ltd.
Karoon
Pura Vida
Latent

Remarks

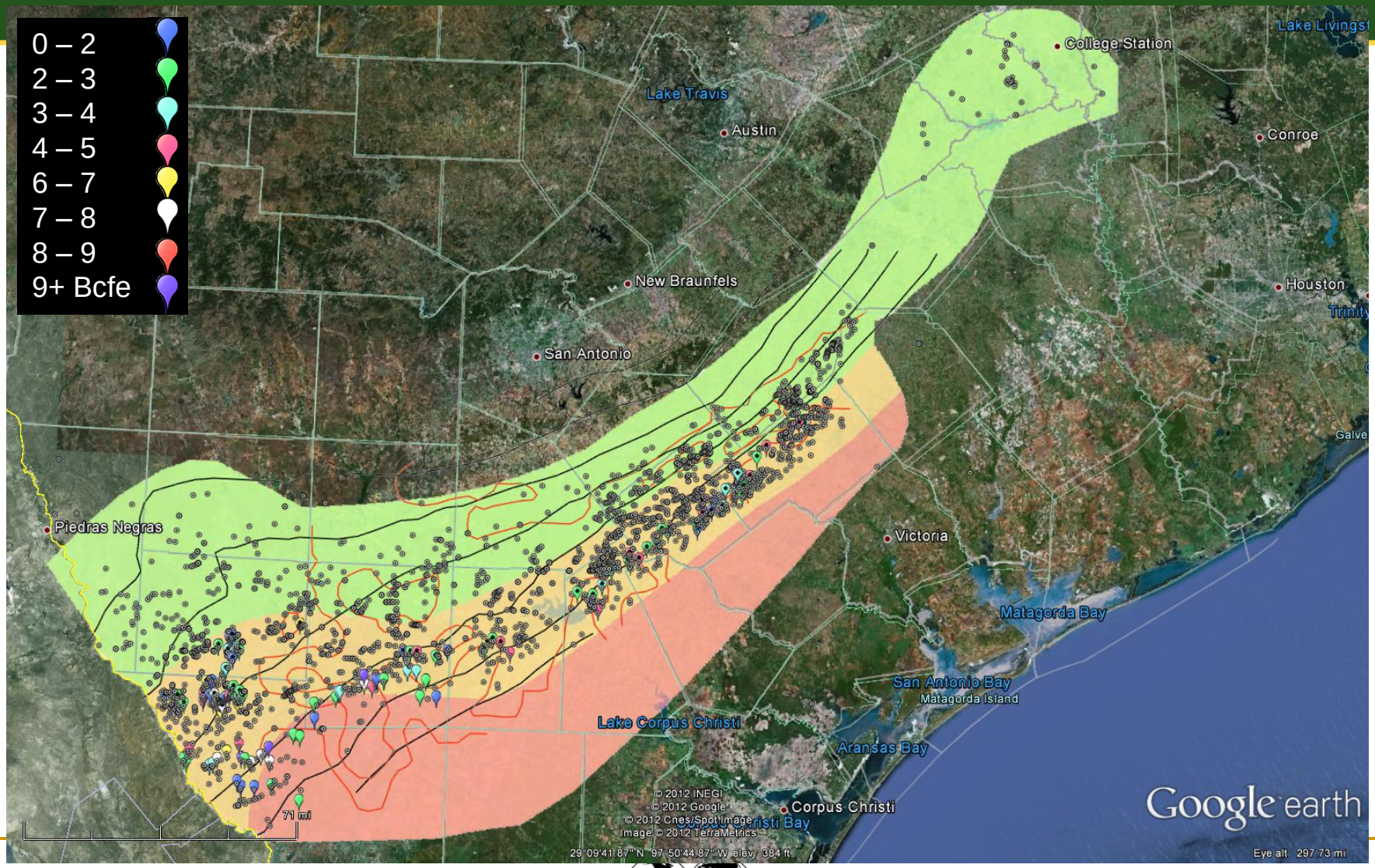
- 2013 Experiences in the Cooper Basin particularly as they relate to unconventional resources
- Review of applicability of North American experience
- Review of the Petroleum Resource Management System (PRMS) and how it applies to new discoveries and contingent resources: reprise of the common language approach used by resource assessment companies like D&M
- Some comments on the development of local analogs and their implications under PRMS and for development pace

2013: Early Maturation in a “Mature” play (s) area

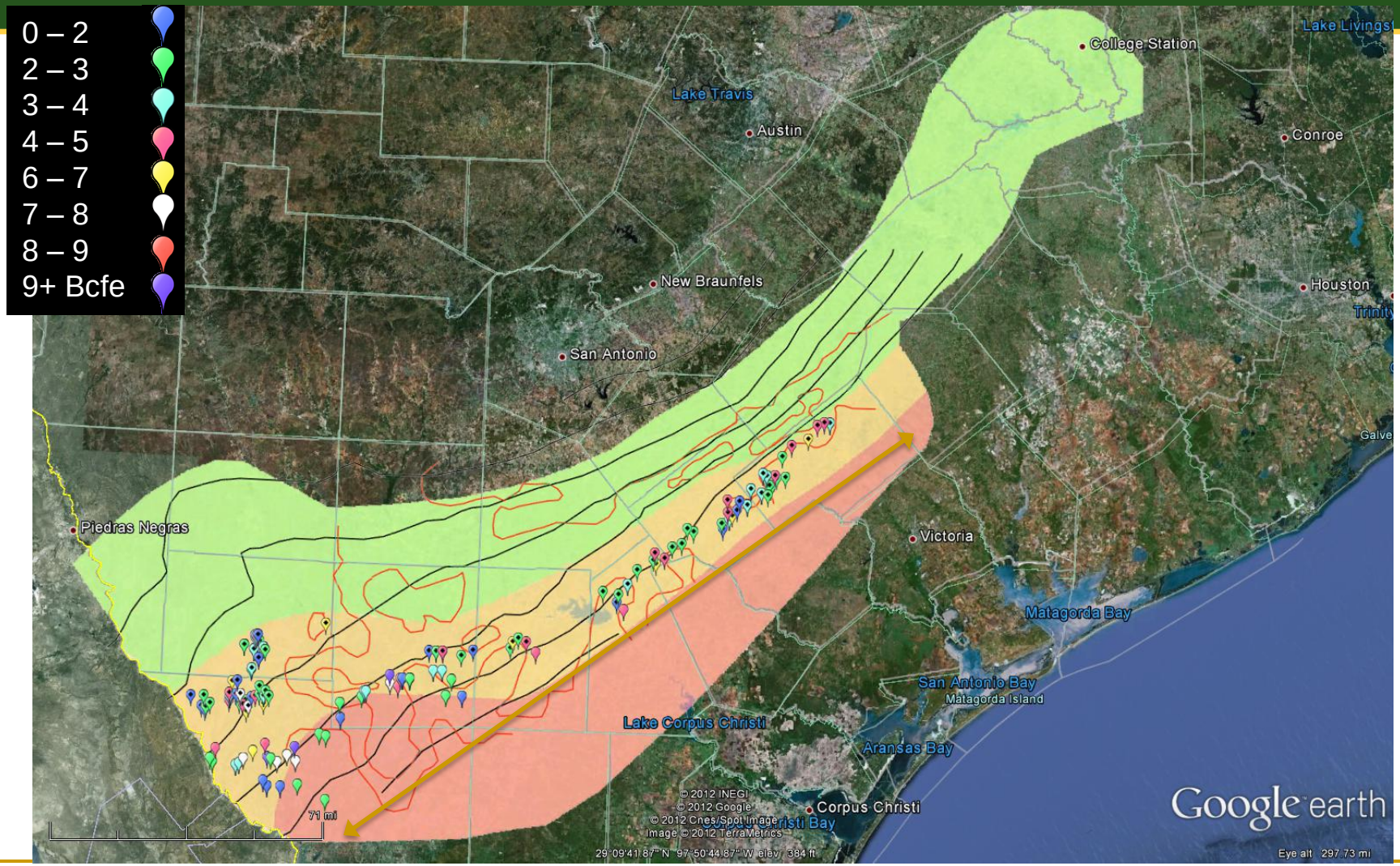
Un-Conventional Resources Eco system and towards local analogue

