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Improved USGS Methodology for Assessing Continuous Petroleum Resources Using Analogs

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Open-File Report 2010–1309

U.S. Department of the Interior
U.S. Geological Survey

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KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2010

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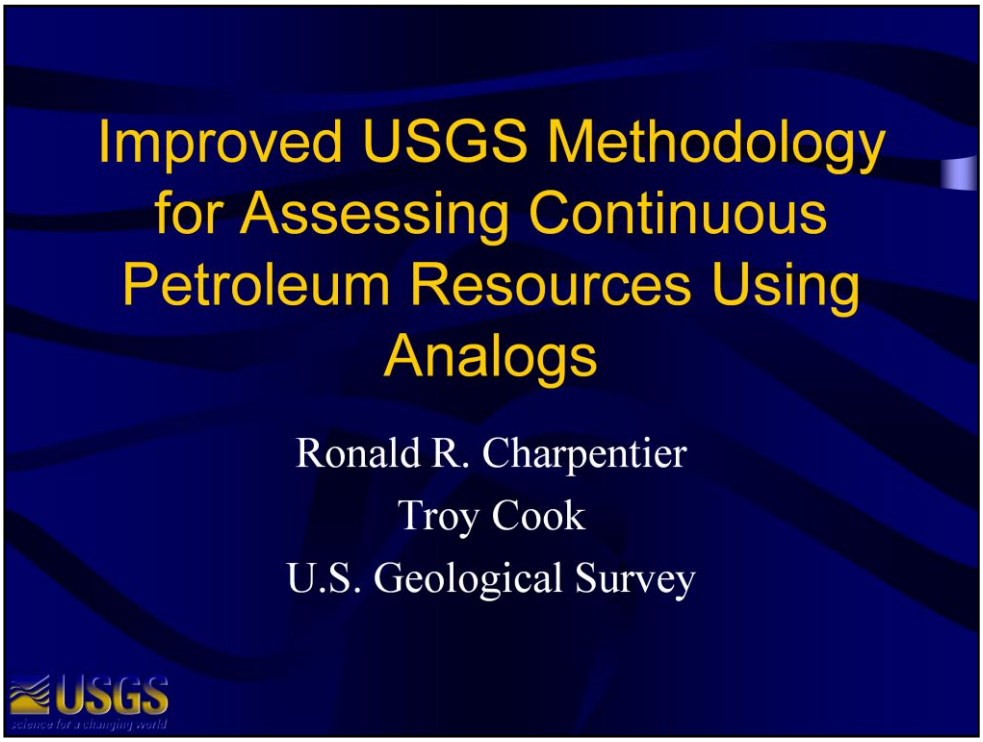
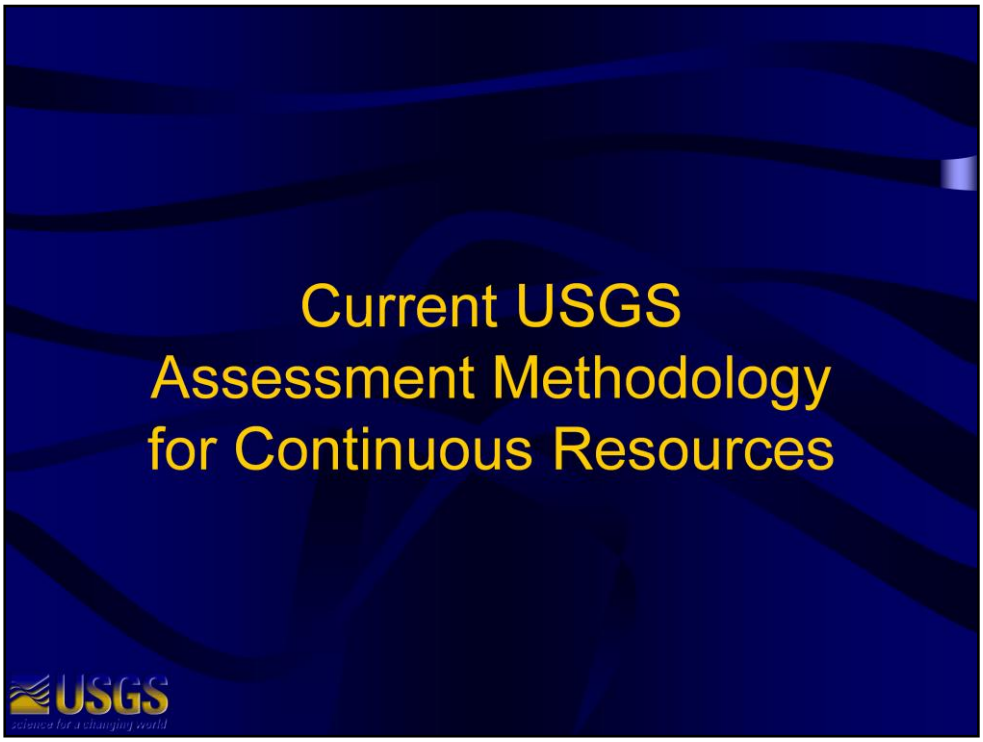
Suggested citation:
Charpentier, R.R., and Cook, Troy, 2010, Improved USGS methodology for assessing continuous petroleum resources using analogs: U.S. Geological Survey Open-File Report 2010–1309, 27 p.



This talk was originally presented at the Third Symposium on Resource Assessment Methodologies in Canmore, Alberta, on September 17, 2010.


