Soil Gas Hydrocarbons: An Organic Geochemistry that Detects Hydrocarbon Signatures in Surficial Samples to Locate and Identify Deeply Buried Targets*

Dale Sutherland[1]

Search and Discovery Article #40684 (2011)
Posted January 18, 2011

*Adapted from oral presentation at AAPG International Conference and Exhibition, Calgary, Alberta, Canada, September 12-15, 2010

[1]Activation Laboratories Ltd., Ancaster, ON, Canada (dalesutherland@actlabsint.com)

Abstract

Surficial soil surveys analyzed for inorganic elements have proven to be a useful predictive geochemistry in determining the location of deeply buried exploration targets. Organic components have also been sited as a potentially useful geochemical tool. Bacteria that leach and metabolize compounds from mineral deposits or petroleum plays at depth eventually release hydrocarbons that migrate to the surface. Surficial samples such as soil, sediments, peat, humus, etc. act as collectors of these hydrocarbons. Past researchers have used very volatile compounds in the C1 to C4 carbon series range, and have also hypothesized the use of heavier hydrocarbons. Research with these heavier hydrocarbons has resulted in a more robust geochemistry, defined as Soil Gas Hydrocarbons (SGH), which extracts the organic compounds absorbed on the surface of soils, sediments, humus, peat, and even snow, for the heavier organic compounds in the C5 to C17 carbon series range. The flexibility of SGH to be able to use a wide variety of sample types is important when sampling in difficult terrain. These SGH compounds may migrate from depth in a volatile form but are not gaseous at ambient temperature and pressure. The SGH technique analyzes each sample for over 160 specific hydrocarbons at a detection limit of one part-per-trillion (ppt). These specific hydrocarbons are now proven to be the remnants of direct bacterial interaction with the deposit or play. The data is reviewed forensically resulting in specific combinations and ratios of the hydrocarbons which defined different organic signatures found to be directly related to the target. The surficial geochromatographic dispersion of various classes of organic compounds has also been researched and found to be able to vector to the location of buried exploration targets. SGH is thus a dual purpose deep penetrating predictive geochemistry that both locates and identifies the type of target that may be present. The SGH geochemical signature has been demonstrated at successfully locating Oil, Gas and Coal plays at depths of up to 1,000 metres. Mineral targets of Uranium, Gold, SEDEX, VMS, Nickel, Copper, PGE, Kimberlite and Rare-Earth formations have also been identified at depths of up to 700 metres from actual surveys.

References

Hamilton, S.M., 1998, Electrochemical mass-transport in overburden; a new model to account for the formation of selective leach geochemical anomalies in glacial terrain: JGE, v. 63/3, p. 155-172.

Southam, C.F., 2000, Potential impact of climate change on Grand River basin groundwater supplies: Conference of the International Association for Great Lakes Research, Program and Abstracts, v. 43, p. A.149.

Website

Golden Band Resources Inc., April 16, 2008 Press Release: Web accessed 10 January 2011.
http://www.goldenbandresources.com/html/news/press_releases/index.cfm?ReportID=203127

"Soil Gas Hydrocarbons: An Organic Geochemistry that Detects Hydrocarbon Signatures in Surficial Samples to Locate and Identify Deeply Buried Targets"

AAPG – ICE Conference

Calgary, September 15th, 2010

Dale Sutherland
Activation Laboratories Ltd.
1336 Sandhill Drive, Ancaster, Ontario

SGH OVERVIEW

- SGH – An exploration geochemistry that uses near surface samples that act as collectors of the hydrocarbon flux from buried mineral and petroleum plays.
- The "***Soil***" in Soil Gas Hydrocarbons is a misnomer. SGH is able to analyze a wide variety of sample types: Soil, till, peat, humus, snow, and even fully submerged lake bottom or sea bottom sediments.
- Very flexible and successful in areas that are difficult to sample.

SGH OVERVIEW

- The "***Gas***" in Soil Gas Hydrocarbons is a misnomer.
- SGH does not measure gases i.e. C1-C4, etc.
- This geochemistry measures 162 hydrocarbons in the C5 to C17 carbon series range.

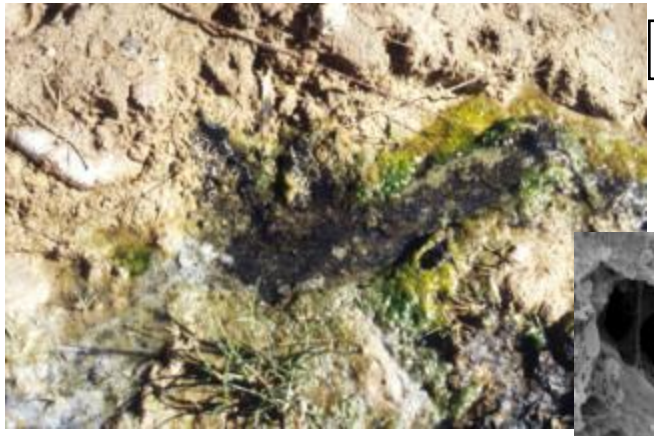
- This is an ultra-sensitive test and is able to report in the low parts-per-trillion (ppt) concentration range. Sensitivity is vital to the use of this geochemistry for mineral exploration.
- Petroleum plays are relatively easy and very compelling.

SGH OVERVIEW

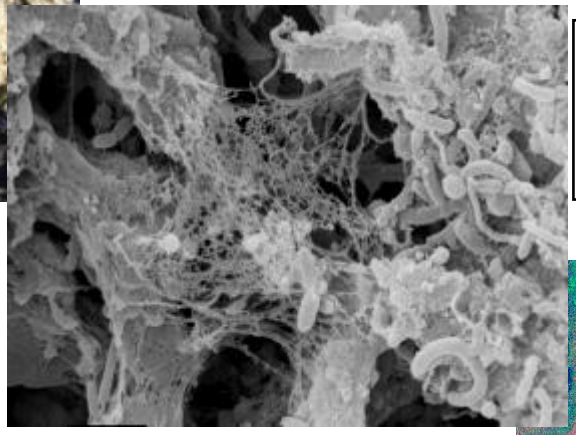
- The SGH method is a weak leach of the samples and thus detects a portion of the hydrocarbon flux from the target at depth.
- SGH measures 162 hydrocarbons in the C5 to C17 carbon series range by High Resolution Gas Chromatography coupled with Mass Spectrometry (HRGC/MS) in the low parts-per-trillion (ppt) range.

Where do these hydrocarbons originate?

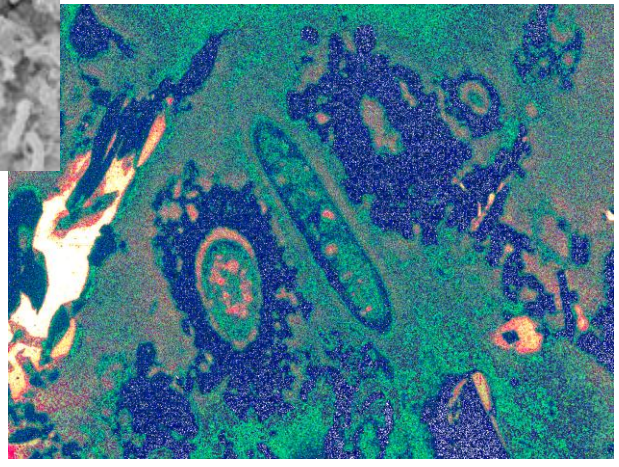
- In 2000 Dr. Gordon Southam and associates at the University of Western Ontario conducted bacteriological experiments in support of a Canadian Mining Industry Research Organization project.



Bacteria can be found at seeps on outcropping ore

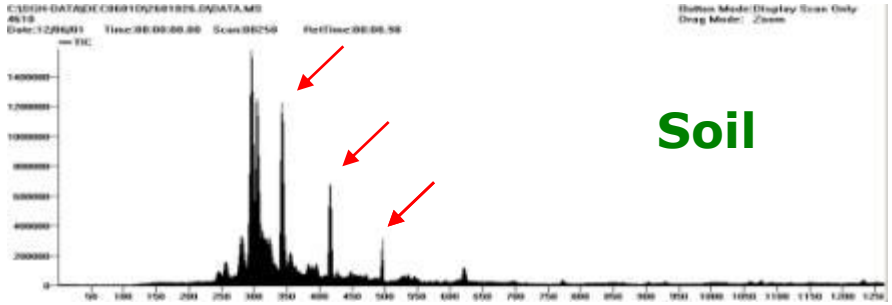


Electron Microscope photographs show evidence of bacteria growing directly on ore.

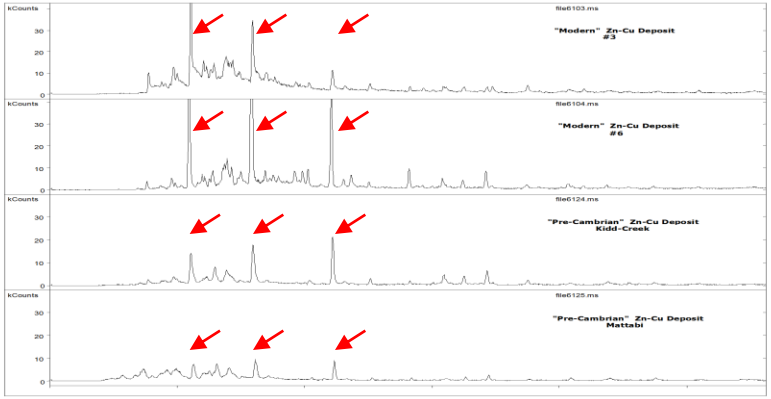


Healthy bacteria (centre) is flanked by dying bacteria (on left) and dead bacteria (on right) illustrating cell membrane disintegration.

