Earth Stewardship Science Research Institute

Nelson Mandela Metropolitan University

Baseline Groundwater Hydrochemistry and Aquifer Connectivity of the Eastern Cape Karoo Prior to the Proposed Hydraulic Fracturing of Shale Gas

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Introduction

- The anticipated exploration and exploitation of Karoo Shale Gas is raising considerable debate regarding the specific benefits and risks associated with the process of harvesting the gas using hydraulic fracturing
- Much focus has been placed on the potential impact of hydraulic fracturing on ecological, environmental and especially its scarce water resources.
- The Karoo region is highly dependent on fresh groundwater as an important water resource and with anticipated climate change it will become increasingly so. Thus, sustainable groundwater management is of prime importance.

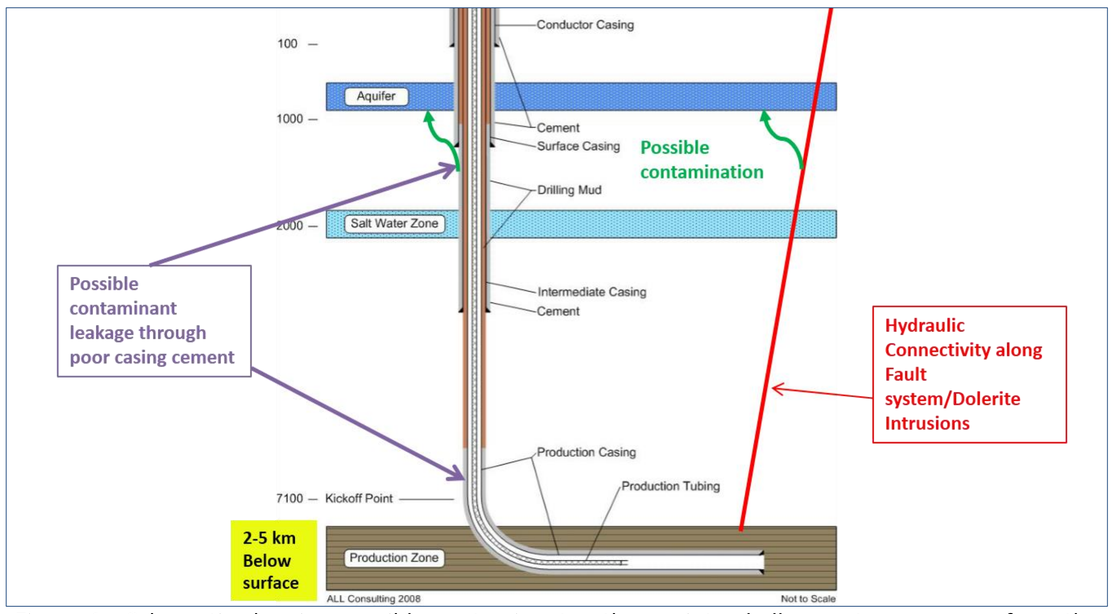

Figure 1. Schematic showing possible contaminant pathways into shallow water recourses from the hydraulic fracturing process.

Research Area

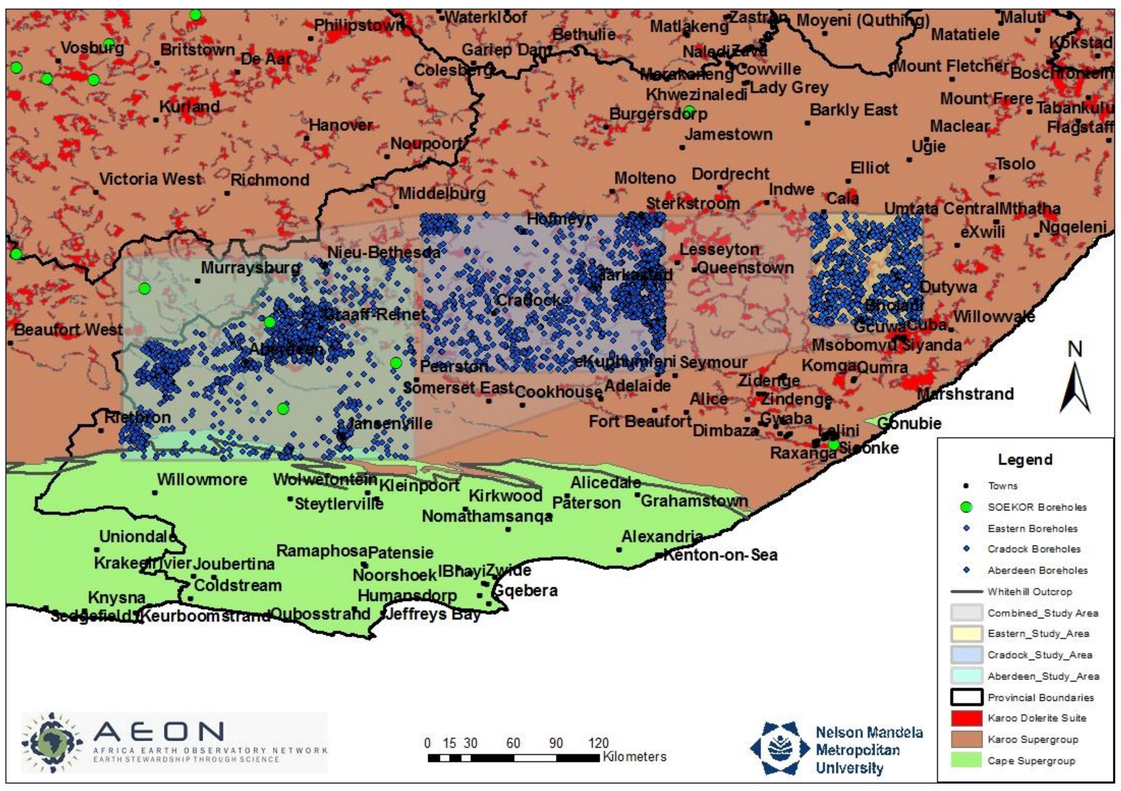

Figure 5. Map showing the research area.

