

GEOLOGY OF NATURAL GAS PATHWAYS AND ACCUMULATIONS UNDER HUTCHINSON, KANSAS

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The Kansas Geological Survey is tasked under statute to investigate and report on the natural resources of the state. We are established as a research unit of the University of Kansas to bring unbiased and scientifically sound expertise to bear on resource issues.

Our role in the Hutchinson situation began the day after the trailer park explosions when it became known that geological investigations were needed. We served initially as geologic advisors to KDHE. When many of the early vent wells turned out to be dry holes, it became clear that complex geologic conditions were likely controlling the pathways and accumulations of the gas. Our work consisted of:

- Determining what layers might serve as geologic conduits for gas under the city;
- Compiling subsurface information on the shape and nature of the geologic layers;
- Compiling information on sinkholes and subsidence in the Hutchinson area;
- Examining rock cores from the Yaggy field and surrounding oil and gas fields;
- Examining geophysical wireline logs from wells to identify possible conduits;
- Producing subsurface geologic maps of relevant horizons;
- Developing a geologic model to guide drilling of vent wells and other remediation actions;
- Recommending additional investigative and exploratory steps.

The Kansas Geological Survey has done the following so far:

- Collected, processed, and interpreted a 3.5-mile long seismic reflection line along Wilson Road between Yaggy and Hutchinson, and a _ mile long line at Rice Park;
- Completed specialized computer processing on the seismic data to identify two possible gas-bearing amplitude anomalies (both were drilled and produced gas);
- Created structure contour maps on a variety of geologic horizons using 3700 oil and gas wells;
- Created a detailed structure contour map on the gas-bearing layer using water well and vent well data;
- Identified and correlated the gas-bearing layer on geophysical logs from oil and gas wells and vent wells in the area;
- Compiled reports on the history of subsidence in the Hutchinson area;

- Examined well cores to determine the geologic origin of the gas-bearing layers in order to predict possible pathways, including the Atomic Energy Commission core in Rice County;
- Acquired, digitized, and processed sonic well logs to create a synthetic seismogram to correlate the seismic lines to the wells;
- Calculated that there are geologically feasible conditions under which high-pressure gas could have traveled 7 miles underground in a few days;
- Examined outcrops in the region that might be equivalent to the gas-bearing layer;
- Advised the Groundwater Management District on a groundwater-monitoring program;
- Analyzed brine samples from the geysers for inorganic materials for source studies;
- Considered the potential for subsidence due to collapse of brine well caverns;
- Produced digital orthophoto quadrangle air photos for plotting data;
- Briefed federal, state, and local officials on the geology;
- Briefed U.S. Department of Energy and NASA; discussed cooperative efforts;
- Organized a one-day technical meeting for involved parties to plan further geologic investigations;
- Worked with KDHE, Kansas Gas Service, and the City of Hutchinson to recommend drilling locations, core locations, and types of logs to run; and
- Responded to scores of inquiries from citizens, consultants, attorneys, and the news media.

We have found that:

- The gas is confined to a relatively thin geologic layer at the top of the Permian-aged (approximately 250 million years old) Wellington Shale, about 200 feet above the Hutchinson Salt Member;
- The regional dip of the deeper rock layers is to the west, meaning that, all other factors being equal, gas would move in general to the east (because methane is lighter than water, it will tend to move updip – from lower to higher areas - through rock);
- The large number of vent wells that are dry holes suggests that the gas pathways are discrete and cover a relatively small area under the city;
- The seismic amplitude anomalies were drilled and found to contain gas; each is about 150-200 feet across;
- The gas-bearing layer may contain narrow belts of a particular type of rock that is preferentially fractured;
- There are anticlines present (rocks folded into an arch) that could serve to direct gas along their crests; and
- There are deep faults or fractures (many thousands of feet deep) that appear to control the orientation of the Arkansas River channel and may have controlled the location and orientation of geologic deposition during the Permian period as well.

What investigations need to be done to return confidence to Hutchinson and ensure that this cannot happen again?

- Determine which of these factors or combination of factors is responsible for the gas moving under Hutchinson: pathways along buried channels or similar sedimentary features; along structural dip or anticlines; along fractures and faults; or along some combination of these features;
- Verify that the vent wells have adequately drained all the pockets of gas;
- Monitor water wells for contamination;
- Locate abandoned brine wells drilled from the late 1800s onward;
- Evaluate gas accumulations in the surrounding areas;
- Establish base line studies in the event of subsidence;
- Identify other potential gas pathways.