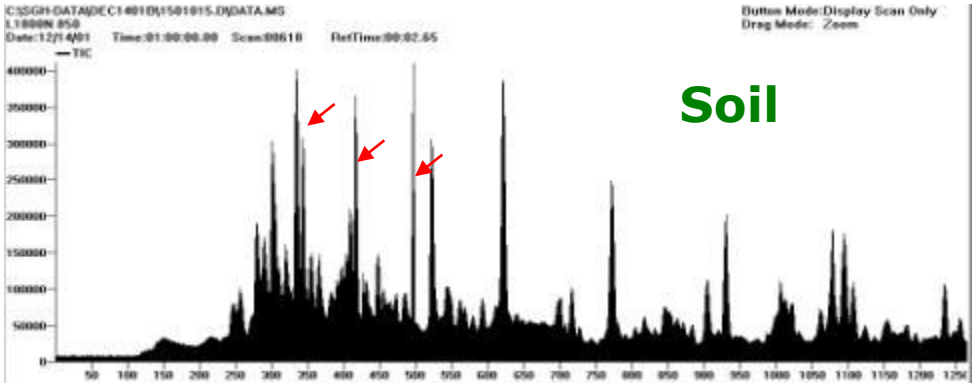
What is does an SGH signature look like?



Soil



Ore

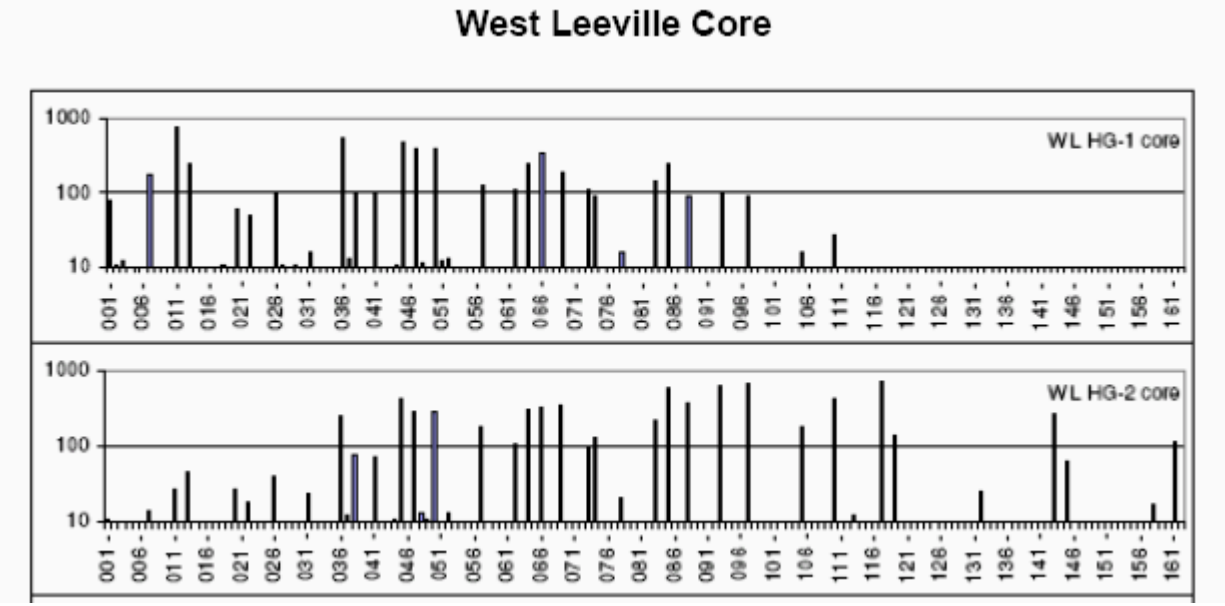


Soil

- These soil samples contain the same "visible" SGH signature as that found in the VMS ore.

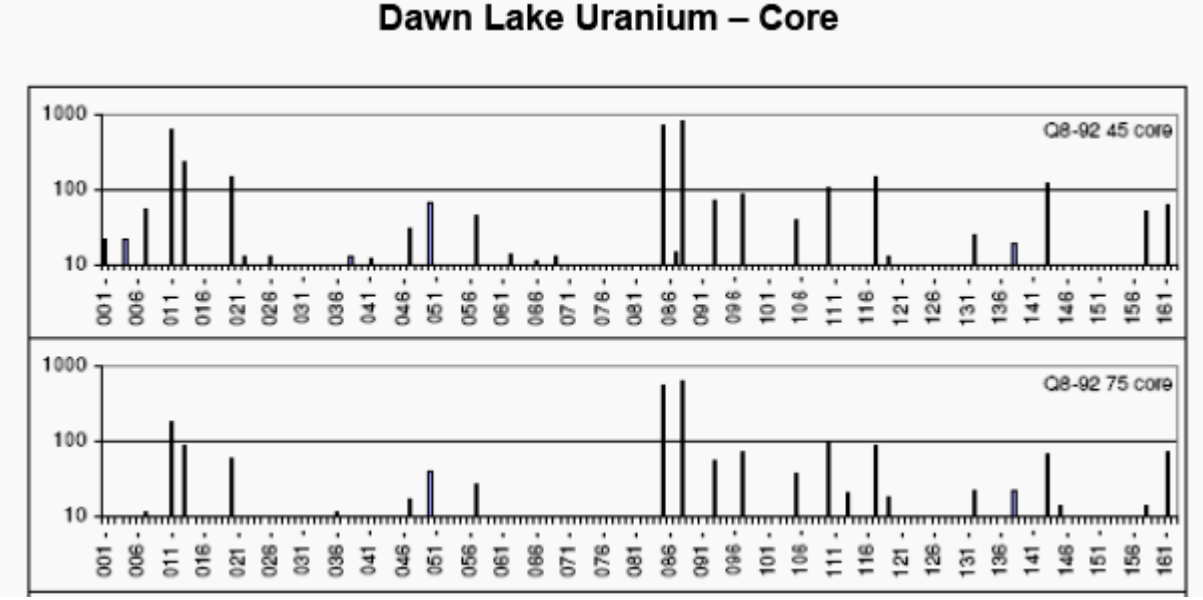
↙ = Individual compound responses -GC/MS

CAMIRO 01E02 – **SGH Results from Bacteria grown on Gold**



CAMIRO 01E02 – Dr. Gordon Southam's report

CAMIRO 01E02 – **SGH Results from Bacteria grown on Uranium**



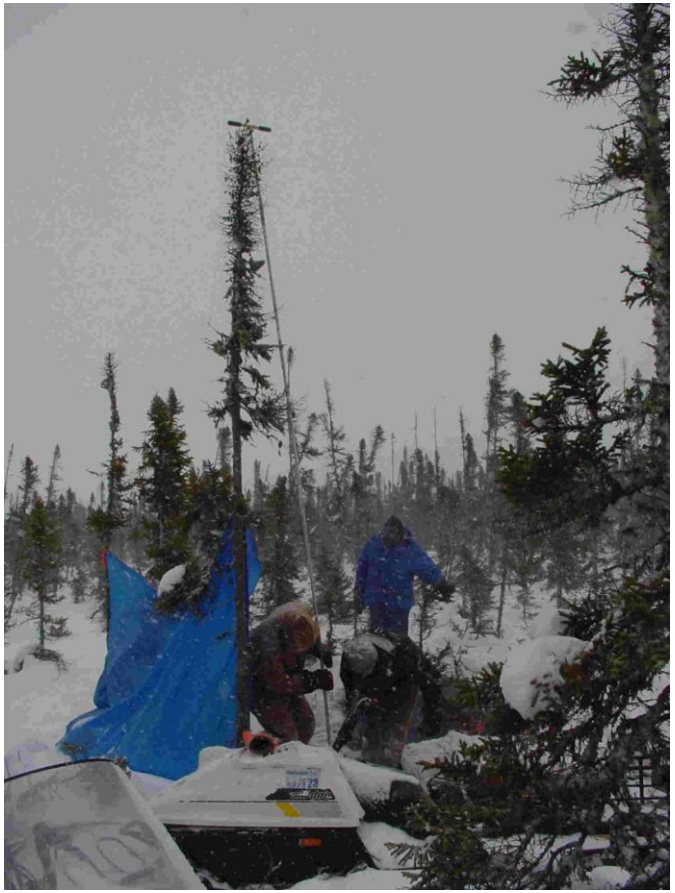
CAMIRO 01E02 – Dr. Gordon Southam's report

SGH Interpretation: Geochromatographic Signature

- **SGH is a DUAL purpose tool:**

  Vectors to the location of a target using the spatial Geochromatography of the SGH Pathfinder classes.

  Used to confirm the identity of a target through the specific mix of the SGH pathfinder classes found.



