DOE-ARRA Geologic Sequestration Training and Research 2011 Yearly Review Meeting

Project DE-FE0002112

Title: Measurements of ^{222}Rn, ^{220}Rn, and CO_2 Emissions in Natural CO_2 Fields in Wyoming: MVA Techniques for Determining Gas Transport and Caprock Integrity

University of Wyoming

Presenters: Drs. John Kaszuba and Ken Sims
Department of Geology & Geophysics

February 24-26, 2011

Project Participants

- Faculty/PIs: John Kaszuba & Ken Sims
- Graduate Students (MS):
  - Tim Moloney
  - Allison Pluda
- Undergraduate students:
  - Virginia Marcon
  - Matt Carberry
  - Katelynd Faler

Introduction

- Background - Natural CO_2 analogues coincide with mapped areas of elevated gamma background radioactivity that may indicate the presence of radon (Rn) gas. Successful measurement of CO_2 and Rn emissions on active volcanoes demonstrates viability of a geochemical tool to relate CO_2 emissions to source regions (i.e., deep vs. shallow) and mechanisms of gas transport toward surface. The purpose of this project is to determine whether quantitative measurement techniques for Rn activity and CO_2 flux, already established for natural volcanic systems, can be applied to natural and laboratory CO_2 analogues as a means of assessing caprock integrity.
- Anticipated Benefits - evaluate and calibrate the use of naturally occurring Rn isotopes for evaluating the reliability of caprock formations

Project Objectives

- Major Objective: Provide training opportunities for 2 graduate students and 1 undergraduate student in geologic & geochemical skills required for implementing/deploying CCS technologies.
- Secondary Objectives (Student centric):
  - Perform fundamental research to advance Monitoring, Verification, and Accounting (MVA).
  - Integrate geologic principles of field measurement at natural CO_2 analogues in Wyoming with geochemical principles of ^{222}Rn, ^{220}Rn, and CO_2 measurement in laboratory and field settings.
  - Evaluate/calibrate potential use of naturally-occurring Rn isotopes for assessing caprock integrity.

Project Funding

- Total Project Cost: $345,708
- DOE Share: $299,768
- Non-DOE Cost Share: $45,940*
- Cost Share Provider: University of Wyoming

*four semesters of masters-level graduate student support, including stipend, tuition, fees, insurance was obligated. By the end of this semester, the Dept. of Geology will have provided the equivalent of five semesters of funding.

Highlights of Project to Date

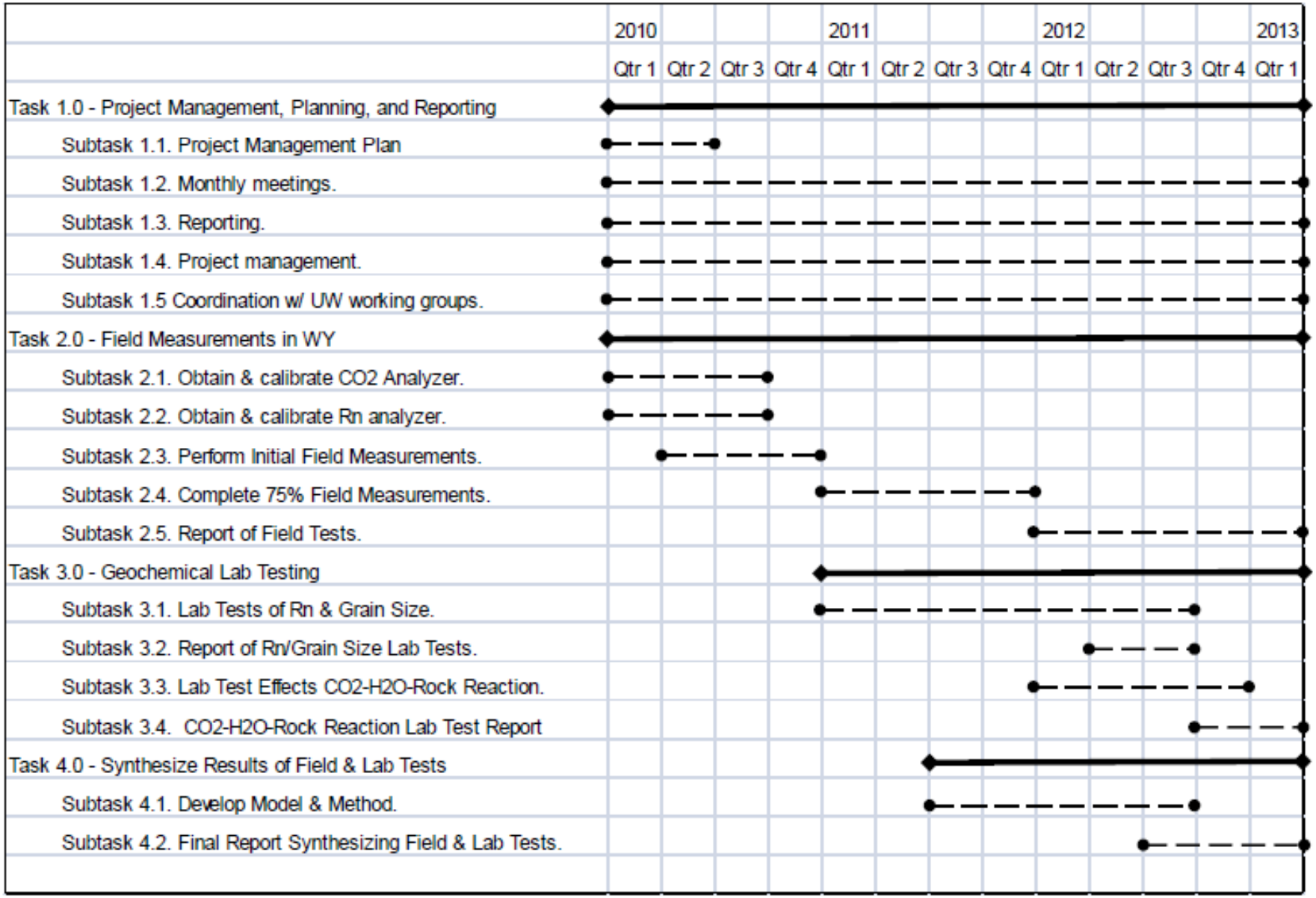
- Joined in field by Dr. Salvatore Giammanco, first author of the journal article that forms the scientific basis for this project*. PIs Kaszuba and Sims (also Giammanco's co-author) along with Giammanco went to the field with 5 students June 29-July 2. Provided the students with instruction in field measurement of Rn and CO_2 and the thought processes necessary for quality science.
- Yellowstone field work completed. Weak inverse relationship observed between ($^{220}Rn/^{222}Rn$) and CO_2 flux from thermal features (Moloney/Sims).
- Completed 1st season of field work on LaBarge CO_2 Field, Moxa Arch in SW Wyoming. CO_2 flux and ($^{220}Rn/ ^{222}Rn$) are lower over the LaBarge Field and generally higher beyond the margin of the LaBarge Field and across faulted & fractured areas (Marcon/Pluda/Kaszuba/Sims).