Current USGS
Assessment Methodology
for Continuous Resources
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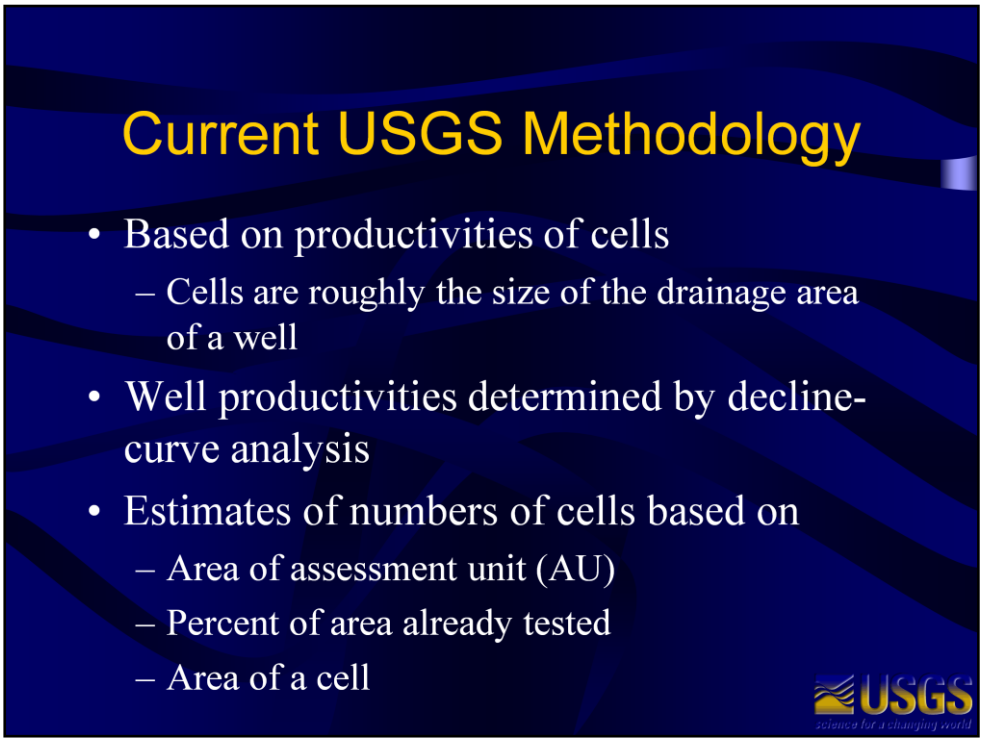
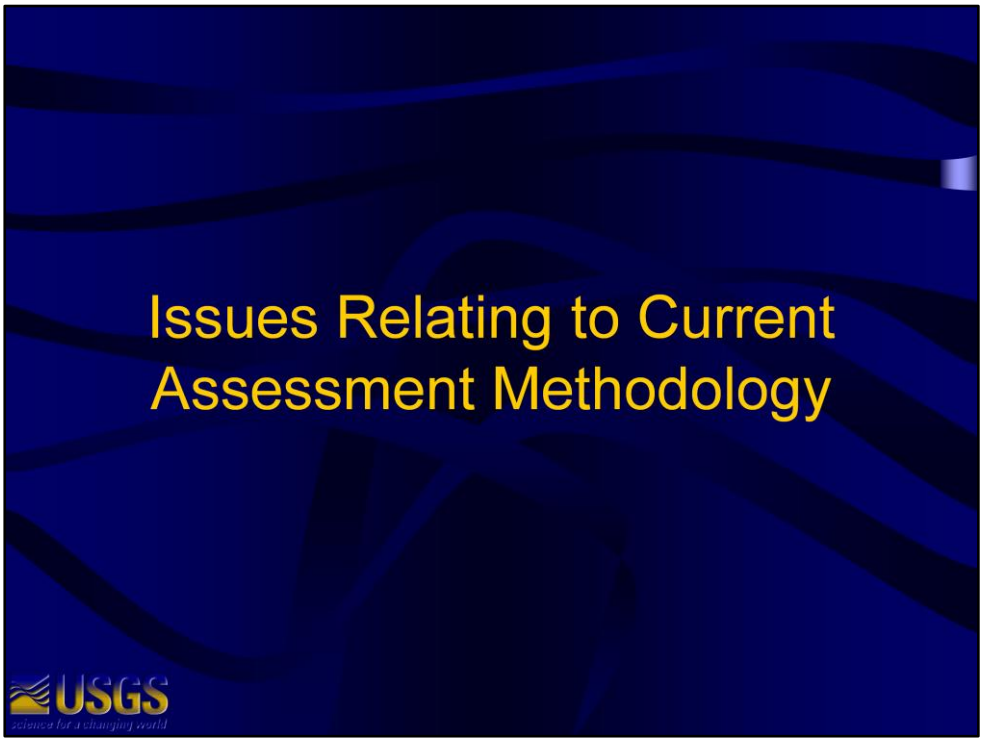


The current USGS methodology uses well production data, as opposed to volumetric calculations based on area, thickness, porosity, and hydrocarbon saturation.


Issues Relating to Current
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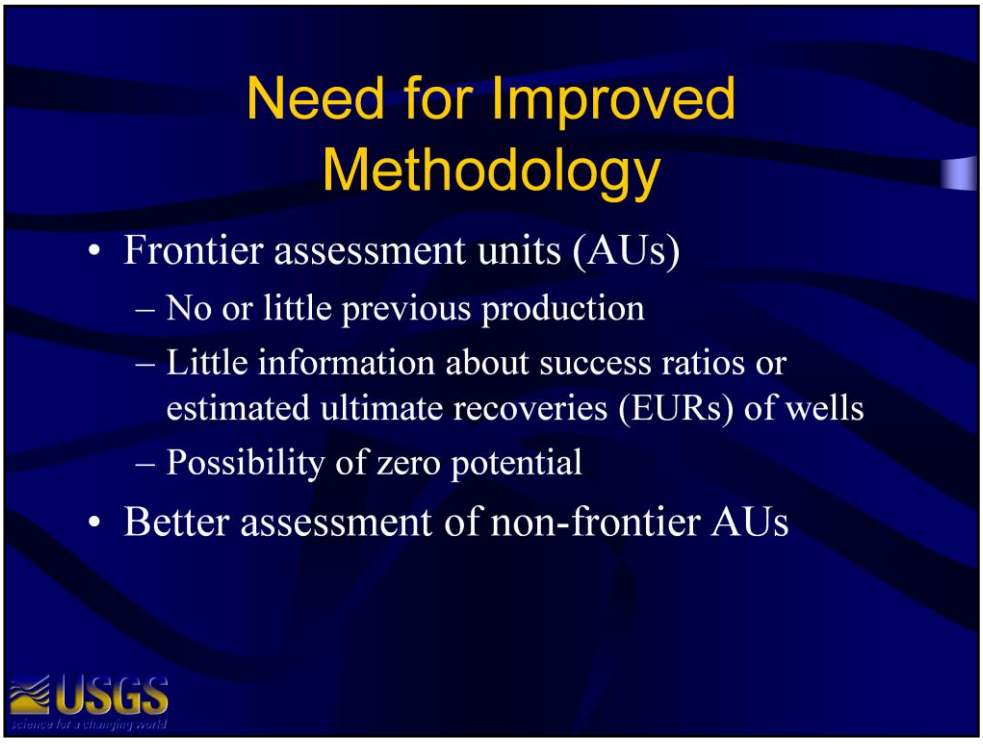
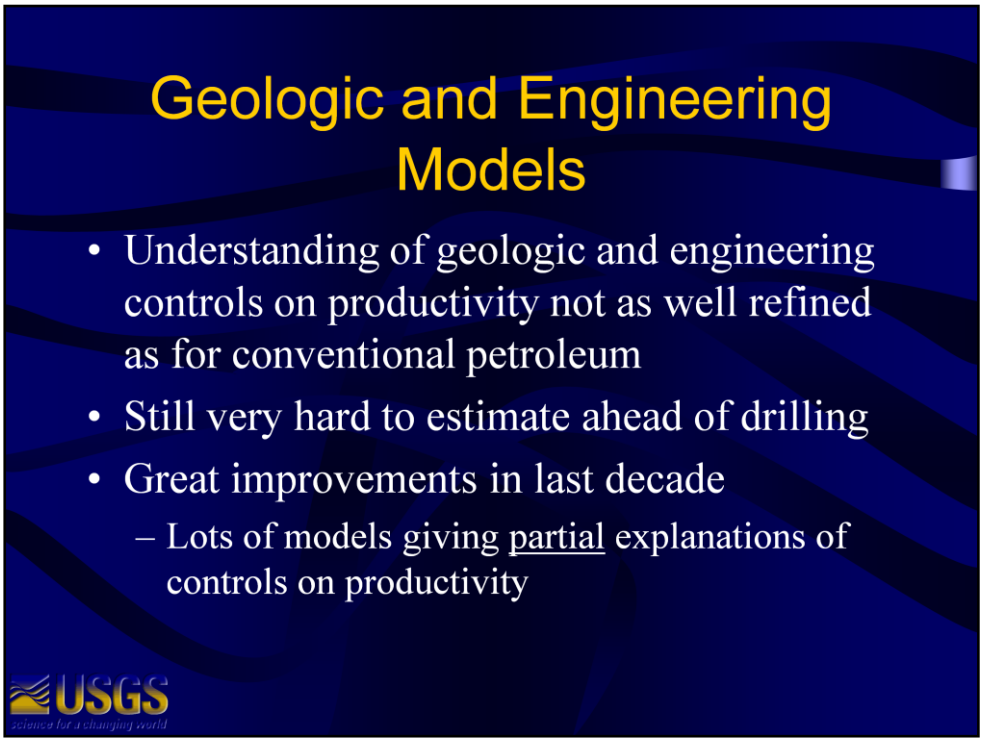
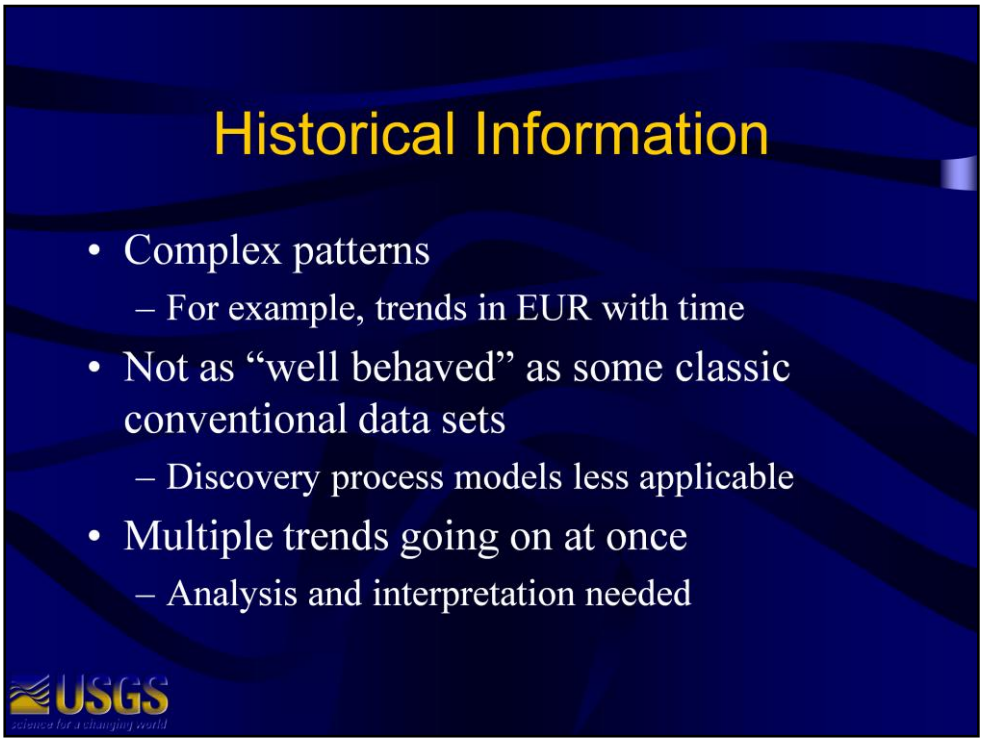


