Hydraulic Fracturing in the Chromo Area

Marvin Johnson [12]

Location

Chromo, SE Archuleta County, Colorado; T32N1E, T33N1E, T33N1E, T33N2E

Background

There has been drilling in the Chromo Anticline & Navajo River valley area since the early 1930s based primarily on surface geology. The area is dominated by the asymmetric Chromo Anticline which is cored in the Cretaceous Lower Mancos shale. Three field areas have been delineated:

> Price Gramps (Field Code 70600): Oil production from an asymmetric anticline in the Cretaceous Dakota sandstone at about 1100'. Basement was penetrated above TD 1172'. The field was discovered in 1935 and production ceased in the 1990s. [1]
>
> Chromo (Field Code 11100): Small amounts of oil and gas discovered in drilling from the early 1930s to 1960. Shows and production were from the Cretaceous Mancos shale at depths of 500' – 600'. (2&3)
>
> Navajo (Field Code 57110): Minor production averaging 150 bbl/month/well from the Cretaceous Mancos shale at depths of 800 – 1000'. [2,3]

Geology

The area is on the east flank of the prolific San Juan Basin, one of the country's largest gas fields. Most of the associated producing formations (Fruitland Coal, Pictured Cliffs, Mesa Verde and Dakota) have been eroded away or are very shallow due to significant uplift & tectonic deformation. Exposures of the producing Fruitland and Pictured Cliffs formations outcrop several miles to the west of the Chromo area.

As mentioned previously, the area is dominated by the asymmetric Chromo Anticline, a major component of the Gallina-Archuleta Arch (also known as the Archuleta Anticlinorium) which separates the San Juan Basin from the Chama Basin (also known as the Chama Platform) and has a dramatic cliff forming surface expression due to the cap rock of Cretaceous Mesa Verde sandstone around the edges. The west flank of the Chromo Anticline dips about 10^o to the west and the east flank dips $60\text{-}80^o$. The anticline is cored with Cretaceous Mancos shale. Near the axis of the anticline, the Cretaceous Dakota sandstone was reported at a depth of 263' in the Crowley #4 (API 05-007-05203, SENW14-32N1E). Off the east flank of the anticline, the top Mancos shale is reported at a depth of 724' in the PC Crowley Heirs #1 (API 05-007-05016, NESE7-32N-2E). Further east, the Price Gramps field was drilled on a faulted, asymmetric anticline with production from the Dakota sandstone at a depth of about 1100'. There is a very thin remnant of Jurassic Morrison and Entrada formations between the Dakota and Precambrian basement. [2,3,4,5,6,7]

The main conclusions to be drawn are that the Cretaceous Mancos & Dakota producing formations are very shallow and highly faulted.

Concerns about Hydraulic Fracturing in the Chromo Area

While there is production from the lower Mancos shale, as noted above, the rates are very low. It would seem logical for a company to try horizontal drilling and/or Hydraulic Fracturing to to improve the production rates. Hydraulic Fracturing is a well known stimulation technique that pumps water, a proppant (usually sand) and a variety of chemicals under high pressure down the well bore to fracture and/or enlarge existing fractures in a specific formation or interval. The most common formulation is approximately 90% water, 9% proppant and 1% various chemicals.

The Chromo area is a very rural and mostly ranching community with some areas of retirement homes. Everyone depends on shallow wells for their drinking water. One of the main concerns about hydraulic fracturing is the possibility of fluids moving from the well bore and induced fractures into the overlying water table. As explicitly noted in the Background section (p. 7 & 8) of the "REVIEW OF HYDRAULIC FRACTURING TECHNOLOGY AND PRACTICES" Hearing before the COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY HOUSE OF REPRESENTATIVES, ONE HUNDRED TWELFTH CONGRESS, MAY 11,2011 Serial No. 112-17:

