PS The Use of Iodine Surface Geochemistry Integrated With Seismic and Subsurface Geology to Find Conventional Reservoirs in the Mid-Continent USA*

Steven A. Tedesco[1]

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Abstract

Surface geochemistry has been used for a 100 years to assist in exploration and discovery of conventional reservoirs. Iodine surface geochemistry was developed by the Russians to help minimize seismic costs. Iodine is a halogen that has a strong affinity to cracked hydrocarbons. Detecting halogenated organic compounds associated with underground hydrocarbon spills is common practice in the environmental industry. While any form of geochemical surveys cannot establish depth of pay, quality of reservoir or volume of hydrocarbons present it is a very useful as a screening tool to determine if a geologic concept or a 3D seismically defined structure or stratigraphic may contain petroleum. The general consensus within the industry is surface geochemical tools are very effective in determining the absence of petroleum in relation to a geologic concept, field extension or seismically defined target. Integrated with seismic, aeromagnetics and subsurface geology, iodine surface geochemistry adds to the explorationist's ability to reduce risk and increase exploration success. Examples will be presented from the Mid-Continent USA where iodine surface geochemistry successfully predicted both production and dry holes.

Reference Cited

Leaver, J. L., and M. R. Thomasson, 2002, Case studies relating soil iodine geochemistry to subsequent drilling results: in D. Schumacher and L. A. LeSchack, eds., Surface Exploration Case Histories: Applications of geochemistry, magnetic, and remote sensing: American Association of Petroleum Geologists, Studies in Geology No. 48, and Society of Exploration Geophysicists, Geophysical Reference Series No. 11, p. 41-57.

The Use of Iodine Surface Geochemistry Integrated With Seismic and Subsurface Geology to Find Conventional Reservoirs in the Mid-Continent USA

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Running Foxes Petroleum Inc.

ABSTRACT:

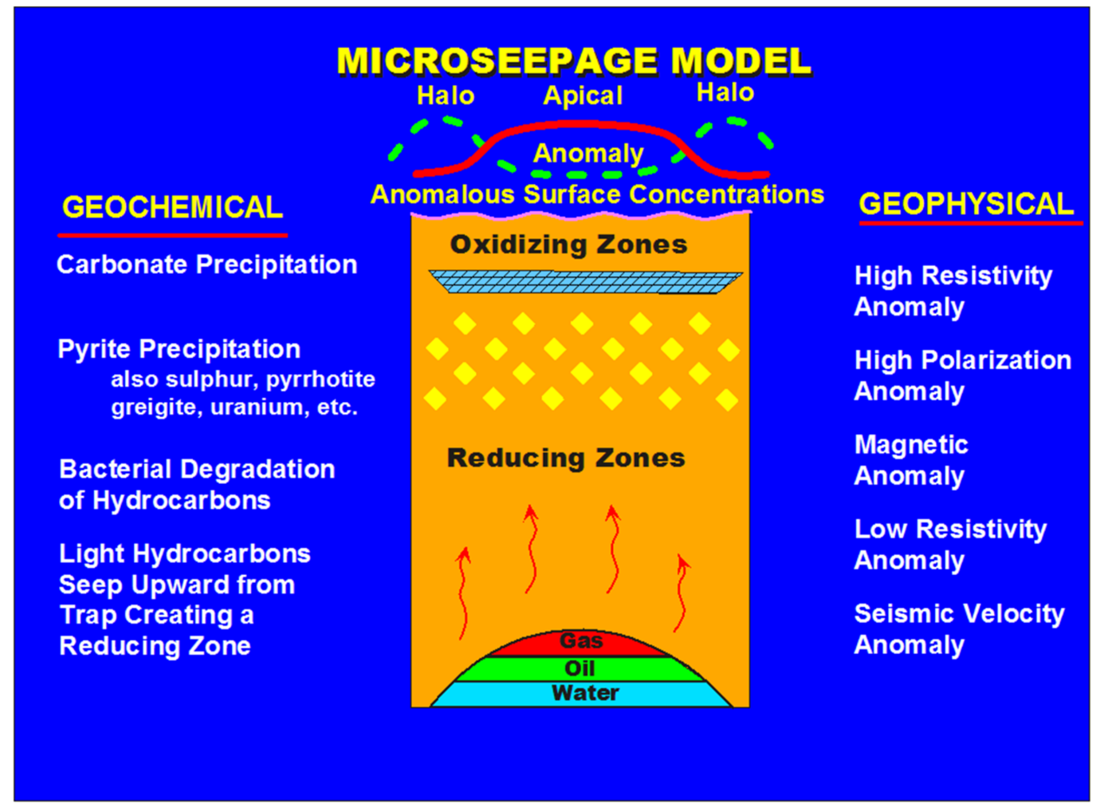
Surface geochemistry has been used for a 100 years to assist in exploration and discovery of conventional reservoirs. Iodine surface geochemistry was developed by the Russians to help minimize seismic costs. Iodine is a halogen that has a trong affinity to cracked hydrocarbons. Detecting halogenated organic compounds associated with underground hydrocarbon spills is common practice in the environmental industry. While any form of geochemical surveys cannot establish depth of pay, quality of reservoir or volume of hydrocarbons present it is a very useful as a screening tool to determine if a geologic concept or a 3D seismically defined structure or stratigraphic may contain petroleum. The general consensus within the industry is surface geochemical tools are very effective in determining the absence of petroleum in relation to a geologic concept, field extension or seismically defined target. Integrated with seismic, aeromagnetics and subsurface geology, iodine surface geochemistry adds to the explorationist ability to reduce risk and increase exploration success. Examples will be presented from the Mid-Continent USA where iodine surface geochemistry successfully predicted both production and dry holes.

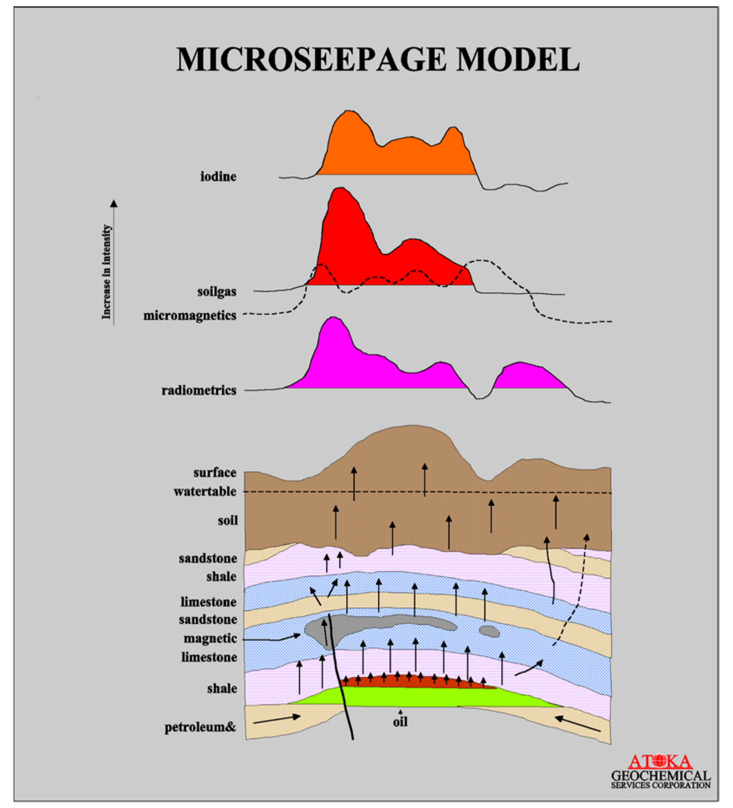
1

Microseepage Model

Surface geochemistry is based on the microseepage model of hydrocarbons leaking from any accumulation at depth and migrating to the surface. The hydrocarbons migrate along fractures, disconformities, uncofomities, lithologic boundaries, etc. The migration tends to be near vertical based on numerous case histories. The hydrocarbons in the soil section cause a vaiety of changes in terms of pH, Eh, conductivity, increase and decreases in radioactive minerals, increases in iodine and other halogens, depostion of magnetic minerals, petroleum consuming bacteria, and formation of carbonate compounds. Changes have also been noted in various rock layers above the petroleum accumulation such as increase presence of magnetic and carbonate minerals and increases in iodine.

These changes can be measured by a variety of methods. These changes are ongoing in the soils and will vary through time.





