***An Extended Exploration Model***

by James M. Fausnaugh geotech.org

Exploration models promote the idea of generating prospects using a series of decision loops based on successive inputs from different sources. Each input contains new data to aid in the decision making process. When surface geochemistry is included as input, existing models tend to support the use of raw concentration data for all methods omitting the compositional information that can be obtained from the direct hydrocarbon methods. By extending the model to include compositional interpretations in each iteration, the loop will allow the explorationist to move from reconnaissance survey, to detail survey, to drilling of the prospect in a timely and cost effective manner. Each iteration should contain parameters for:

- definition of anomalies using raw data from indirect or direct methods,
- definition of compositional anomalies using direct methods, and
- geochemical analog comparisons.

**Definition of anomalies using raw data.**

The data must pass stringent or somewhat rigorous statistical analysis. This usually requires that the data somehow be compared to an average or mean. Statistical analysis of means should be non-parametric to allow for small data sets which are often located within the confines of the predefined geological prospect. Using the median is preferable to the mean because geochemical data have a log normal distribution skewed to the left. In addition to the median, the geometric mean and harmonic means may also be used.

When combining multiple geochemical parameters, data normalization via median or mean is essential for comparison between variables.

**Definition of compositional anomalies** (when using direct methods)

Several statistical methods are available to facilitate the compositional analysis of surface geochemical data. The primary focus is on using these methods to help characterize the reservoir at depth by determining the source of the hydrocarbons detected at the surface. The most efficient and popular methods are Factor Analysis, Canonical Analysis, Discriminant Analysis, and Cluster Analysis for compositional testing between variables.

The use of ratios for compositional testing has long been the standard approach to surface hydrocarbon interpretation. Ratios can help the explorationist determine whether the detected microseep is related to oil, gas, or condensate from the reservoir at depth.

**Analog comparisons**

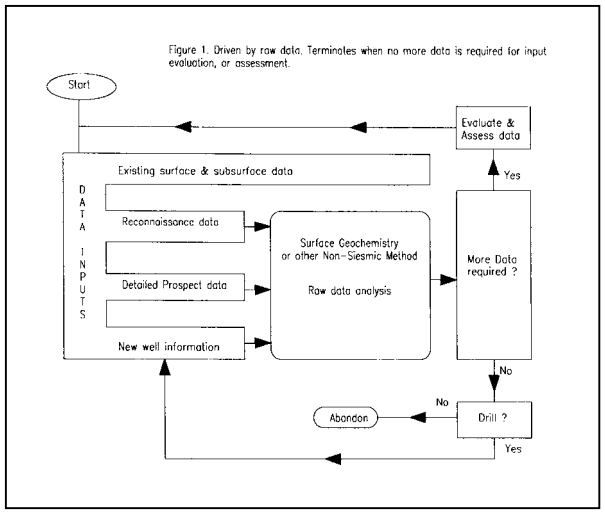
Comparisons using compositional information from published articles. field guides, and government agencies or from near surface hydrocarbon studies can often give a very accurate representation of the characteristics of the prospect under investigation. Use of near surface geochemical analogs for compositional analysis is less dependent on concentration than composition. Here statistics can be used for direct comparison, or by deriving statistical models based on analogs, residuals can be plotted to study the differences between the known and unknown.

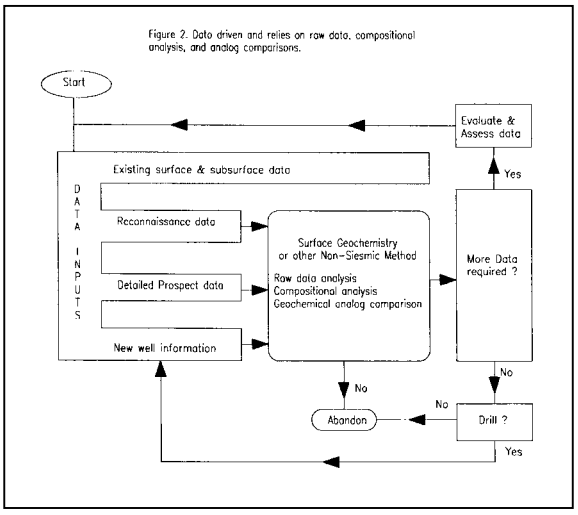
Analog comparisons allow generalizations regarding reservoir characteristics to be made. For instance, objective data regarding lithology, hydrocarbon gravity, and fluid types can be obtained.

The direction of data flow, within the model, is guided by the type of data input into the system. Indirect detection methods will terminate only when no more data is required to evaluate and assess the prospect. This portion of the loop is driven by cost. Due to the decisive nature of the direct hydrocarbon methods the loop will terminate when the data fails any of the comparative procedures. If at any point, an anomaly cannot be substantiated with the geochemistry, the loop terminates.

Like other models this one uses an iterative approach in evaluating the prospect. However, by using an exploration model driven by direct hydrocarbon detection methods and compositional analysis the explorationist can save time and money by letting the data terminate the loop.

Figure 1 uses only the raw data analysis, terminating when no more data is required for input, evaluation, or assessment. Any technique could be used in this model regardless of whether it is an indirect or direct detection method. The end result is a well defined "anomaly", though not necessarily related to hydrocarbons at depth. The degree to which the anomaly is defined is most likely driven by cost. Figure 2 is data driven and relies on the decisive nature of the direct hydrocarbon methods. During either the reconnaissance or detail surveys, the loop will terminate when the data fails any of the comparative procedures, bypassing the evaluation, assessment, or the gathering of more data. The additional expenditures related to multiple surveys and drilling can be avoided if the initial reconnaissance data fails the comparative steps.

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www.geotech.org
jmfausnaugh@geotech.org