2006 ITGUAM

High Resolution Seismic Reflection Investigations for Salt Dissolution Features in Kansas

By

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What is Salt Dissolution?

- Removing the natural occurring salt layers by the addition of fresh water.
Salt Dissolution Features in Kansas

- Dissolution Front
- Salt Mine Activities
- Oil Production
Investigative Procedures Using High-Resolution Seismic Reflection Techniques

Goal: delineate subsurface expressions of sinkholes or paleo-sinkholes
- lateral extent
- locate and estimate size of void areas
- identify bridging or slump
- preferential growth directions
- evidence for catastrophic failure
Acquisition Parameters

- 240-channel fixed spread
- 2.5 m receiver station spacing
  - Two 40 Hz geophones
- 5.0 m source station spacing
  - IVI Minivib
    - 25-250 Hz
    - Three 10 second sweeps
A 240-channel fixed spread allowed the recording unit to remain stationary while the source traversed about 600 m of line.
Receivers set in the base of the ditch with the source on the road shoulder.
Approximately 10 Gigabytes of information is collected each day! Data is recorded unfiltered and unstacked.
High Resolution Seismic may have not been developed for finding sinkholes but the end result is the same.
Kansas Projects

- US-50 and Victory Road
- US-50 Hutchinson South Bypass
- US-61 from Hutchinson to McPherson
- I-70 Crawford and Witt Sinkholes
- US-54 Interchange Between Goddard and Wichita
Looking Northwest from the Project Site!
I-70 Sinkholes

Salt Member is 270 feet thick and approx. 1300 feet below I-70

I-70 has dropped over 20 feet and continues to sink at over 4 inches per year.
Cross-section of the Crawford Sink, drawn after the initial deep study in 1967.
Thousands Are Spent, But I-70 Still Sinks

By TED BLANKENSHIP Energy Editor

Thousands of dollars have been spent on a one-mile stretch of I-70 in western Kansas, and still it sinks steadily into the ground, petroleum geologists were told here this week.

“We have spent what amounts to $1,000 a week over the past five years on that road,” said Robert F. Walters of Wichita. “And none of the money has gone into causes (of why it's sinking).”

Walters, who operates his own drilling company and is a consultant to the Nuclear Regulatory Commission, spoke to delegates to the American Association of Petroleum Geologists Mid-Continent Regional Meeting in the Broadview Hotel.

He quoted Virgil A. Burgat, chief geologist of the Department of Transportation, who had told the meeting earlier that the stretch of road six miles west of Russell still is sinking at a constant pace.

Walters, who has made a study of salt formations for the old Atomic Energy Commission, says improperly plugged oil and gas test holes allow salt in the area to be dissolved, and the dirt and rocks above simply drop down to fill the void.

The road problem in particular is caused by uncased aquifers (water bearing rock, sand or gravel) above the salt in the old Gorham oil field west of Russell.

THE GORHAM FIELD lies within a five-county area comprising the Hutchinson Salt Member. In this area — Barton, Rice, Ellsworth, Russell and Lincoln counties — salt is found in beds up to 400 feet thick.

Over the past 75 years or so, more than 72,000 oil and gas test holes have been drilled through this salt, Walters said, with the remarkable result that only seven sink holes have developed because of a failure of the salt beds.

It just happened that an interstate highway was built over one of those failures.

Walters doesn’t have a solution for damage already done nor does he know what to do about all the unknown old wells that may be eating away at the salt beds. He has definite ideas, however, for preventing future damage.

IN THE CASE OF the Gorham field,
Sinkholes grab highway; can Kansas be far behind?

By Cindy Schwartz
Kansas Correspondent for The News

TOPEKA — Will some Kansans, as some Californians have been known to do, begin to worry about the earth dropping out from under them?

Probably not. But then if you live in an area underneath which lies salt deposits and where oil wells have been drilled — as a good majority of central and western Kansas — the chances are always there.

In fact, the Kansas Geological Survey meeting in Topeka Tuesday with three other state agencies in an attempt to pool information and expertise as to what to do about a current concern, indicated in the future there may be some information available warning of potential hazards.

But the current concern of the geological survey, Kansas Department of

it salt leaving what the experts refer to as a “void.”

While the focus of their problem is in the Russell area in what is known as the Gorham oil field, the situation is not restricted to that area. Kansas Geological Survey teams have recently discovered what they believe a similar situation in the McPherson area near the town of Conway.

The immediate concern of those in the Russell area, is the bottom falling out of a stretch of I-70 or a bridge which spans it, collapsing.

KDOR officials continue to emphasize they don’t believe the likelihood of either happening is great, “we think it’s going to continue to subside and that will be it.”

But to satisfy themselves and gather possible information for the future, the group has agreed to begin

“As long as you’re going down you might as well plug,” he said.

The age of the wells was one angle the experts hoped might lead them to draw conclusions about other potential sink holes.

Some believed that plugging methods — filling the holes with mud and cement — might not have been as effective prior to the 1950s.

However, a sink hole which developed this summer in Ellis County almost discounted that theory because the oil well there was drilled in 1962 and plugged in 1970.

Two of the wells in the Russell area were plugged in the 1940s and the other in the late ’50s.

Another earlier conclusion which the Ellis well might have discounted was that surface material was usually thought to loosen prior to the sudden collapse of the land, but that did not
Hutchinson Salt and Site Map and Victory Road Seismic Lines
Sinkhole on US 50 Near Hutchinson

- Intersection US 50 and Victory Road
  - 1998 subsidence measured @ 30 cm below grade at centerline
  - 2001 subsidence measured @ 1 m below grade at centerline & 100 m in diameter
  - Averaging about 20 cm/yr
  - Centered a few 10s of meters to the NW
- Two orthogonal, 1 km seismic profiles
Several episodes of subsidence
Characterized by both normal and reverse type faults
Bridging and undercompacted (relative)
Interpreted North/South Profile

- Constrained to small fault-defined area
- Aborted subsidence feature
- Dormant paleosinkhole
Conclusions

- No compelling evidence to suggest risk of catastrophic subsidence

- Subsidence will continue in this area for many years into the future, as it has for at least the last million years.

- Growth to the west should be expected @ vertical rates of 10 to 20 cm/yr
US-50 South Hutchinson Bypass
US 61 from Hutchinson to McPherson

26 miles of new 4-lane highway across the solution front of the salt.
Approximate Location of the Dissolution Front
Let's start at the beginning when you *ADD* something, you increase what you have. You combine.

I don't want to learn this! It's completely irrelevant to my life!

This isn't irrelevant. Everyone needs to know this.

I don't! I can get along fine without math!

Oh yeah? What do you want to be when you grow up? Every job requires some math.

That's not true! I'll be a... a...

A geologist! Yeah!

That's not really a job.
Any Questions?