Available online at www.sciencedirect.com

ScienceDirect

Procedia Earth and Planetary Science 17 (2017) 189 – 192

Procedia Earth and Planetary Science

15th Water-Rock Interaction International Symposium, WRI-15

Hydraulic fracturing in the upper Humboldt River basin, Nevada, USA

James Thomas[a,1], Greg Pohll[a], Jenny Chapman[b], Karl Pohlmann[b], Rishi Parashar[a], Susan Rybarski[a], Ronald Hershey[a], Wyatt Fereday[a]

[a]*Desert Research Institute, 2215 Raggio Parkway, Reno, NV 89511, USA*
[b]*Desert Research Institute, 755 E Flamingo Rd, Las Vegas, NV 89119, USA*

Abstract

Water-quality and isotopic data were collected in central Nevada, USA in an exploration hydraulic fracturing area with no previous oil or gas production. The target shales of the Elko Formation are unique fresh-water hydrocarbon reservoirs with relatively dilute source water (8.5 g/L total dissolved solids [TDS]). Additionally, the Elko Formation is underlain by a fresh-water carbonate aquifer (0.2-0.3 g/L TDS) that outcrops downgradient of the exploration area. The water quality and isotopic data were used to evaluate pre-hydraulic fracturing conditions in this undeveloped area. The same data were also collected for groundwater and surface-water sites about two months and one year after exploration hydraulic fracturing. No systematic differences in water chemistry were observed between pre- and post-hydraulic fracturing samples. Based on water chemistry of shallow groundwater, surface water, and from the production zone, the most useful constituents identified for monitoring for potential future incursion of reservoir-associated fluids into the near-surface environment are TDS (or electrical conductivity), chloride, propane, methanol, ethanol, and 2-butoxyethanol. Groundwater flow and transport models were developed to evaluate the potential movement of hydrocarbons and hydraulic fracturing fluids from the targeted zones, which are about 1800 to 3600 m beneath the land surface, to shallow groundwater (<300 m below land surface). Model simulations indicate that hydraulic fracturing fluid remains contained within the target shales for at least 1,000 years for most development scenarios.

Peer-review under responsibility of the organizing committee of WRI-15

Keywords: Hydraulic fracturing; Water chemistry; Groundwater modeling; Transport modeling

1. Introduction

Hydrocarbon resources are being explored in the upper Humboldt River basin of northeastern Nevada, USA (Fig.

* Corresponding author.
E-mail address: jthomas@dri.edu

Peer-review under responsibility of the organizing committee of WRI-15
doi:10.1016/j.proeps.2016.12.065

1). Hydraulic fracturing is being conducted to assess the economic viability of the low-permeability rock formations in this area. The current target for hydrocarbon exploration in the project area is oil shales in the Elko Formation, which range in depth from about 1800 to 3600 m beneath land surface. The target shales are unique fresh-water hydrocarbon reservoirs with relatively dilute source water (8.5 g/L TDS). Overlying the Elko Formation is the Indian Well Formation (with low to moderate permeability) and beneath the Elko Formation are carbonate rocks with fresh water (0.2-0.3 g/L TDS) that are characterized as moderately to highly permeable and outcrop downgradient of the exploration area. Groundwater flow paths for the upper Humboldt River basin are from the mountain ranges toward adjacent creeks and valleys, eventually leading to discharge along the Humboldt River[1] (Fig. 1).

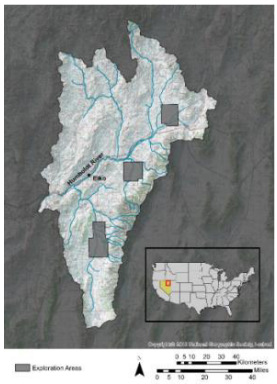

Fig. 1. Location of proposed hydraulic fracturing areas in the upper Humboldt River basin, northeastern Nevada, USA.

To evaluate pre-hydraulic fracturing water-quality conditions, shallow groundwater and surface-water chemistry samples were collected from three exploration areas and the surrounding region. Sampling occurred prior to, and after, exploratory hydraulic fracturing. The analytical suite included natural gas components associated with petroleum reservoirs, refined hydrocarbons, and related chemical compounds associated with land surface exploration activities; components associated with generic hydraulic fracturing fluids; and chemical, isotopic, and radiochemical constituents found in water.

2. Geochemistry and Water Quality

Water-quality and isotopic data collected during this study were used to characterize shallow groundwater and target-shale source water and to identify hydraulic fracturing fluids that could potentially migrate from hydraulic fracturing zones, potential contamination from land-surface activities, and the origin of methane in waters[2]. Data collected and presented in this report are from[3]. Constituents sampled for this project and an explanation of why they were sampled are presented Table 1.

Table 1. Chemical and isotopic parameters and the purpose these parameters were selected for this study.

Parameter or Constituent	Purpose
Methane, Ethane, Propane	Indicators of crude oil release
Diesel Range Organics, Gasoline Range Organics	Indicators of refined hydrocarbon release from land-surface activities
MTBE, Benzene, Toluene, Ethylbenzene, Xylenes	Indicators of refined hydrocarbon release from land-surface activities
Temperature, Electrical Conductivity, pH	Characterize local groundwater, identify mixing of shale water
Ca, Mg, Na, K, Li, B, Ba, Sr	Characterize local groundwater, identify mixing of shale water
Alkalinity, Cl, SO_4, Br, NO_3, F, SiO_2, Total Dissolved Solids	Characterize local groundwater, identify mixing of shale water
Gross Alpha, Gross Beta, Radium-226, Radium-228	Establish natural background in local groundwater; mixing of shale water
δ^2H, $\delta^{18}O$, $\delta^{13}C$ DIC water	Characterize local groundwater, identify mixing of shale water
δ^2H, $\delta^{13}C$ methane	Identify source of methane: biogenic or thermogenic
Ne, Ar, Kr, Xe, ^4He	Identify source of natural gas, characterize local and shale waters
R/R_a ($[^3He/^4He]_{groundwater}$ / $[^3He/^4He]_{atmosphere}$)	Identify source of natural gas, characterize local and shale waters
Methanol, Ethanol, Isopropanol, 2-Butoxyethanol, Acrylonitrile, Glycerol, Ethylene Glycol, Propylene Glycol, Ammonium Persulfate	Indicators of hydraulic fracturing fluid release