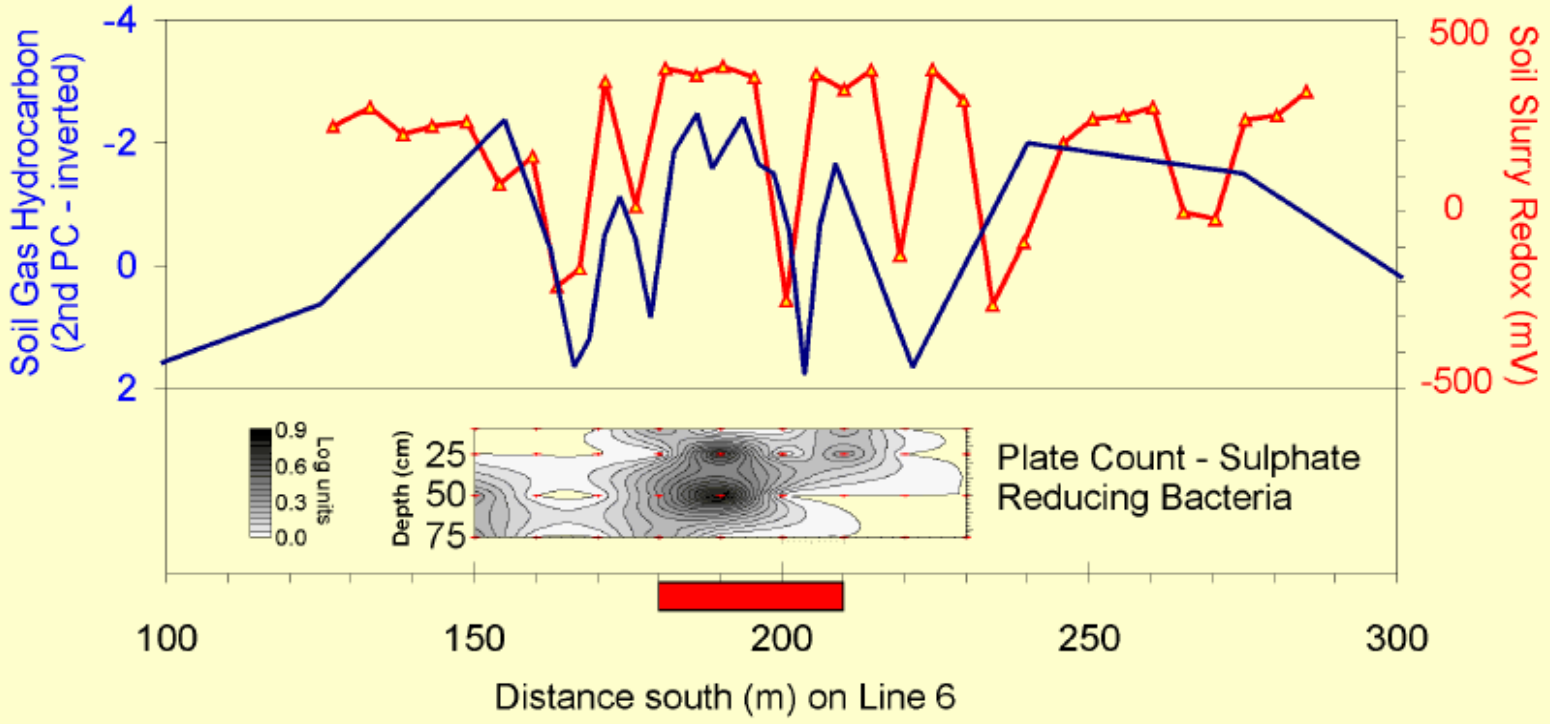
SGH Signature – A Proxy for REDOX Measurements

- The Ontario Geological Survey (OGS) has commented that:

"SGH appears to be an excellent tool for identifying reduced areas or REDOX CELLS in the overburden and possible microbiological activity at depth".

(pers. comm. Dr. Stewart Hamilton, Nov. 2004)

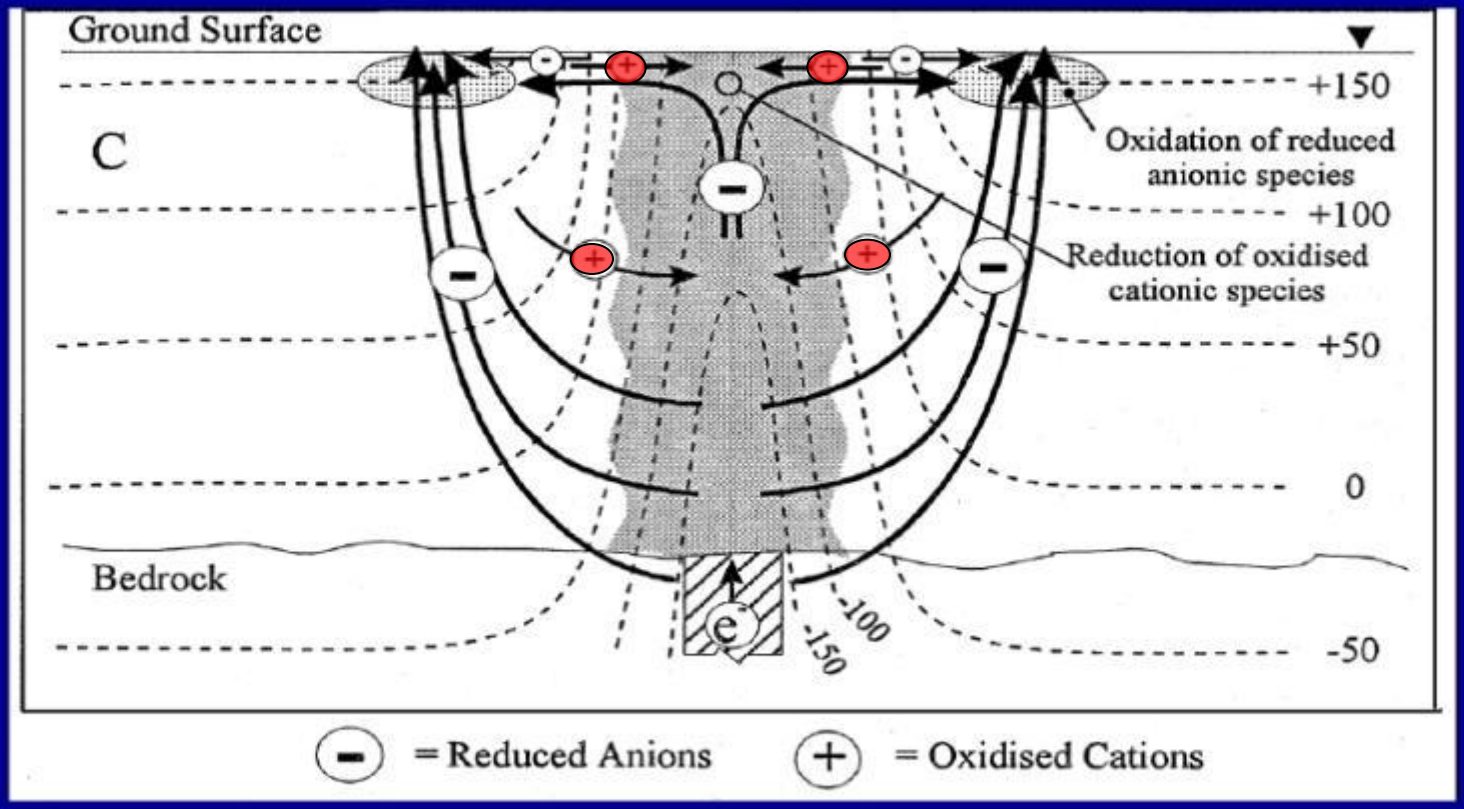
SGH & Redox



Ontario Geological Survey

OMET

Modification of redox-equipotential lines in glacial overburden overlying sulphide conductor



From Hamilton, 1998, JGE, flow of redox-active species

SGH – A Forensic Interpretation: Geochromatographic Signature

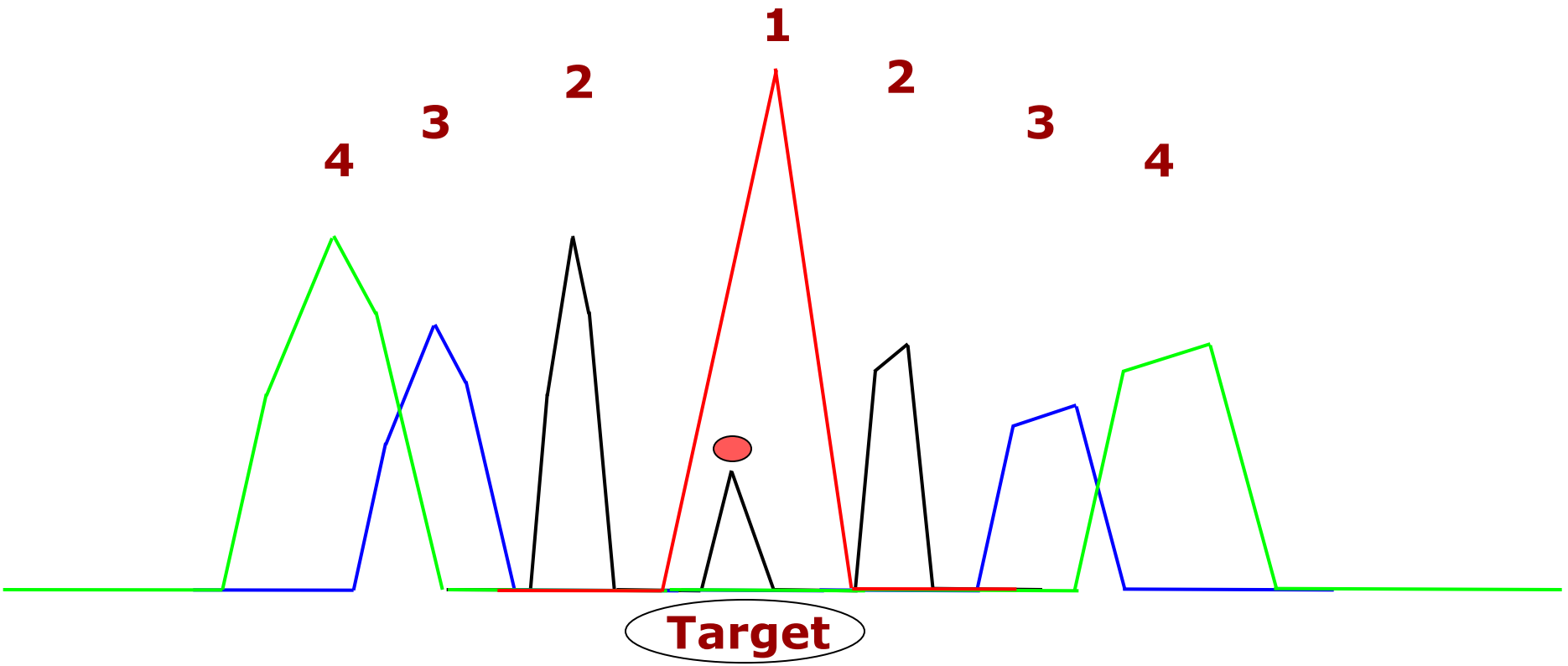
- SGH has 19 different groups or chemical classes of compounds that have different chemical characteristics. The compounds within each group have similar characteristics e.g. molecular weight, solubility, structure, partition coefficients, etc.
- Different mineral or petroleum based targets display a different mixture of these classes that is used to forensically identify the type of target at depth.
- Each group or pathfinder class moves through the overburden at different rates and disperse away from the deposit to a different distance based the process of "geochromatography".