- Planning and execution of vertical and horizontal well pilots
- Big League Farm-outs with access to very experienced COE teams
- More Discoveries with better testing
- Increased emphasis on oil to pay the bills and fund fixed investments
- Growing recognition of the Cooper Basin Un-conventionals as an alternative source for Eastern States required gas supply
- US analyst coverage picking up (Tudor Pickering)
- Bigger service co. contracts with more third parties arriving
- People stopped saying “it’s the same as the Haynesville” for Cooper Shale: We have **no** local sub-surface analogue for the shale…yet
- Analogue: should have sufficient similarity to the discovered accumulation to conclude that it is capable of producing gas at comparable rates and recoveries…important implications in terms of confidence and hence pace

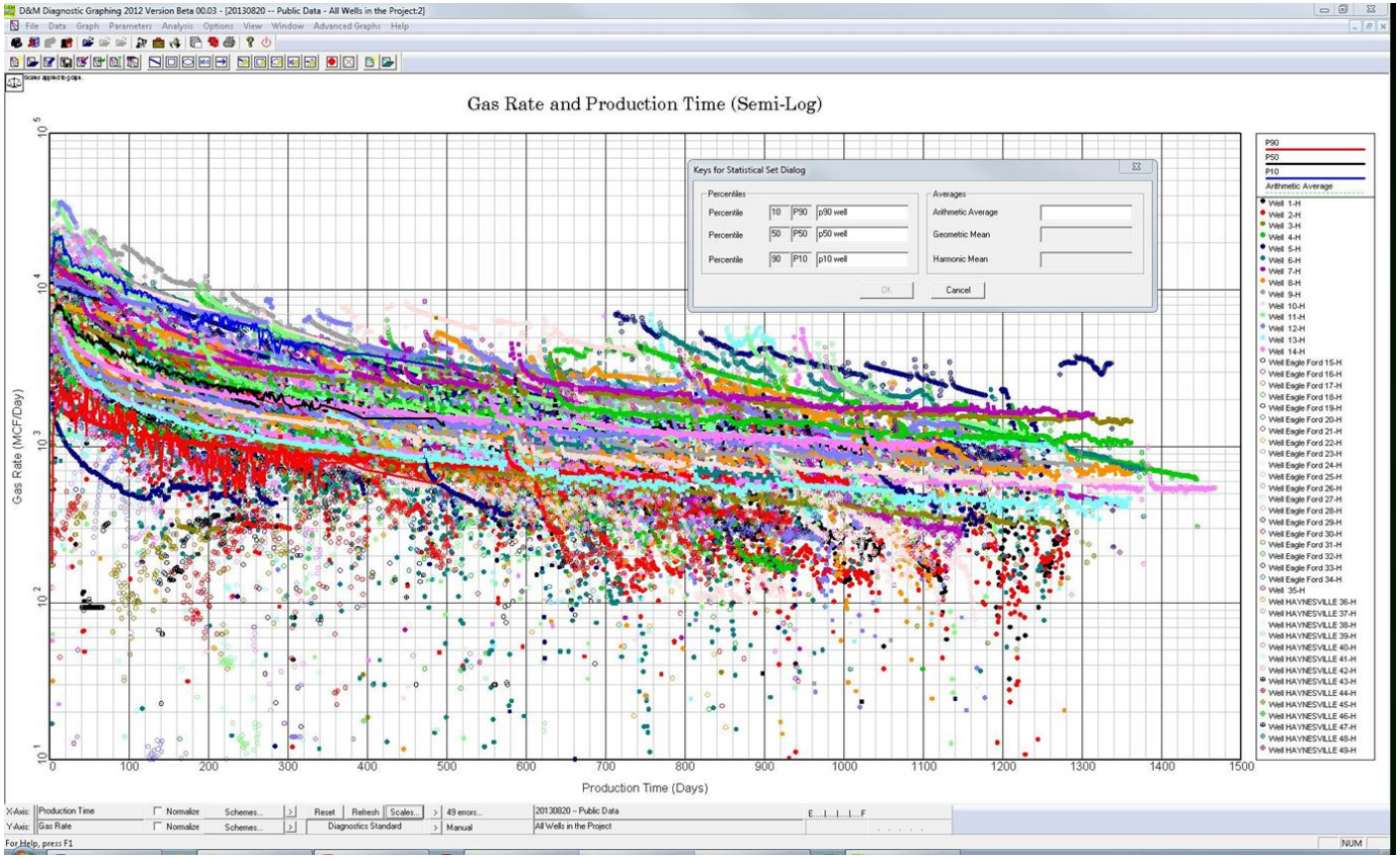
What aspects of the NA experience relevant then?