*Giammanco, S., Sims, K.W.W., and Neri, M., 2007, Measurements of ^{220}Rn and ^{222}Rn and CO_2 emissions in soil and fumarole gases on Mt. Etna volcano (Italy): Implications for gas transport and shallow ground fracture, Geochemistry Geophysics Geosystems, Volume 8, Q10001, doi:10.1029/2007GC001644).

Tasks – Overview

Task No.	Task Description	Task Duration	Task Funding
1	Project Management and Planning	12/01/2009 – 11/30/2012	$34,571
2	Field Measurements in Wyoming	12/01/2009 – 11/30/2012	$172,854
3	Geochemical Laboratory Testing	11/01/2010 – 11/30/2012	$103,712
4	Synthesize Results of Field and Laboratory Tests	06/30/2011 – 11/30/2012	$34,571

Project Schedule



Discussion – Task 2.0
Field Measurements in Wyoming

<u>Goal</u>: Systematic field survey of Rn isotopes and CO_2 flux measurements.

- ✓ *Subtask 2.1*. Obtain/calibrate CO_2 Gas Analyzer (EGM-4 Environmental Gas Monitor
- ✓ *Subtask 2.2*. Obtain and calibrate dedicated Rn analyzer (Durridge RAD7 electronic radon monitors)
- ✓ *Subtask 2.3*. Perform initial field measurements

Subtask 2.4. Complete field measurements.

Subtask 2.5. Report of field tests.

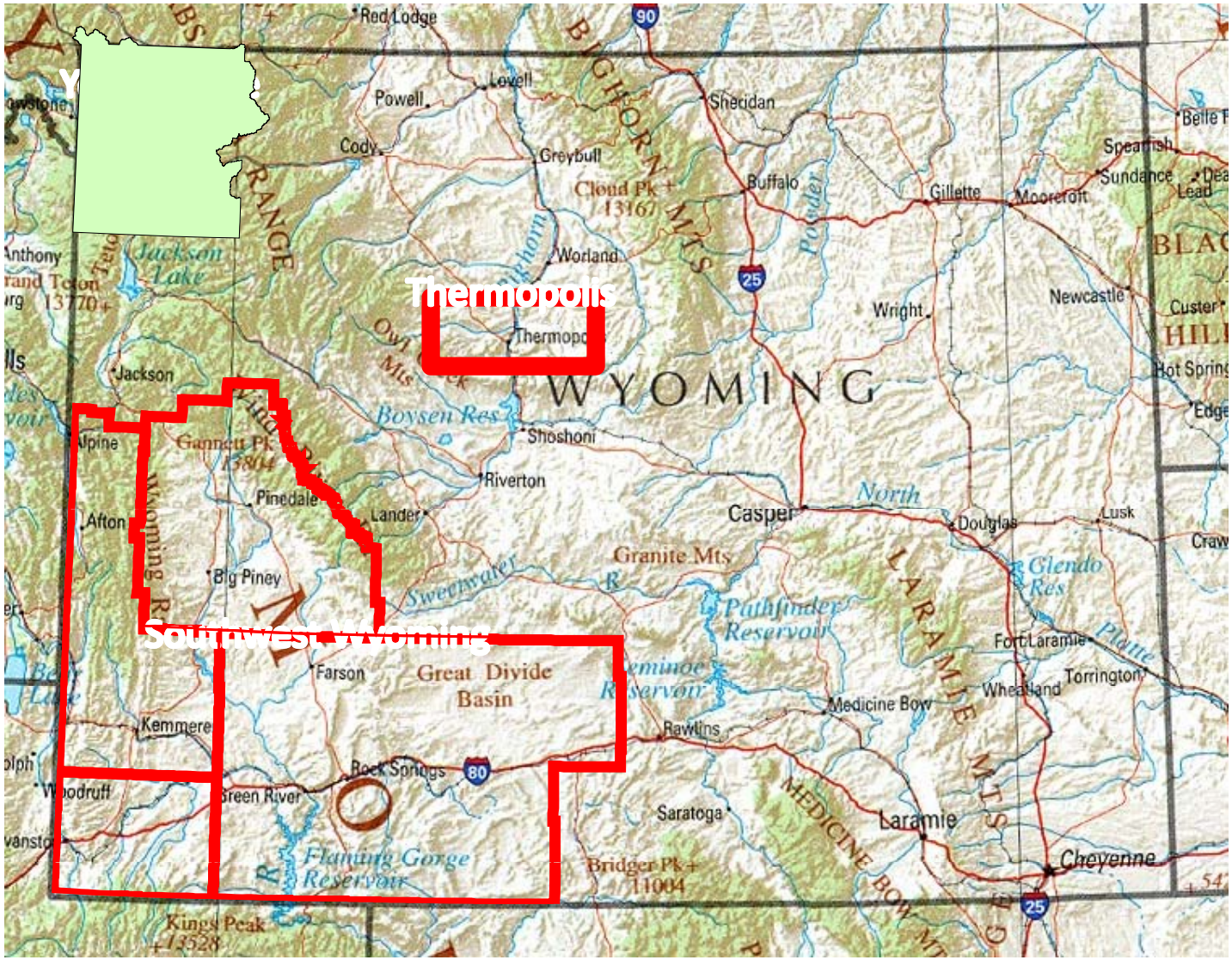
Discussion – Task 2.0
Field Measurements in Wyoming

