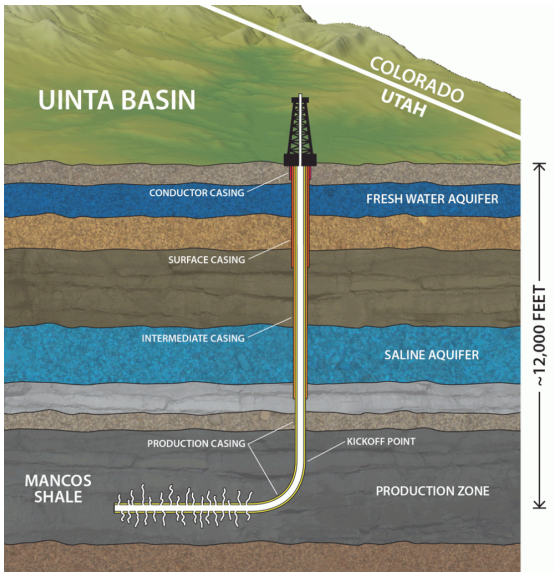
Science Policy Outreach Task Force at Northwestern University

Overview of hydraulic fracturing and common geological concerns

What is hydraulic fracturing (aka "fracking")?

- Hydraulic fracturing is a technique to extract oil and gas from low permeability rocks (i.e. rocks through which fluids have a hard time flowing).
- Water, sand, and chemicals are pumped into a well under high pressure, creating fractures in the rock that facilitate the flow of oil and gas into the well.
- Hydraulic fracturing is often combined with horizontal, or directional, drilling. Horizontal drilling allows wells to extend thousands of feet laterally from the initial drill site and increases the volume of oil and gas-bearing rock that a single well can access.



(*Above*) Schematic of fracking and horizontal drilling. Courtesy of Utah Geological Survey [1]

Concerns about water quality

- The drinking water aquifer is generally much shallower than the rock layers targeted by hydraulic fracturing (although this does depend on local geology).
- Although relatively uncommon, drinking water contamination from methane and brine (salt water) has been attributed to drilling activity in Pennsylvania [2]. Water contamination can occur where the well passes through the drinking water aquifer and at the surface [2]. Casing a well (sealing the sides with steel and cement) can reduce contamination risk. Inadequate casing or improper storage and disposal of wastewater (brines that return to the surface with the oil and gas) can lead to surface and groundwater contamination.
- There appears to be low risk of drinking water contamination due to fracking chemicals moving from deeper layers, where the fracking occurs, into drinking water aquifers. In Pennsylvania, a state with extensive hydraulic fracturing, there have been no documented cases of fracking chemicals moving from deeper rocks into drinking wells [3]. Nationally, only two possible incidents have been reported, but both results remain disputed [4]. Inadequate casing or surface spills would be the most likely sources of any fracking chemical contamination [5].
- Without establishing a pre-drilling water quality baseline, identifying the causes of water contamination can be challenging [4]. Many of the contaminants can also be naturally occurring or produced by other human activities.

Concerns about earthquakes

- Hydraulic fracturing can induce earthquakes; however, most are too small to be felt. The largest documented was a magnitude 4.4 earthquake in western Canada [6]. An earthquake of this size will cause light shaking but is unlikely to result in any damage.
- The vast majority of oil and gas-related earthquakes are not due to hydraulic fracturing itself, but instead from separate disposal wells where wastewater is pumped back underground into deep rock layers [7]. These wastewater disposal wells are primarily responsible for the recent increase in earthquakes in Oklahoma [8], the largest of which were the 2011 magnitude 5.7 and 2016 magnitude 5.8 earthquakes. Both caused moderate local damage.
- Local geological factors—such as the presence of large faults, pathways for fluids to migrate to faults, and pre-existing stresses in the rocks—and wastewater volumes and disposal rates play a significant role in whether a wastewater disposal well will cause felt earthquakes [7].

References and additional resources

[1] Utah Geological Survey: (https://geology.utah.gov/map-pub/survey-notes/energy-news/energy-news-hydraulic-fracturing-and-shale-gas/)

[2] Brantley et al., 2014, Water resource impacts during unconventional shale gas development: The Pennsylvania experience. *International Journal of Coal Geology*, **126**.

[3] Brantley et al., 2018, Engaging over data on fracking and water quality. *Science*, **359**, 3674.

[4] Vidic et al., 2013, Impact of shale gas development on regional water quality. *Science*, **340**, 6134.

[5] Llewellyn et al., 2015, Evaluating a groundwater supply contamination incident attributed to Marcellus Shale gas development. *PNAS*, **112**, 20.

[6] BC Oil and Gas Commission, 2014, Investigation of observed seismicity in the Montney Trend.

[7] Rubinstein et al., 2015. Myths and facts on wastewater injection, hydraulic fracturing, enhanced oil recovery, and induced seismicity. *Seismological Research Letters*, **86**, 4.

[8] United States Geological Survey (https://earthquake.usgs.gov/research/induced/)

American Geosciences Institute: https://www.americangeosciences.org/critical-issues/factsheet/pe/groundwater-protection-oil-gas-production

The Geological Society of America: https://www.geosociety.org/GSA/Science_Policy/Critical_Issues/GSA/Policy/issues/home.aspx

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