The Impact of Integrated Teams: Examples from unconventional gas plays

or

How we acquired 14 new friends who don’t even speak our language

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Goal: predict the production performance over a 20-year period for the top four shale gas plays in the U.S.

- 2 year project funded by Sloan Foundation
- Rapidly developing plays, some mature but others just starting
- Gas prices low, so development pace is slower than anticipated
- Many uncertainties about well performance and what drives it
Impact

- Reality check on the new shale gas boom
  - How substantial?
  - How long sustained?
  - How profitable?
- Did not address:
  - How safe, how environmentally friendly, true EROI (energy return on energy invested), etc
North American Shale gas forecast by Baker Institute, 2011

This and other studies indicate strong shale-gas production for several decades. Do we believe this?

Medlock, Jaffe & Hartley, 2011
Future shale gas production rates

- Difficult to forecast because of interactions of geology, price, recovery per well, spacing, refracs, technology change, costs, drilling pace, well attrition, and accessibility
- Forecasting starts with aggregating single-well data like this:

**Example Well #1**
- 8.5 years of data;
- 65% decline in first year

**Example Well #2**
- 1 year of data;
- 64% decline in first year
Team
~16 people

- 6 geologists including 1 student and 1 post doc
- 4 petroleum engineers (1 student)
- 5 economists (2 students)
- 1 GIS/mapping/database expert
- Age range 22 to 80+
- 5 nationalities
- 2 cities
- 4 departments in 2 universities
Work Flow: Barnett Shale Basin Assessment

Log and microseismic data

Geologic Characterization
- Structure, porosity, net pay-zone maps

Production history data and directional surveys

Production Decline
- Production rate estimate, EURs

Well Spacing
- Well Recovery, Drainage Areas, Infill drilling locations (by tier)
  \( \Rightarrow \) Technically Recoverable Resources

Well Economics
- Average well production profile by tier
- Incremental economics

Production Outlook
- Pace of drilling as a function of historical patterns, incremental economics, attrition, logistics
  - Cumulative production under different scenarios

Econometric Data Analysis
- Validate Decline Curve; Test Geologic and Other parameters; Describe “typical well”

Source: Bureau of Economic Geology/Univ. of Texas at Austin
Team “Languages”

- Stratigraphy
- Structure
- Organic Geochemistry
- Decline-curve analysis (future performance of existing wells – curve-fitting and the underlying physical basis)
- Economics
- Panel analysis
- Computer mapping and spatial analysis
- Petrophysics
Terminology

- Keep in mind others may not know terms you use...
  - Permeability means nothing to economists;
  - Externalities means nothing to geologists;
  - Devonian means nothing to engineers.
- The same terms may have different meanings for different people, e.g.
  - matrix may mean something that has nothing to do with numbers....
Hassles

- Team not fully staffed when project began
- Needed complete geological workup prior to launching many other tasks
- Having incomplete geological datasets (no seismic, few cores, etc)
- Deadline pressure – 4 major studies in 2 years
- Communicating among disciplines takes time
- Perfecting a workflow never ends; how much older work do you re-do?
- Highly-charged politics surrounding shales; conflict-of-interest concerns
Teamwork difficulties

1. Language – terminology
2. Identification of objectives, difference of perspectives (on what the problems are, and how they can be solved)
3. Ability to stay focused to deliver to other team members what they need for their analysis
30-Year Natural Gas Productivity
Barnett Shale, TX*

*Each sq. mile block is colored based on the estimated productivity of the average 4,000 ft. horizontal well in that block.

30-year production projection (Bcf).
For further details, see Ikonnikova et al. (2013).
Uncertainties

• The total outlook / project uncertainty is the combination of all the incremental uncertainties.
• It is a challenge to put all the uncertainties together and see their interplay
Rewards

- Recognition for tightly-integrated complex study
- Likelihood of continued funding
- Publications
- Pride in contributing sound science that will aid in policy and business decisions
- Friendships
Questions?