SGH *Interpretation:* *Geochromatographic Signature*

- The order of dispersion, or the geochromatography, of the different pathfinder classes is a constant.
- The knowledge of the geochromatography, represented by dispersion halo anomalies is used to vector to the location of the centre of a REDOX cell which is theoretically over the centre of the deposit.

SGH INTERPRETATION OVERVIEW

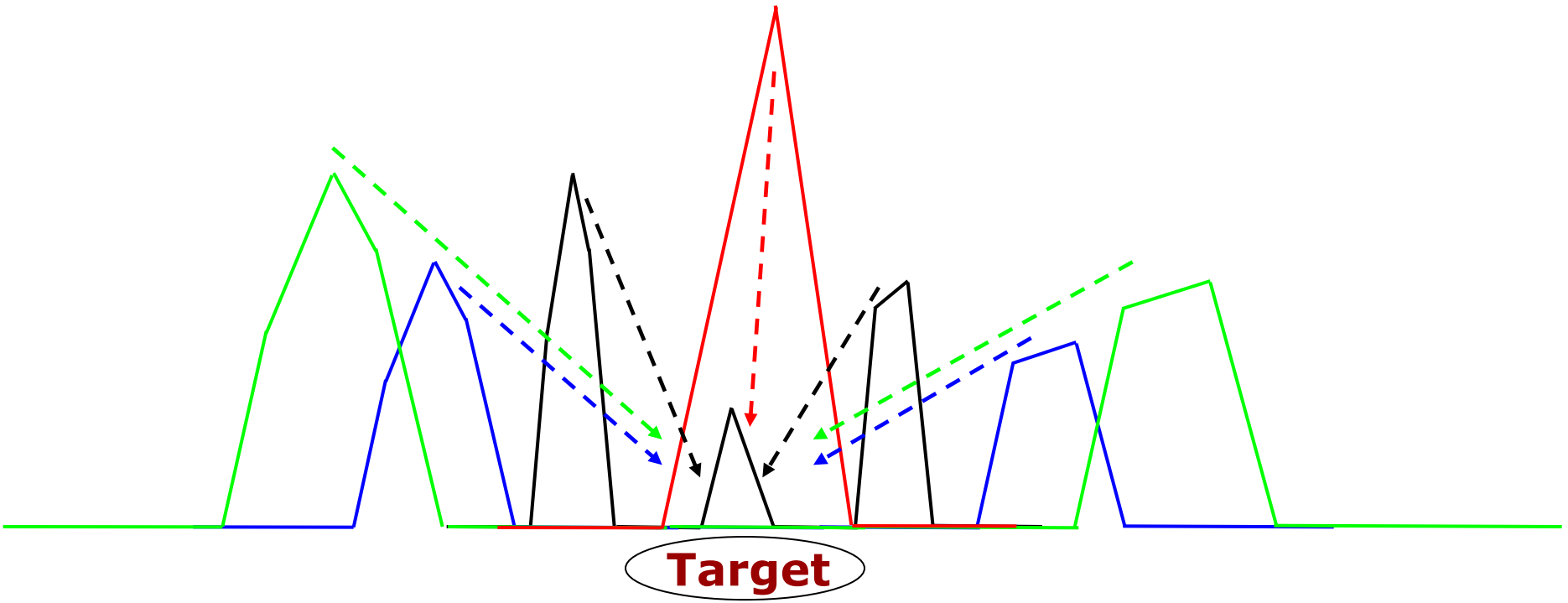
The "geochromatographic order" of the dispersion of the SGH hydrocarbon classes is a **"constant"**. Spacing will be different.



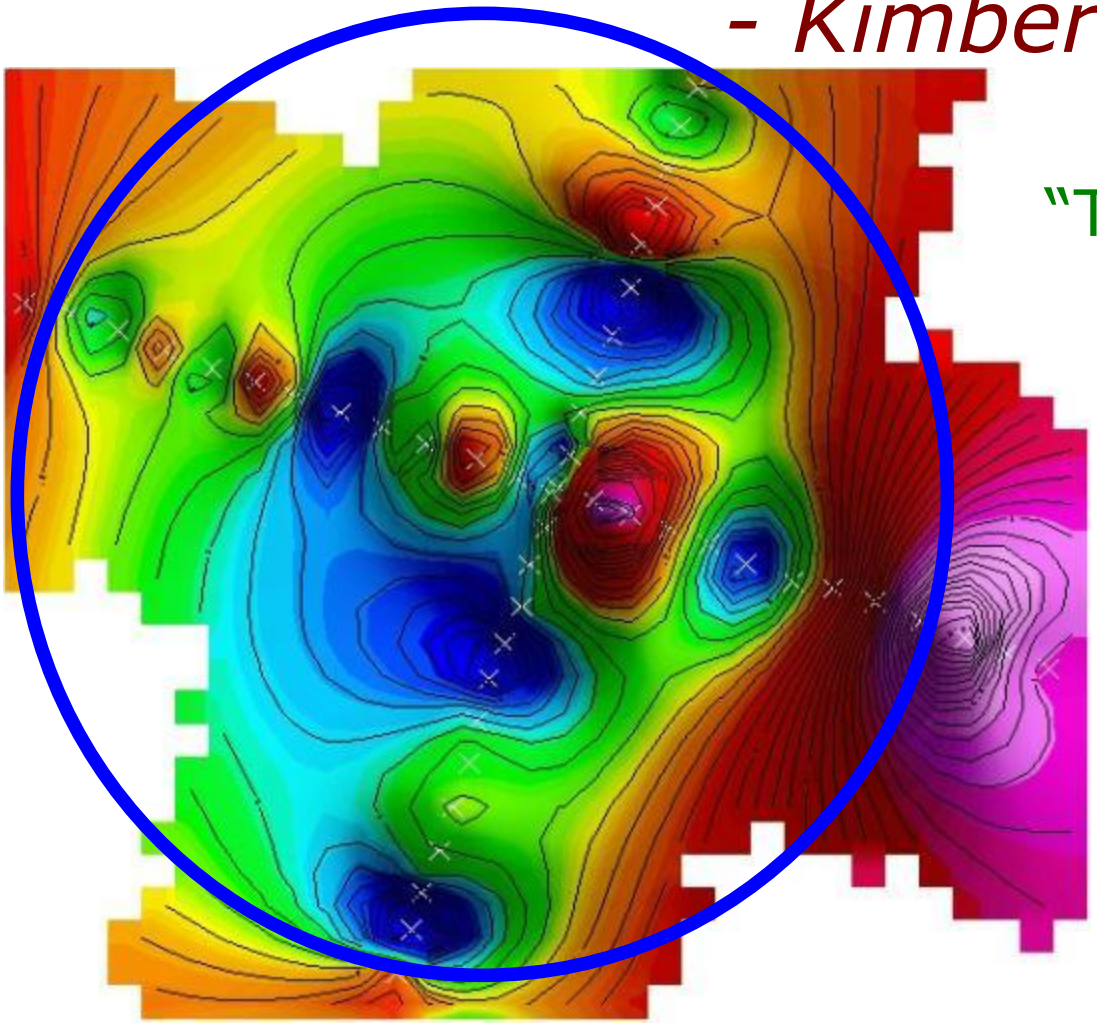
SGH INTERPRETATION OVERVIEW

Multiple SGH classes accurately vector to the location of target.

The use of multiple class vectors improves the confidence in identifying the target location.



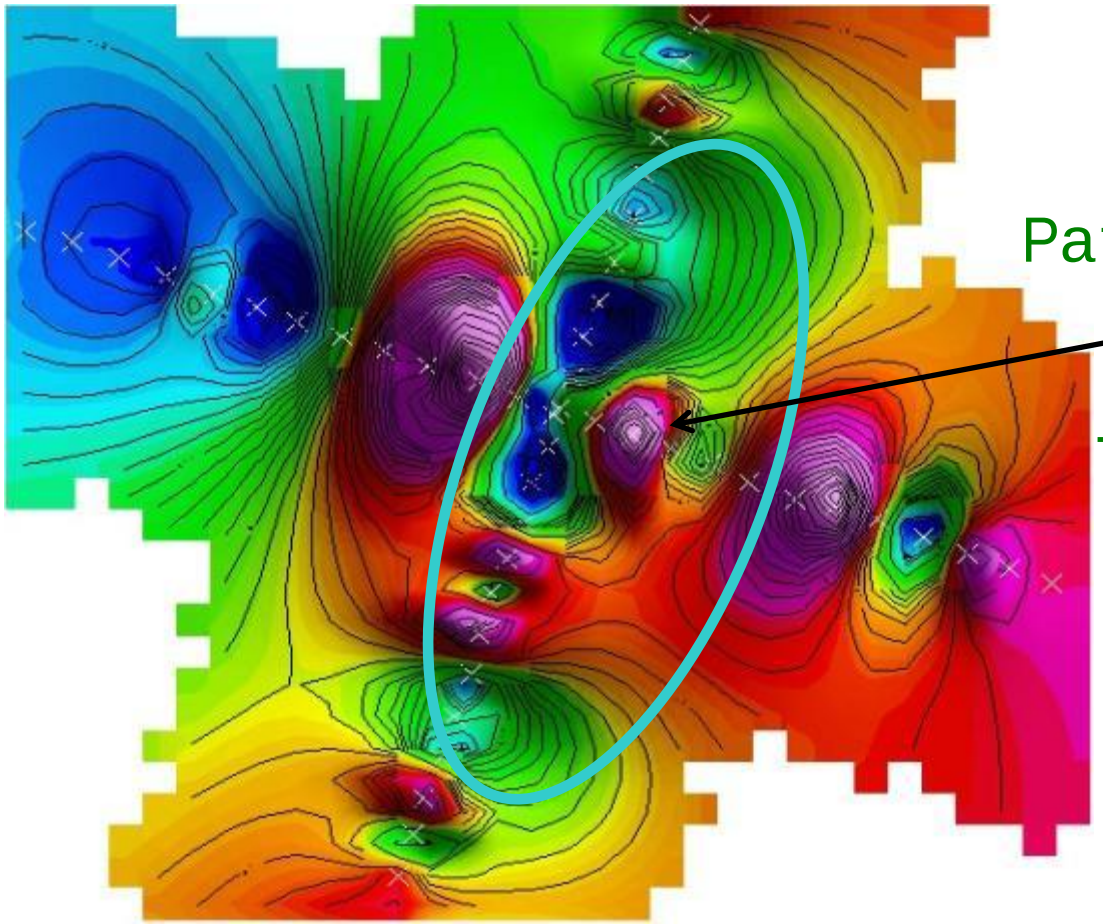
SGH "Geochromatography" – - Kimberlite Case Study



