

SHALE GAS FUNDAMENTALS

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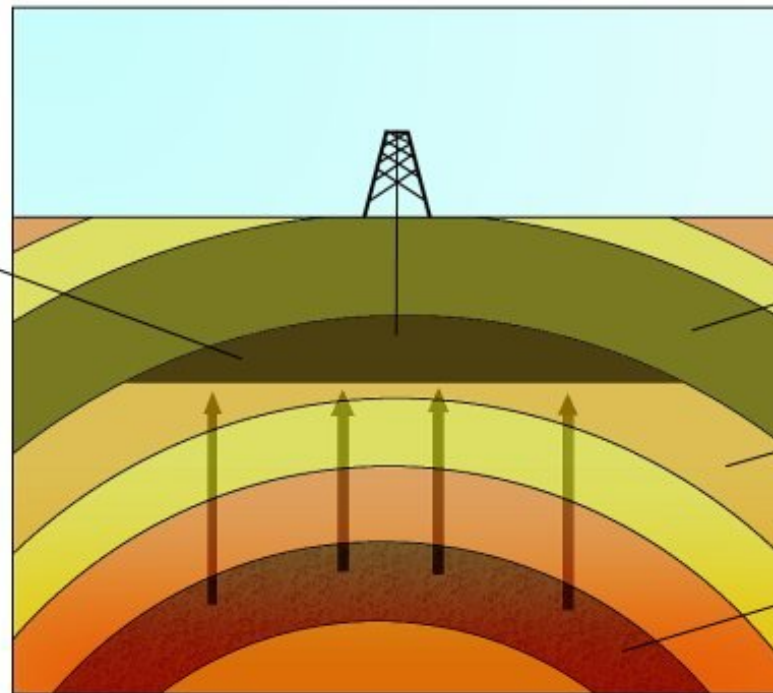
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NATURAL GAS

- How it formed
- What makes shale gas different
 - Directly producing from source rock
 - New resource pool: plentiful
 - Low permeability: must be fractured
 - Horizontal wells: why necessary
 - Unique environmental hurdles

oil and gas migrated from the source rock to the reservoir rock and trapped beneath the cap rock



impervious cap rock

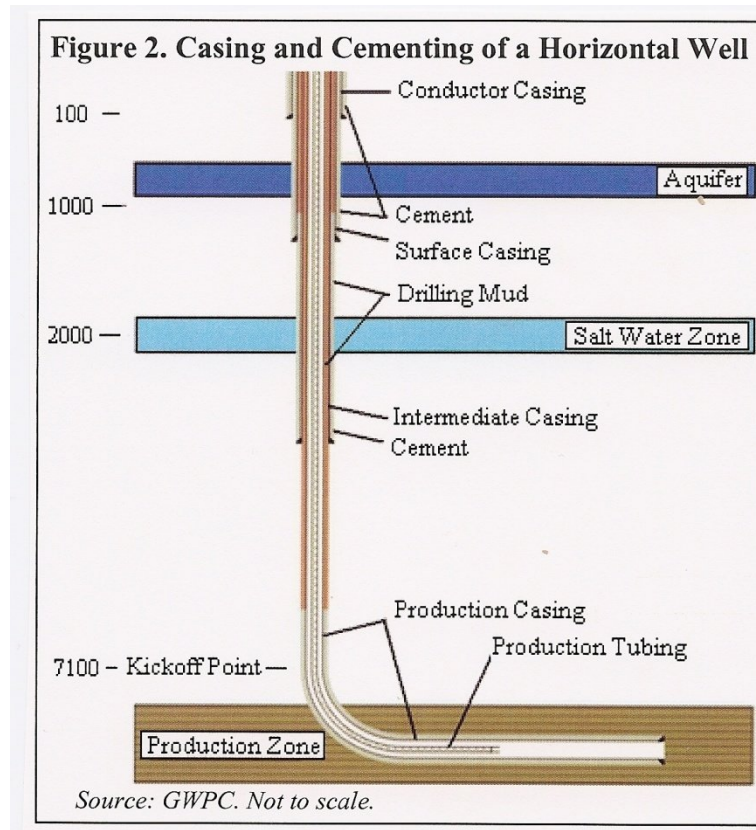
porous reservoir rock

organic rich source rock
exposed to heat and pressure

DRILLING AND COMPLETION

- Features Common to All Wells
 - Isolation of fresh water
 - Isolation of saline water and shallow gas
 - Create a conduit for producing the fluid
 - Casing and cementing to achieve this
- Shale Gas: need to fracture rock

HORIZONTAL WELL COMPLETION



HYDRAULIC FRACTURING

- Process Steps
 - Perforate the first zone
 - Inject fluid and sand at high pressure
 - Fracture rock and remove fluid
 - Leave sand behind to “prop” fractures open
 - Repeat in multiple zones
 - Produce from all zones simultaneously

HYDRAULIC FRACTURING

- Economic Issues
 - Total organic carbon
 - High depletion rates
 - Possible remedy: refracturing
- Environmental Issues
 - Fresh water usage
 - Chemicals in frac fluid
 - Disposal of flow-back water
 - Naturally occurring radioactive elements

HYDRAULIC FRACTURING

- Environmental Issues (contd.)
 - Well water contamination
 - “Earthquakes”
 - Excessive road usage
- Potential Remedies for Above