> *"The use of hydraulic fracturing has raised questions regarding the potential effect of this technology on drinking water supplies. The purpose of injecting fracking fluids into the ground is to create enough pressure to fracture subsurface structures. There are two distinct areas of concern regarding this process: first, the injection itself, or the creation of subsurface fractures, could allow fracking fluid to contaminate underground sources of water, and second, the handling and disposal of fracking fluids to the surface.*
>
> *The risk of contamination of underground water sources is managed in different ways. Risks associated with leakage of the fracking fluid during the injection and fracturing job are reduced by: adherence to state well construction requirements; the vertical distance between the fractured zone and ground water, and, the presence of vertically impermeable zones between the fractured zone and the deepest ground water; and the presence of vertically impermeable formation that act as geologic barriers to the movement of fluid from the fractured zone into ground water resources." [Department of Energy, State Oil and Gas Regulations Designed to Protect Water Resources. May 2009]*

The direction, size and extent of hydraulically induced fractures depend on the stress field in the formation being fracked which is controlled by the lithology, depth of burial and tectonic stresses. The characterization of fractures is a rapidly evolving science but most recent work using reservoir modeling, downhole tiltmeters and microseismic analysis suggests that most induced fractures have a half length of 400' – 1500' (distance from wellbore to tip of fracture) and a height of 100'-300' (vertical distance) in both vertical and horizontal wells. [8, 9, 10]

However, nearly all hydraulic fracturing has been performed in formations that are significantly deeper than in the Chromo area. For instance, the average depth of the fracturing horizon is 4500' for the Fayetteville Shale; 7400' for the Barnett shale, 9000' for the Eagleford shale and 7100' for the Marcellus shale. [8, 9] In addition, these shale plays are relatively flat and unstructured. It is noted that in the Barnet shale play, horizontal wells often cross small faults. Even when the perforations for fracking are placed away from the faults, microseismic activity was still concentrated around the fault planes and fracturing was influenced by these faults. [11] As noted previously, the Chromo area has been subjected to significant tectonic activity and contains many faults which may be both a focus for increased fracturing and leakage.

Recommendation

Hydraulic Fracturing should be avoided in the Chromo area as it fails to satisfy the criteria set forth in the Congressional Hearing referenced above:

the vertical distance between the fractured zone and ground water – this is clearly not the case in the Chromo area where the distance between groundwater and the fracked formation may be as little as 200', clearly in the half fracture height zone.

the presence of vertically impermeable zones between the fractured zone and the deepest ground water – the Mancos shale is does not contain any significant impermeable zones.

the presence of vertically impermeable formation that act as geologic barriers to the movement of fluid from the fractured zone into ground water resources - given the tectonic activity (faulting and folding) and uplift any impermeability inherent in the Mancos shale is very likely to have been breached . This is evidenced by 'hot springs' and oil seeps in the area.

Citations

(1) W. Donovan, "Oil and Gas Fields of the Four Corners Area, Volumes I-II", 1978
(2) Colorado Oil and Gas Conservation Commission
(3) www.eser.org
(4) Wood, G. H. etal, "Geology of the southern part of Archuleta County, Colorado, USGS, Oil and Gas Investigations Preliminary Map 81",1948
(5) L. Woodward, "Tectonics of Central Northern New Mexico", New Mexico Geol. Soc. Guidebook, 25th Field Conf., Ghost Ranch (Central-Northern N.M.", 1974
(6) W. Muehlberger, "Structure of the Central Chama Platform, Northern Rio Arriba County, New Mexico", New Mexico Geol. Soc., Eleventh field Conference
(7) W. Muehlberger, et al, "Stratigraphy of the Chama Quadrangle, Northern Rio Arriba County, New Mexico", New Mexico Geol. Soc., Eleventh field Conference
(8) EPA Hydraulic Fracturing Workshop, March 10 – 11, 2011 by Chesapeake Energy
(9) S. Maxwell," Hydraulic Fracture Height Growth", CSEG Recorder, November 2011
(10) G. Waters, etal,"The Effect of Mechanical Properties Anisotrophy in the Generation on Hydraulic Fractures in Organic Shales", SPE 146776, Society of Petroleum Engineers Annual Technology Conference, 30 October-2 November 2011
(11) L. Bennett, etal, "The Source for Hydraulic Fracture Characterization", Oilfield Review, Winter 2005/2006
(12) M. Johnson, BS Geophysical Engineering, Colorado School of Mines and 35 years experience as an Exploration/Producing Geophysicist for a major oil company. Mr. Johnson can be contacted at PO Box 130, Chromo, CO 81128