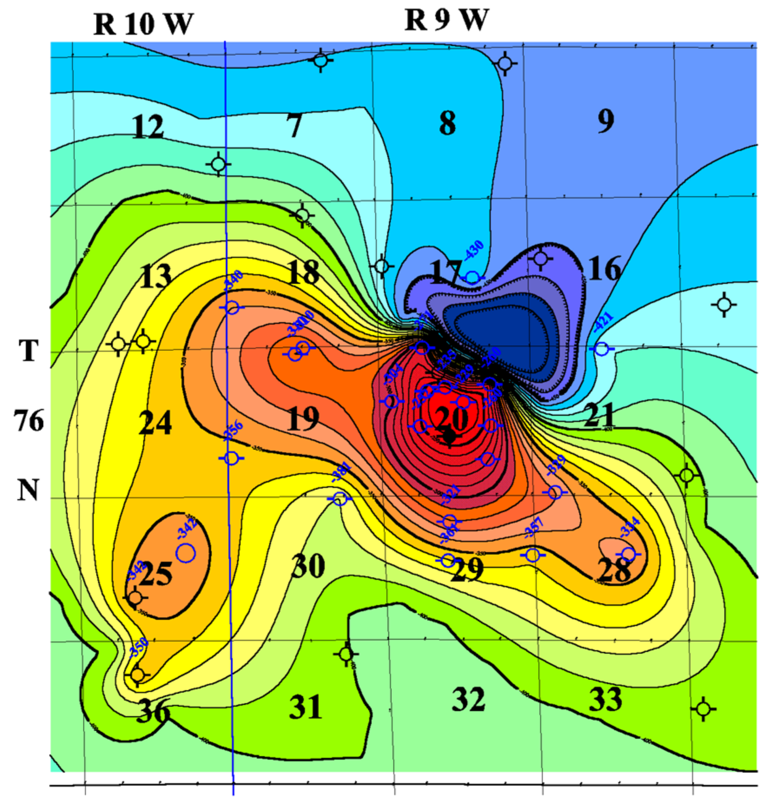
Proof of Concept

2

Keota Natural Gas Storage Facility
Washinton Co., Iowa, Forest City Basin

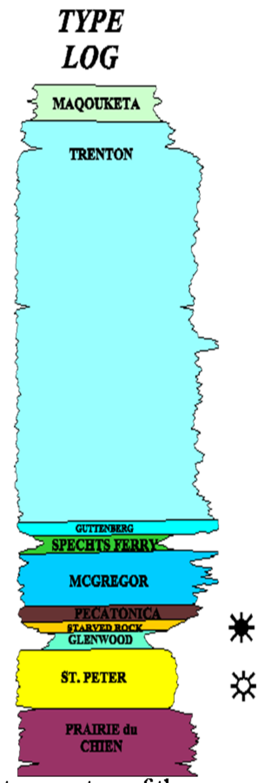
The Keota Natural Gas Facility stores gas in the St. Peter (Simpson) sandstone (Ordovician) at 990 feet. The reservoir Is capped by the Decorah and Platteville carbonates and carbonaceous shales. This in turn is overlain by the Trenton (Viola) Limestone and then the Maqouketa Shale. Most geologists and engineers would rightly assume that these rocks would be sufficent to create a seal for the reservoir.

However, there is leakage in minor amounts of hydrocarbons that can seep through and migrate into the soil section.



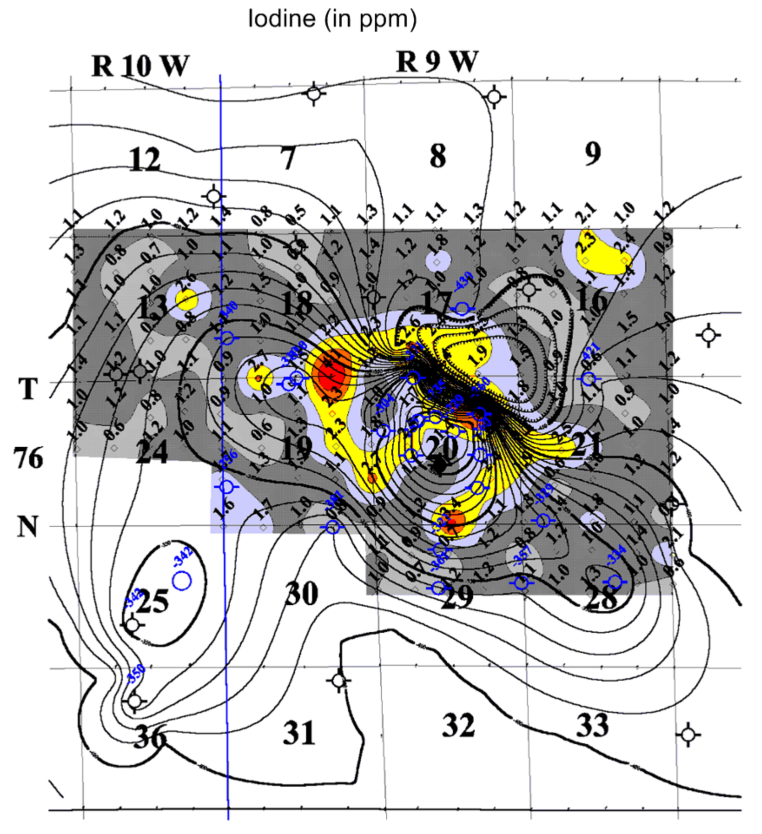
The land use in the area is farm land. Samples were collected in the field and within the edges of the field adjacent to the right of way for the roads. The soils were deposited by galciers and are very rich in organic material.

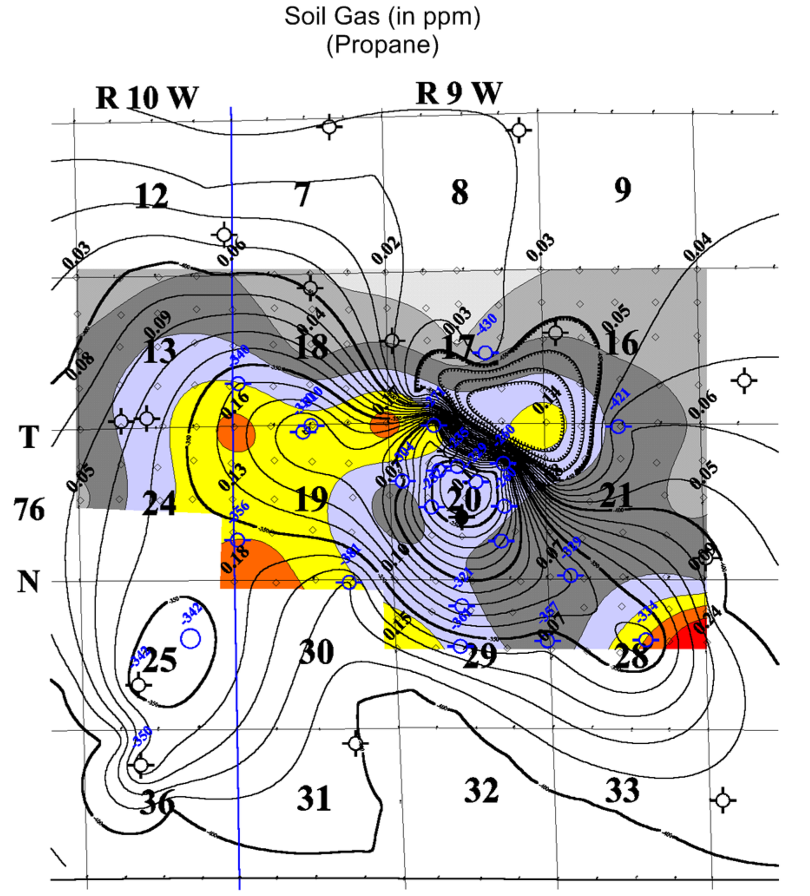
Keota Dome,
Washington County, Iowa



Structure on top of the
Trenton Limestone Ordovician
Depth: 330 meters
Operating Storage: 10 BCF
Reservoir: St. Peter Sandstone

A

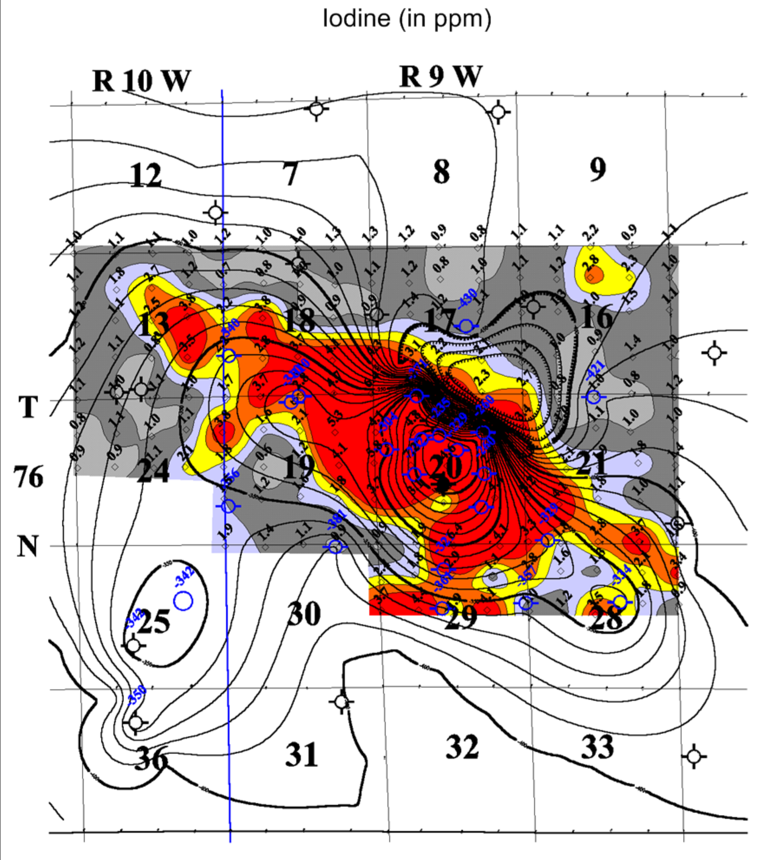


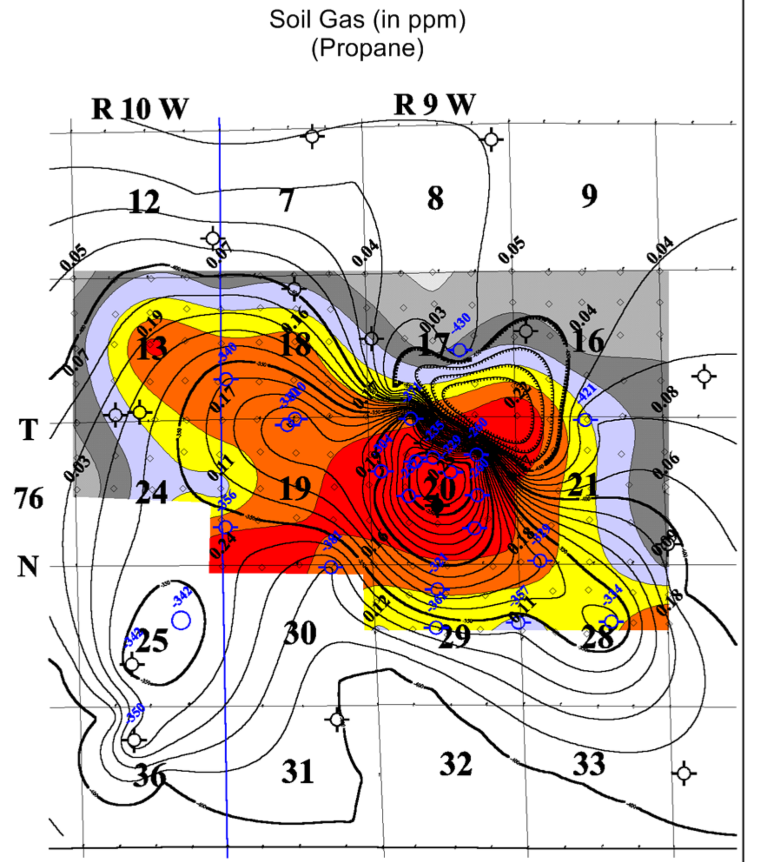


Summer -1988

The storage facility indicates iodine and soil gas anomalies anomalies for soil gas and iodine in association with the Keota Dome. The storage facility at this is generally in a depleted state or being subject to injection of natural gas.