Responsible parties

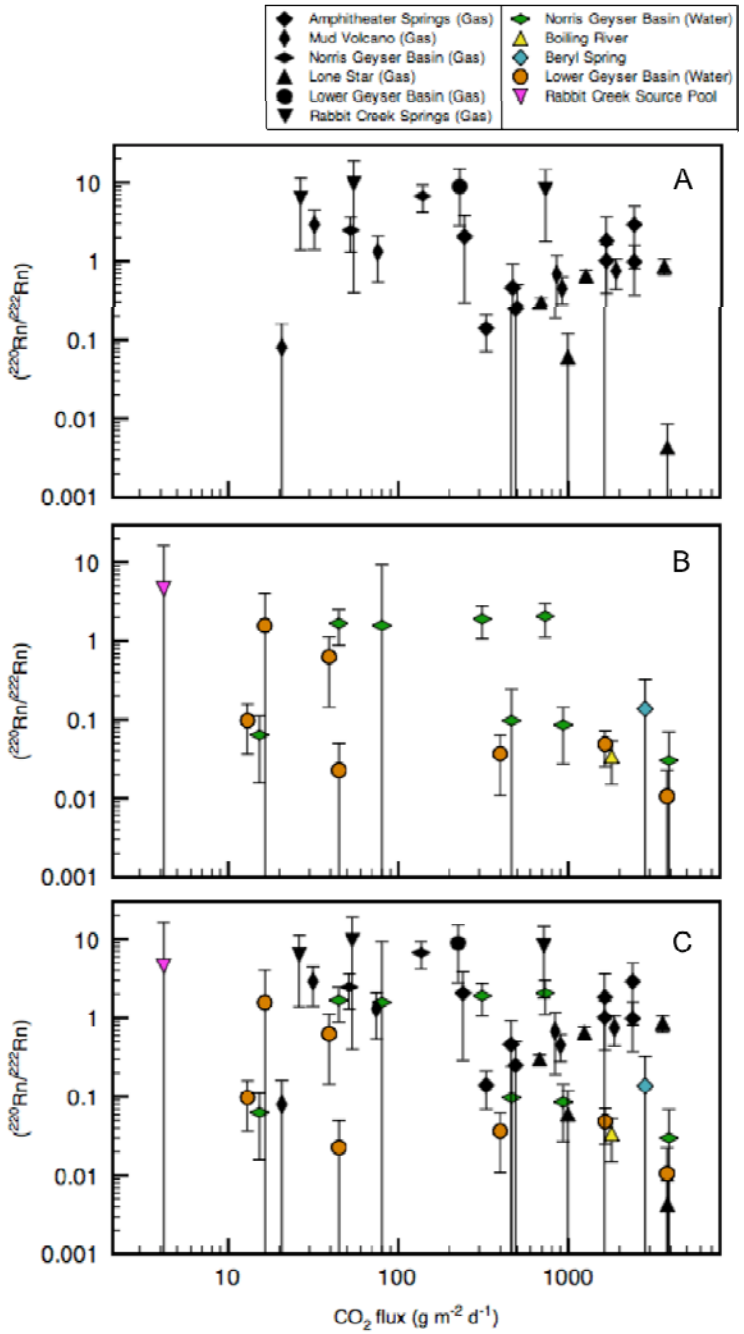
- Faculty: Kaszuba and Sims
- Students: Moloney, Pluda, Marcon

Task Status: 20% complete

Wyoming Field Areas



Yellowstone – Weak inverse correlation between ($^{220}Rn/^{222}Rn$) and CO_2 flux

