

## Kimberlite Exploration Integrating SGH<sup>SM</sup> Geochemistry



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### Abstract:

Soil Gas Hydrocarbons (SGH<sup>SM</sup>) is a method of geochemical exploration, which detects 162 specific hydrocarbon compounds in the C5-C17 carbon series range. Hydrocarbon compounds that have migrated from a mineralised body in the subsurface through cover rock and overburden are adsorbed onto surficial soils. SGH<sup>SM</sup> analyses detect these hydrocarbons and these are of use to the explorationist as a method of detecting blind mineralised bodies. Recent research has shown that there are relationships between specific commodities and compound classes that are unique to them.

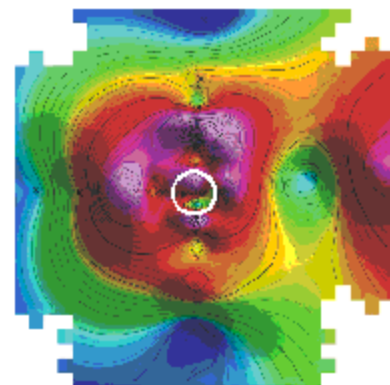
Identifying these relationships provides a 'hydrocarbon fingerprint' that is unique to a specific commodity. The suite of compounds detected within soils over kimberlite pipes has also been found to be unique, bearing little resemblance to the suite of compounds detected in soils over base metal deposits. This basis of classifying compounds to a particular commodity type provides a diagnostic method of interpreting the results of an SGH<sup>SM</sup> survey. Knowledge gained out of 'fingerprinting' a particular commodity type gave rise to the investigation of a neural-net (NN) software system as a means of reducing interpretive time and enhancing SGH<sup>SM</sup> survey findings. 'Score maps' from the NN depict compound similarities within an SGH<sup>SM</sup> dataset. Initial NN research conducted on several Canadian kimberlite pipes has provided some of the most startling results to date.

### Introduction:

Soils that have been dried <40°C and sieved at minus 60 mesh are extracted for hydrocarbons and are subsequently analysed by gas chromatography-mass spectrometry (GC-MS). Compound separation is done within the GC and detection is accomplished with the MS. This highly developed method of analysis allows for monitoring of specific compounds and provides detection limits of 1 part-per-trillion (ppt).

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*Integration of NN with SGH<sup>SM</sup> facilitates rapid and robust interpretations. Multiple compound and class responses with built-in redundancies, ensure a reduction in spurious responses.*



Research conducted with CAMIRO over the past seven years has focused on the applicability of SGH<sup>SM</sup> to a variety of geographical locations, differing commodity types and varying cover thicknesses. Given the recent explosion in diamond exploration, it came as no surprise that a portion of the most recent research was focused on how SGH<sup>SM</sup> could be applied for diamond exploration. Soils from several Canadian kimberlite pipes were the subject of study as SGH<sup>SM</sup> analyses were performed on the blindly submitted samples. After the analyses had been performed, UTM coordinates for the soil sample locations were provided, which permitted evaluation of the surveys. Results from these surveys were quite revealing, as responses were found in multiple compounds across multiple compound classes – sharply delineating the pipes.

One of the primary benefits gained from an SGH<sup>SM</sup> survey is the amount of highly specific data obtained. A dataset is usually comprised of a 'site signature' which represents the hydrocarbon background of the survey region. The 'mineral signature' is the portion of the 'site signature' which is indicative of a particular commodity type. 'Site signature' compounds usually occur at much higher concentrations than those of the target 'mineral signature'.

Research involving a NN system allowed the interpretation of the kimberlite SGH<sup>SM</sup> datasets. Employed as a predictive tool, the NN system was 'trained' on one of the datasets and then allowed to evaluate the other datasets.

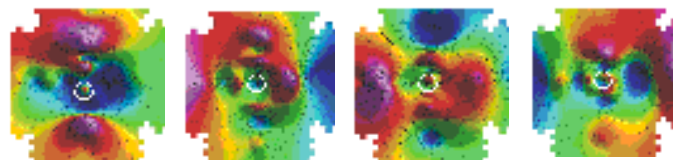


*Figure 1. Four diagrams depict individual NN score-maps from an SGH<sup>SM</sup> survey over a Canadian kimberlite pipe. The NN was initially trained on one pipe at another location to establish the 'learning set' for the NN. Parameters that were established as part of the 'learning set' were then applied to other kimberlite pipes.*

On their own, each individual score-map exhibits a particular compound class. Examined collectively, the diagrams exhibit the vectoring behaviour of the compound classes. Certain classes are more tightly constrained over the pipe itself, whereas other classes are constrained to the periphery of the pipe. This concentric nature of the responses is analogous to zonation based on chemical properties of the various classes.

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The NN system was basically ‘taught’ a series of observations; in essence, it was guided to look for other such observations based on previous knowledge. The NN system is able to establish connections between patterns in datasets that may be far too complex for the human eye to evaluate. During the NN interpretation of the Canadian kimberlite pipes, the NN revealed minute relationships of specific organo-sulphur compounds which were previously unseen. The NN processing eases the interpretation by reducing workload and also has the benefit of commodity-specific experience. Furthermore, NN interpretation has the ability to evaluate strong anomalies in relation to subtle mineral responses. Thus subtle responses are not overlooked, which removes human bias. The NN sets developed are able to recognize a wide variety of anomaly patterns (halo, apical, singular, concentric) and it works best when sampling is conducted in a grid formation rather than in a single line. Irregular survey design introduces a numerical anisotropy which may yield false responses as the algorithm attempts to explain the data spatially.

Due to differences in diffusion and mobility rates, it was observed through the NN interpretation that SGH<sup>SM</sup>

compound classes might provide a vectored response in proximity of the pipe. Certain compound classes were tightly constrained around the pipe, whereas other compounds were not as constrained and had a more divergent, yet definitive response. A possible and plausible reason for this ‘concentric’ response over and around the pipes is that the compounds are behaving as they do in a GC. The compound separation around the pipe may be a result of ‘geochromatography’ in the overburden.

Several NN sets have been developed for SGH<sup>SM</sup> data processing. Each has been specifically “trained” on a particular commodity type. For each commodity there are individual NN sets that are used to interpret several compound classes. The NN applies the specific commodity signature identified in previously known study sites onto the client’s SGH<sup>SM</sup> survey data. When given sample coordinates, the result is the consolidation of 162 individual compound maps, previously used to review SGH<sup>SM</sup> data, into 19 compound class NN score maps specific to the commodity sought. These NN processed maps are not a simple summation of each compound class. Rather, the NN has determined, based on previous experience, the significance of each compound relative to each other in a compound class and applies them to the new data.