There is need to be able to make assessments for areas that are data-poor. These changes will also lead to improved assessments for areas that are data-rich.

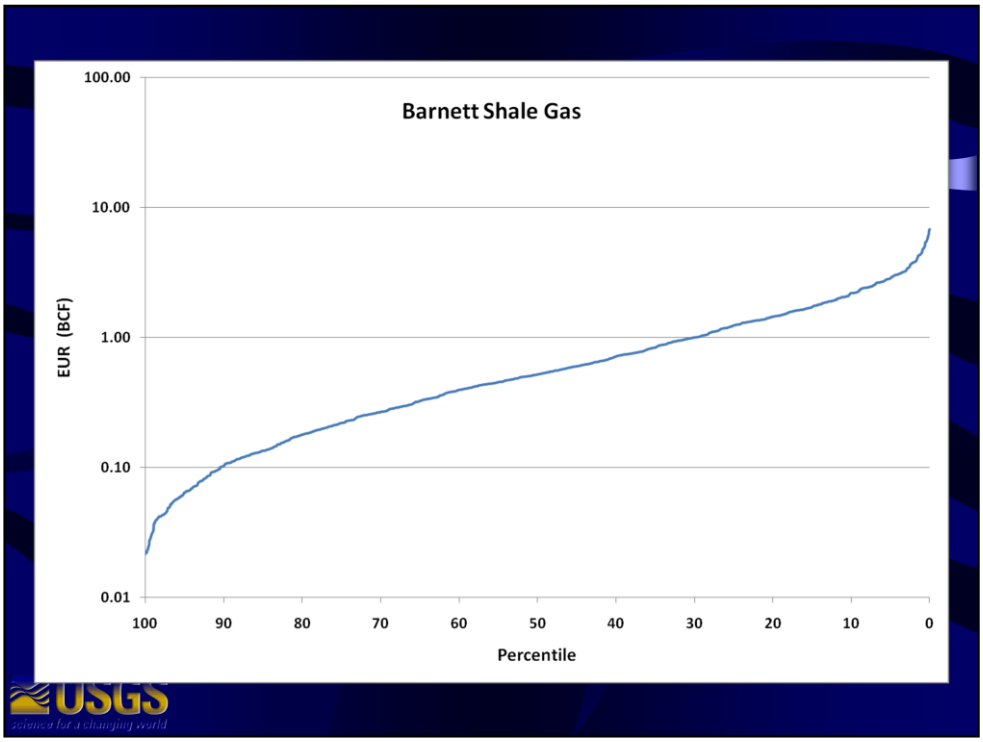
The "Lake Wobegon" effect is where all the wells are better than average.



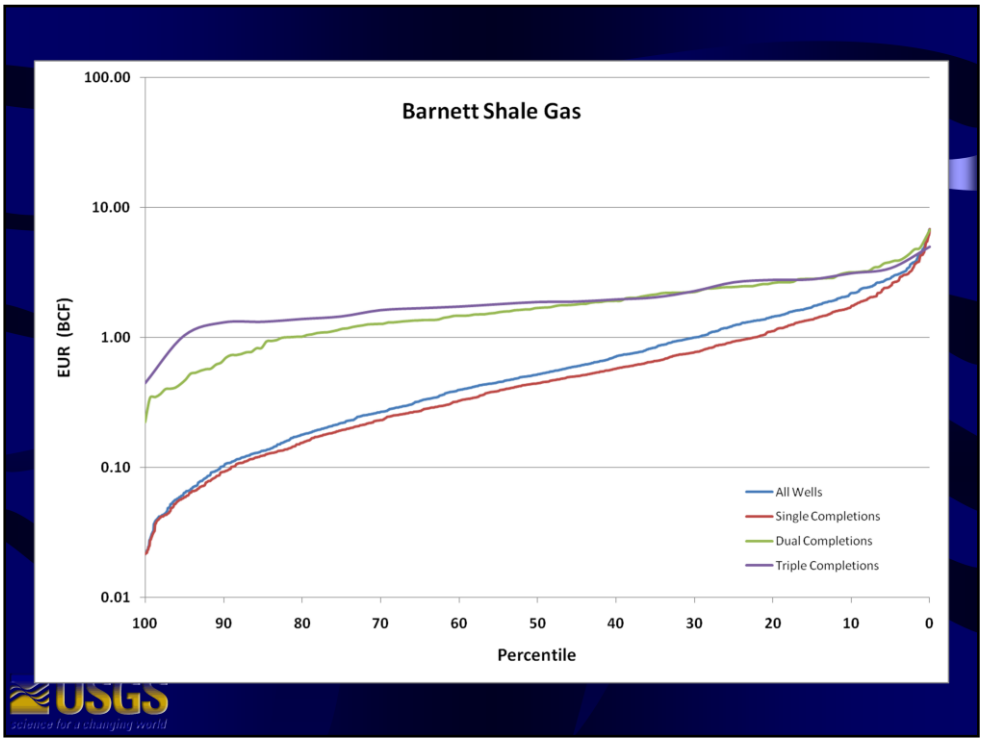
The improved methodology is not tied to specific geologic and engineering models, but is robust enough to take into account improvements in geologic and engineering understanding.