Evaluated Wells By EUR – Eagle Ford

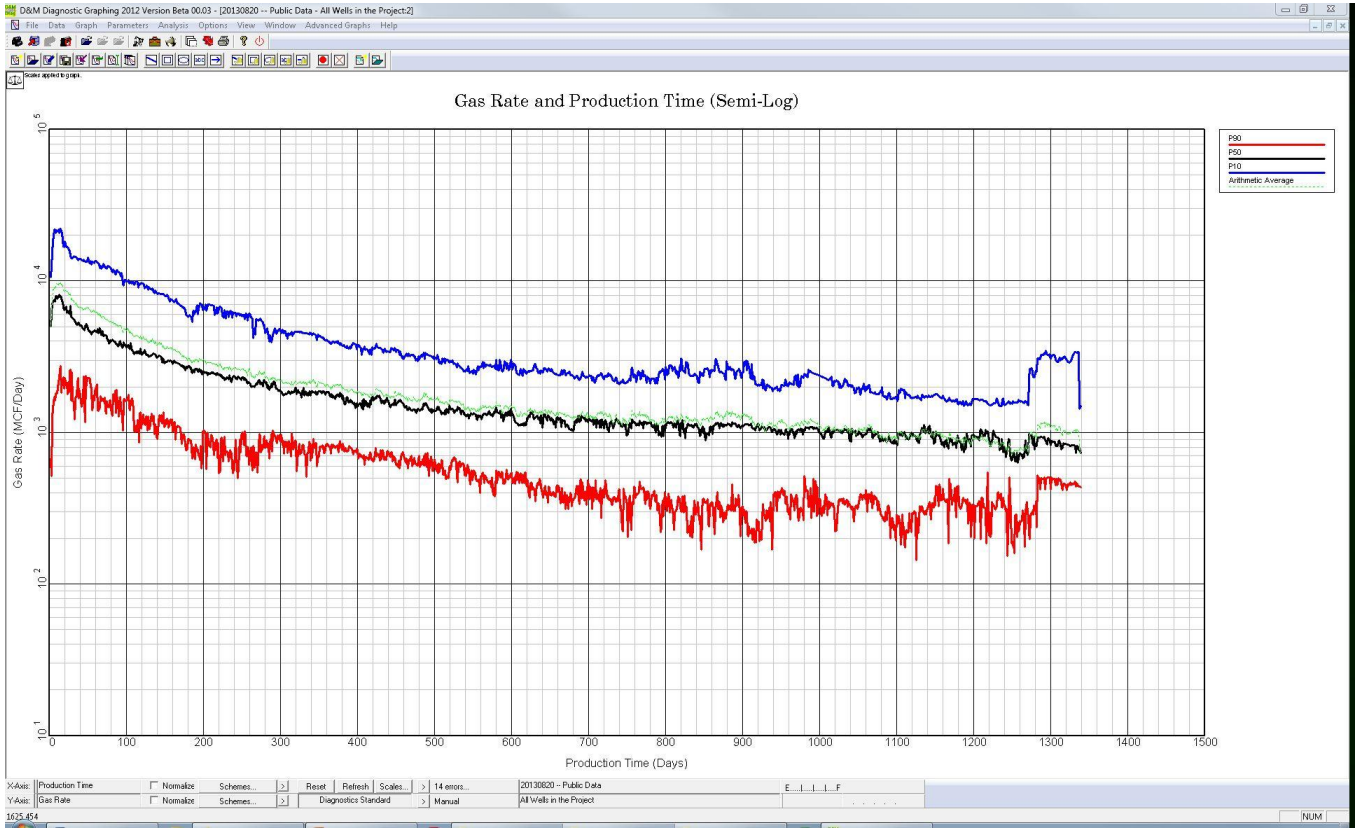


Single Play Case



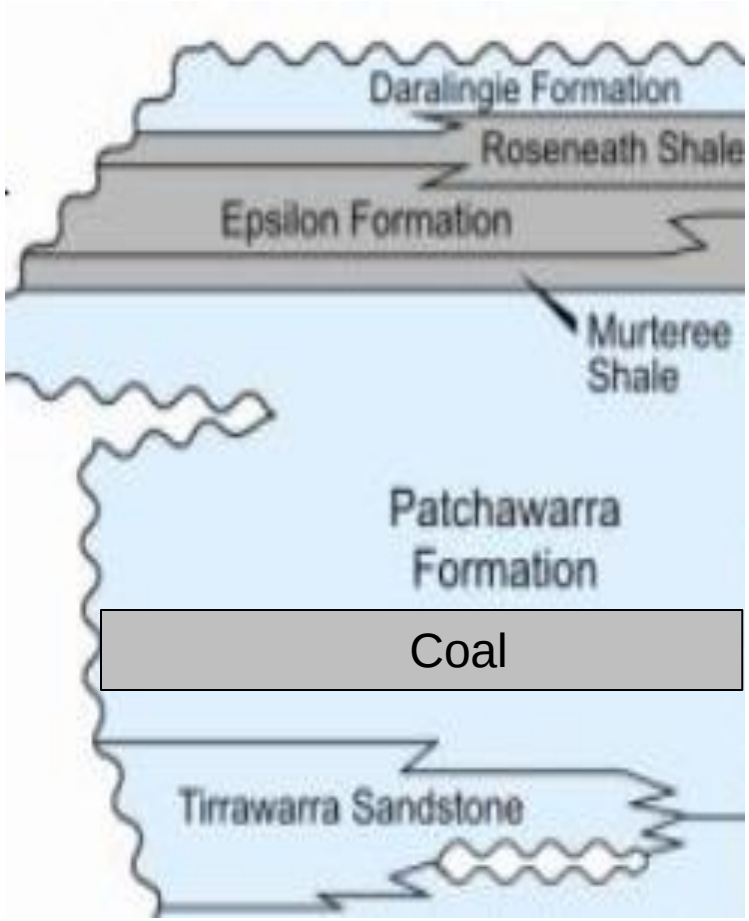
- Statistics option allows to calculate average well behavior and percentiles for 80 plus Eagle Ford Wells.

Eagle Ford p10/ p50/ p90



- Percentiles and arithmetic average for all wells in the project.

And We Have Multiple Plays..

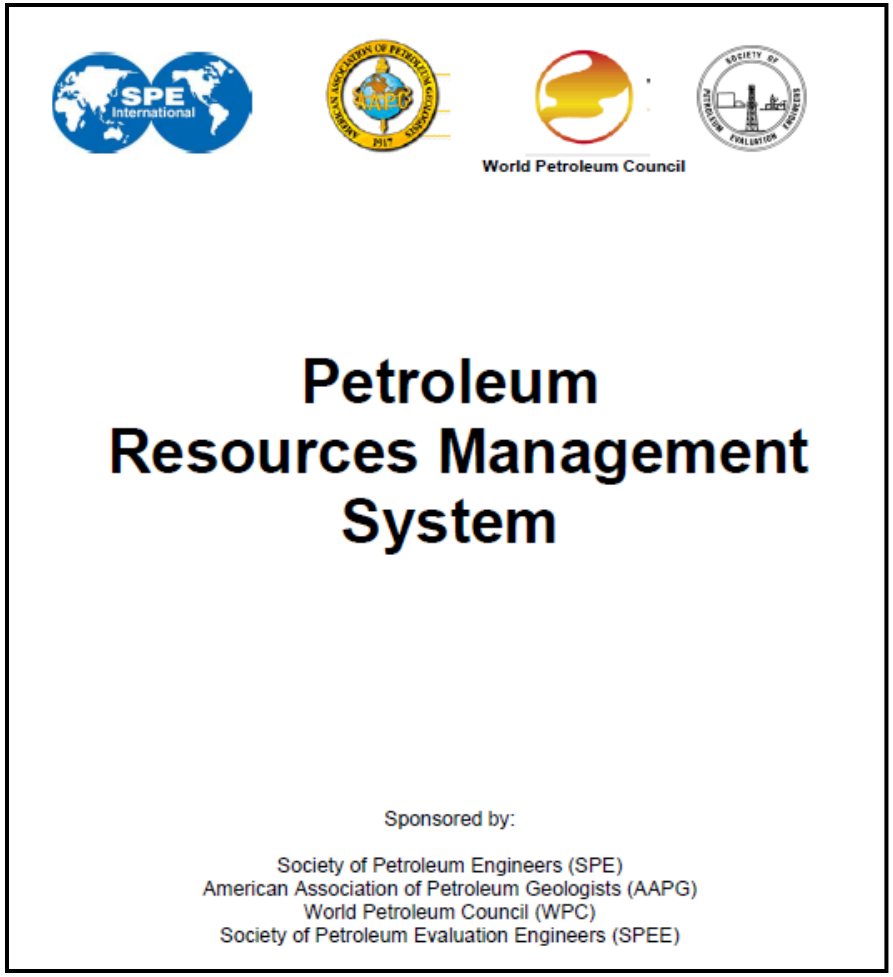


The most relevant part of the NA Shale Experience…

- Large/ single type plays shrink to core areas (fairways)
- Single play trends must be understood (statistical play mentality)
- A small number of wells provide most of the hydrocarbons (mean >> median EUR)
- Early well performance and gas-in-place estimates are uncertain (models don't eliminate uncertainty, and some don't even bound it)..
- But lot of value can be squandered if you don't understand what you have
- Technical understanding and discipline are paramount
- Companies must be disciplined, creative and have **stamina**
- PRMS has been used to assist in categorizing and ranking the portfolio of projects

The Petroleum Resources Mgmt. System

- PRMS was created by the SPE Oil and Gas Reserves Committee and released in March, 2007
- Approved by other professional societies
- Key component of the 2009 SEC rules revisions and now ASX follows suit
- Commonly called the "Definitions" document
- http://www.spe.org/industry/docs/PRMS_guide_non_tech.pdf