B

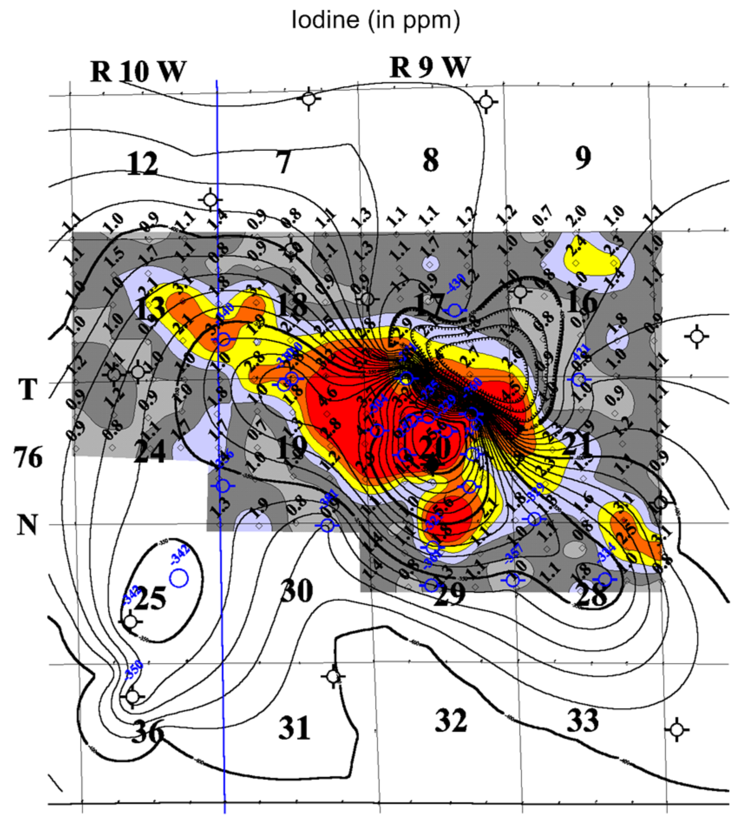


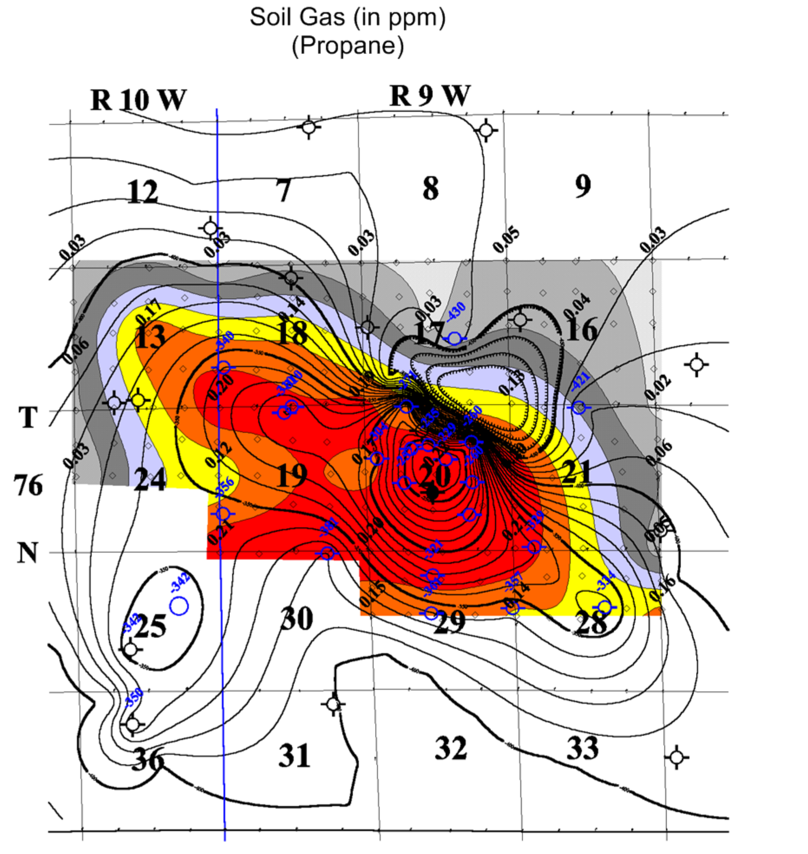


Fall -1988

Gas had been injecting in the storage during the summer. Toward the end of the summer a soil and gas and iodine survey was carried out. The data a large anomaly of iodine and propane over the storage facility.

C

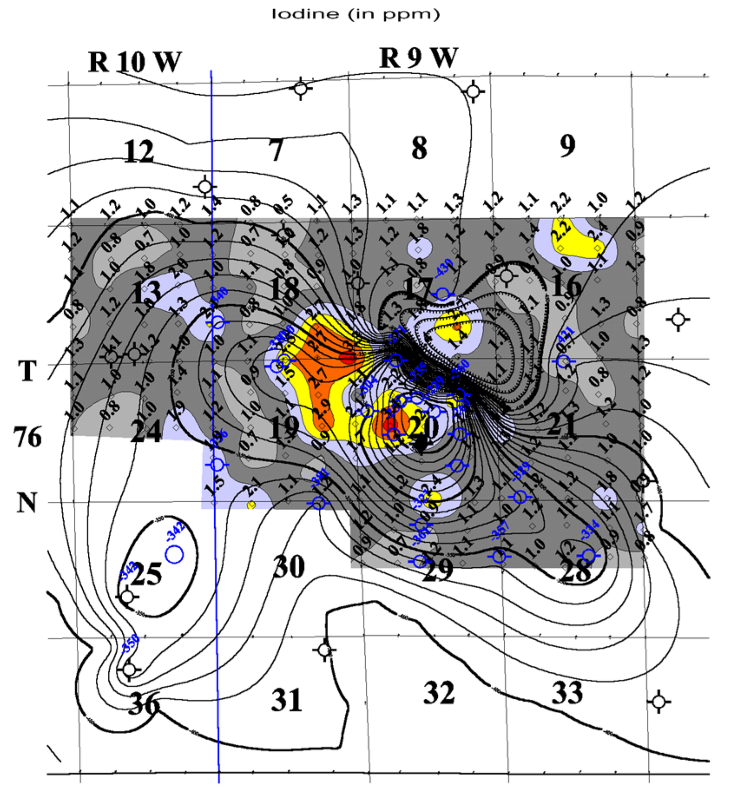


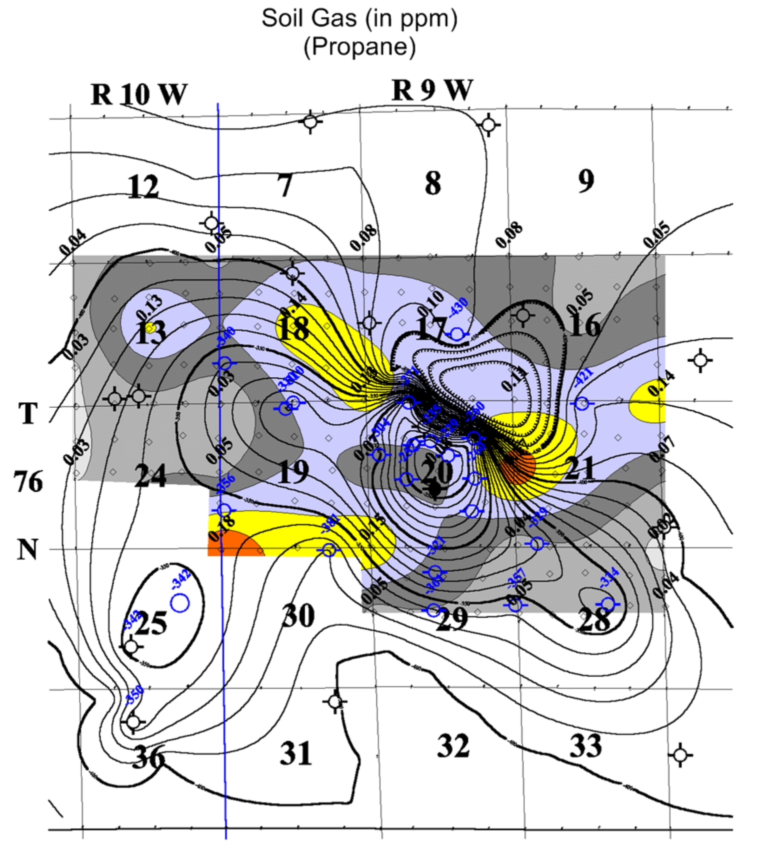


Winter -1989

As gas is withdrawn there is some degradation of the iodine and soil gas anomalies.