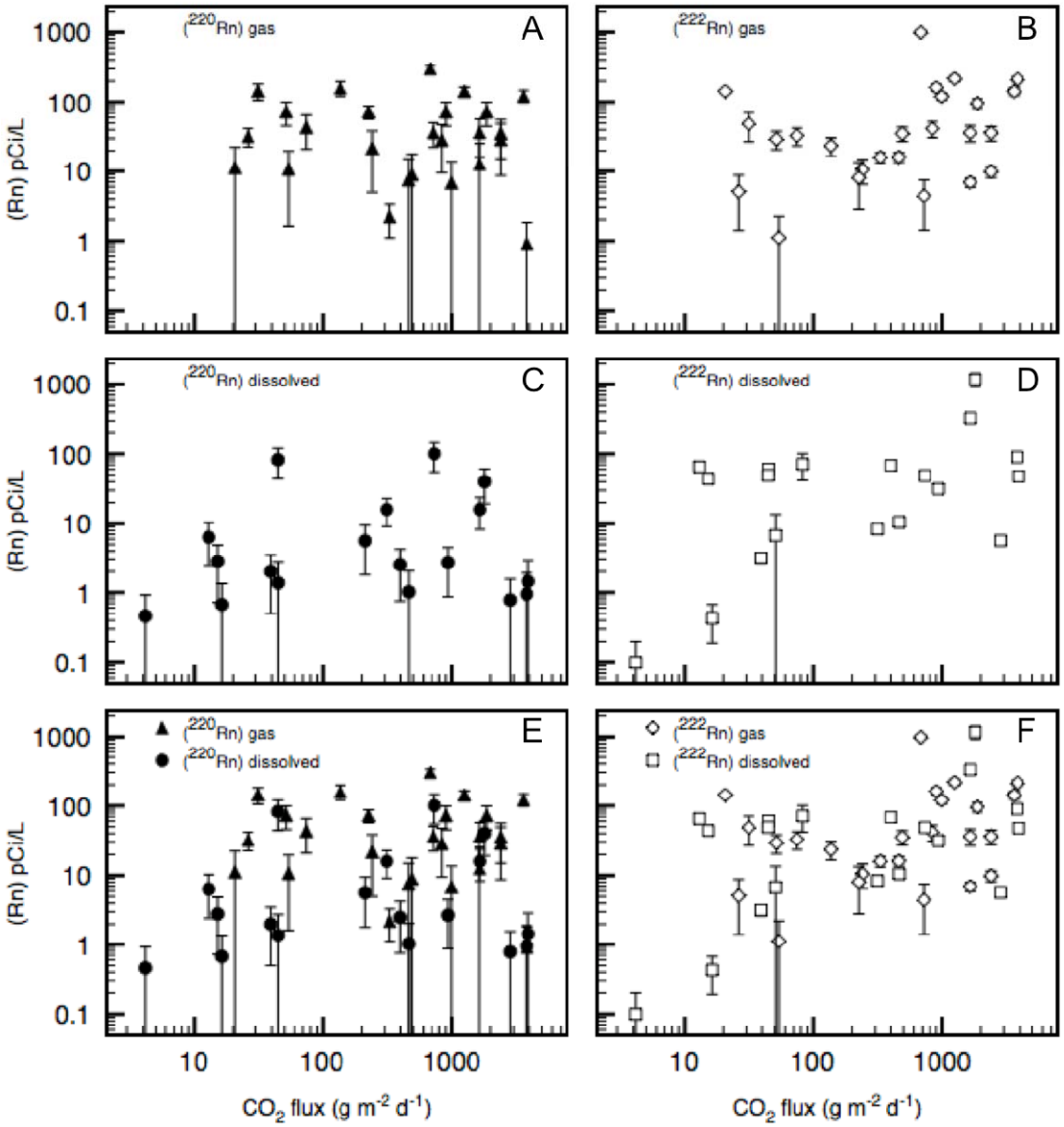


gas vents

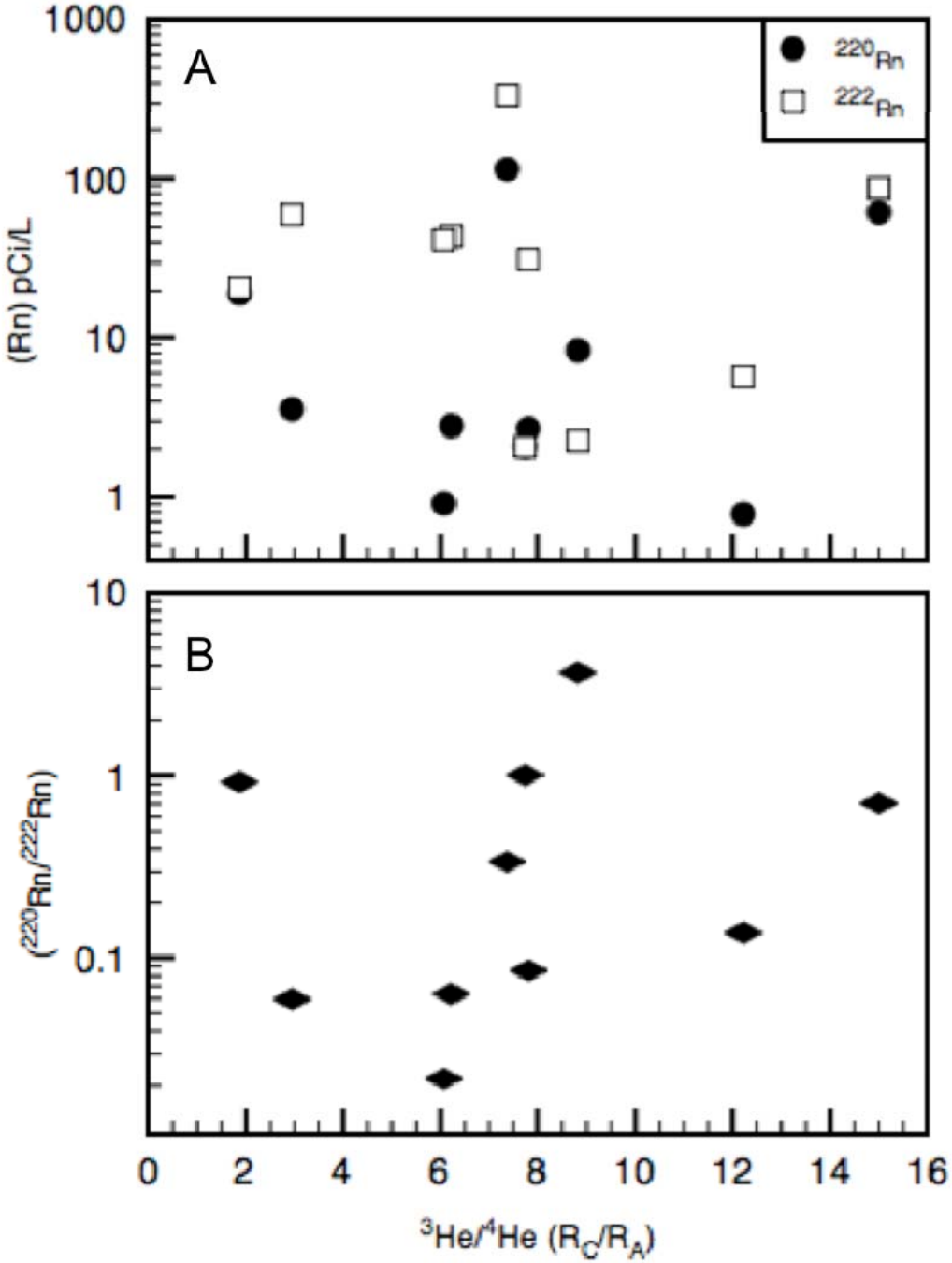
thermal springs

gas vents and springs

Yellowstone – ^{222}Rn and ^{220}Rn in hydrothermal fluids