SGH Kimberlite "Tertiary" Pathfinder Class Map

This SGH ***class*** always develops a "wide" halo anomaly over a target

SGH "Geochromatography" – - Kimberlite Case Study

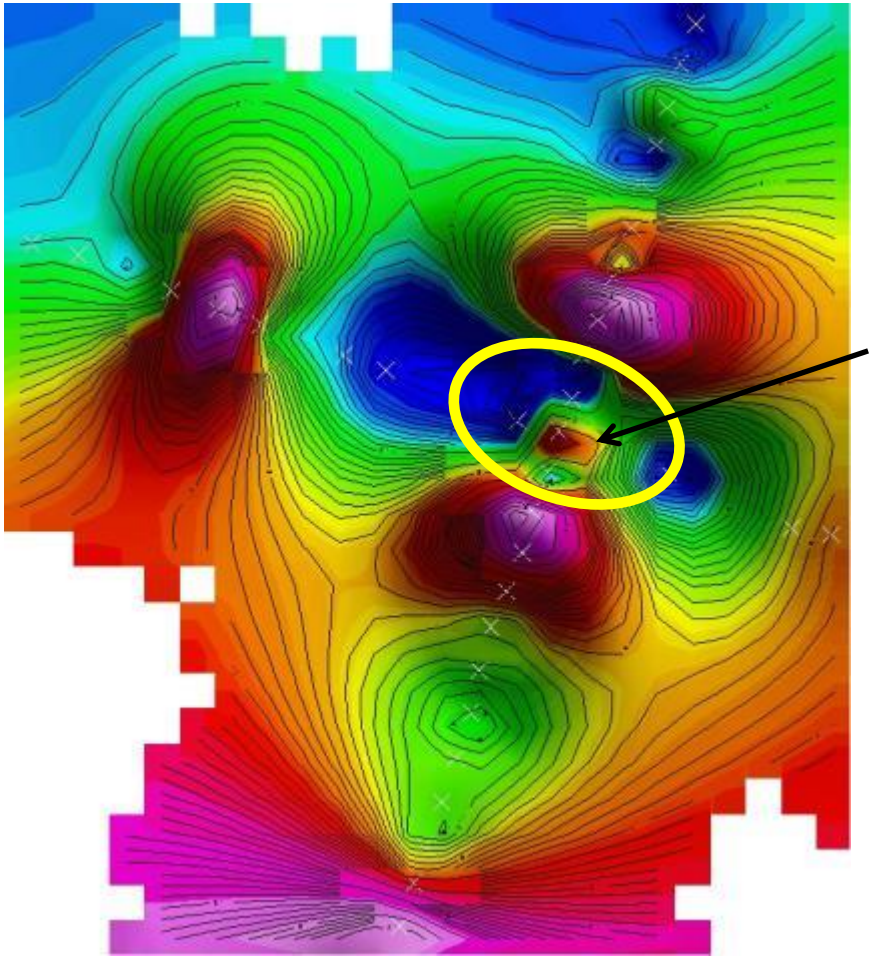


SGH Kimberlite "Secondary" Pathfinder Class Map

"Nested halo" anomaly

This compound class has "nested halo" anomalies that are more focused.

SGH "Geochromatography" – - Kimberlite Case Study



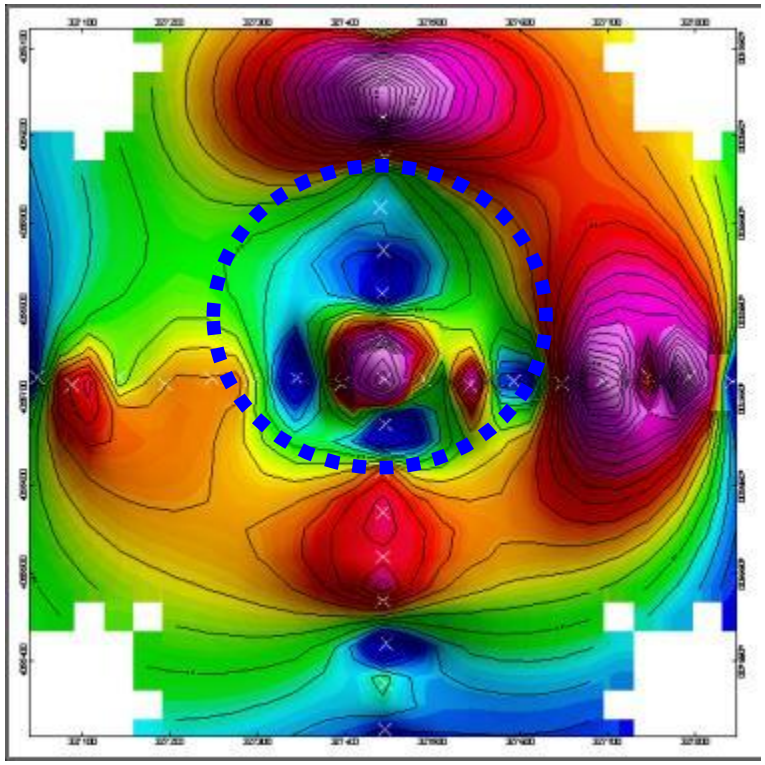
SGH Kimberlite "Primary" Pathfinder Class Map

"Nested halo" anomaly

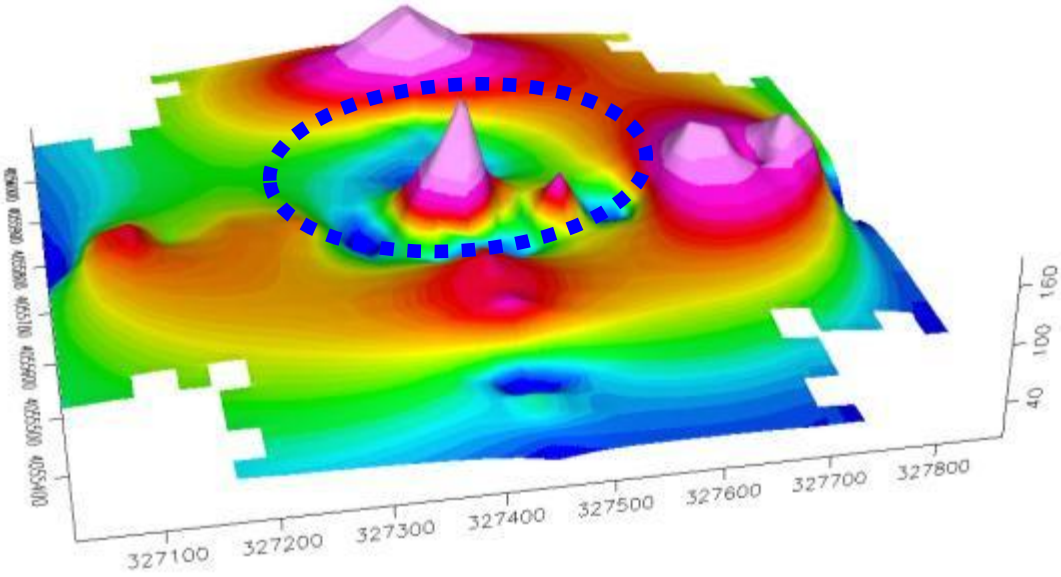
The primary compound class is consistently the most focused and shows the edges of the pipe.

This vectoring "order" of classes is a constant.

SGH – Uranium - Breccia Pipe – Also in Arizona



SGH can yield high contrast anomalies – a well developed "Redox" cell is seen at this site using the same Uranium pathfinder classes.



SGH Interpretation: Target Specific pathfinder Classes

- Templates of groups of classes have been developed that together describe the SGH signatures for Gold, VMS, Nickel, Copper, SEDEX, Kimberlite, Uranium, IOCG, Rare Earth Elements and Polymetallic type deposits as well as Wet Gas and Oil plays.

- These templates list at least three SGH "pathfinder chemical classes" that are used to locate and identify each type of target. Different mixtures of these classes define the signature for the different target types.

- Each pathfinder "class" is made up of 4 to 14 specific pathfinder compounds.

SGH Interpretation: Geochromatographic Signature

- SGH interpretations and reports are thus based on the agreement of a specific mixture of classes containing a total of 16 to 42 or more SGH compound responses.
- This depth of interpretation results in a geochemistry with a high level of confidence.
- As the interpretation is made up of a large number of responses the results have a low level of variability.
- The use of a group of pathfinder classes is also the reason why SGH can be used with a wide variety of sample types even in the same survey.