D



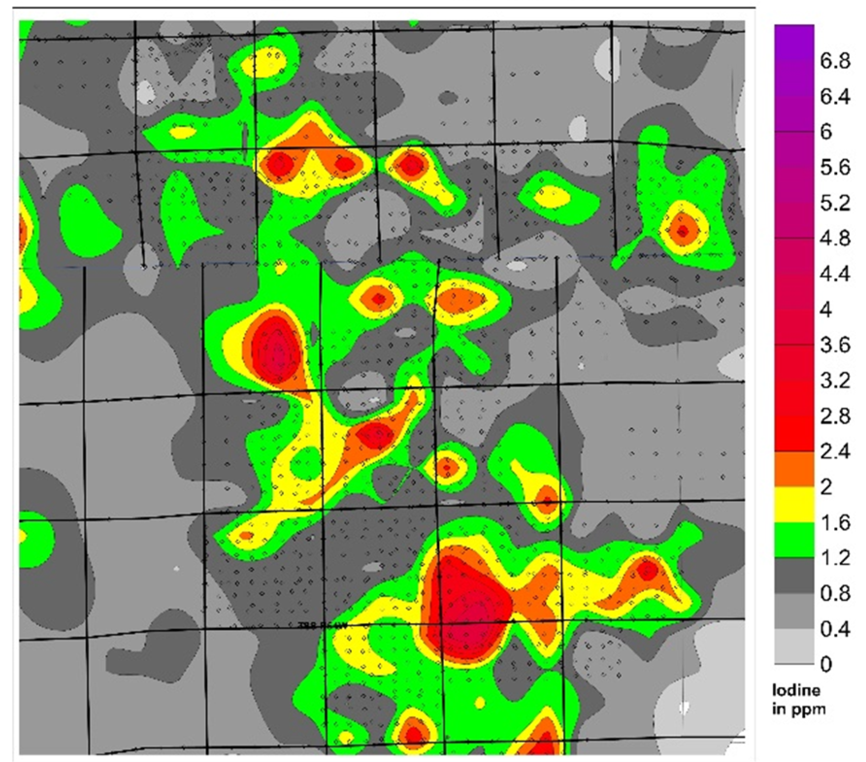


Spring -1989

The reservoir is depleted and back to normal or under pressured conditions.The rapid changes in the iodine and soil gas response indicates that the process of vertical migration is relatively quick and it elminates diffusion as a mechanism.

3 Arikaree Creek Field - Iodine and Seismic Success

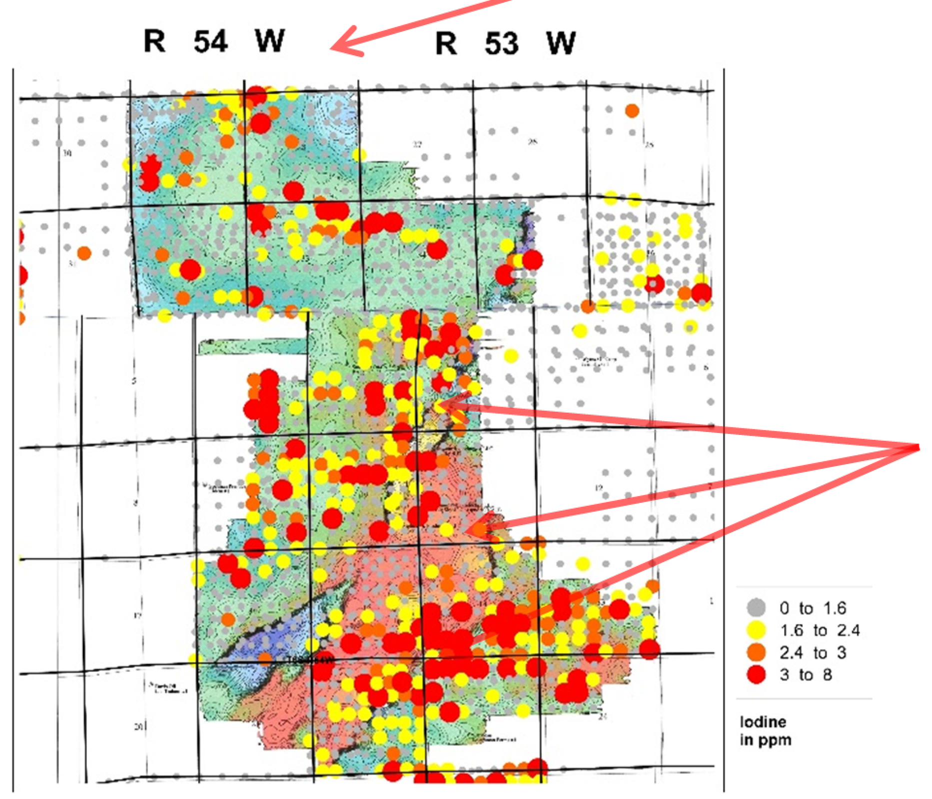
A



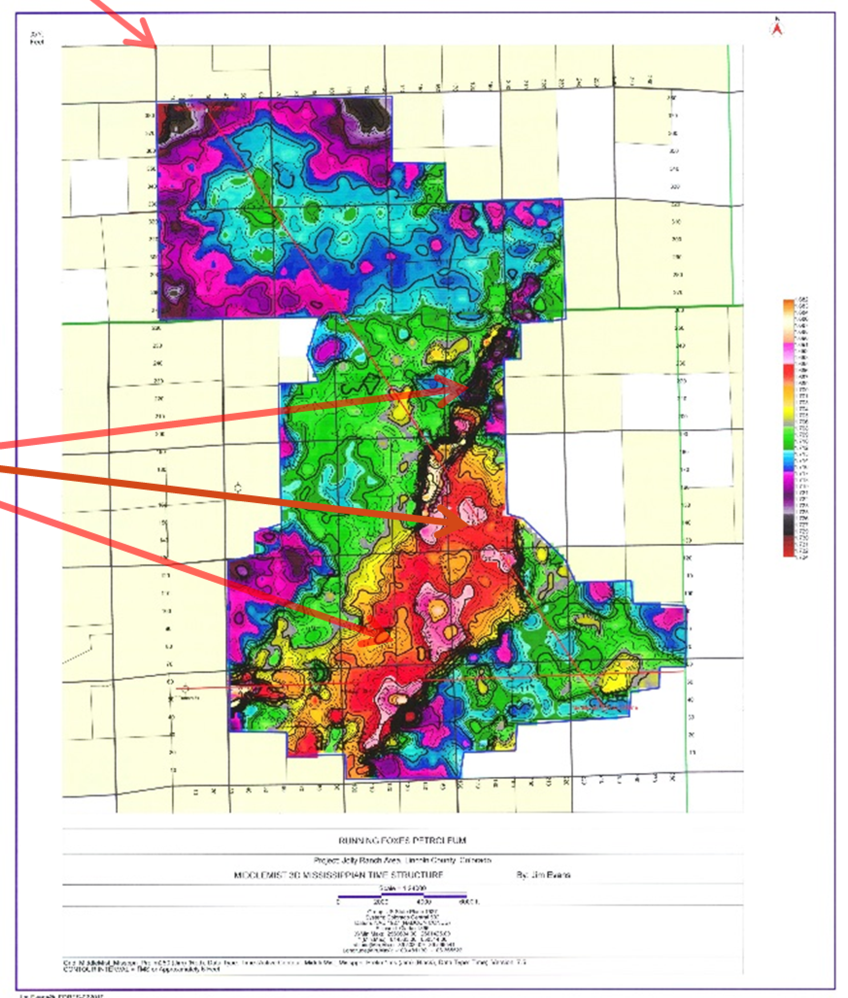
B

3D Outline

Originally preseneted at the AAPG International Conference and Exhibition 2014
September 14-17 Istanbul, Turkey