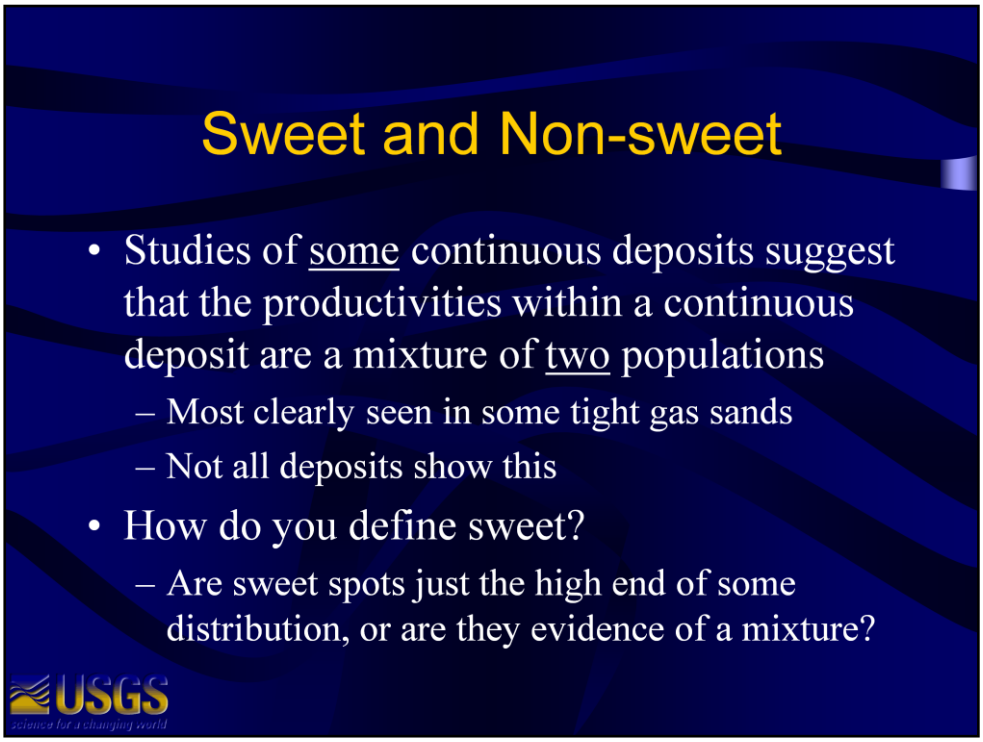
Historical production data from data-rich areas show complex patterns that cannot be interpreted by simple models. Instead, significant effort is commonly required to interpret the data trends.



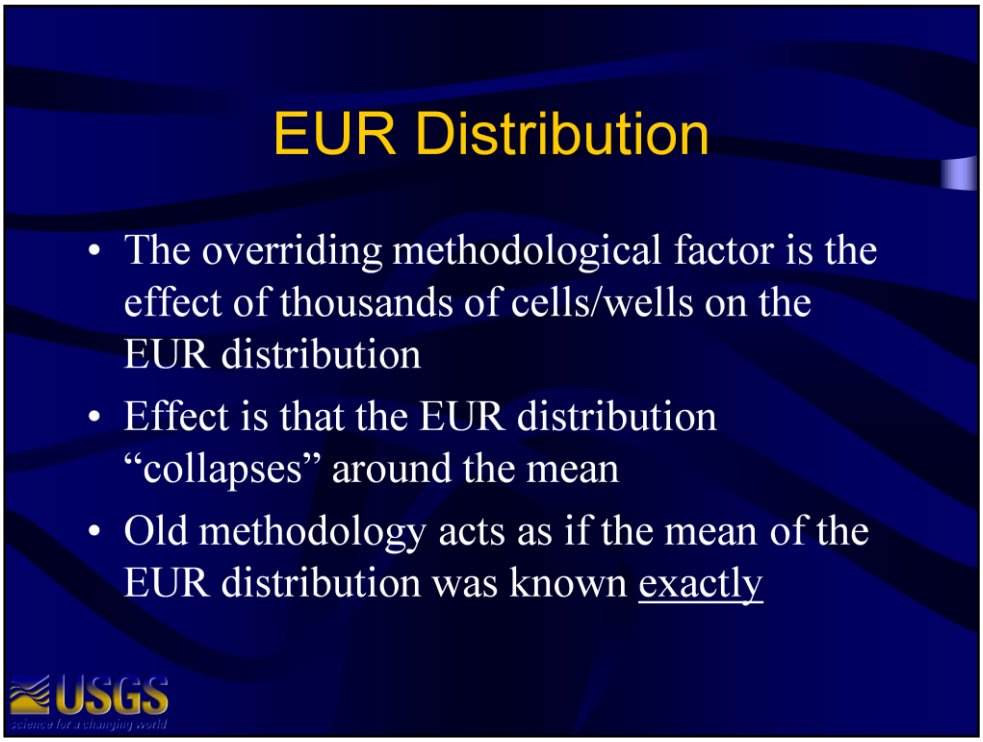
This graph presents the estimated ultimate recovery (EUR) for 1,417 vertical wells in the Barnett Shale as of 2003. It shows the distribution of EURs for those wells with an EUR of at least 0.02 billion cubic feet (BCF). The percentiles indicate what percent of the wells have an EUR of at least the indicated amount. Note that the range of EURs is greater than two orders of magnitude.



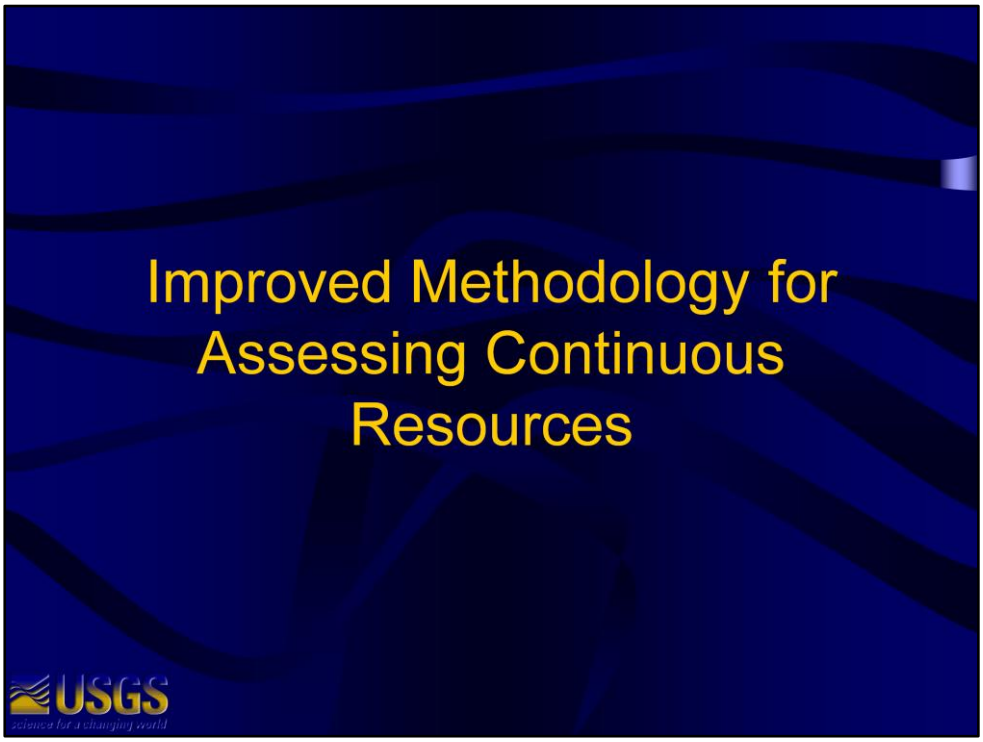
This graph adds lines for those wells used in the preceding graph with single completions (1,240), dual completions (156), and triple completions (21).



The spatial distribution of well productivities is not well understood, but in many cases the highly productive wells seem to be concentrated spatially in sweet spots.



