Intra Molecular Isotope in Natural Gas Exploration and Resource Assessment

A Cooperative Research and Development Program

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Introduction

This document outlines a proposed three-year study to be jointly conducted by researchers from GeoIsoChem Corporation and participated oil companies. The main objectives of this project is to understand the applications of intra molecular isotope for oil and gas explorations, The significance of this work will directly enhance our understanding of the processes that lead to the formation of natural gas accumulations, and increase our ability to explore for and assess natural gas resources. More specifically, when integrated with other geologic data, intramolecular isotope will provide useful information related to the origin, maturity, timing, and migration of natural gas, which are key elements for gas explorer to greatly reduce the exploration cost by increasing the accuracy of gas reserves assessment.

Background

Because natural gases are dominated by a few simple, low molecular-weight hydrocarbons, important genetic information is commonly obtained from stable carbon and hydrogen isotope ratios. Compound specific isotope analysis (CSIA) on the C_1-C_5 hydrocarbon has been uniquely suited to provide valuable information on origin and fate of gas compounds which can be used to assess the nature and thermal maturity of potential source beds, the pathways by which gas migration occurred, the presence of mixed-source gases and, more controversially, reservoir accumulation and loss histories. A further improvement of such an evaluation is the isotope analysis of not only one but two or more elements, such as ^{13}C and ^{2}H isotopes, in the same reacting molecules. Such a two-dimensional isotope pattern allows for a more definite source attribution and can reflect the different chemical bond transformations involved in different reactions. On the other hand, the isotope composition of an element is not necessarily the same for all positions in the molecule to that analysis of parts of a molecule (intramolecular isotope analysis) or even single atoms (position-specific isotope analysis) will yield an even high resolution with respect to the isotope information stored. In this sense, the intramolecular isotope analysis of propane and butane may provide unique information about gas origin, maturity and formation temperatures. We believe this will lead enormous progress on gas isotope geogeochemistry.

Method

Intra Molecular Isotope Measurement **–** The carbon isotope of propane will be measured by gas chromatography combustion isotope ratio mass spectrometry (GC-C-IRMS). Such an online coupling of GC-C-IRMS method has made it possible to analyze bulk isotope ratios of lower molecular weight compounds in small, environmentally relevant concentrations. The propane will be converted to isopropanol by suing soluble methane monooxynenose (pMMO and sMMO) from Methaylococcus capsulatus. The chemical degradation of isopropanol will form acetate according the iodoform reaction. After drying the combined organic layers, lithium alumimum hydrite will be used to convert acetate to alcohol for GC-C-IRMS analysis.

Proposed Work Plan and Deliverables

We propose to study three natural gas systems including marine source rock, coal and oil associated gases.. For each natural gas system, we will select minimum 10 natural gas samples (at different maturity) for intra molecular isotope studies. Thus, minimum 30 gas samples will be analyzed (if we have 4 members). Through these studies, we anticipate to provide important scientific opinions to improve our fundamental understandings of the natural gas generation, and applications of intra molecular isotope technique towards the natural gas exploration and assessments.

Cost of the JIP Program

Duration of this JIP is 3 years with the annual subscript fee for this JIP membership of $50K (continuation is based on mutual agreement).