SGH – Source of Hydrocarbons

SUMMARY

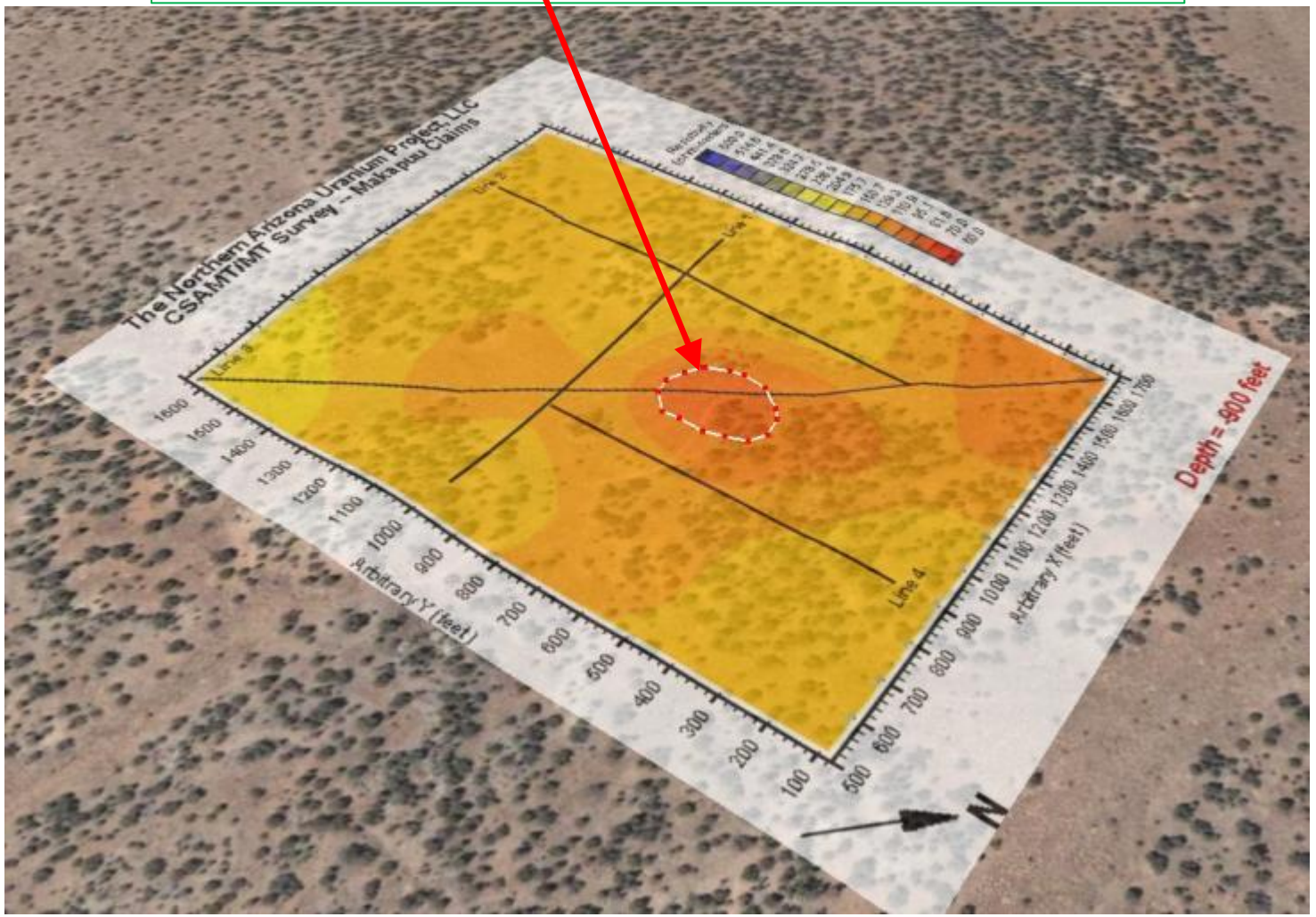
- Bacteria mobilize/leach compounds from the deposit as a food source and internally metabolize new compounds. When bacteria die the cell membranes rupture which releases the hydrocarbons that are measured by the SGH geochemistry. These hydrocarbons rise to the surface to form a signature that can locate and identify buried mineral or petroleum targets.

SGH – Part of the Solution

- SGH often agrees with Geophysics thus enhancing the confidence in assigning drill targets.

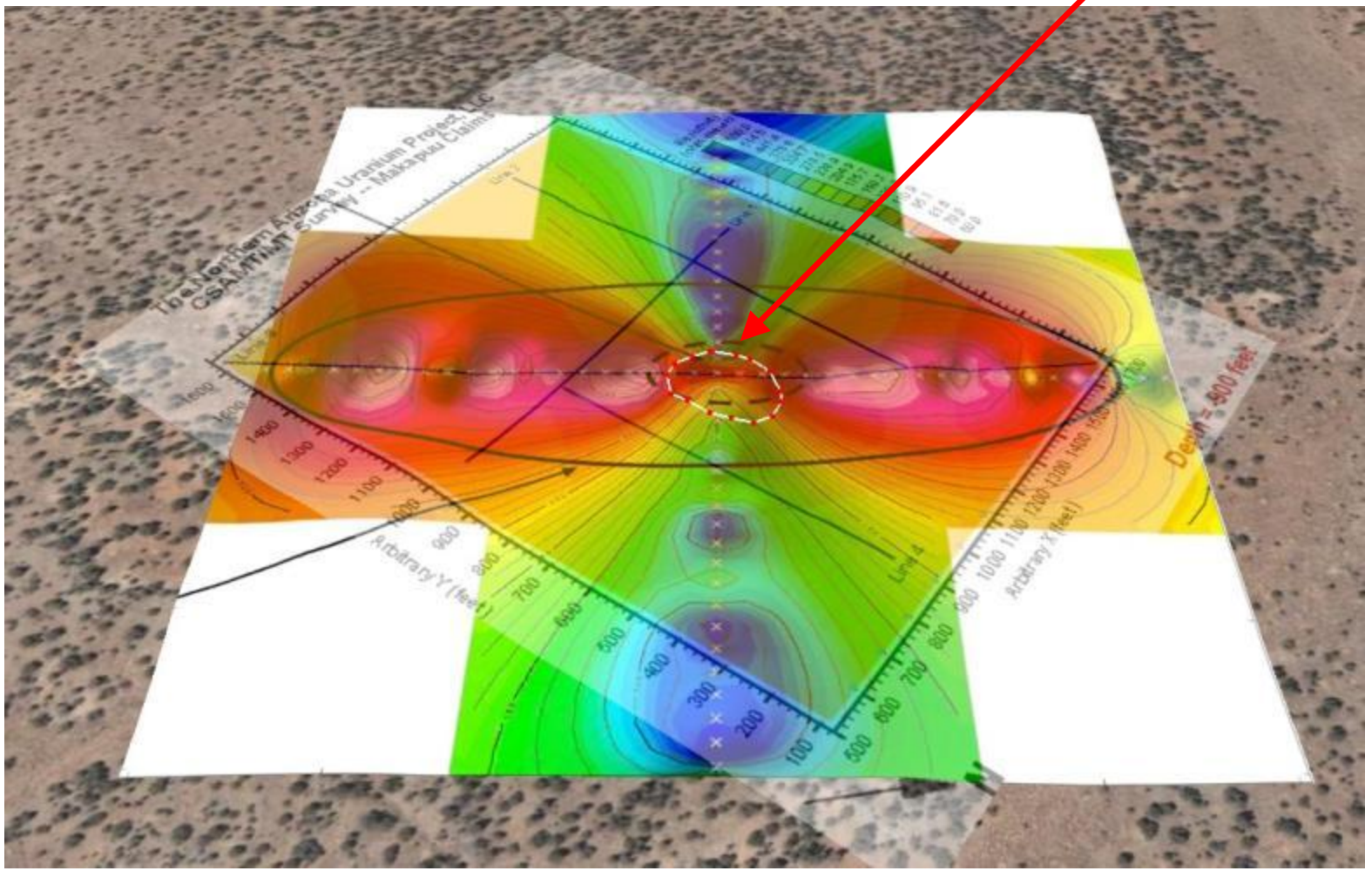
Breccia Pipe – "North Arizona Uranium Project"

"CSAMT Survey – Makapuu Claim"



Breccia Pipe – "North Arizona Uranium Project"

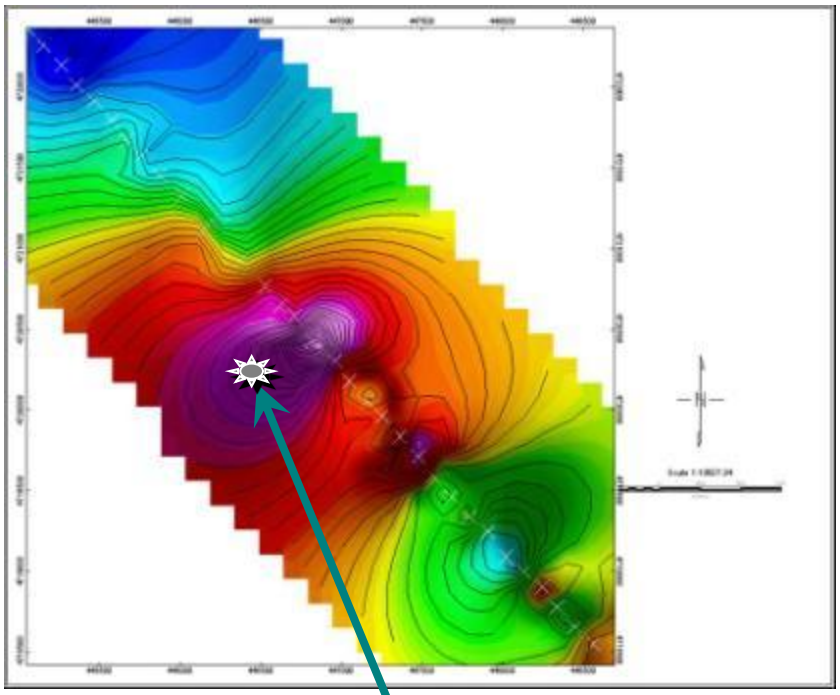
"CSAMT and SGH Interpretations Agree"



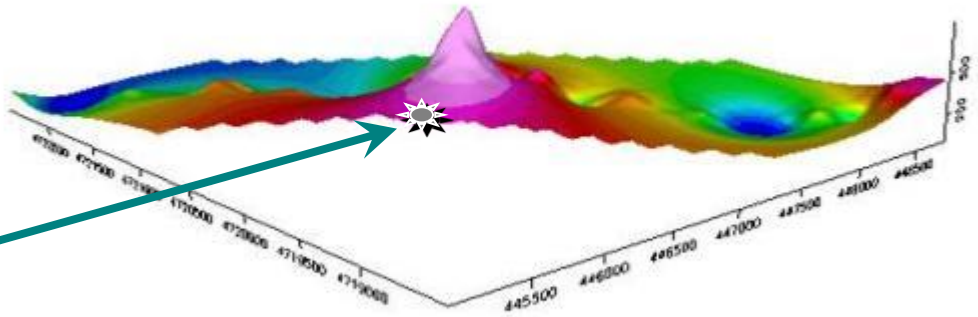
PETROLEUM TARGETS

- A company submitted two sample test lines which were taken from the road side right-of-way in areas adjacent to two gas producing wells.
- Although these samples were taken within 5 metres of secondary paved roads, there was no interference to the SGH analysis due to the proximity of the roadway.