When assessment models aggregate thousands (or tens of thousands) of EURs from an EUR distribution, the result is very close to merely multiplying the number of cells by the mean EUR. Thus the assessment model acts as if the mean were known exactly. This underestimates the uncertainty in the result, especially for frontier AUs where the mean EUR is very uncertain.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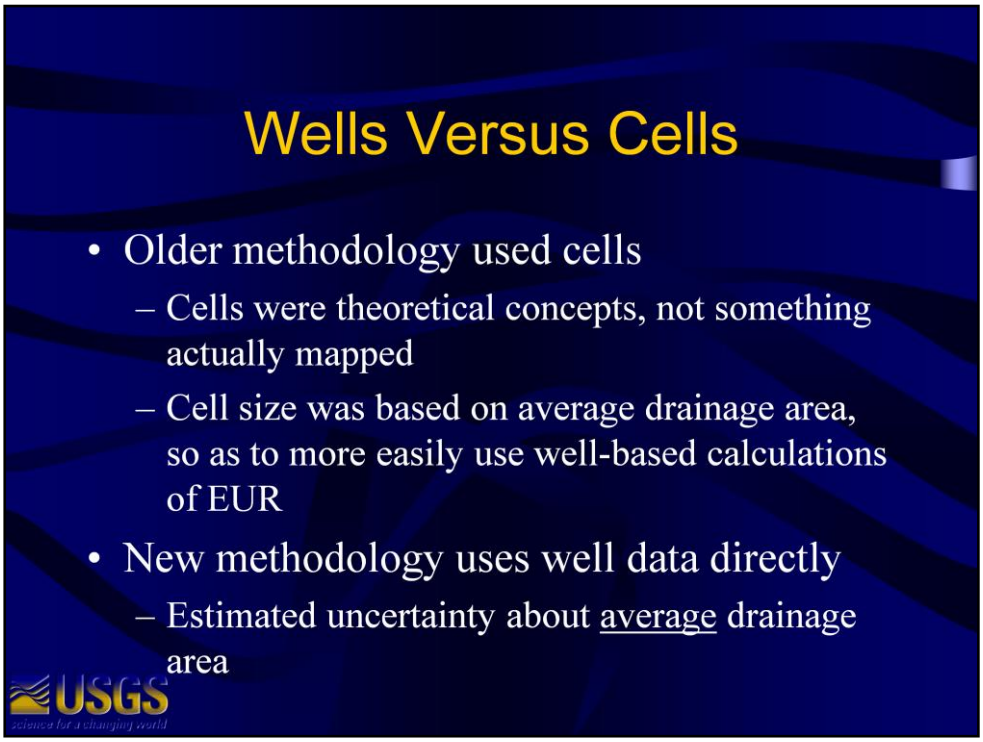
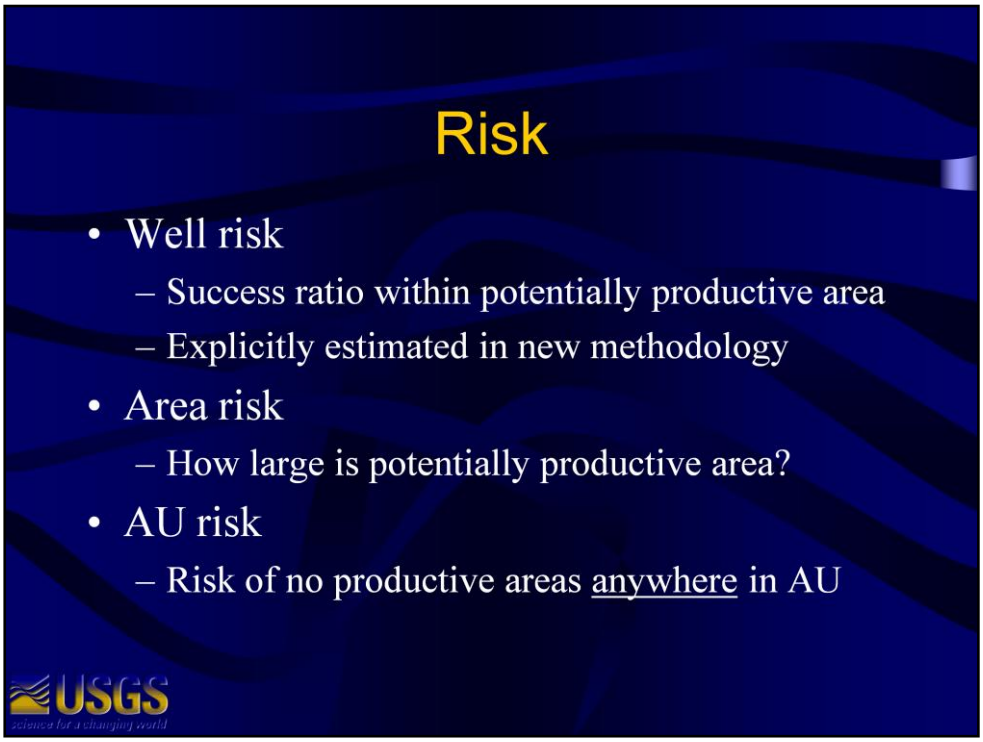


This change leads to less confusion about wells versus cells.



Risk in the new methodology is subdivided into three categories: well risk, area risk, and assessment unit (AU) risk.

Sweet Versus Non-sweet Spots

- Old methodology treated non-sweet spots as having negligible potential
- New methodology offers option:
  - One population with one success ratio and one EUR distribution (100% sweet spots)
  - Two populations with separate success ratios and EUR distributions (< 100% sweet spots)