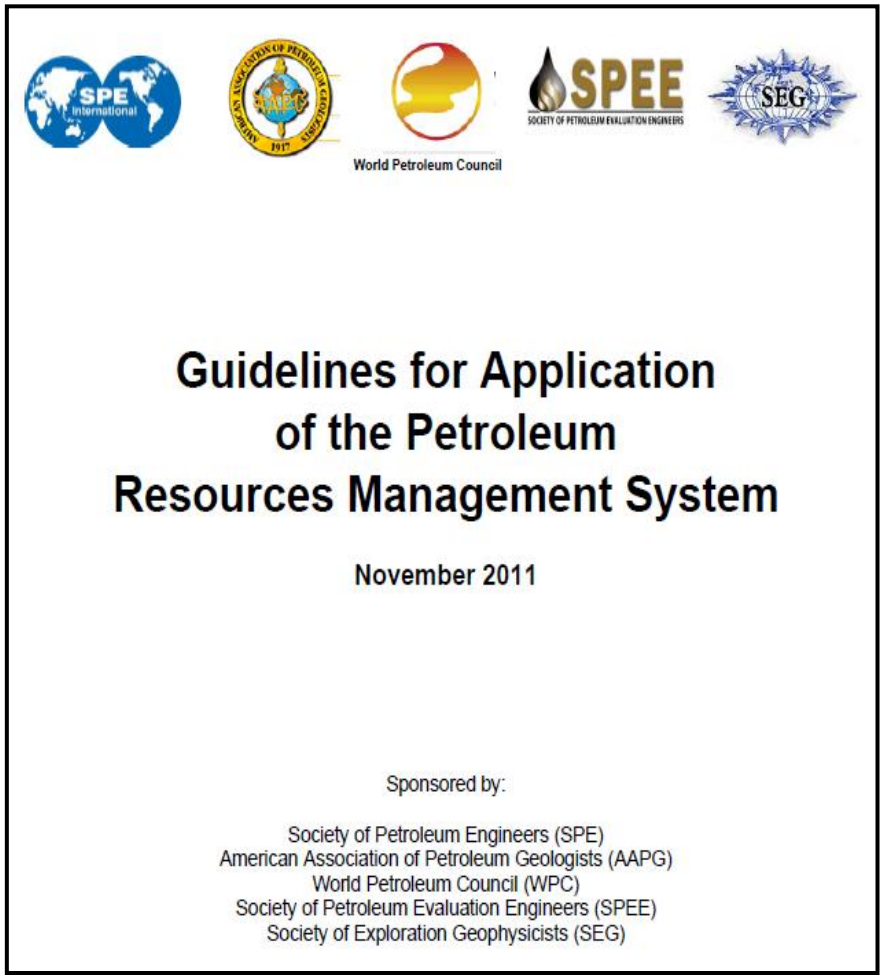


What PRMS Says about Unconventionals

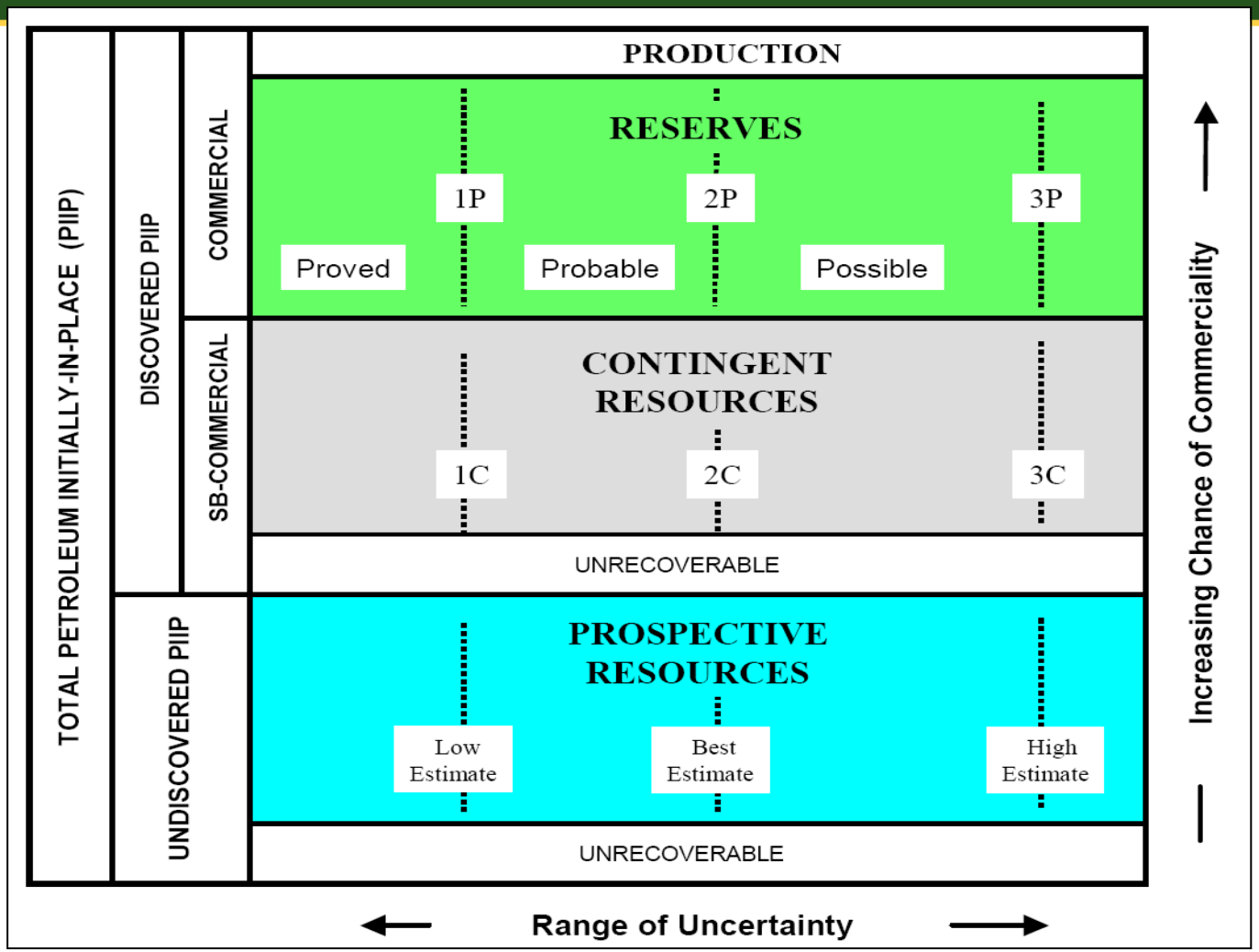
- Exist in petroleum accumulations that are pervasive throughout a large area
- Are not significantly affected by hydrodynamic influences (also called “continuous-type deposits”)
- Typically need increased sampling density to define uncertainty of in-place volumes, variations in reservoir and hydrocarbon quality, and their detailed spatial distribution
- May require successful pilots or operating projects in the subject reservoir or successful projects in analogous reservoirs to establish a distribution of recovery efficiencies

The PRMS Applications Document

- Released in November 2011
- Provides additional guidance for the application of PRMS
  - Emphasizes that the discovery test needs to be satisfied prior to making any estimates of discovered resources
  - Clarifies the criteria for a good local analog and, in the absence of this, requires a planned and budgeted pilot project
  - Restricts the areal extent to which discovered resources can be assigned around a discovery well

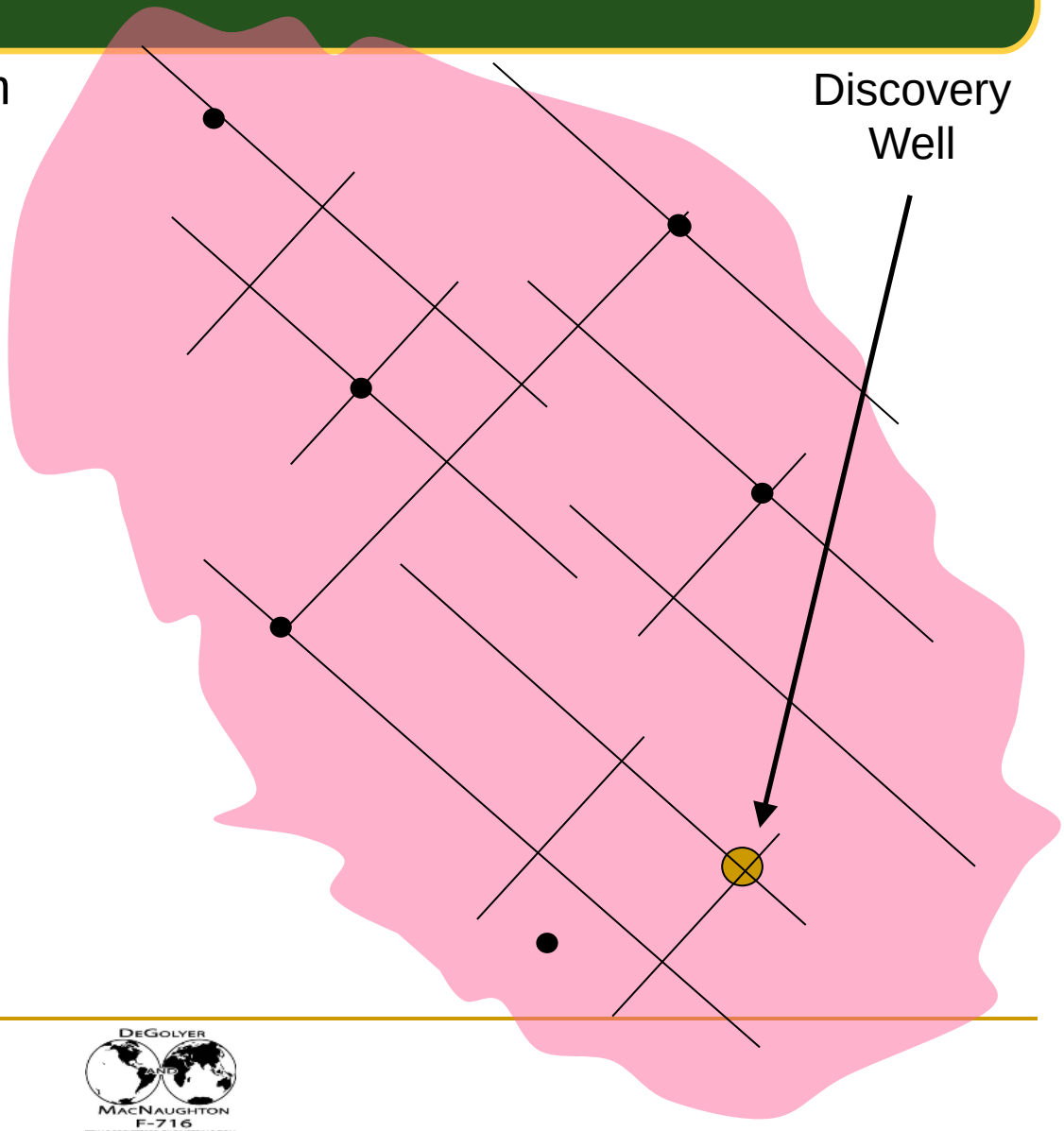


The PRMS Classification Framework



The Discovery Well

- A discovery is one petroleum accumulation, or several petroleum accumulations collectively, for which one or several exploratory wells have established through testing, sampling, and/or logging the existence of a significant quantity of potentially moveable hydrocarbons.



