Fuzzy Classification of Surface Geochemistry Data Applied to the Determination of HC Anomalies

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Surface geochemical methods use surface or near-surface occurrences of hydrocarbons (microseepage) as clues to the location of oil and gas accumulations. The rationale of such methods is that hydrocarbons are generated and/or trapped at depth and leak in varying quantities to the surface. Surface geochemical surveys provide direct evidence of the existence of an active petroleum system, helping in the identification of most prospective areas and in the evaluation and ranking of exploration leads and prospects. During the last decades, a remarkable advance in analytical techniques has allowed the detection of minute traces of hydrocarbons. Conversely, interpretative methods have been mostly limited to straightforward statistical approaches that define background and anomalous hydrocarbon concentrations assuming a lognormal or normal distribution.

In this study, fuzzy reasoning numerical techniques were applied to integrate surface geochemical (headspace C1 to C6+ concentrations from soil samples) and geologic data in a Subandean sedimentary basin. Fuzzy reasoning techniques are a key for human-friendly computerized devices, allowing symbolic generalization of high amount of data by fuzzy sets and providing its linguistic interpretability. A methodology is proposed to compute anomalous regions. Firstly, clusters of similar geochemical values were computed by the fuzzy c-means algorithm disregarding the location of the samples. In a second phase, a fuzzy classifier was trained to recognize the anomaly region generated by cluster analysis. The inputs to the classifier were sample’s coordinates and the outputs were the classes identified in the cluster analysis. Finally, a grid of points was generated and the classifier was used to map the clusters in the grid.

The results of the proposed approach have allowed a better definition of areas anomalous areas, taking into account all the geochemical parameters in an integrated way (instead of considering concentrations of each gas independently) and also geological data normally disregarded, such as, outcropping lithologic units, soil characteristics, etc., providing an encouraging alternative to standard geostatistic techniques.

Keywords: Surface geochemistry, hydrocarbon gas, fuzzy reasoning.