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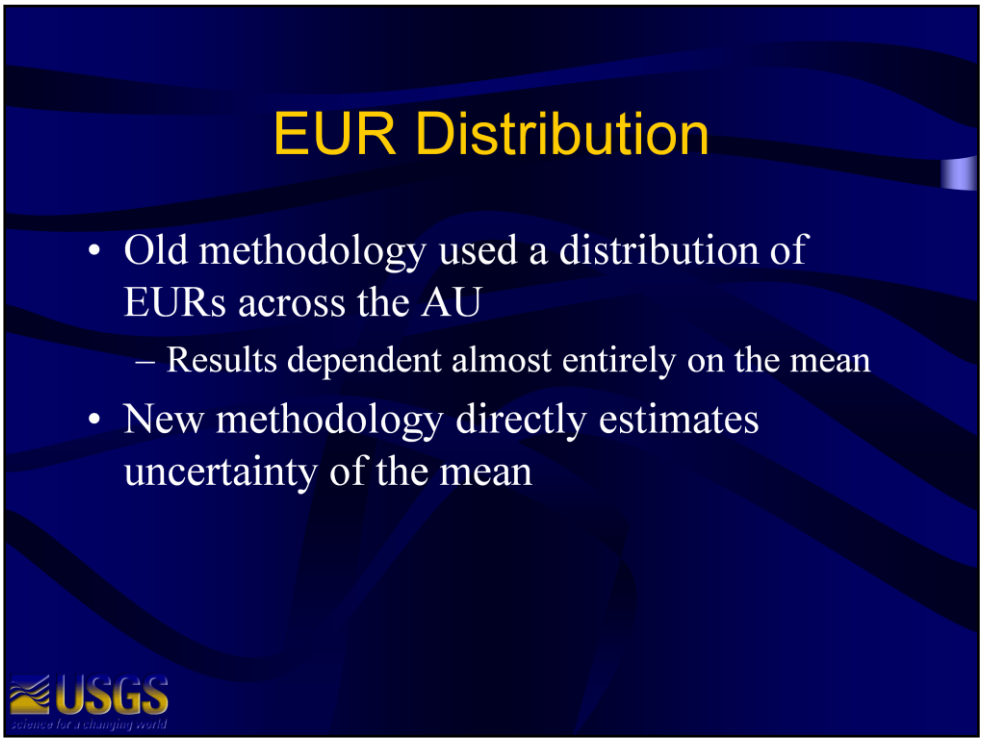
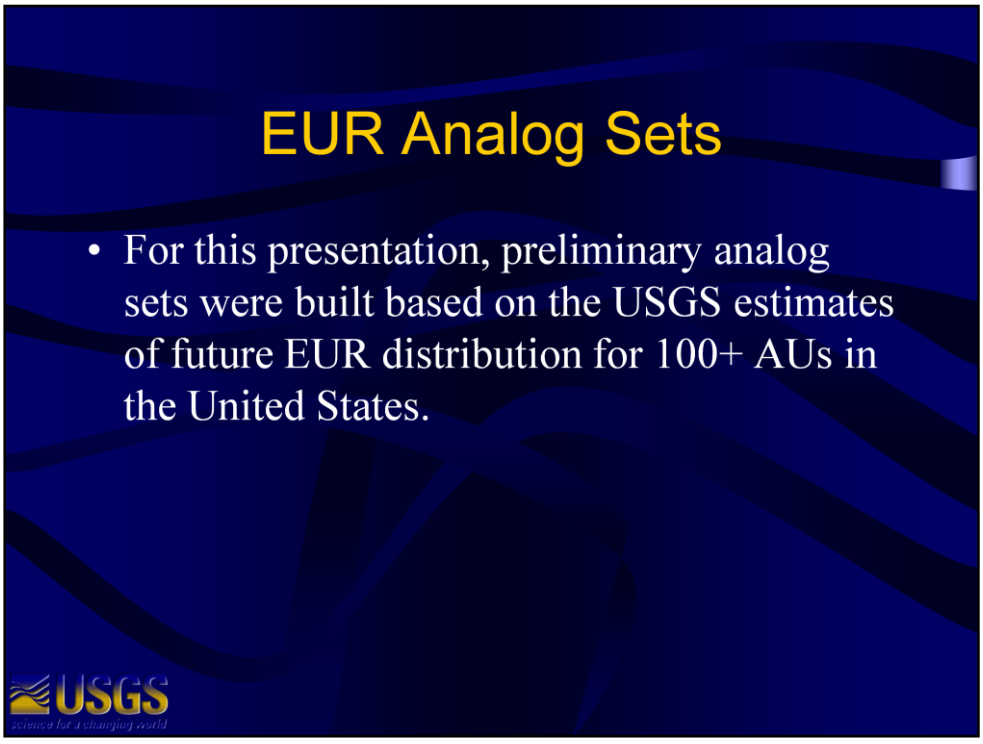
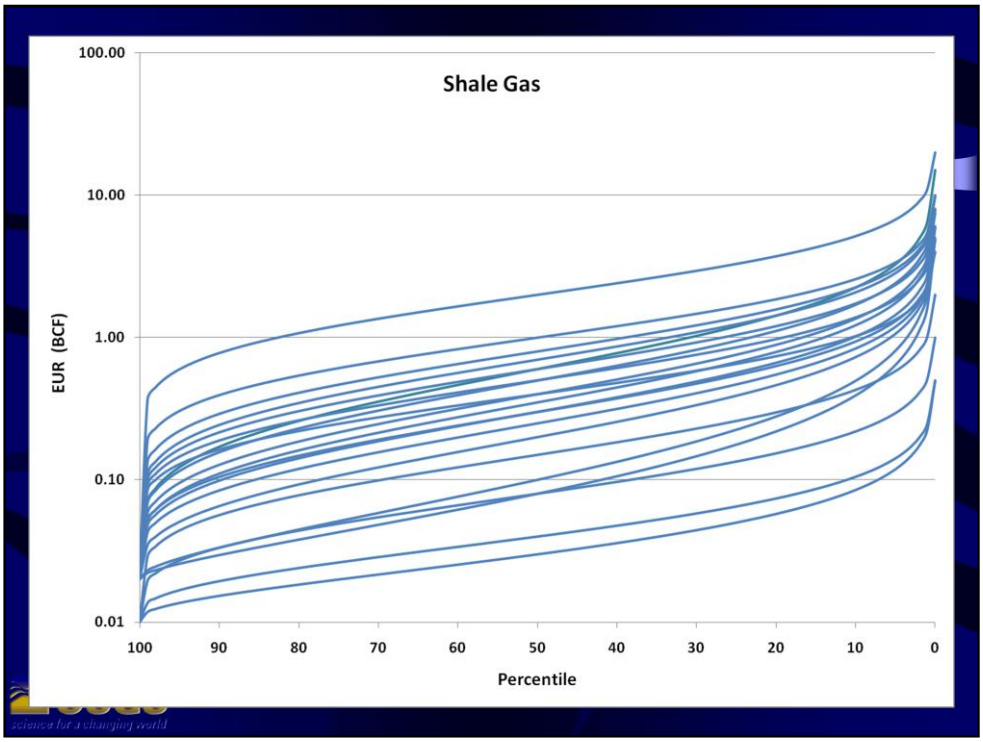


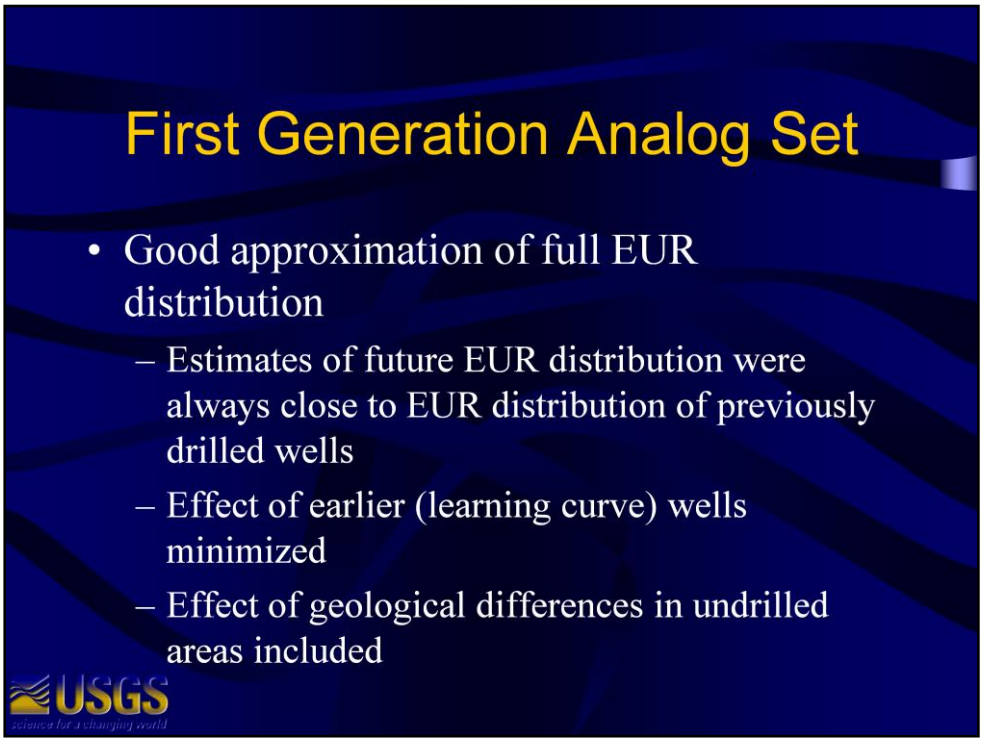
This makes the improved methodology much more applicable to frontier areas.