The Discovery Test Worksheet

Category	Importance	Data	Score	Supporting Comments
Natural or stimulated flow of hydrocarbons to surface	5	5	25	Most definitive criteria; flow must come from the reservoir interval. Data score can range from 1 (flow to small to measure) to 5 (greater than 100 MCFD)
Significant thickness from log and core data	4	5	20	Need to have some idea what the lithology is (mudlog) and some type of core data (sidewall core, whole core) for calibration. For a data score of 5, need at least 100 feet of pay for shale or 25 feet of pay for coal
Analog (commercial, nearby, geologically comparable)	3	0	0	Difficult to collect enough evidence in the discovery well to achieve this unless the target interval is being developed in an offset area
Core desorption (gas content)	3	0	0	Data score of 5 would be hundreds of scf/ton, desorb quickly, and come from an interval that is gas-saturated (or nearly so) with respect to the isotherm
Well test (DFIT, MDT) indicating permeability	2	0	0	Very important in CBM if coals have not yet been dewatered
Mudlog shows, gas kicks, composition of gas	2	0	0	Must be gas moving through matrix into wellbore - not from a few open fractures, or by destruction of wellbore rock by drilling
Favorable core properties (perm, porosity, Sw)	1	5	5	Measurements are difficult to make in these tight rocks and there is significant variability from well to well
			50	TOTAL SCORE of 42 required to pass the Discovery Test

Passing the Discovery Test

- The simplest way to pass the discovery test is with a significant flow of hydrocarbons to the surface from a thick accumulation
  - Natural or stimulated flow of hydrocarbons to surface
  - Significant thickness from log and core data
- In the absence of flow to surface, other less definitive data can be used to demonstrate that moveable hydrocarbons are present
  - The desorption of cores at the surface
  - Gas kicks and mudlog shows during drilling
- For coalseam gas reservoirs that are not dewatered, a well test (to show permeability), core desorption, and a good analog are needed to satisfy the discovery criteria
- Significant thickness, an analog, and favorable core properties alone will be insufficient for a discovery because this dataset lacks sufficient indications of potentially moveable hydrocarbons.

Assigning Contingent Resources

- Once an accumulation is declared “discovered”, contingent resources may be assigned if the technology that will be used to produce the hydrocarbons has been demonstrated to be commercially viable in analogous reservoirs, and a development plan is provided
- If the technology has been demonstrated to be commercially viable in other reservoirs that are not analogous, then a pilot project will be necessary to demonstrate commerciality for the subject reservoir
- If a pilot project is planned and budgeted, discovered recoverable quantities may be classified as Contingent Resources.
- If no pilot project is planned and budgeted, all quantities should be classified as Discovered Unrecoverable Resources.

What's An Analogous Reservoir?

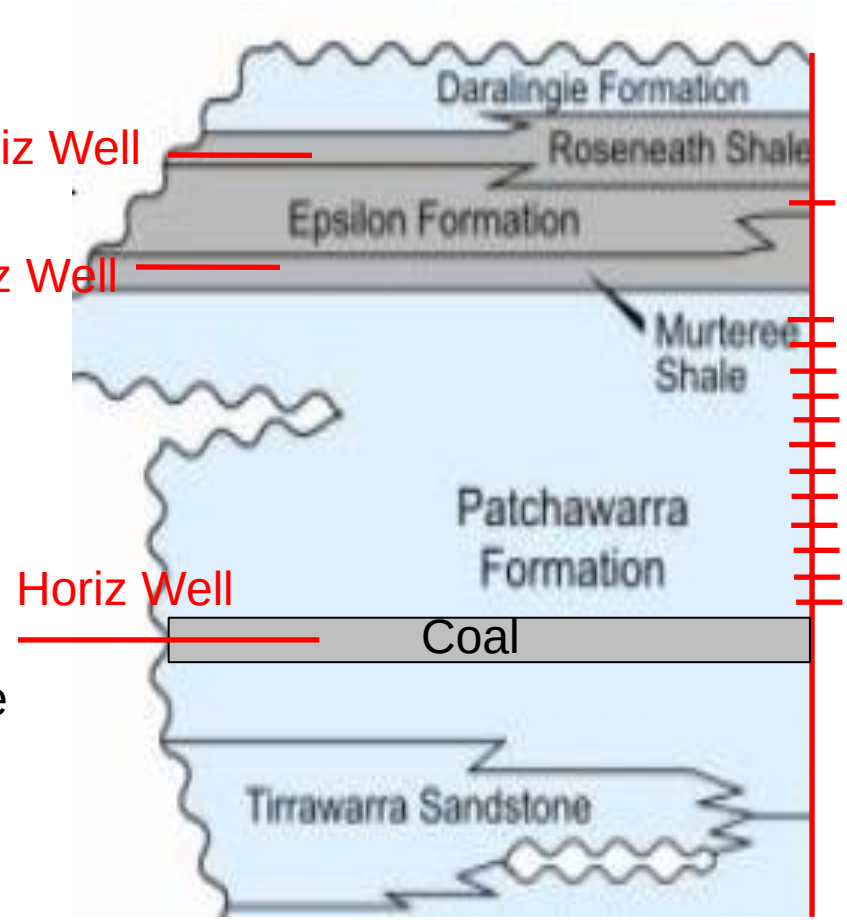
- An analogous reservoir is a commercially-productive accumulation that is similar to that encountered in the discovery well.
- An analog should have similar reservoir characteristics including approximate depth, pressure, temperature, reservoir drive mechanism, original fluid content, reservoir fluid gravity, reservoir size, gross thickness, pay thickness, net-to-gross ratio, lithology, heterogeneity, porosity, permeability, and development plan
- An analog should be in close geographic proximity (within the same play fairway) to the discovered accumulation
- Most importantly, the analog should have sufficient similarity to the discovered accumulation to conclude that it is capable of producing gas at comparable rates and recoveries
- In all cases, the similarities and differences between the analog and the discovered accumulation should be documented

What's A Pilot Project?

- A project represents the link between the petroleum accumulation and the decision making process, including budget allocation
  - In general, an individual project will represent a specific maturity level at which a decision is made on whether or not to proceed (i.e., spend money) and there should be an associated range of estimated recoverable resources for that project
- A pilot project is a small-scale test or trial operation that is used to assess the suitability of a given recovery method
- The pilot needs to be designed to reduce the uncertainty in key reservoir parameters, test various completion/drilling technologies, and assess full-field development issues
- The purpose of the pilot project is to demonstrate commercial production potential