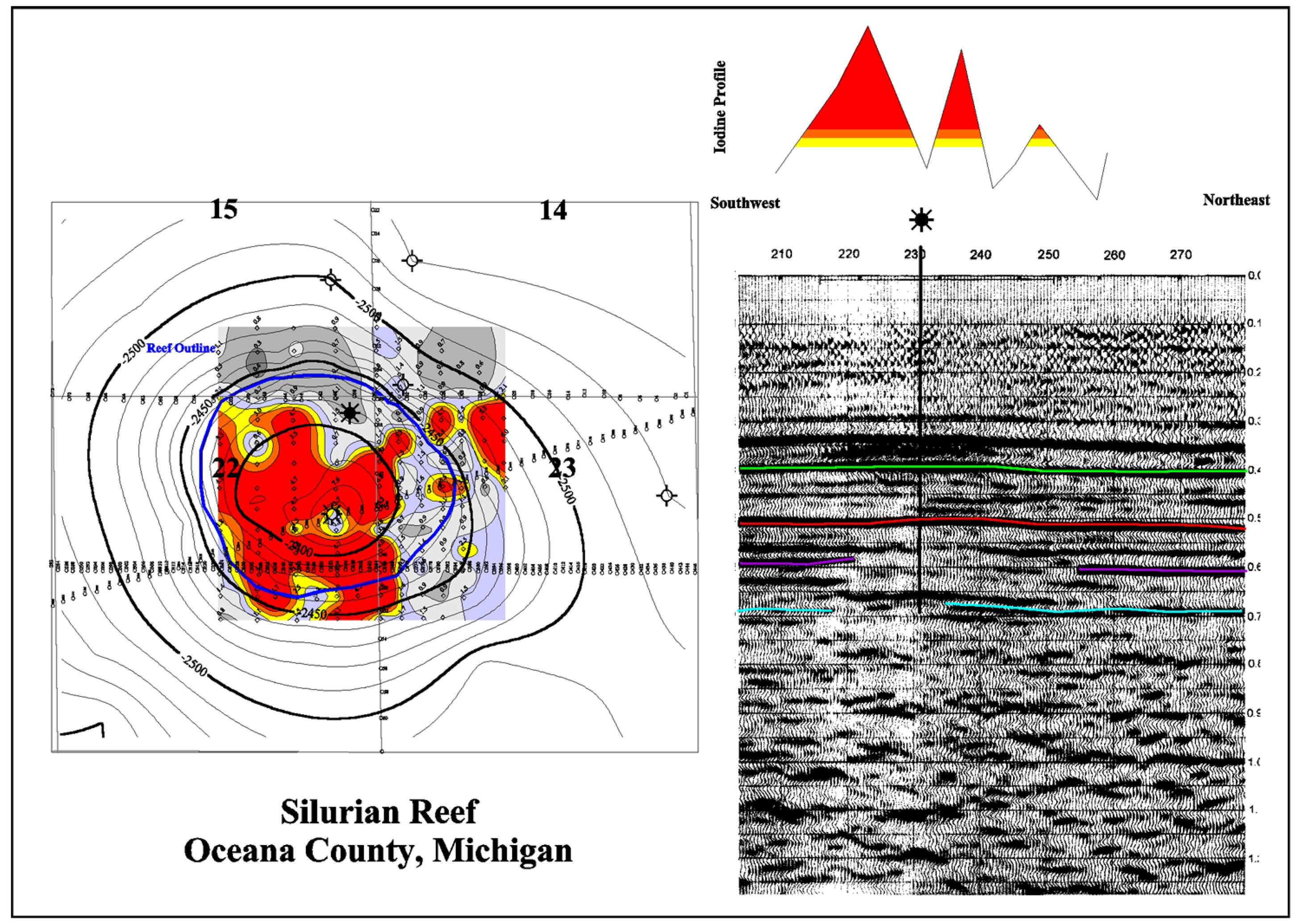


Horst



The Arikaree Creek Field was discovered by iodine and seismic. The iodine survey as contoured in A indicates several anomalies that can be interpreted as both halo and apical. The 3D seismic and iodine survey (classed post interpretation) in B survey indicate a complex that is a wrench fault system. The surface geochemical is typical of a complex structure leaking hydrocarbons. The upper horst the wells flowed 400 BOPD each from the Mississippian.

4



AThis reef in Oceana County was defined by drilling prior to the iodine survey. Based on engineering analysis and seismic interpretation there is an indication that the reservoir was undrained. A development well was not drilled because of the presence of H2S in the gas.

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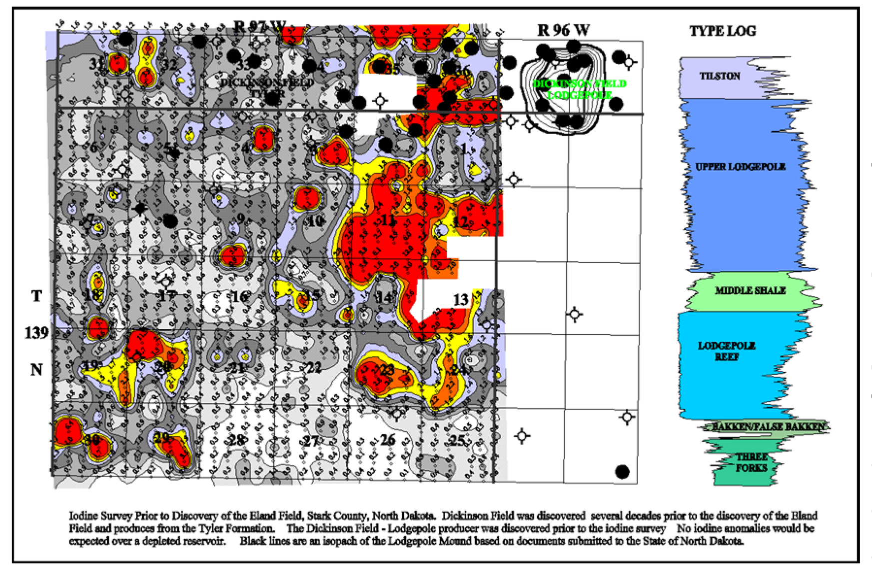
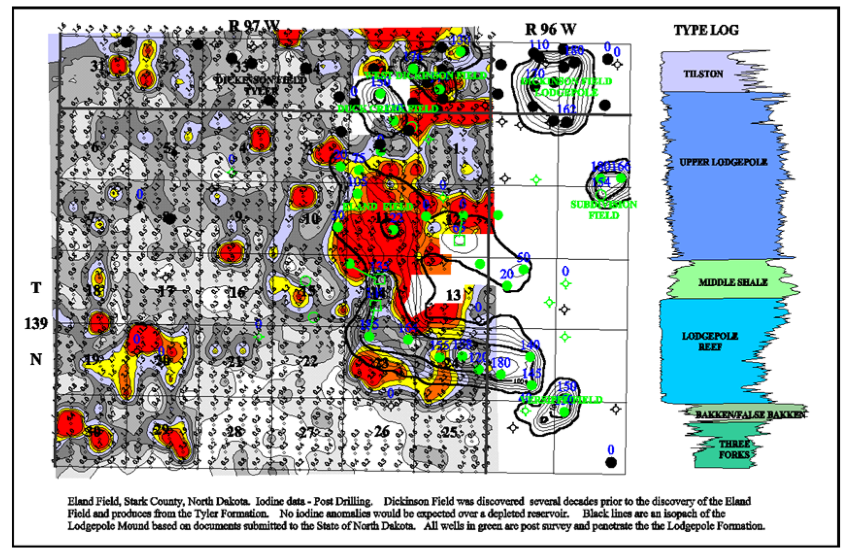
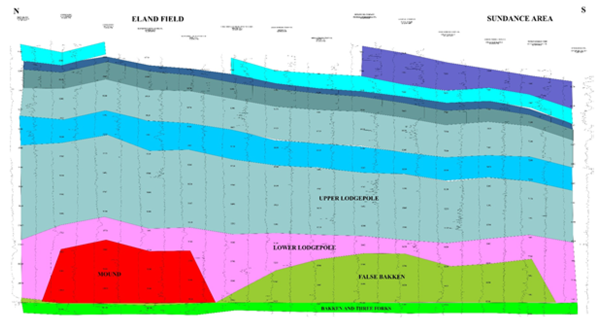


Eland Field Pre-Drilling Stark County, North Dakota, Williston Basin



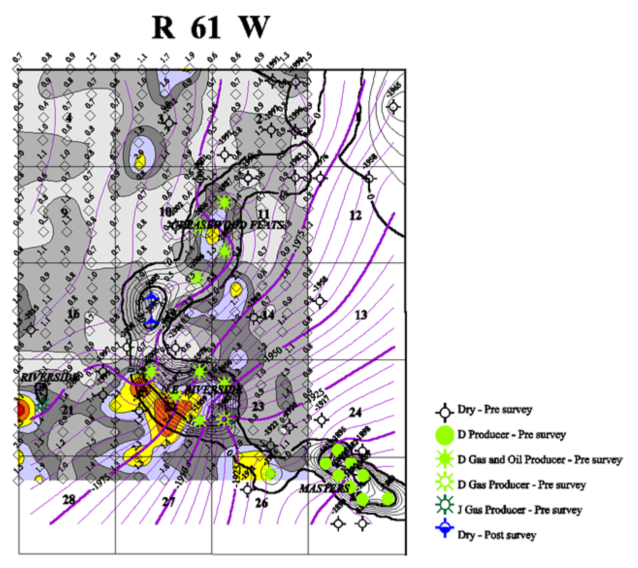
Eland Field Post-Drilling Stark County, North Dakota, Williston Basin

The Eland Field produces from a Lodgepole monud and was discovered using seismic. The iodine survey was done while drilling the discovery well. The existing production in the area has minimal anomalies associated with them. The anomalous indicates both apical and halo effects. The area presently has numerous horizontal Bakken wells. The nature of the Bakken Shale not be conducive to using surface geochemistry to find sweet spots.