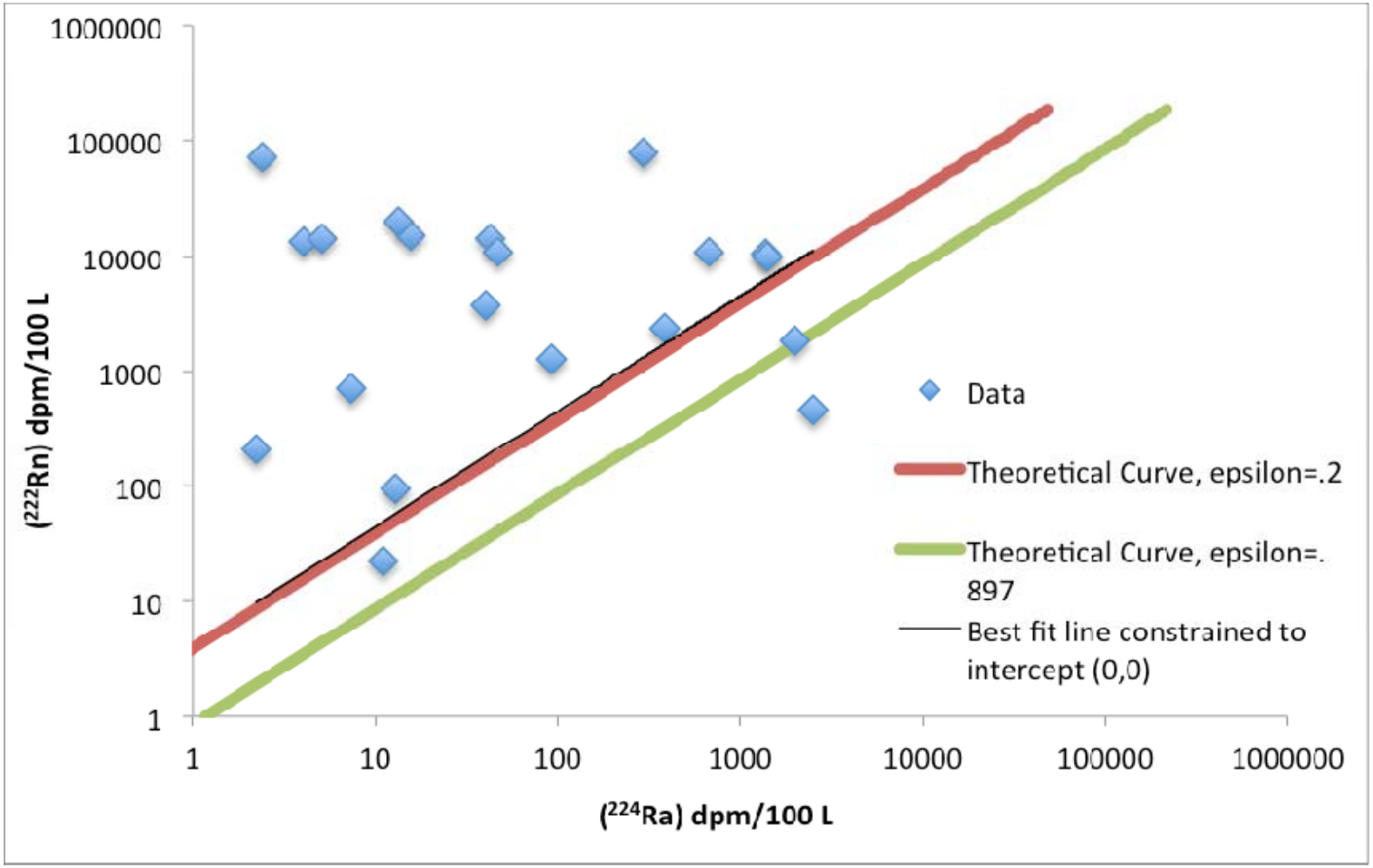


(^{220}Rn) appears to increase with CO_2 flux to about 100 g m^{-2} d^{-1}, then decrease with higher CO_2 fluxes. (^{222}Rn) shows a weak positive correlation for all values of CO_2 flux.