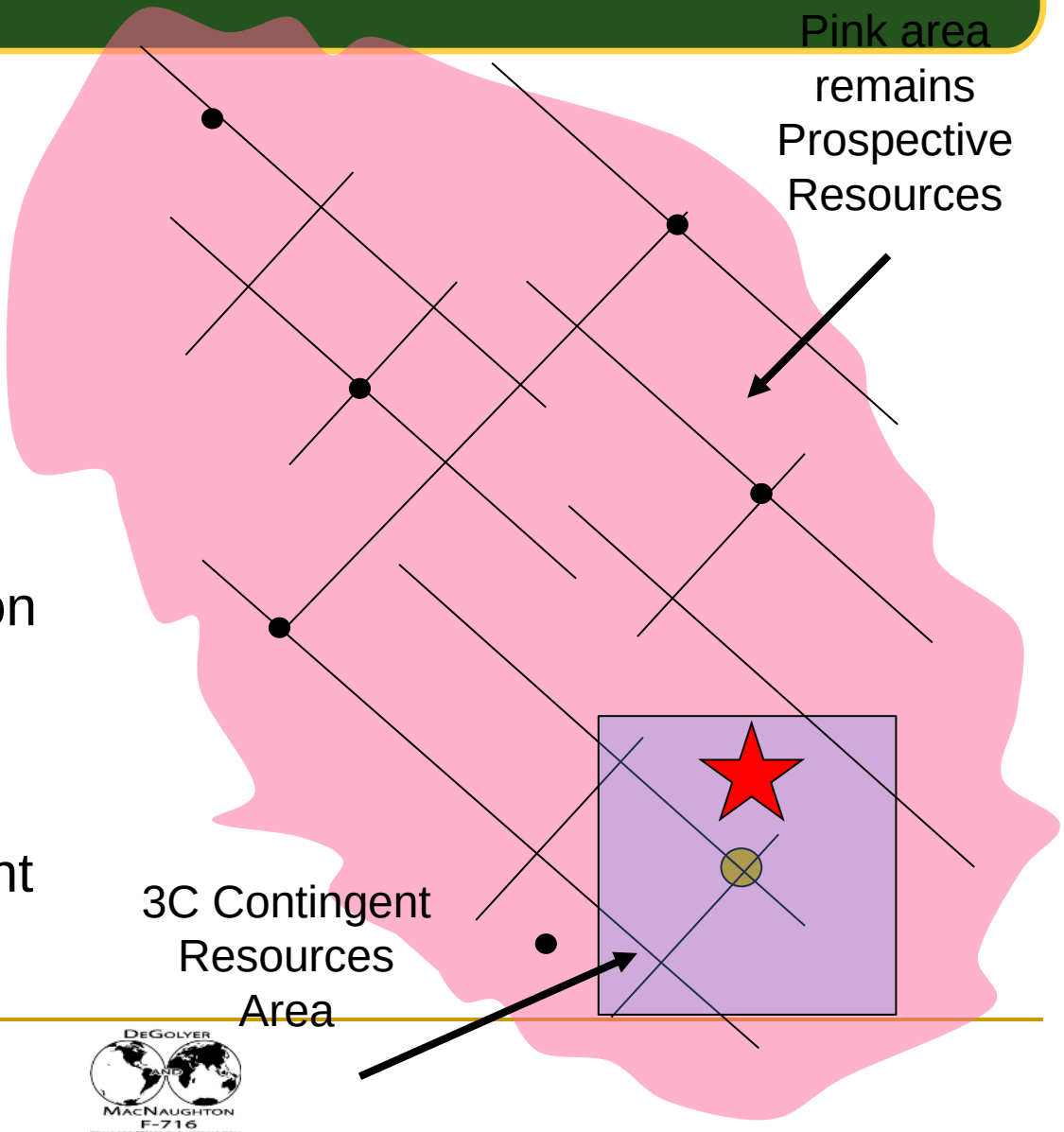
Cooper: Multiple Pilots for Multiple Targets

- Pilots may be horiz. or vertical wells
- Data collected will be specific to lithology type and reservoir mechanism
- Pilot parameters (well length, completion type, spacing, expected rates and recoveries) should come from analytical and numerical models
- Multiple pilots that are focused on different intervals may be conducted concurrently in the same area
- The commingling of multiple pilot zones using vertical or multi-lateral wells may be necessary for commercial development



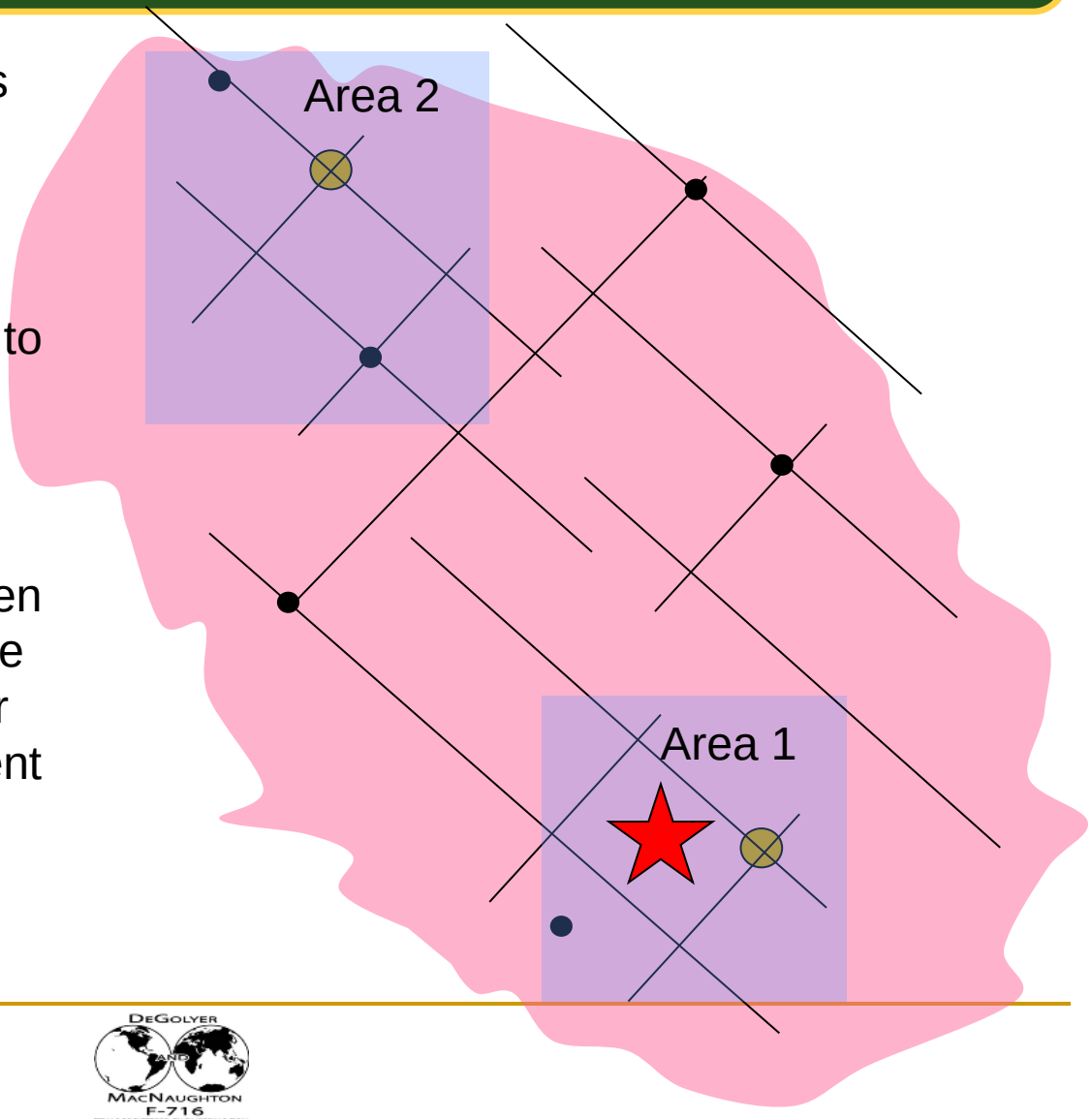
Delineating the Project Area

- The project area to be assigned contingent resources is located around the discovery well
- A planned and budgeted pilot project (★) is located within the 3C Contingent Resources area
- The 3C area is centered on the discovery well ( ) and contains concentric rings representing 1C, 2C, and 3C estimates of Contingent Resources