Cross-section through the field area

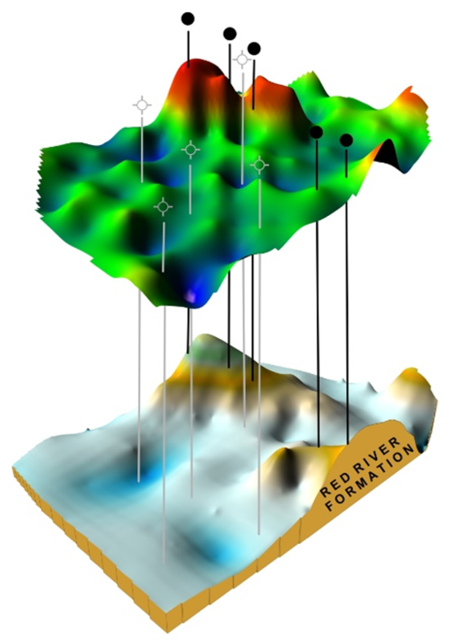
6

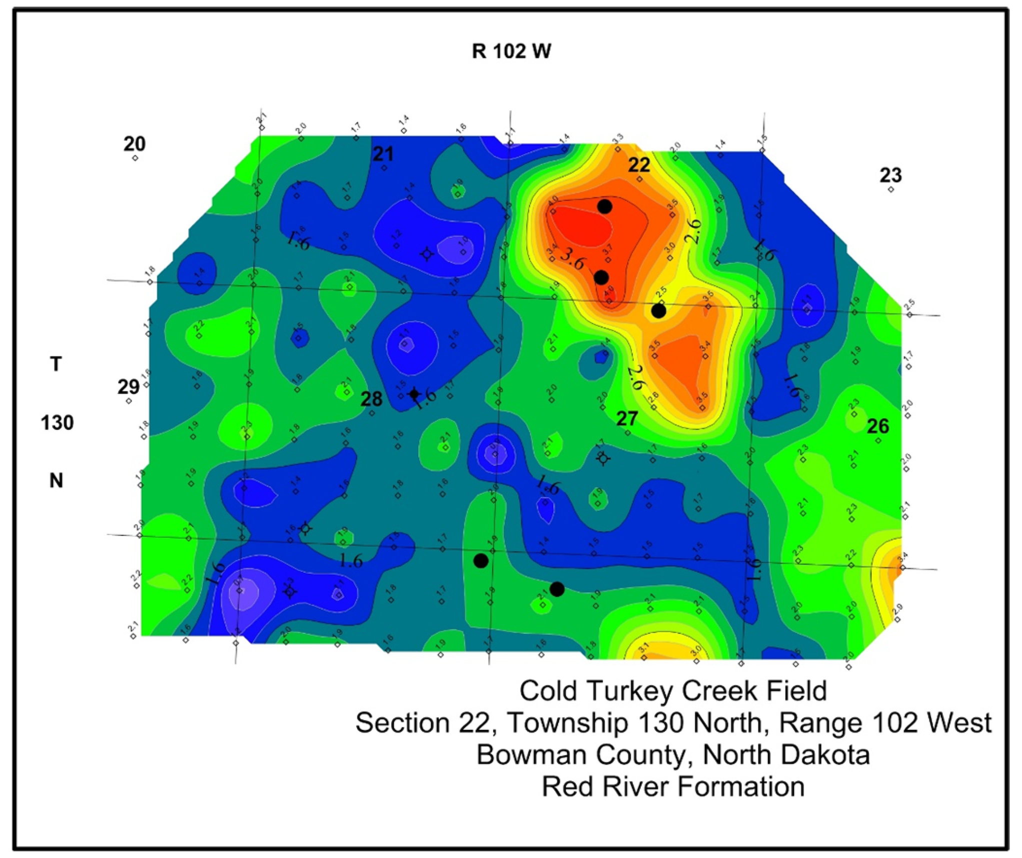


NE Riverside Field Weld County, Colorado, Denver Basin

THe NE Riverside Field is an old reservoir that produces from the D sand. Engineering work suggested that the reservoir being drained was over a much larger area. The iodine survey was run previously to define sandstone bodies along the Greasewood channel trend of which NE Riverside was part. The well successfully found D sand that was oil staurated. A DST run indicated that the reservoir pressure was significantly less than expected reservoir pressure for an undrained part of the field. The lack of an iodine anomaly clearly indicates that the reservoir had been drained over a large area.

7

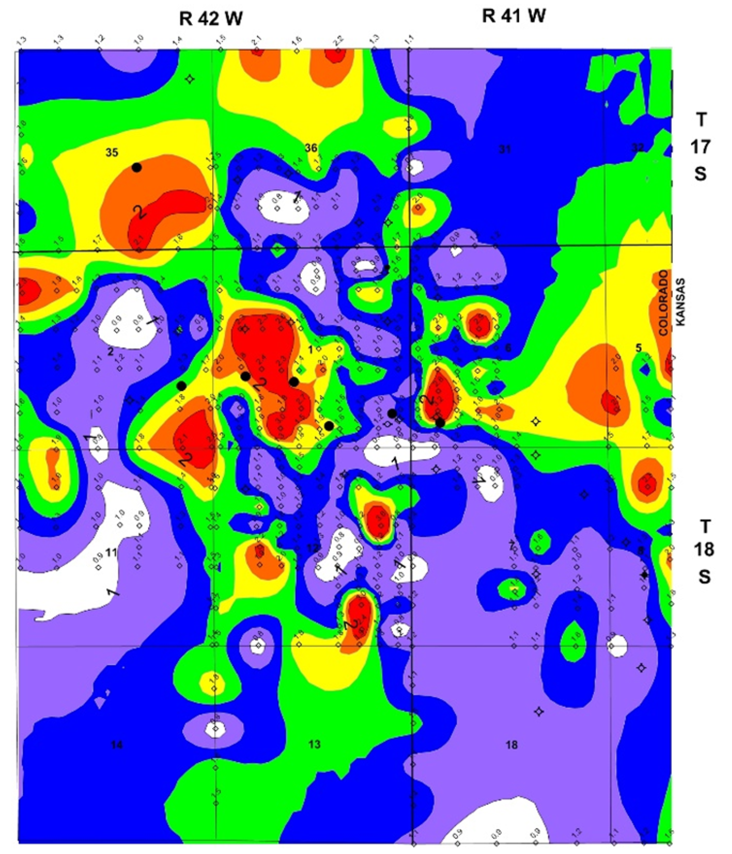




Cold Turkey Creek Field
Section 22, Township 130 North, Range 102 West
Bowman County, North Dakota
Red River Formation

The Cold Turkey Field produces from the Red River (Ordovician) reservoir. The iodine survey was done a few years after the field had been discovered.

