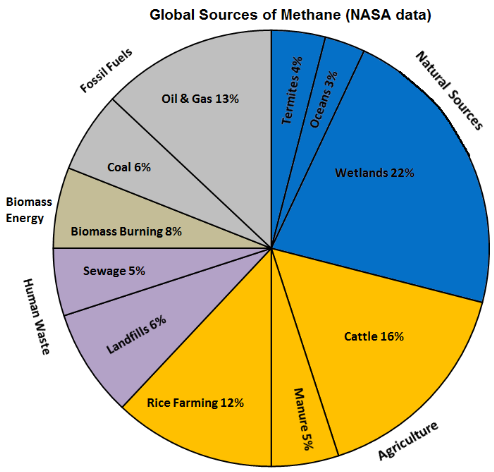
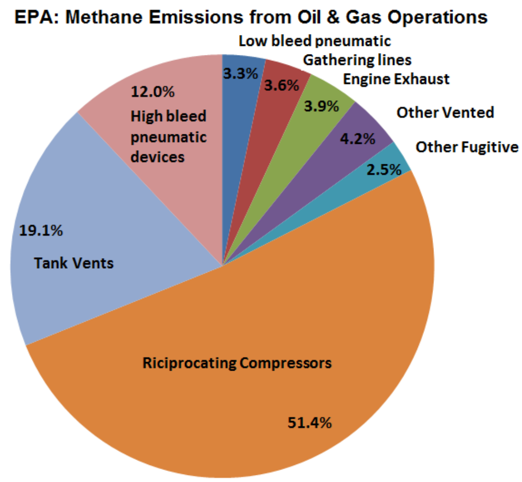
The Basics of Wells – Natural Methane Seeps and Methane in Groundwater

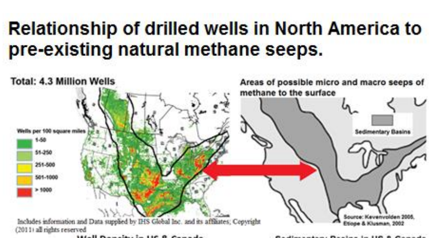
Natural gas is mostly methane gas, CH_4, and is a greenhouse gas that is potentially responsible for part of the human-created aspects of climate change. Methane is one of the most common natural contaminants of our atmosphere and groundwater. Global sources of methane are widely varied and allocated into large groups as natural or human methane contributions from energy, food production and living impacts. Methane from oil and gas sources has been targeted by regulators as a controllable segment of the total methane emissions. Emission sources in oil and gas operations are largely from gas handling and distribution with only a small amount from wells and any fracturing operations.





Natural seepages of oil and methane gas from 5,000 known natural seeps and perhaps as many as 30,000 natural seeps worldwide have often been ignored although emission volumes from such seepages are substantial, possibly as much as 20% of all fossil energy emissions according to studies by university experts (Kvenvolden & Rogers, 2005). Most deep natural gas evolves from organic-rich shales that underlie a large part of the world's land and ocean areas. Gas escaping from these source rocks rises towards the surface through the rock strata and may be trapped in rock reservoirs or escapes at the surface to be oxidized to CO2 or be consumed as food by bacteria. Natural seepage of gas through rocks, water and soils over these shales is extensive and have continued for hundreds of years as shown by reports of explorers going back to the time of Marco Polo. Natural seeps emit about 5 to 10 billion cubic feet (bcf) of methane per day. Early energy explorers used these seeps as an indicator of oil and gas deposits and today's well accumulations outline many seep locations. Interestingly, oil and gas wells drilled into the source rocks under these seeps decrease the rate of gas seepage at the surface.

These natural seeps will also influence methane collection in groundwater and fresh water wells. Depending on the area of the country and the specifics of the aquifer, groundwater, either fresh or saline, may dissolve and carry small amounts of methane gas. Sudden changes in pressure within a groundwater reservoir will also change the amount of free methane gas by causing gas to move from solution into free gas phase. Investigations of stray natural gas incidents in Pennsylvania reveal that stray gas migration was not caused by hydraulic fracturing. The possibility of some gas migration events being related to drilling or well construction cannot be dismissed, but EPA, USGS and state agency investigations have ruled out wells in most cases. The worst of these migrations appear to be in areas with known history of



shallow gas occurrence in water wells, most of which predate any oil or gas well drilling.

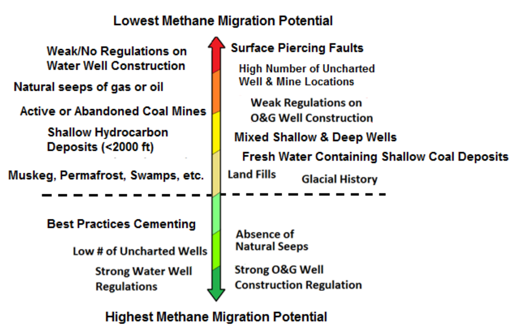
Early wells such as the 1821 William Hart well near Fredonia New York that hit flowing gas at a depth of 23 feet and Drake's 1859 well near Titusville Pennsylvania, which found oil at 69-1/2 feet, are proof that shallow gas and oil coexisted at the same depth of shallow groundwater and are often ften in the same reservoirs.

Free (non-dissolved) methane gas exists in many aquifers under the caprock or in rock layers and methane gas is frequently released from organic formations such as coal or shale as the pressure is reduced by producing the water from these formations. As water flows out of a rock formation and into a wellbore, pressure is lowered, creating opportunity for some dissolved methane gas to move out of the water and become a free gas phase (similar to the CO_2 escaping as a freshly opened bottle of carbonated soda). Higher draw-downs on fresh water (higher withdrawal) will enable more gas to come out of solution (similar to rapidly pouring any carbonated beverage). Any free gas will rapidly rise in a water well and can accumulate in the highest part of the well piping system. If not vented by proper water well construction, gas will follow the moving water when the water tap is opened in the house. This is the cause of burnable gas seen in 200 year old historical reports on igniting water wells and in more recent dramatic TV and movie shots of burnable gas quantities in faucets and garden hoses. If the fresh water well is constructed correctly, a vent cap allows the methane to escape from the well and prevents most gas accumulation.

Causes of natural variation in mineral and methane content in ground water and brine zone include: seasonal variance, barometric pressure changes, changes produced by runoff, water recharge routes into the reservoir, recharge sources, recharge rates, depth of water withdrawal and rate of withdrawal. According to groundwater experts, overdrawing or over-drafting a groundwater reservoir (withdrawing water faster than it can be recharged) can produce notable changes in the reservoir water composition including pulling contaminants in from above and salt from below. This variability confuses single comparisons of water quality. Many fresh groundwater aquifers are connected to more saline water sources below and, salinity of a water source often varies with depth.

Frequency of gas appearance in groundwater is influenced mostly by geographical and geological factors. Wells, particularly those drilled with air, can cause air charging of shallow water sands or by displacing shallow pockets of methane into the low pressure areas caused by groundwater withdrawal. The number of water supply wells drilled in the US is near 15 million, not counting those that have been dug or drilled and then abandoned without being reported. The problem is worst when there are few water well standards. Improperly constructed, poorly maintained, and improperly abandoned water wells can be a primary pathway for aquifer contamination by a variety of materials, both from surface and subsurface inflow, regardless of the source of the gas.

Controlling methane emissions is critical for our energy future, but accurate information on causes and effective solutions is needed for controls to be effective.



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Reference: Kvenvolden, K.A., Rogers, B.W.: "Gaia's Breath – global methane exhalations," Marine and Petroleum Geology 22 (2005) 579-590.