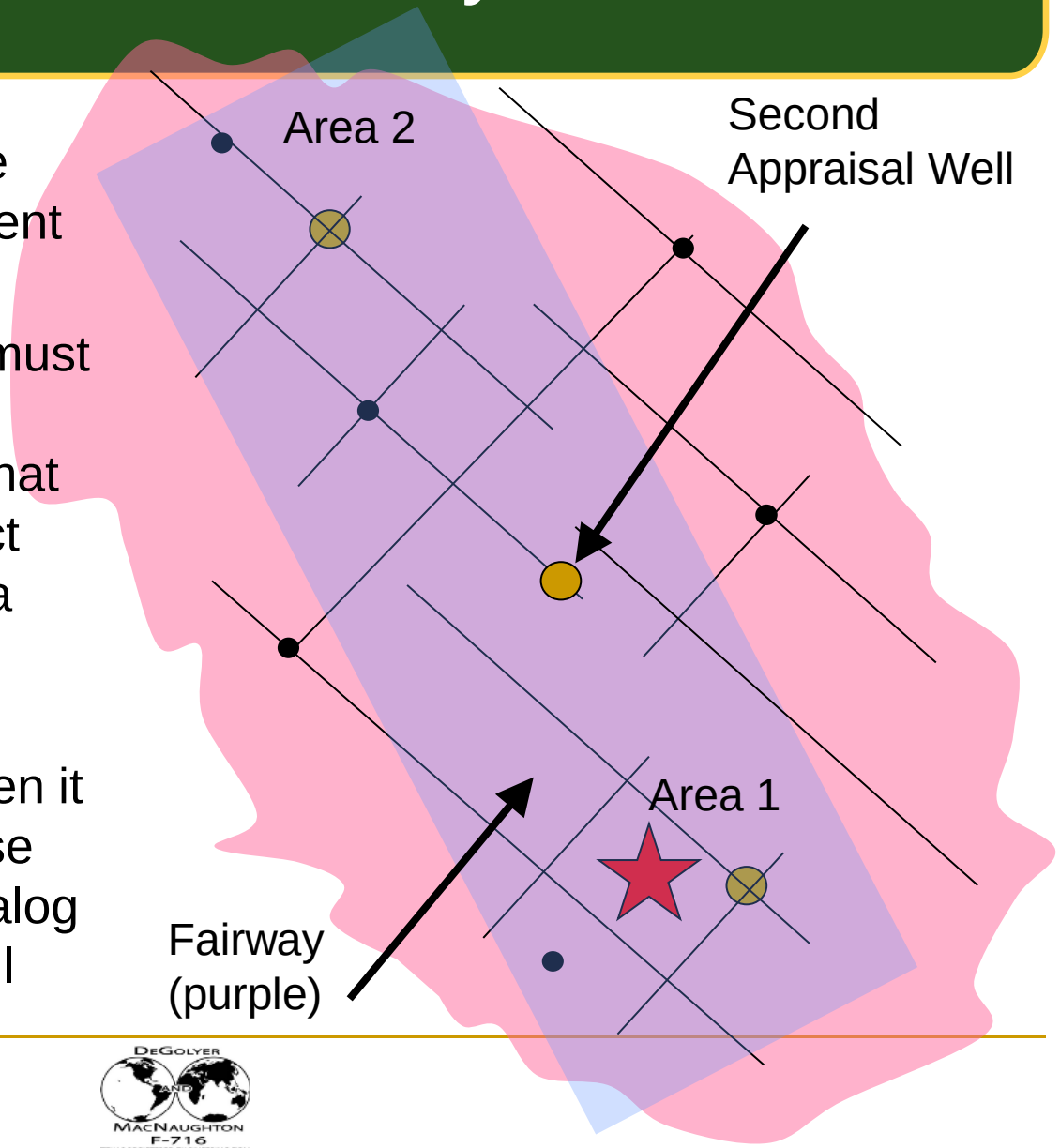
Expanding the Project Area

- Assume that a discovery well is drilled in Area 1 and a pilot is planned. An appraisal well is then drilled in Area 2
- If this well is sufficiently similar to the discovery well, then Contingent Resources can be assigned to Area 2
- If it is not sufficiently similar, then a separate pilot project will have to be planned and budgeted for Area 2 to be assigned contingent resources



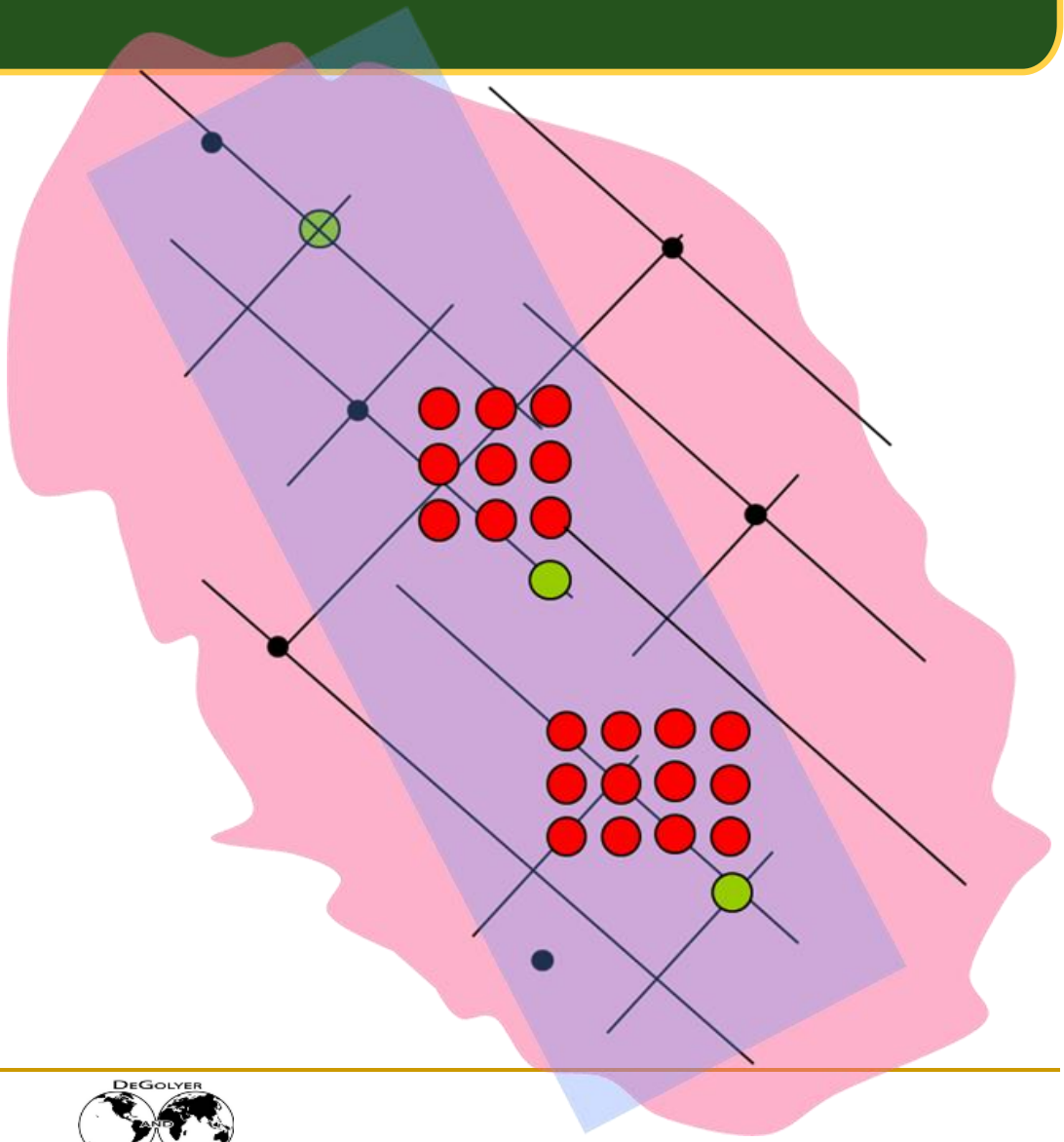
Contingent Resources Fairway

- A second appraisal well between Areas 1 & 2 can be used to designate a contingent resources fairway
- This second appraisal well must be sufficiently similar to the discovery well to conclude that the results of the pilot project will be applicable to the area around it
- If the pilot project is already commercially successful, then it needs to be shown that these wells are an appropriate analog for the second appraisal well



Converting Contingent Resources to Reserves

- The performance of the pilot project, analogous reservoirs, and modeling are used to generate an optimal plan and begin development drilling (●)
- Contingent resources can be converted to reserves once technical and commercial contingencies are resolved and other requirements are met.