Significance

- The research is critical for the successful governance of groundwater of the Karoo in light of the proposed Shale Gas development.
- In its absence, effective regulation of the sector will not be possible.

References

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Objective

The research will aim to:

- Hydrochemically characterise both the shallow groundwater (<300m) and deeper saline groundwater in the vicinity of the Shale Gas bearing formations, based on major and trace elements, as well as gas isotope analyses.
- Test the possible hydraulic connectivity between the shallow and deep aquifers, particularly in those areas where dolerite intrusions and fault systems may enhance preferential flow of water, using the chemical forensics complemented with passive seismic profiling/imaging and deep penetrating Magneto-Telluric imaging.

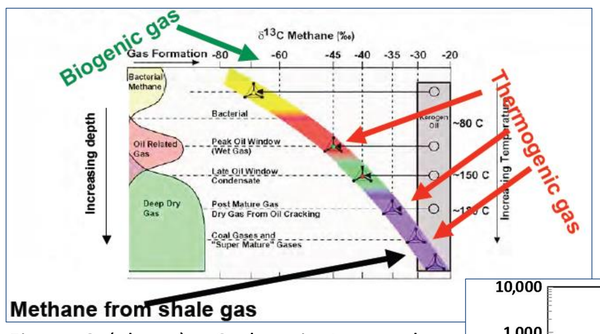
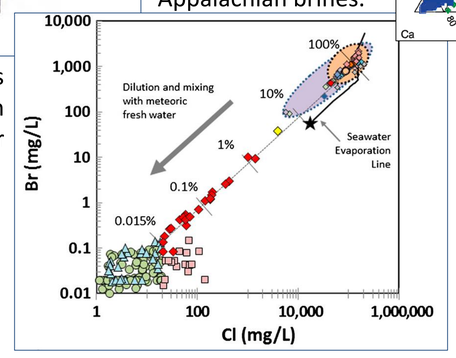


Figure 2 (above). Carbon isotope values determining origin of gas to distinguish between shallow and deep groundwater (modified from M. Schoell, 1988).

Figure 3 (below). Expected results as modified from Warner et al, 2012, Bromide vs chloride concentrations (log-log scale) in shallow groundwater and Appalachian brines.



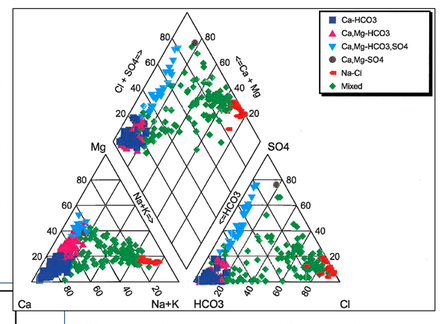


Figure 4 (above). Piper diagram showing different groundwater chemical groupings (modified from St. Johns River Water Management District, 2013).

Methodology

Desktop Study

- To date, includes the collation of information to determine the areas with the highest potential for Shale Gas Exploration throughout the Eastern Cape Karoo.
- The boreholes as obtained from online databases of the Department of Water Affairs (DWA) have been spatially visualised.

Date: Completed

Hydro-census

- Conduct a hydrocensus during which downhole electrical conductivity profiling of the water column will be recorded.
  - ➢ Identify depth of aquifer.

Date: 01/10/2014 – 28/11/2014

Borehole Selection

- Finalise the borehole selection from the acquired information.

Date: 30/11/2014 – 19/12/2014

Purging & Pump Test

- Purging and pump tests of all inactive boreholes.
  - ➢ Remove chemical accumulation
  - ➢ Determine shallow aquifer characteristics

Date: 01/03/2015 – 31/03/2015

Sampling and Analyses

- Sampling and analyses of each borehole a minimum of three times.
  - ➢ Seasonal sampling.

Date 1: 19/01/2015 – 20/02/2015 (Pilot run) Date 2: 01/04/2015 – 31/05/2015 Date 3: 01/10/2015 – 30/11/2015

Results

- Present hydrochemical results as chemical ratios by use of graphs, Ternary diagrams, Piper diagrams, Durov diagrams and expanded Durov diagrams.
- Compile the relevant parameters to be translated into spatial GIS maps.
- Identify geological structures on MT and seismic profiles.

Date: 18/01/2016 – 30/06/2016

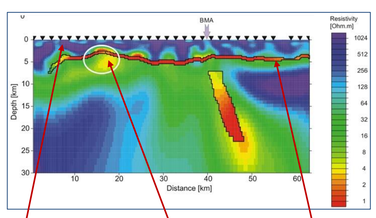


Figure 6. Example of deep penetrating magneto-telluric imaging showing the Whitehill Formation and underlying saline reservoir (Branch et al, 2007).

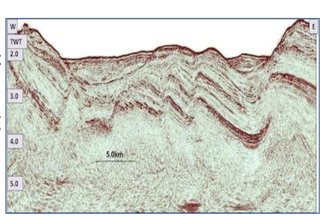


Figure 7. Example of passive seismic profile showing fault systems (A. Okere, 2011).

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