The Mancos Shale is an Emerging Giant

Garfield County Energy Advisory Board Meeting
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There are about 12,000 producing oil and gas wells in the Piceance Basin today. Most produce gas from the Williams Fork sands in the central part of the basin.
Piceance Basin Structure

- Spoon-shaped basin
- Uplifts along eastern margin formed the Grand Hogback
- Extensive tertiary intrusions and structural deformation in the SE
- Douglas Creek Arch along the western margin separates the Piceance from the Uintah Basin
The Mancos shale lies directly above the Dakota sandstone, and below the Corcoran sandstone.

Its gross thickness can exceed 4,000 feet.

The lower half of the Mancos shale is the focus of natural gas development across the Piceance Basin.

The 800-ft thick Niobrara section has been the primary development target to date.

The entire lower and part of the upper Mancos interval has proven gas productive in the SE area of the basin.

The Upper Mancos has proven productive in the central area of the basin.
The Piceance Basin Mancos shale play is one of the thickest shales in the world.

Mancos development economics are competitive with other major U.S. gas shale plays.

The entire Mancos section appears to be gas-saturated, yielding OGIP/section in excess of 1 TCF in the central basin area.

Development to date has focused on the Niobrara (lower) portion of the Mancos.
Petrophysical Confirmation of Gas Resource

- Average >500 BCF/section free GIP in SE Piceance area
- More than 3000’ of Mancos section contains abundant gas across the basin
Niobrara section of the Mancos is the primary target for development

Averages 800 feet thick, 110 BCF free gas/section GIP
East-West Central Area Cross Section

Thickness of the Niobrara across the basin, 800 to 2,170 feet

After Cumella et al, 2014
Mancos Shale Gas Resource Play

An Emerging Giant:

- ~2X OGIP than the Marcellus shale deposit
- Massive GIP - > 3000 TCF
- Very thick, gas-saturated shale deposit
- Estimated 2.6 Million acres potentially productive
- Central portion of basin is highly overpressured
- SE Piceance area has extensive natural fractures, moderate overpressuring
Shale Plays GIP Comparison

![US Major Shale Plays Gas In Place](chart.png)
Piceance Basin Mancos Shale Gas Production

• Mancos shale gas production grew to 100 MMCFD from 75 wells over the last 4 years.
• Current production is 70 MMCFD, from about 105 producing wells
• Mancos development slowed with the decline in natural gas price.
Mancos Development Progress

- Initial Mancos wells were vertical completions.
- Horizontal wells have much higher rates and EUR’s
Mancos Development Progress

- There is a strong correlation between fracture stimulation volume and EUR.
- Horizontal wells far outperform vertical wells.
Mancos Shale Individual Well Production

The trend to longer laterals and larger fracs has increased production rates & EUR’s.
Example Mancos Well – Encana Fed 36-1H

- Estimated EUR 16 BCF
- Cumulative Gas 6.3 BCF
- Current Rate 1.6 MMCFD (6/2016)
- 34 Stage Slickwater Frac
  - 417,000 bbls
  - 6.26 Million lbs sand
Future Mancos Development

- Multiple wells per pad – 48 or more
  - Estimated 880’ lateral spacing, 400-500’ completion intervals, 4 stacks
- Drilling rigs specially designed for horizontals, multiple wells/pad
- Long lateral horizontals – 10,000 feet or more
- Improved fracture stimulation treatments, new designs
- Simultaneous drilling & completion operations – reduced surface impact days
- Better drilling technology – RSS & LWD
- Higher ROP’s – may approach DJ Basin rates of > 400 feet/day
- Better mud and solids handling – closed loop circulation, landfill cuttings disposal
- Natural gas fueled drilling rigs and frac stimulation equipment
Future Mancos Development

• **Development of 20% of the basin (520,000 acres) would require:**
  – 13,000 new wells (7000’ laterals, 880’ lateral spacing, 4 stacks)
  – Well capex of ~ $130 Billion ($10 Million/well)
  – Infrastructure capex of ~ $25 Billion
  – At 5 acres/48-well pad, about 1350 acres of well surface space

• **With 40 rigs drilling and 30 days/rig, would require >25 years to drill**

• **Would generate ~ 130 TCF of reserves (assuming 10 BCF/well),**
  – Sales revenue of $390 Billion @ $3/MCF

• **Would increase production to > 5 BCFD, 2.5X current pipeline capacity**