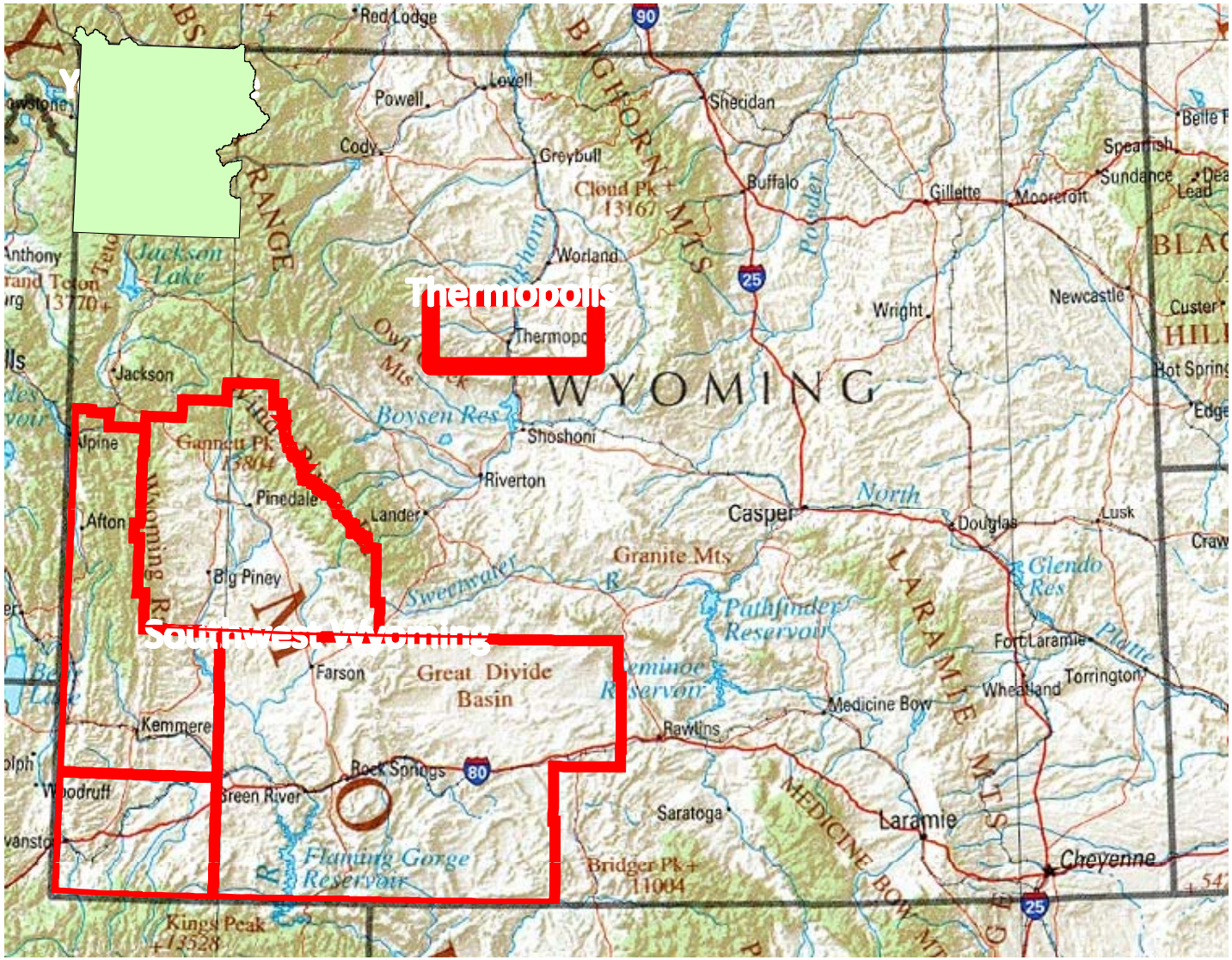


Yellowstone – Radon isotopes show no relationship with helium isotope ratios

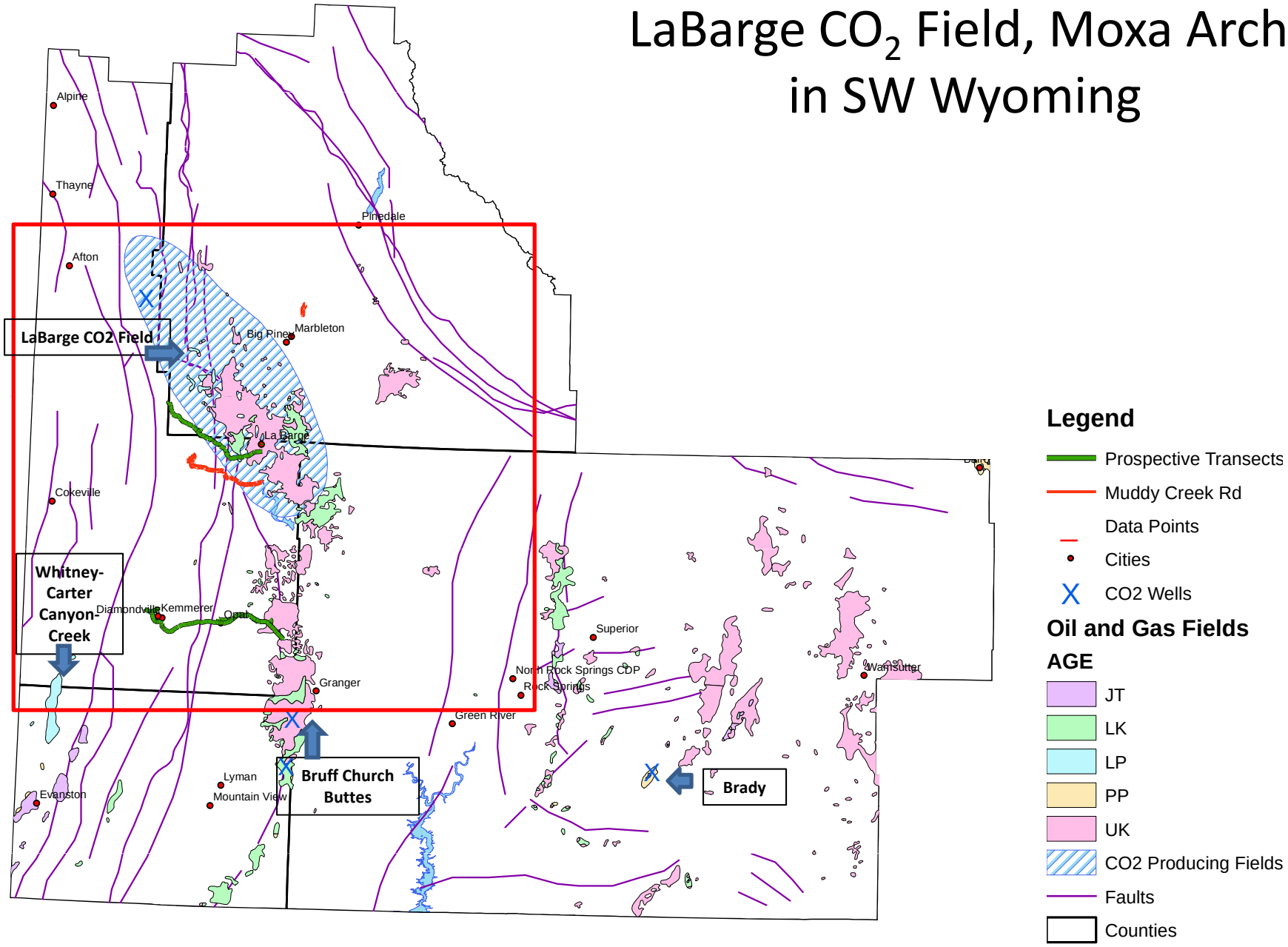
Yellowstone –