Wet Gas Play – Line A- Southern Ontario

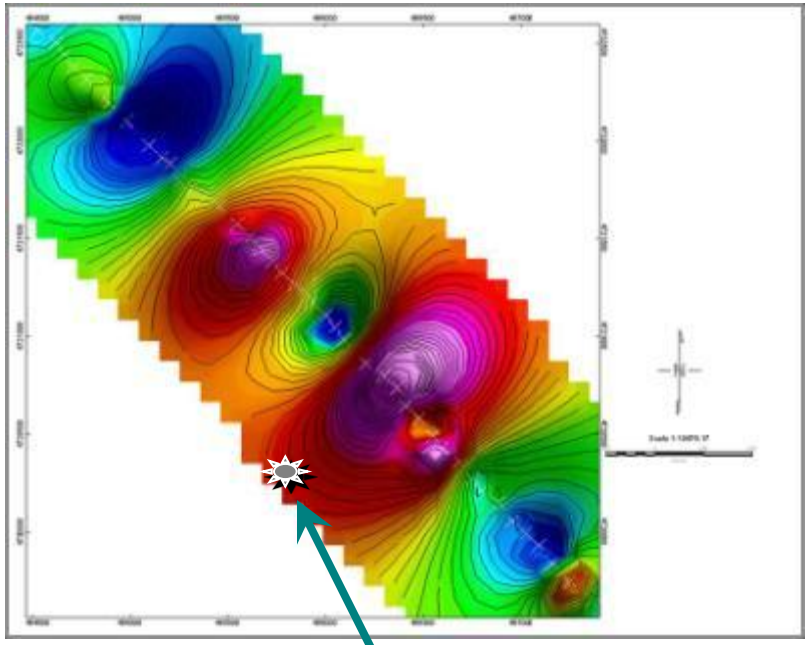


Gas well intersected two zones at 410m and 535m depth that reached down into the Grimsby formation. SGH anomaly was definitive.



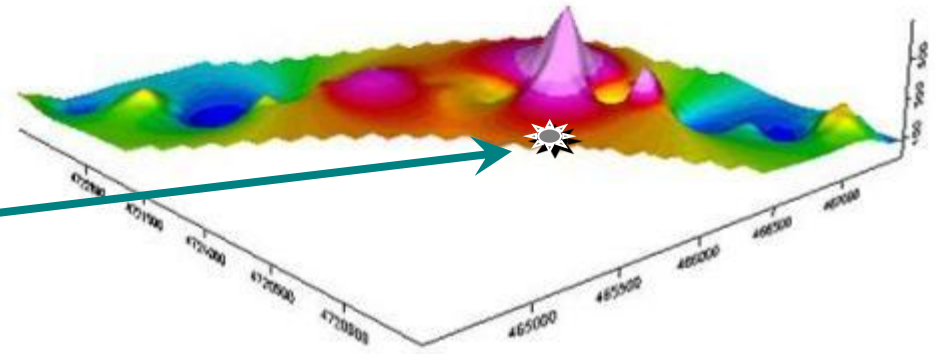
Producing Gas Well

Wet Gas Play – Line C- Southern Ontario



This SGH anomaly was directly adjacent to another gas producing well from this roadside sampling conducted in the same township as Line A.

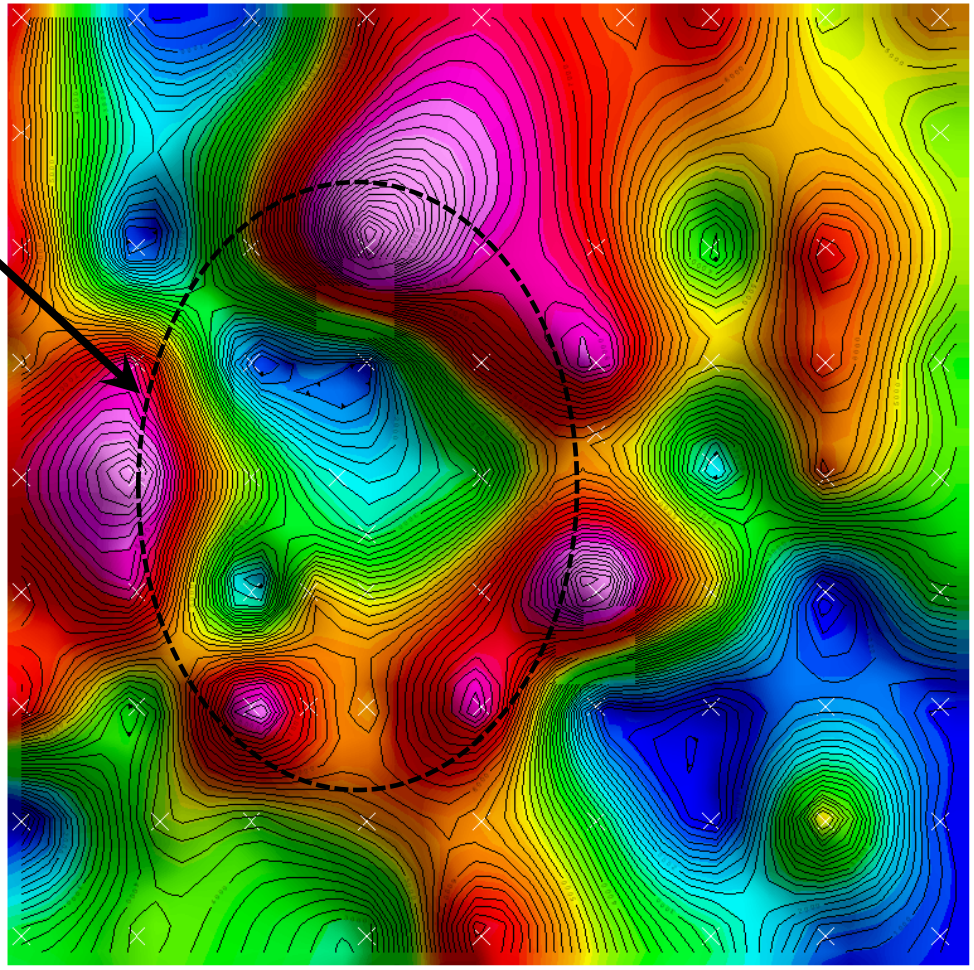
Producing Gas Well



SGH shows REDOX cell over deep Ordovician oil pool "Bromhead" - SE Saskatchewan

Vertical Projection of Oil Pool Boundary

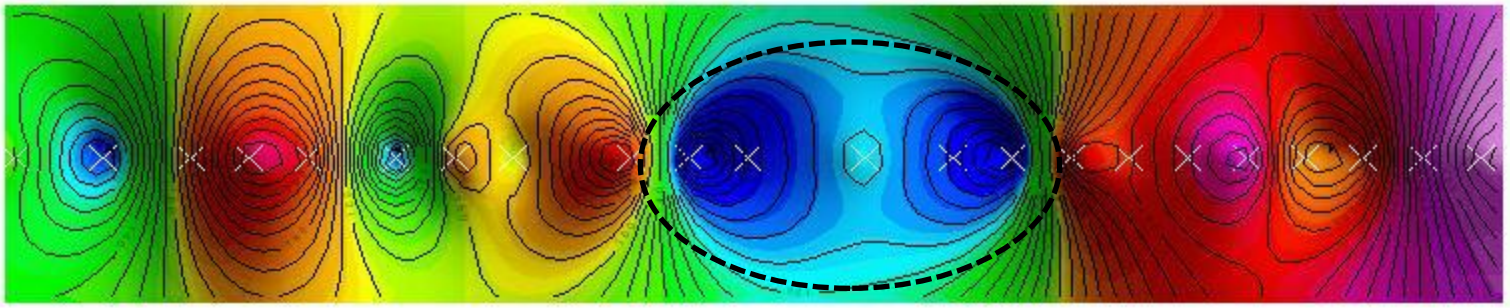
REDOX Cell



Depth
= 950 metres
(2850 feet)