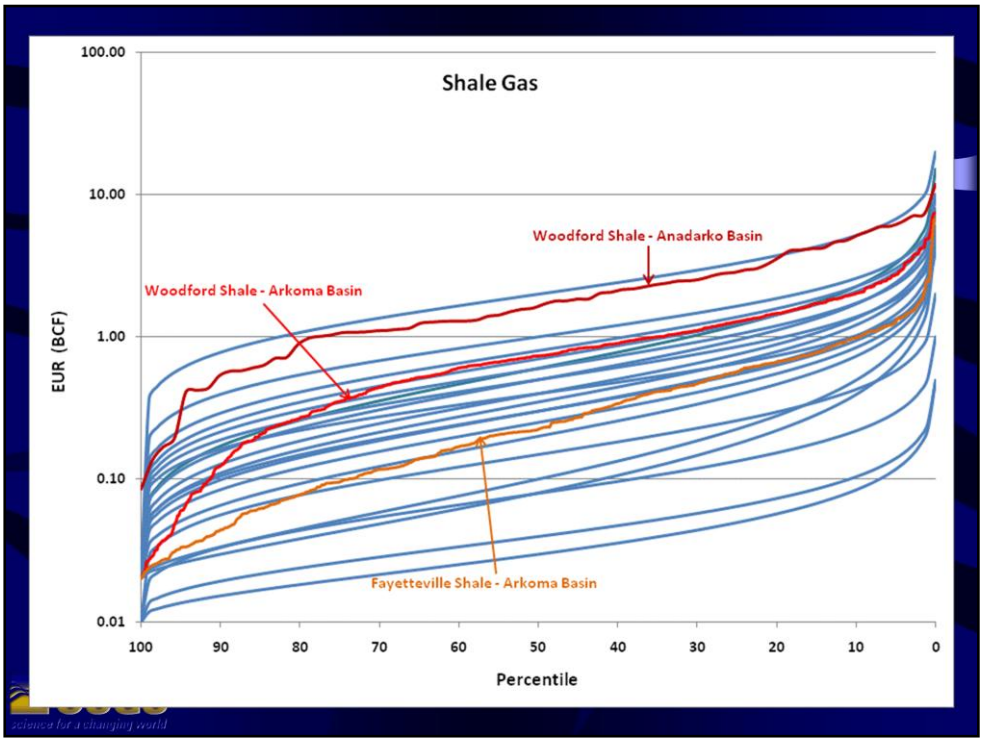
Of the 100+ AUs for continuous oil and gas resources, 21 shale-gas AUs will be used for the example in the following graphs.



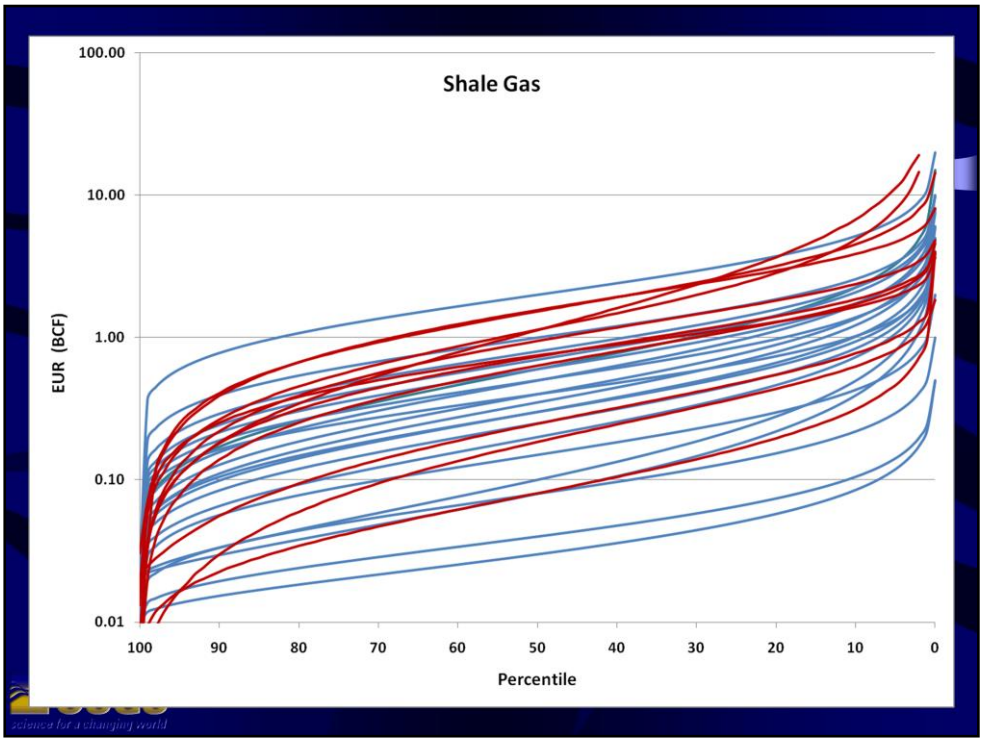
This graph shows 21 shale-gas EUR distributions, based on USGS assessments of undiscovered shale-gas resources. Each distribution is a truncated shifted lognormal, and thus is a smooth curve. The graph thus presents the "distribution of the distributions." Each distribution is a USGS estimate of the EUR distribution for undrilled productive cells of a particular assessment unit. This graph is termed a "spaghetti plot," which shows how EUR distributions can vary for different shale-gas assessment units. The overall area defined by the variation in EUR distributions is termed "the cloud."



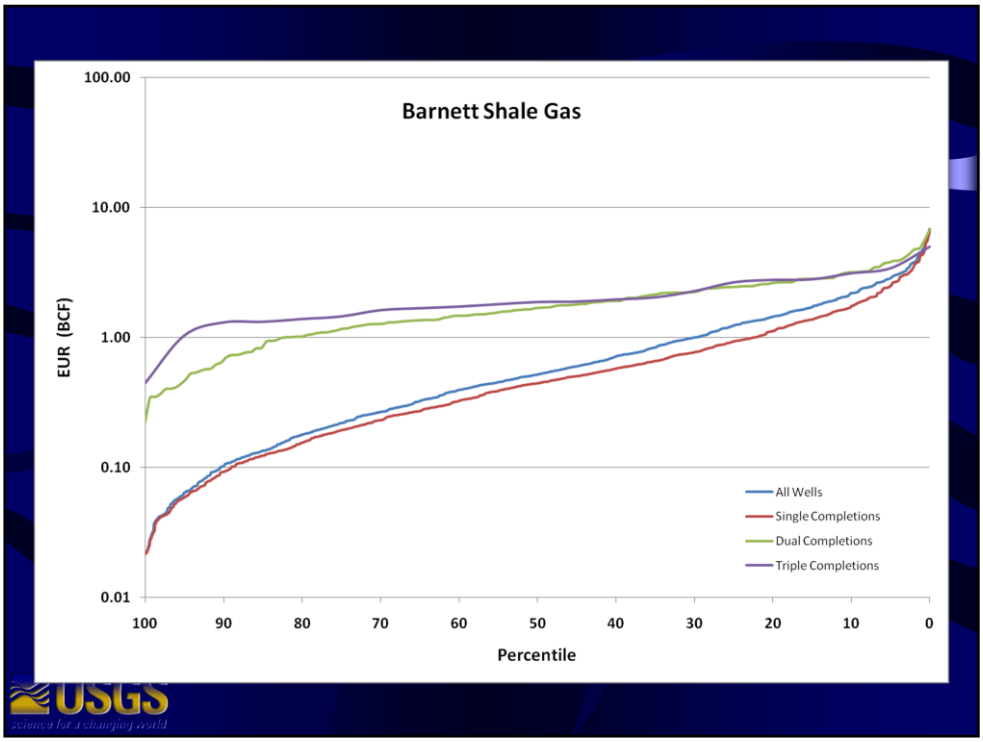
Defining the cloud by using USGS estimates of EUR distributions of undrilled cells gives a good approximation of the range of distributions. Assessments have been conducted over the last decade in a wide variety of reservoirs using a variety of completion practices, and the present sample captures much of the range of distributions based on current technology.