Activities of ^{222}Rn and ^{224}Ra in hot spring water.



Wyoming Field Areas



LaBarge CO_2 Field, Moxa Arch in SW Wyoming



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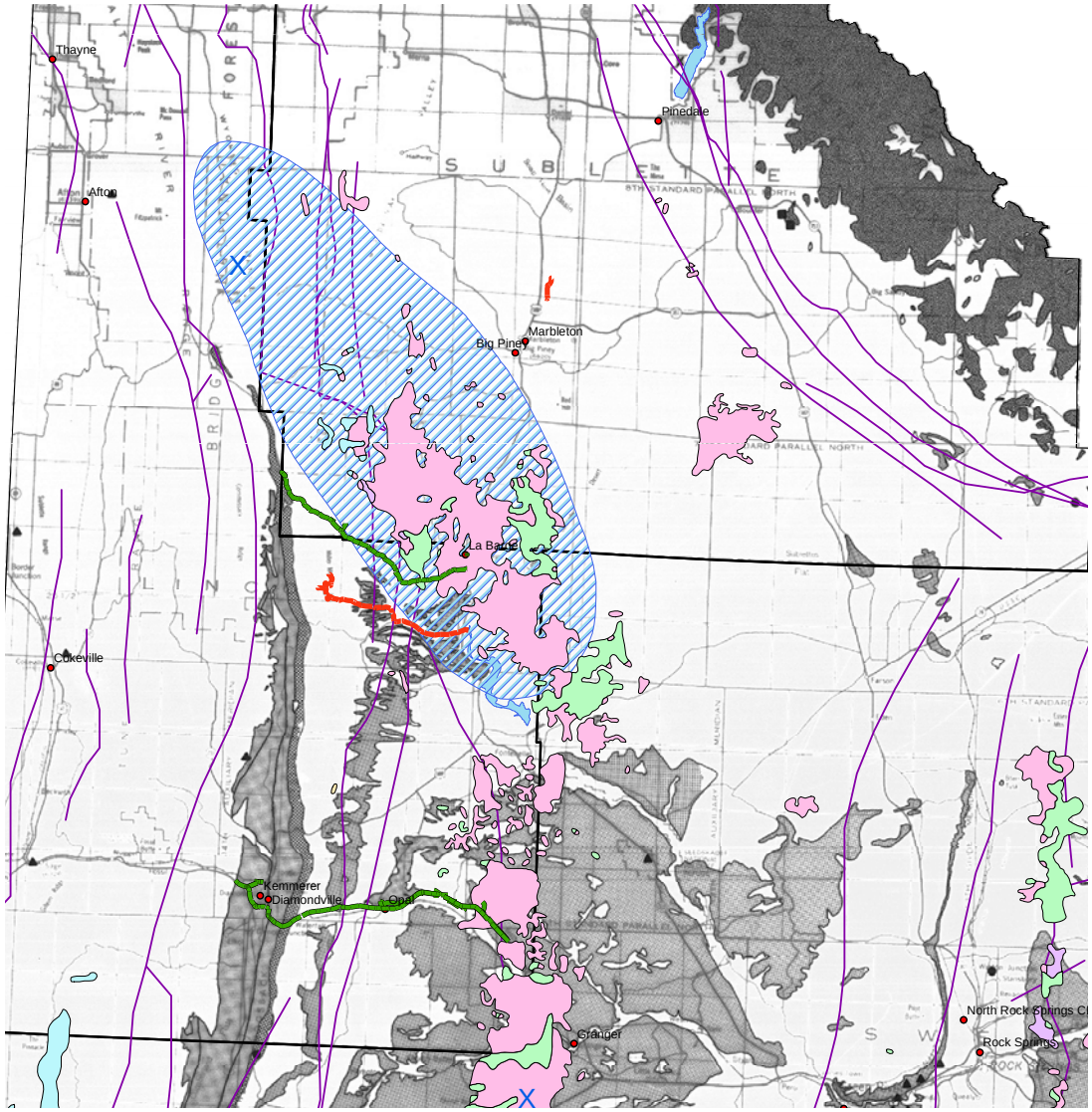