SGH shows REDOX cell over Oil Play "Hillman" Oil Field SW Ontario

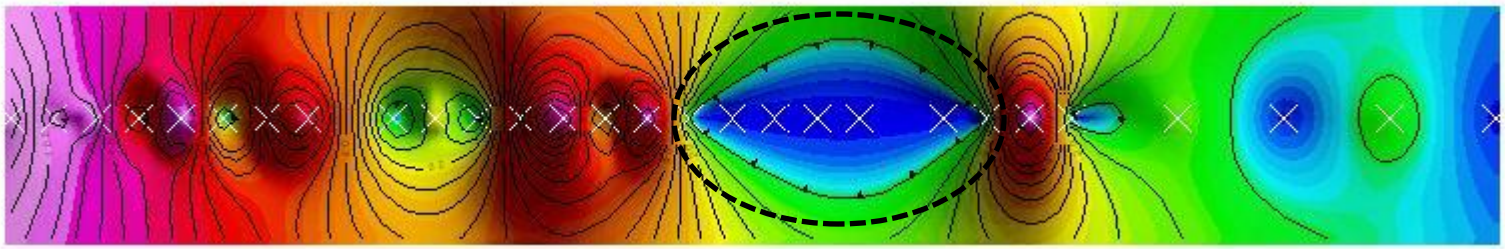
Samples from Road Right-of-Way



Oil Reservoir

SGH shows REDOX cell over Oil Play "Clearville" Oil Field,Ontario

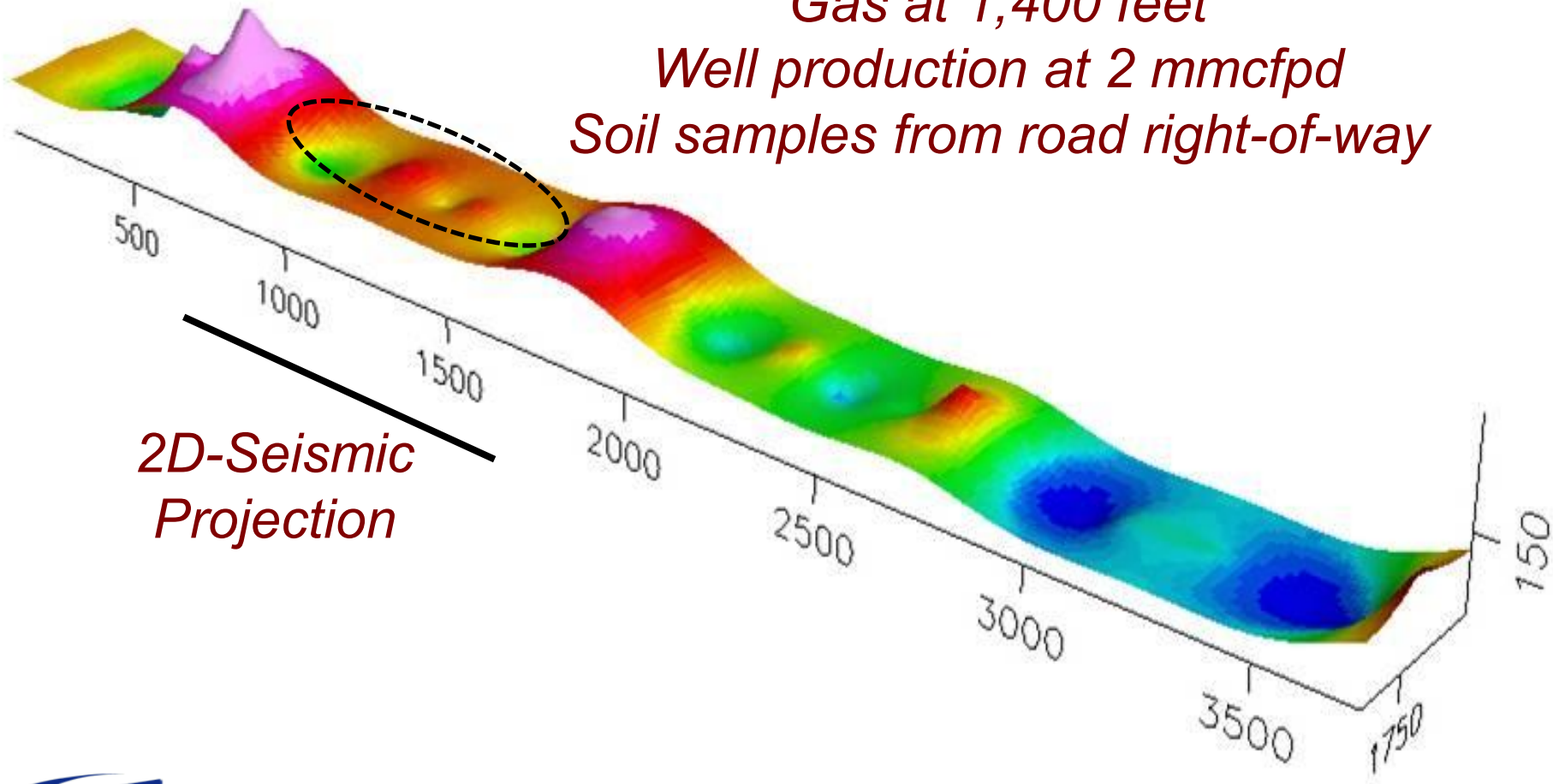
Samples from Road Right-of-Way



Oil Reservoir

SGH shows REDOX Cell over "Hensel Graben" Gas Play, Wyandot County, Ohio

Gas at 1,400 feet
Well production at 2 mmcfpd
Soil samples from road right-of-way



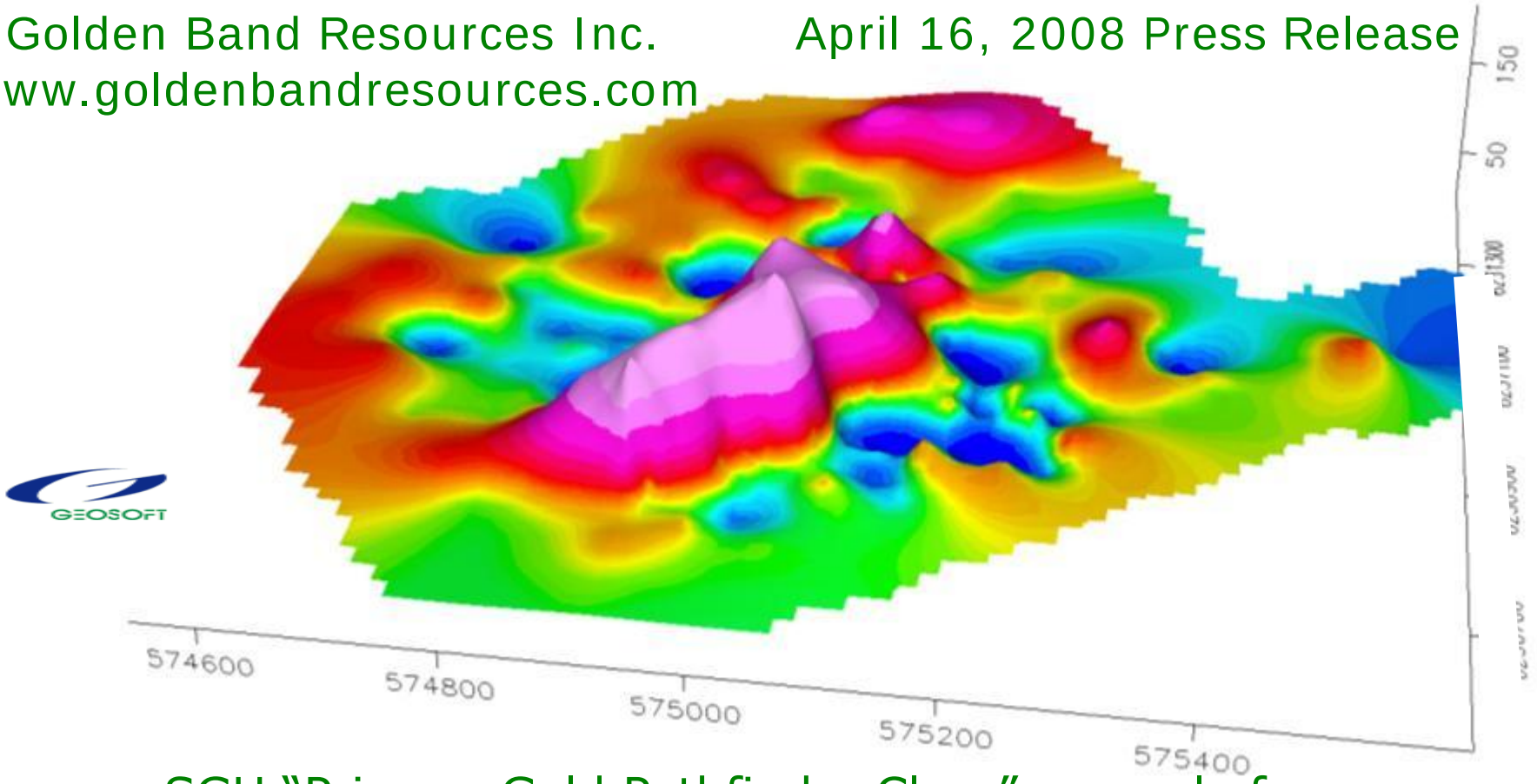
UNCONVENTIONAL PETROLEUM TARGETS

- SGH has been reported to have successfully helped discover an unconventional oil play in New Brunswick, Canada.

(not available as a case study at this time)

SGH Gold Signature – N. Saskatchewan

Golden Band Resources Inc. April 16, 2008 Press Release
www.goldenbandresources.com



SGH "Primary Gold Pathfinder Class" anomaly from a large grid of soil samples. Two drill holes in this anomaly resulted in cores having "visible" gold in quartz veins at ~95 metres drill depth.

SGH – SOIL GAS HYDROCARBONS

BENEFITS

- Unobtrusive and only one field visit is required
- Easy sampling – use Soils, Peat, Humus, Sediments, etc.
- Easy shipping – only small "fist sized" samples are needed
- No special preservation is needed
- Has been shown to be an excellent "Redox Cell" locator
- Has been successful at locating targets from 10 metres to over 900 metres below surface.

SGH – SOIL GAS HYDROCARBONS

BENEFITS

- The analysis is rugged to sampling procedures, geographical features and to cultural activity.
- The SGH class geochromatography "vectors" to the target.
- SGH signature can "identify" the type of target.

QUESTIONS **- dalesutherland@actlabsint.com**