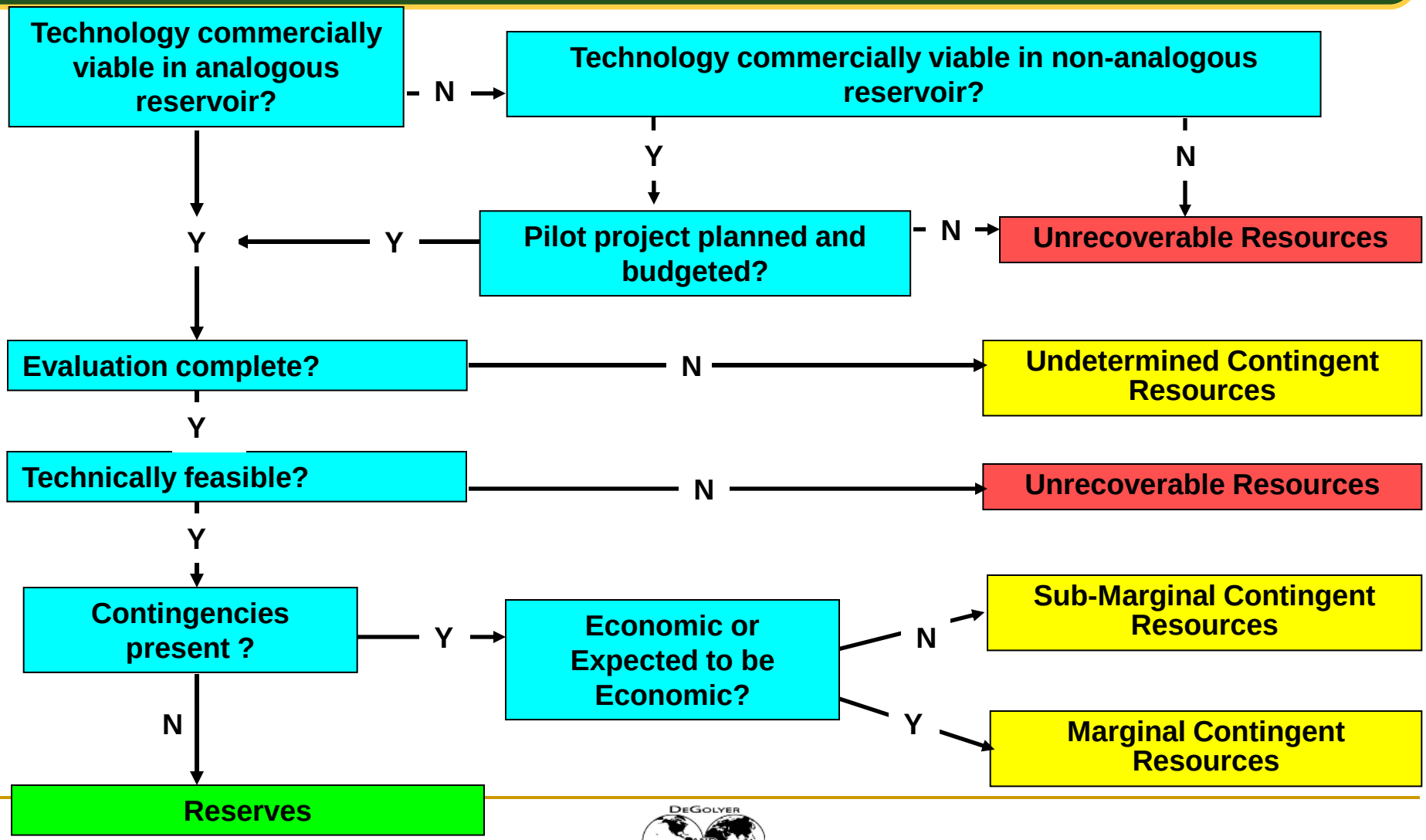
Examples of Project Contingencies

- Technical contingencies
  - Permeabilities are too low
  - Insufficient porosity or gas saturation
  - Inability to dewater coalseams
  - Highly compartmentalized (small sandbody sizes, faults)
  - Ineffective fracture stimulations
- Commercial contingencies
  - Low gas prices
  - No gas treatment or transport facilities
  - Costs are too high (remote location, too deep)
  - Lack of approvals by partners or regulatory agencies
  - Lack of financing or commitment

Risking Contingent Resources

- There are several ways to do this, one of them is to assign contingent resources to *economic subclasses*
  - **Undetermined Contingent Resources**
    - Known (discovered) accumulations where evaluations are incomplete such that it is premature to clearly define the ultimate chance of commerciality
  - **Marginal Contingent Resources**
    - Known (discovered) accumulations for which a development project(s) has been evaluated as economic or reasonably expected to become economic but commitment is withheld because of one or more contingencies
  - **Sub-Marginal Contingent Resources**
    - Known (discovered) accumulations for which evaluation of development project(s) indicated they would not meet economic criteria, even considering reasonably expected improvements in conditions.

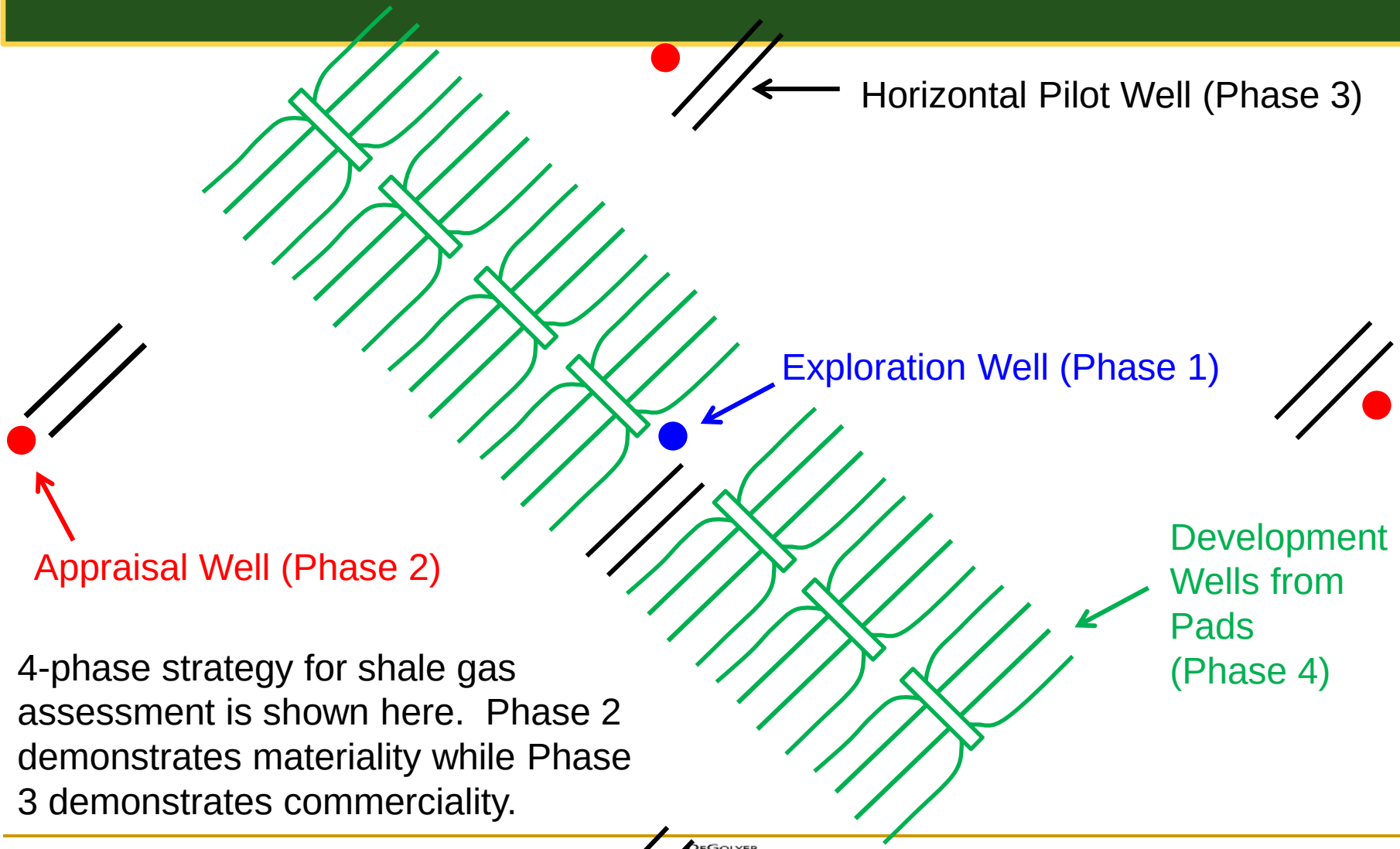
CR Classification Flowchart (assumes a discovery)



Progressing Contingent Resources to Reserves-Local Analogues (reserves) help

- Contingent Resources may be considered commercially producible, and thus Reserves, if the entity claiming commerciality has demonstrated firm intention to proceed with development in a reasonable timeframe (usually 5 years) and such intention is based upon **all** of the following:
  - Evidence to support a reasonable timetable for development.
  - A reasonable assessment of the future economics of such development projects meeting defined investment and operating criteria:
  - A reasonable expectation that there will be a market for all or at least the expected sales quantities of production required to justify development.
  - Evidence that the necessary production and transportation facilities are available or can be made available:
  - Evidence that legal, contractual, environmental and other social and economic concerns will allow for the actual implementation of the recovery project being evaluated.
  - A reasonable expectation that all required internal and external approvals will be forthcoming

Linking Resource Estimates to Strategies



4-phase strategy for shale gas assessment is shown here. Phase 2 demonstrates materiality while Phase 3 demonstrates commerciality.

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