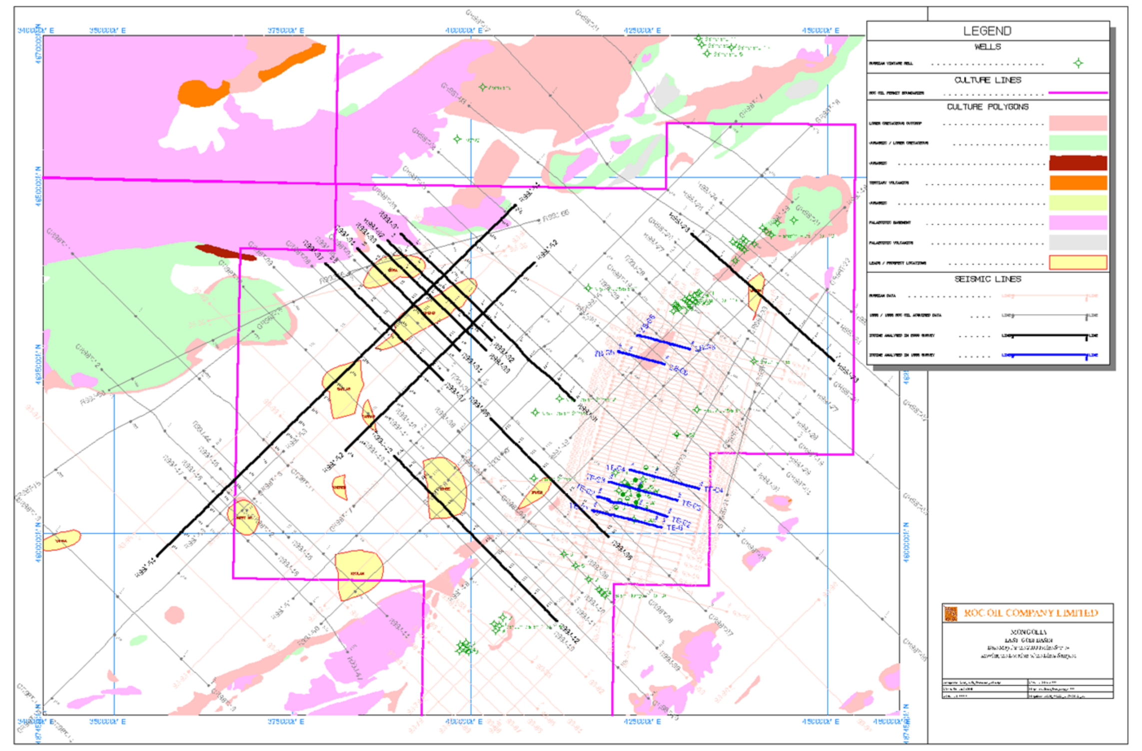
8

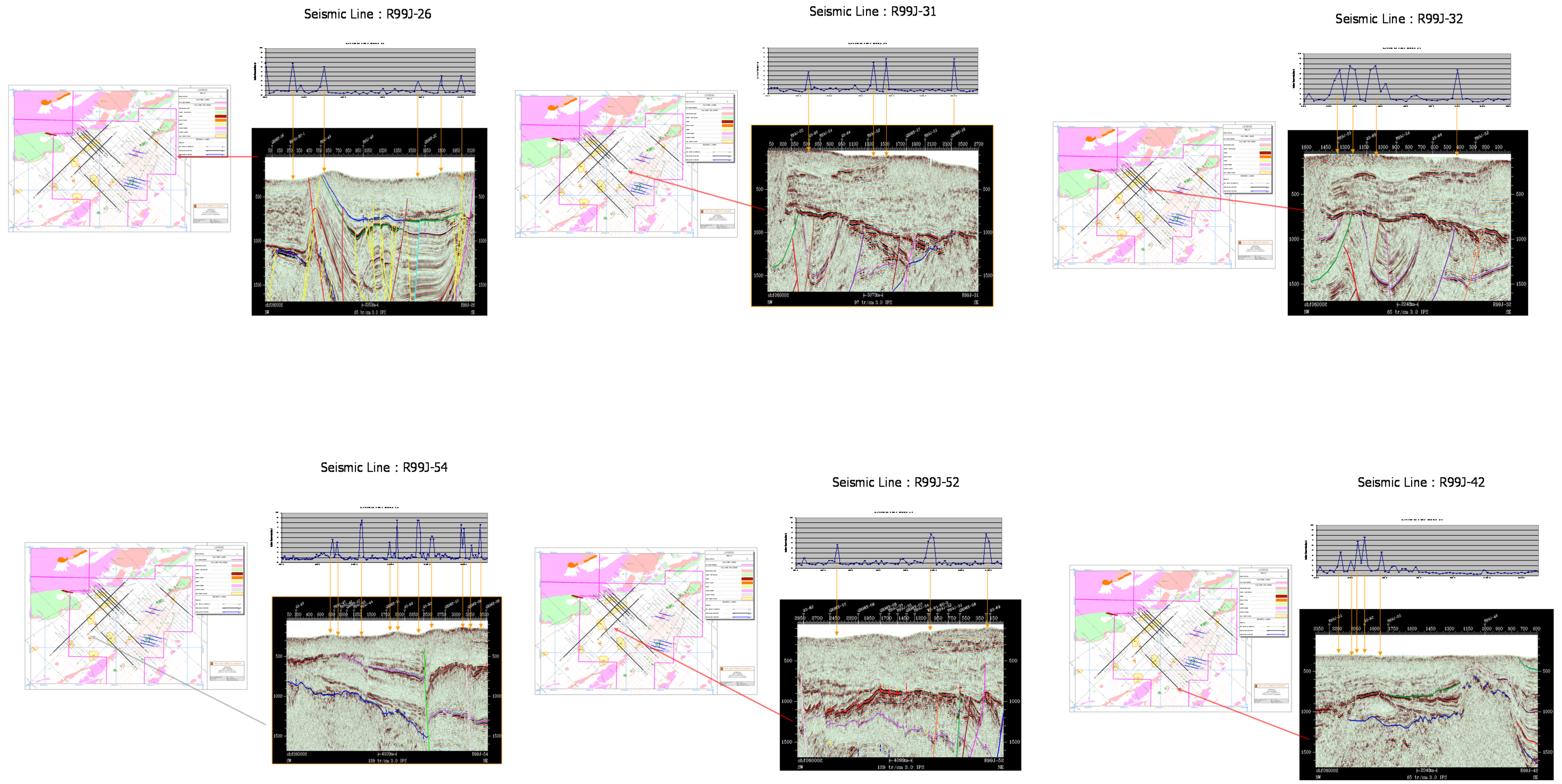


Jace Field
Kiowa Co., CO

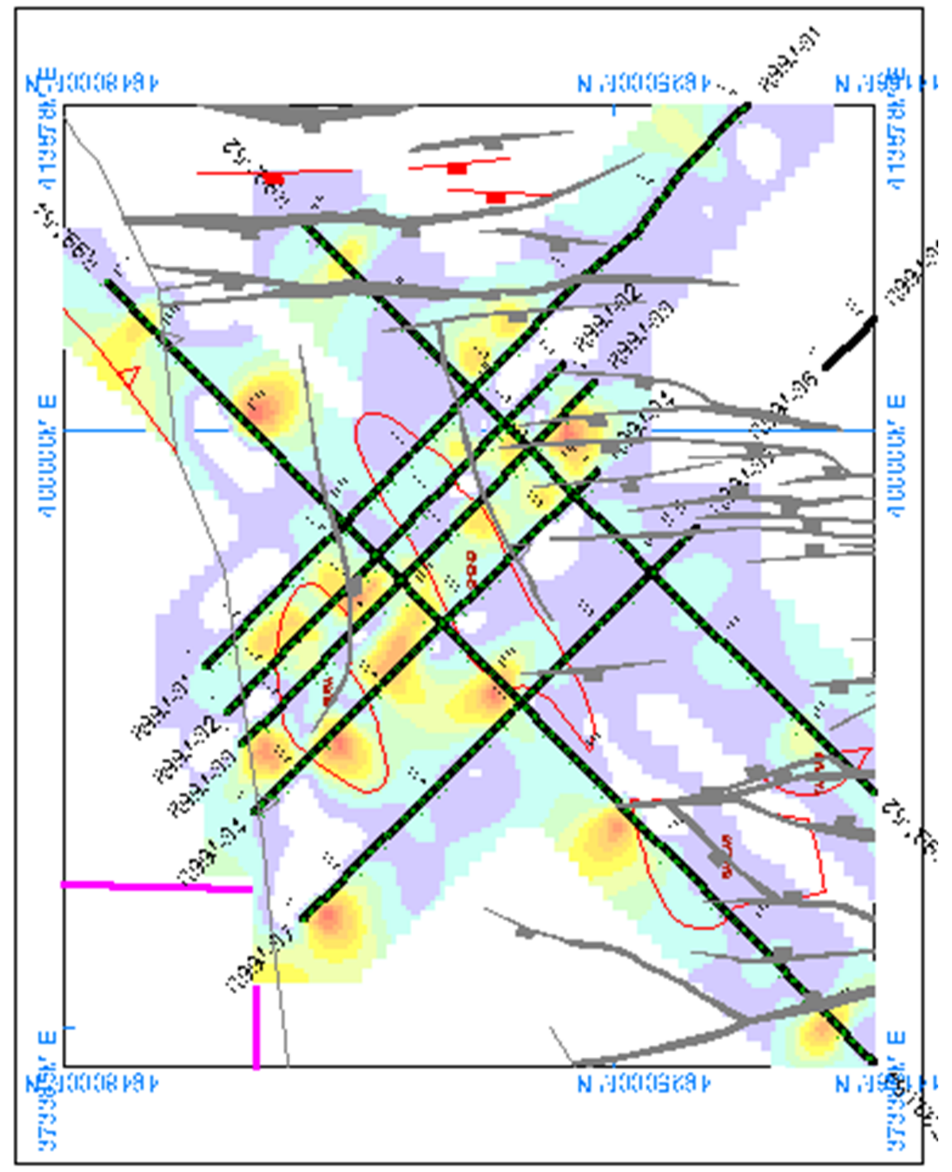
The Jace Field produces from the Morrow (Pennsylvanian) Sand along the Las Animas Arch, Southeast Colorado. The iodine survey was done prior to the field discovery as part of a larger survey.

9 Iodine as a Recon Tool





A recon iodine survey was done along seismic lines Zuunbayan and Unegt basins. The iodine survey was done prior ro drilling. Iodine values along of the lines correlate well with faulting. The iodine survey suggested there was no signficant accumulations where the iodine and seismic survey were done in together. Subsequent drilling resylted in two dry holes.

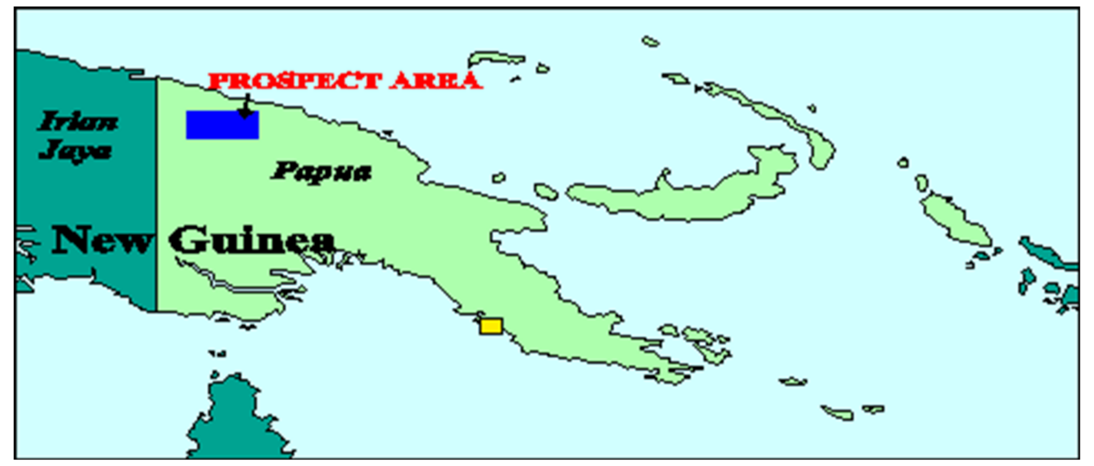


Iodine samples Gridded over the Chono / Buga area with the top Sharlyn faults plotted (Line interval 2000m, grid interval 500m)

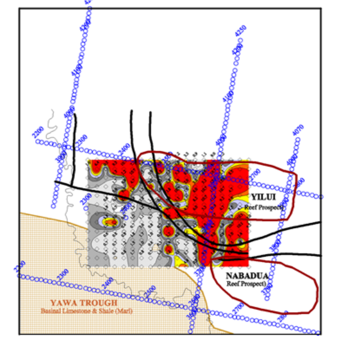
13

REEF PROSPECT

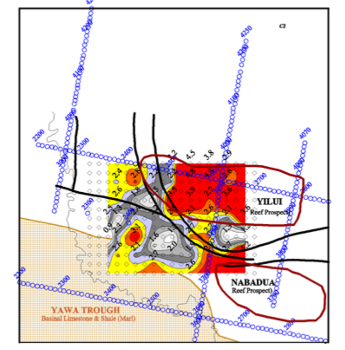
Papua New Guinea

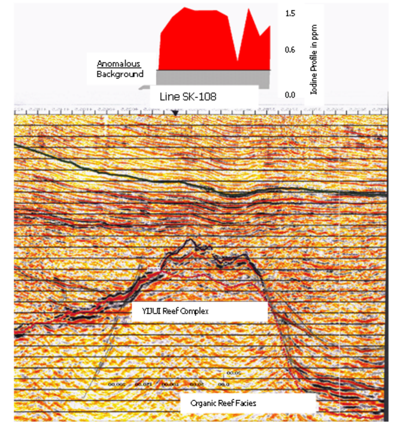


Iodine



Soil Gas





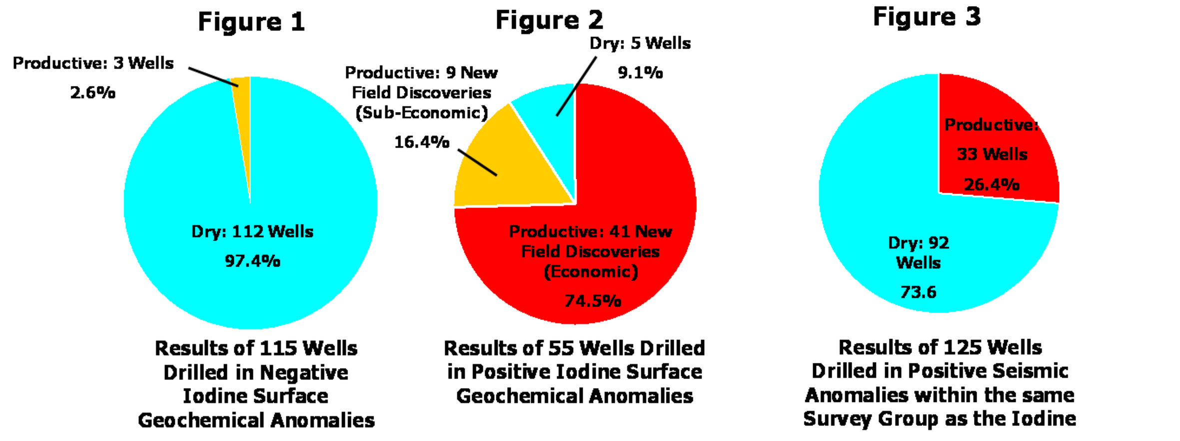
This reef prospect was developed by an independent out of Casper, Wyoming. Soil gas, iodine and microbial methods correlated well with the seismic definition of a Miocene Reef. The prospect was never drilled. Not due to problems with drilling, access, etc. But due to cannibals in the area.

