Recommendations for integrating isotope fingerprinting in Environmental Baseline Assessment as part of regulation on unconventional gas exploration and exploitation

Wolfram Kloppmann, Bernhard Mayer, Pauline Humez, Florian Osselin, Eric Gaucher

RECOMMENDATIONS FOR INTEGRATING ISOTOPE FINGERPRINTING IN ENVIRONMENTAL BASELINE ASSESSMENT AS PART OF REGULATION ON UNCONVENTIONAL GAS EXPLORATION AND EXPLOITATION

W. Kloppmann[1], B. Mayer[2], P. Humez[2], F. Osselin[2,3], E. Gaucher[4]
[1]BRGM, Direction des Laboratoires, Orléans, F-45060, France
[2]Department of Geoscience, University of Calgary, Calgary, Alberta, Canada T2N 1N4
[3] Earth Sciences Institute of Orleans (ISTO), University of Orléans, Orléans, F-45060, France
[4] TOTAL CSTJF, Pau, F-64000, France
E-mail address: w.kloppmann@brgm.fr

Abstract: Multi-isotope fingerprinting of gases (methane, higher alkanes, CO_2) and of dissolved compounds in saline fluids (C, S, O, Sr, B, Li, U, Cu, Zn,…) allows for the discrimination of point contamination related to unconventional gas development compared to the environmental baseline. We present results from a multitude of settings worldwide with a focus on the identification of thermogenic stray gases from the natural background values, taking into account the prevailing redox conditions. A second aspect are the specific isotope fingerprints of flowback waters from hydraulic fracturing compared to natural saline fluids.

1. INTRODUCTION

The recent expansion of the unconventional gas industry in North America and its potential advent in Europe has generated strong public concern regarding the protection of groundwater and surface water resources. Potential contaminations are linked to stray gas, saline formation water and hydraulic fracturing chemicals. The determination of the non-impacted baseline is both a scientific challenge and an indispensable prerequisite for an accurate and quantitative environmental impact assessment in the context of unconventional hydrocarbon development. The Franco-Canadian NSERC-ANR G-Baseline project has developed an innovative and comprehensive methodology of geochemical and isotopic characterization of the environmental baseline for water and gas samples from all three essential zones that we recommend to investigate systematically in the frame of Environmental Baseline Assessment (EBA): (1) the production zone, including flowback waters, (2) the intermediate zone comprised of overlying formations, crucial for confinement or migration of fluids and gases, on the base of improved knowledge on migration mechanisms of gases and brines and (3) shallow aquifers and surface water systems where contamination may result from diverse natural or other human impacts.

2. METHDOS

The methodology developed in the project is based on isotopic tracer and monitoring techniques for detecting and quantifying and modeling stray gas and leakage of saline formation water mixed onto flowback fluids into fresh groundwater resources and surface.

3. RESULTS AND DISCUSSION

We found that the chemical and isotopic composition of different types of gases and groundwaters can be used as fingerprints allowing differentiating potential contaminations related to unconventional oil and gas development from the geochemical baseline. This task is complex as this baseline may comprise both natural contaminations and previous pollutions. Potential leakage of fracking fluids and stray gas need to be distinguished from natural sources and other types of contamination. We developed a comprehensive set of environmental tracers, including in particular the isotope signatures of gases (alkanes, CO_2,…) and dissolved elements (C, S, O, Sr, B, Li, U, Cu, Zn,…) allowing for discriminate those diverse sources. Some of these tools were developed and applied to EBA for the first time (e.g. Cu and Zn isotopes). This toolbox was tested in the Canadian provinces (ex. Alberta) where a long and complex history of conventional oil and gas superposes to an increasing development of unconventional resources [1-3]. Other provinces (ex. Yukon) have adopted, like France, a moratorium on those activities, providing good conditions for characterizing the environmental baseline conditions. The project also investigated natural analogues of gas leaks, like gas emanations from the Jurassic shales from the Subalpine Chains (French South-Eastern sedimentary basins)[4], and the deep saline and fresh groundwater of the Paris Basin. We had access to fluids derived from hydraulic fracturing at industrial sites in Argentine and Canada and characterized their multi-isotope fingerprints.

4. CONCLUSIONS AND OUTLOOK

The multi-isotope data produced on a variety of study sites worldwide provide the basis for decision support for industrial and regulatory stakeholders, including practical methods to distinguish biogenic and thermogenic gases in shallow freshwater resources in a more reliable way and to discriminate saline flowback from hydraulic fracturing from natural saline fluids.

Ongoing and future research, within the European H2020 project SECURe « Subsurface Evaluation of Carbon capture and storage and Unconventional Risk», focuses on synergies of EBA monitoring strategies and techniques between two fields of application of isotope fingerprinting, Carbon Capture and Storage (CCS) and unconventional gas development.

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