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Gas Well Production Enhancement

SNL-KOGAS collaboration

Erik Webb, Hongkyu Yoon, Moo Lee

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DOE-MOTIE Meeting

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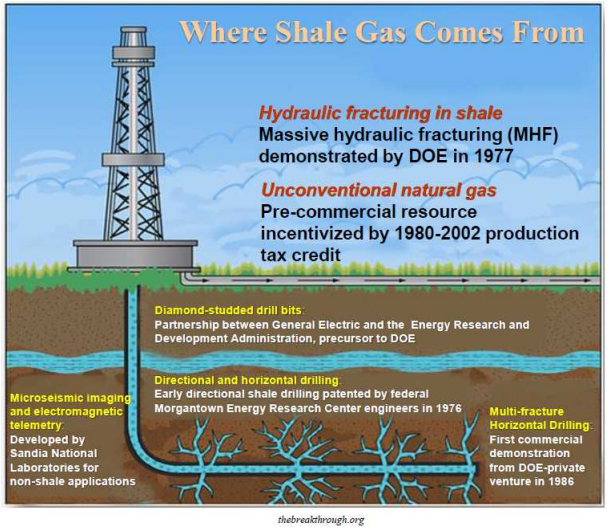
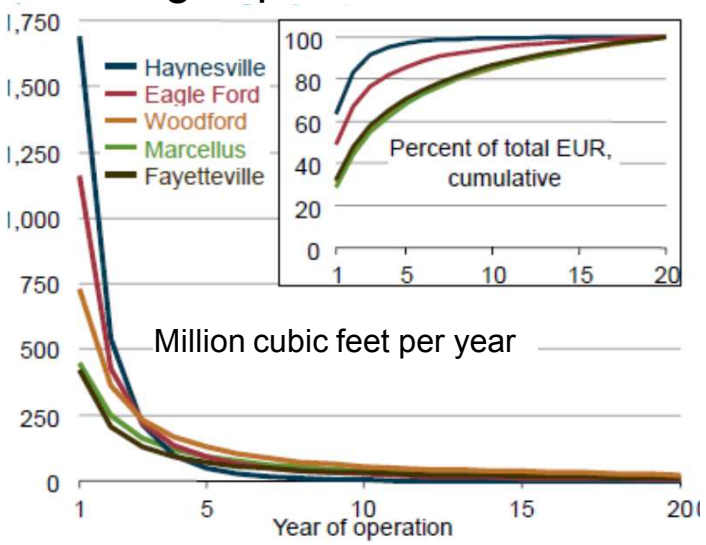
OBJECTIVE: Research to Advance Our Understanding of Gas Well Production in Shale

- Deepen the ability to predict shale gas production decline for specific geological setting / individual wells
- Develop practical solutions to enhance production
- Science questions:
  - Develop advanced models for poro-hydro-mechanics of fractured and porous rock
  - Account for precise physics underlying shale gas production decline
  - Predict stimulated volume and proppant displacement



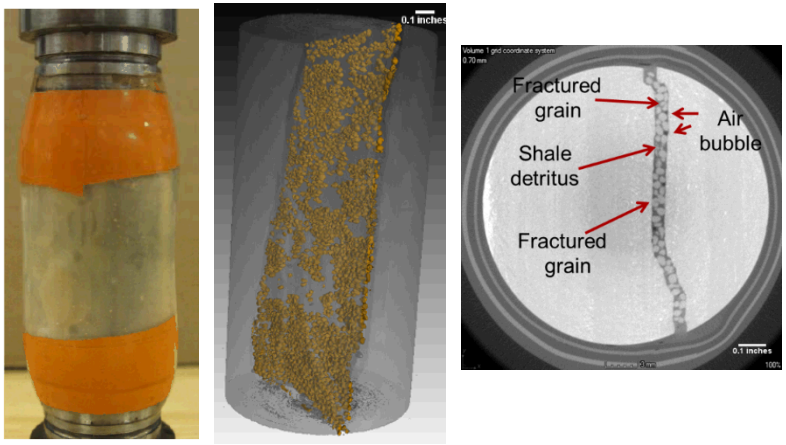
Shale gas production decline



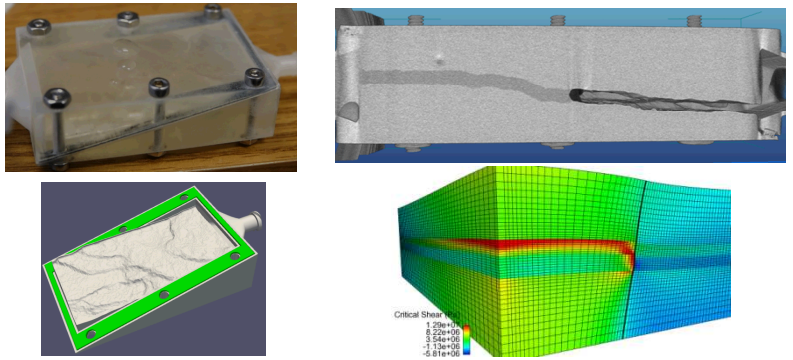
Source: US Energy Information Administration Annual Energy Outlook 2012

METHODS: 3D Printing for Petrophysical and Rock Mechanical Characterization of Shale

- Understand structural and topological properties of pore and fractured systems
- Replicate real rocks by digital and synthetic rocks at the highest level of quality and resolution
- Upscaling pore-scale characteristics to the reservoir scale
- Quantitative analysis of the effects of geological and engineered processes on the petrophysical / geomechanical properties
- Use the KOGAS Horn River Shale Base data to test all these methods



Testing shale core, proppants displacement in a fracture, and microCT image (Ingraham et al., ARMA, 2015)



Assembled fracture network, microCT image of fracking flow in printed fracture, 3D printing design, and reservoir scale simulation of injection induced deformation (Martinez et al, 2015)

VISION: Shale Gas Production Design and Monitoring Evaluation Research Field Site

- Shale science to promote a "first principle" approach to unconventional resources for
  - Flow and production mechanisms from nano-Darcy Shale
  - Physical, chemical, and mechanical properties of rocks
  - Hydrofracture propagation
  - Developing robust discrete fractured networks
  - Testing alternatives to fracking fluids to mitigate environmental impacts
- Shale engineering to promote a "practical solution" approach and tools for quantifying unconventional reservoir production
- Field test these tools to integrate the laboratory, simulation and field shale science approaches for improved production

COLLABORATION: Multiple Funding Sources

- KOGAS Proposal to KETEP – "Investigation of Petrophysical / Geomechanical Properties of Unconventional Resources using 3D Printing Techniques"

- SNL/Purdue Proposal to DOE FE – "Integrated Geomechanical and Geophysical Diagnostic Tool for Hydraulically-Induced Fractures"

- SNL LDRD Funding – Integrated Geomechanics and Geophysics in Induced Seismicity: Mechanisms and Monitoring" based on previous "Digital Rock Physics"

- KOGAS Funding – potential university based field test bed