Independent Study by Leaver and Thomasson 2002

AAPG STUDIES IN Geology No. 48/SEG Geophysical Reference Series No. 11, Chapter 3: Case Studies Relating Soil-Iodine Geochemistry to Subsequent Drilling Results

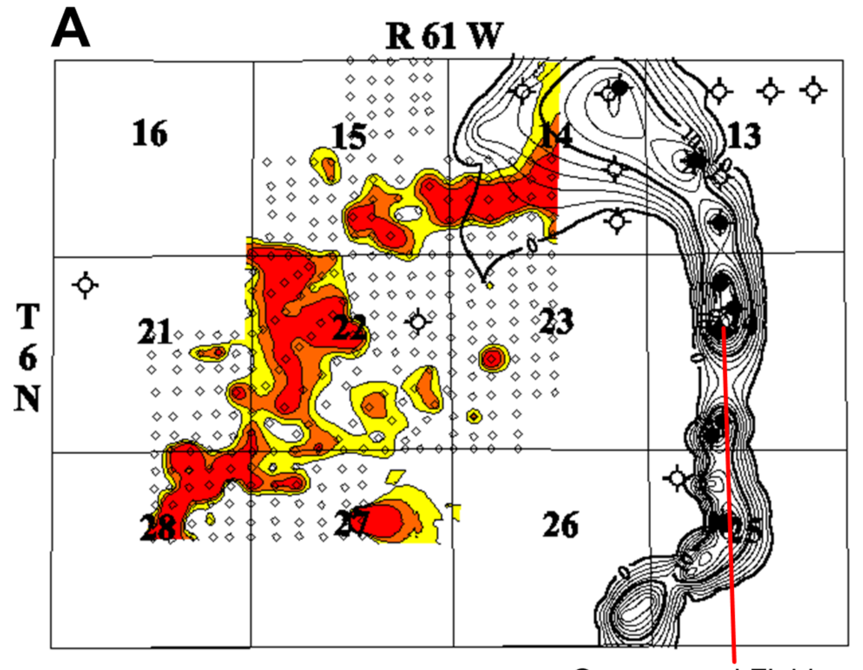
he authors concluded:
That the iodine method predicted 58 wells predicted dry, 53 were dry and 5 were producers;
Of the 32 producers predicted productive, 27 were accurately predicted and 5 were dry;
The study covered surveys in Wyoming, Illinois, New York and Colorado.

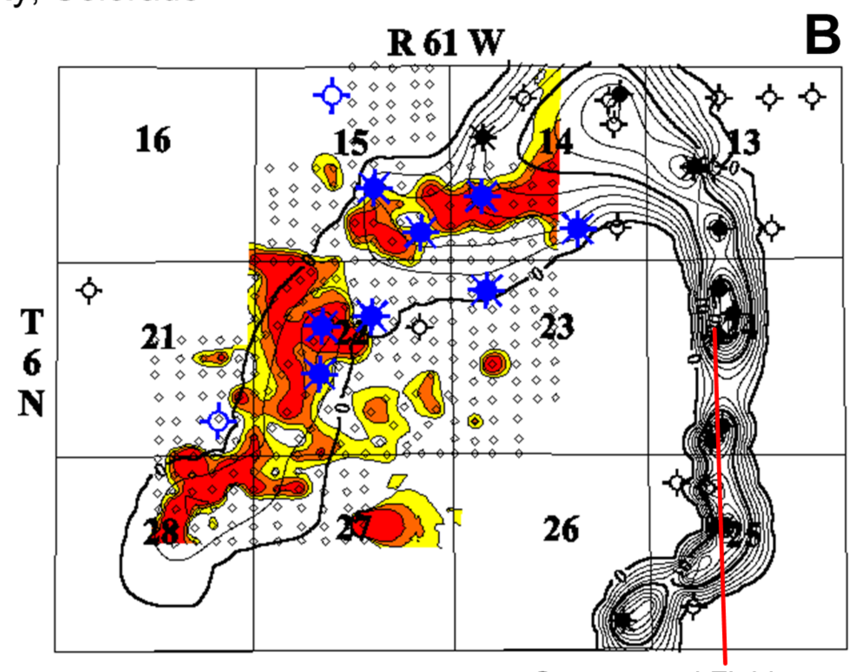
Seven Companies Experience from 1992 to 2001

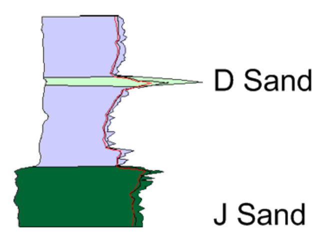


10

Dolley Field
Weld County, Colorado

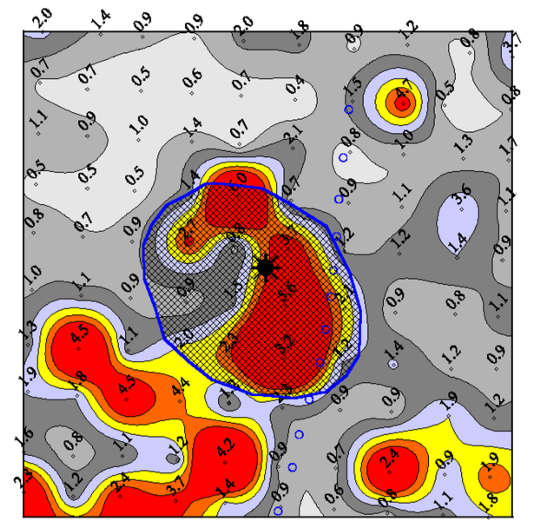




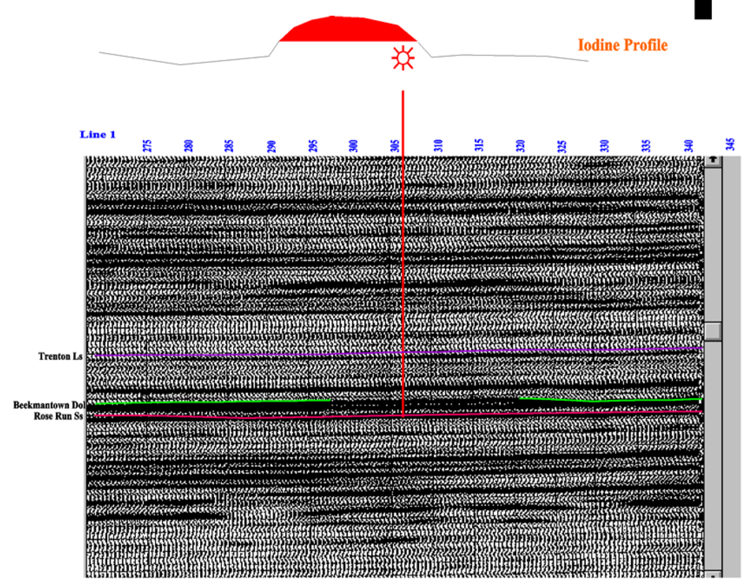


The Dolley Field was discovered using seismic and iodine surveys and it produces from a D crevasse splay. A is the survey done prior to drilling. B is the drilling post survey. The sand is at 7,500 feet. The D zone is one to two feet thick.

11

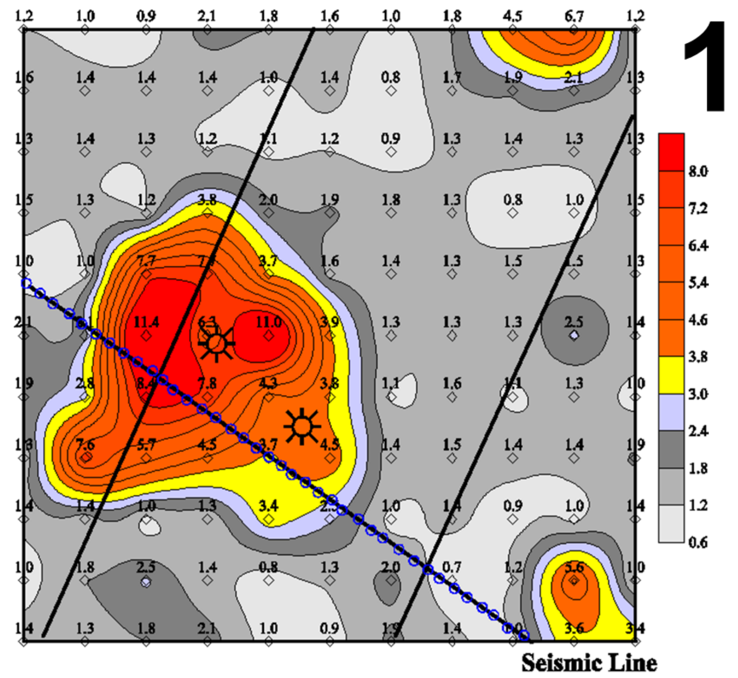


RATLIFF WELL
Vinton County, Ohio



The Ratliff well flowed at 1.4 MMCFGPD. The well produces from an erosional remnant in the Knox Formation. The iodine survey was done prior ro drilling

12



ASHFIELD 1E-III REEF
ASHFIELD TOWNSHIP
HURON COUNTY, ONTARIO

Ashfield Reef was discovered prior to the use of the iodine survey. The wells were capable of over 1 MMCFGPD but were shut-in due to lack of a pipeline. The survey was run to use as a model for other potential targets in the area.

Summary

Iodine surveys analyze the soil for iodine in ppm. These surveys provide another tool for the explorationist to use in the search for conventional. The tool is relative inexpensive and can be done ahead of or with seismic acquisition. Iodine surveys that do not have any anomalous areas almost 96% of the time predict a dry hole. Drilling results support this statistic. Where there are anomlaies that gives a reason to explore further by shooting seismic or another geophysical tool.

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