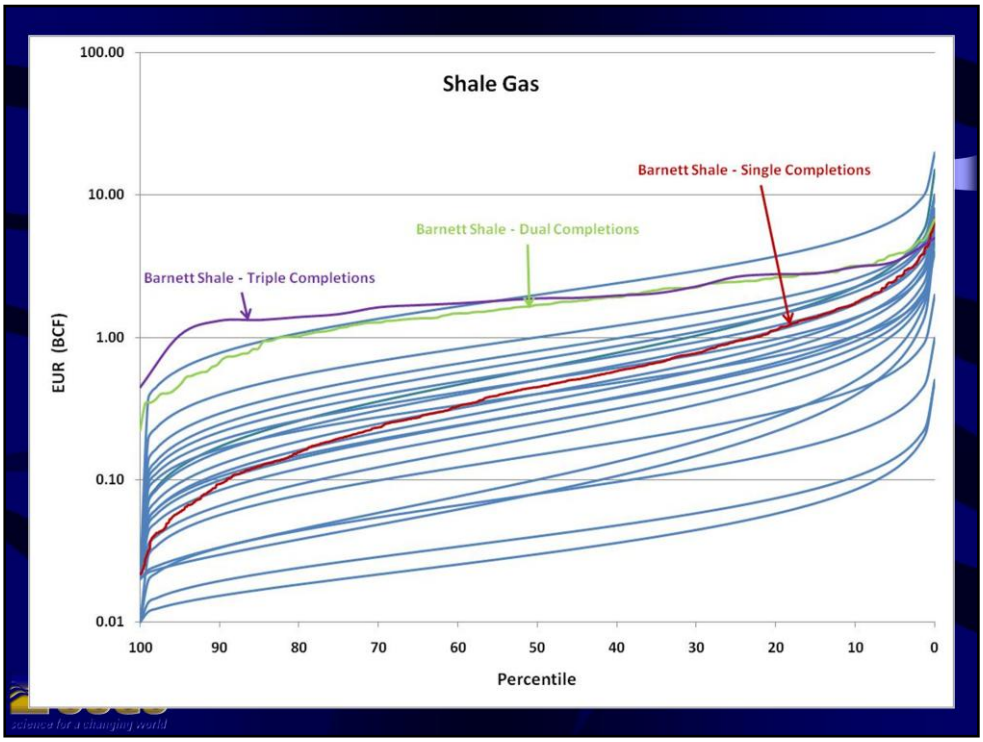
This graph adds the EUR distributions for three recent USGS sets of shale-gas wells, plotted against the cloud shown previously, to put the three distributions in context. The three additional curves are not smooth because they are based on actual well data and not on fitted distributions.



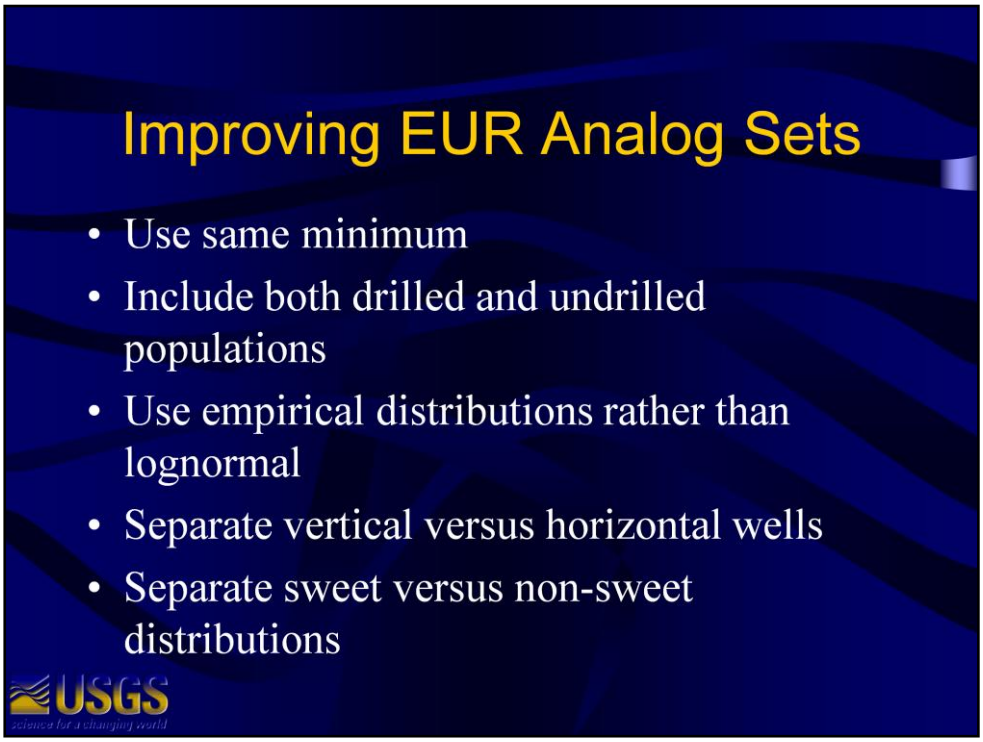
In this graph, the EUR distributions for 11 sets of shale-gas wells are plotted against the cloud to put them into context. These red curves are smooth because the data have been fitted to distributions.



This is a repeat of the graph shown on a previous slide.



The data from the previous graph are now plotted against the cloud to put them in context.



Although these graphs presented a reasonable first approximation for the range of variation in EUR distribution, that approximation can be better refined by the ways listed here.

Future Work

- Develop analog databases
- Study AU and areal risk
- Study effects of spatial patterns
- Study sweet/non-sweet mixture

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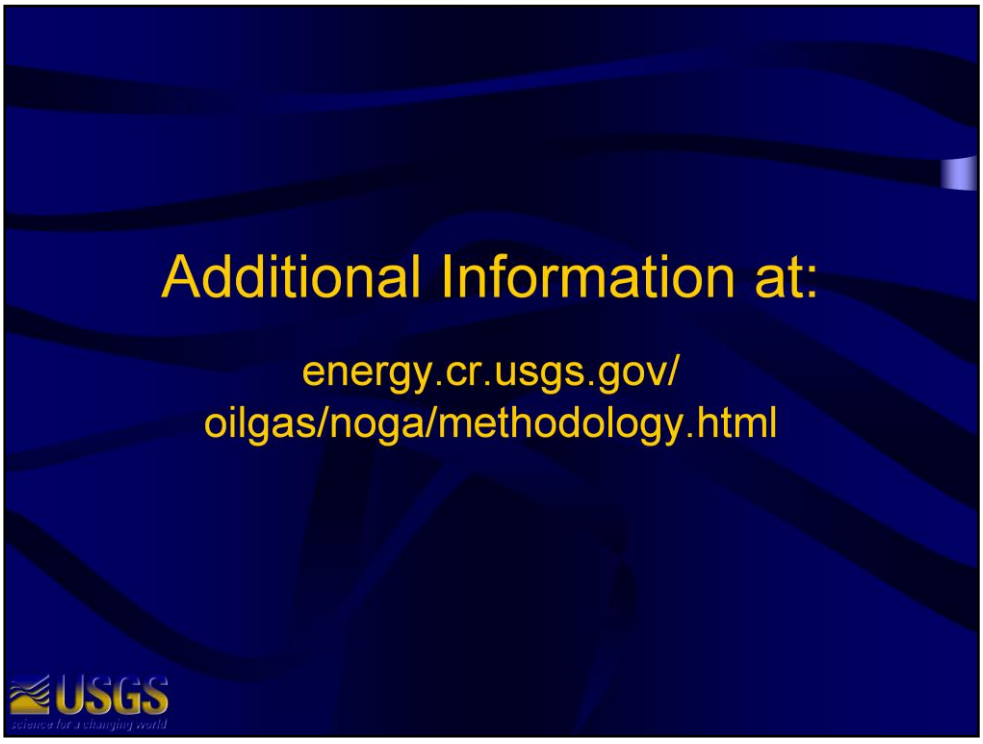

This website has links to references concerning the new USGS methodology, as well as references concerning previous methodologies.