Geological Favourability Mapping of Hydrocarbon Potential Using a Fuzzy Integration Method, Western Sverdrup Basin of Canadian Arctic Archipelago.

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In a petroleum exploration program, there are two essential processes, target finding and target ranking. Target finding usually consists of evaluating and identifying favourable conditions indicative of existence of oil and gas deposits, which involves interpretation of geological evidences and geophysical indicators from various data sources. Target ranking involves comparison amongst the available targets in terms of the likelihood of containing petroleum, possible size of the accumulation as well as the economic aspects of cost against profit. As all necessary geological conditions leading to a petroleum accumulation are a spatial function, a better understanding of the spatial characteristics of the controlling factors and their impact on petroleum accumulation is important. There are problems to be handled in quantitatively describing the spatial characteristics of geological conditions favourable for hydrocarbon accumulation in a frontier region due to the availability and nature of the geoscience data:

1) Geoscience information from various sources requires a precise representation for spatial reasoning. In many cases, the information to be represented is possibilistic or transient in nature, and needs a mathematical tool that can adequately represent the information with a degree of possibility and/or uncertainty.
2) Uncertainty of interpreting each geological evidence and of correlating the results with physical parameters of a petroleum accumulation should be expressed explicitly.
3) The evidences and indicators of the existence of a petroleum accumulation come from various data sources and vary in degree of uncertainties. These uncertainties should be integrated into a petroleum accumulation model so that exploration risk can be objectively evaluated in a subsequent economic analysis.

We propose here the use of a fuzzy integration method to handle these problems. The proposed method is based on fuzzy implications coupled with multiple-criteria-decision making theory. The method uses possibility theory to describe the satisfaction levels associated with each of the essentials for the formation of hydrocarbon deposits, such as the presence of reservoir, source rock, trap, top seal and timing in a spatial domain. The uncertainties associated with data and evaluation are explicitly incorporated in the aggregation of the geological factors. The proposed method and application procedure are illustrated through the evaluation of geological favourability for hydrocarbon accumulation in strata of the Heiberg Group/Formation of western Sverdrup Basin, Canadian Arctic Archipelago.