Legend

- Prospective Transects
- Muddy Creek Rd
- Data Points
- Cities
- X CO2 Wells

Oil and Gas Fields

AGE

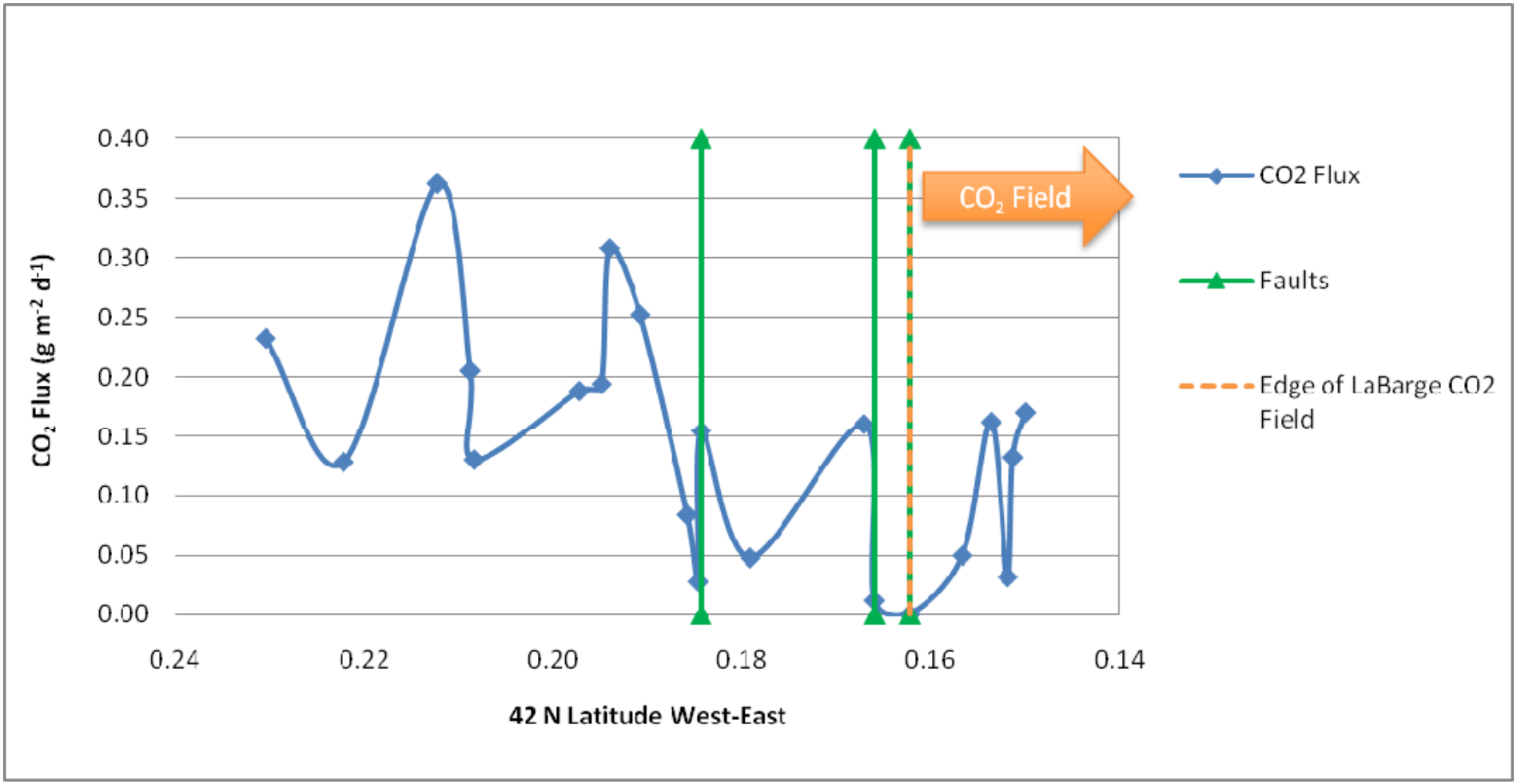
- JT
- LK
- LP
- PP
- UK
- CO2 Producing Fields
- Faults
- Counties

Background Gamma Value

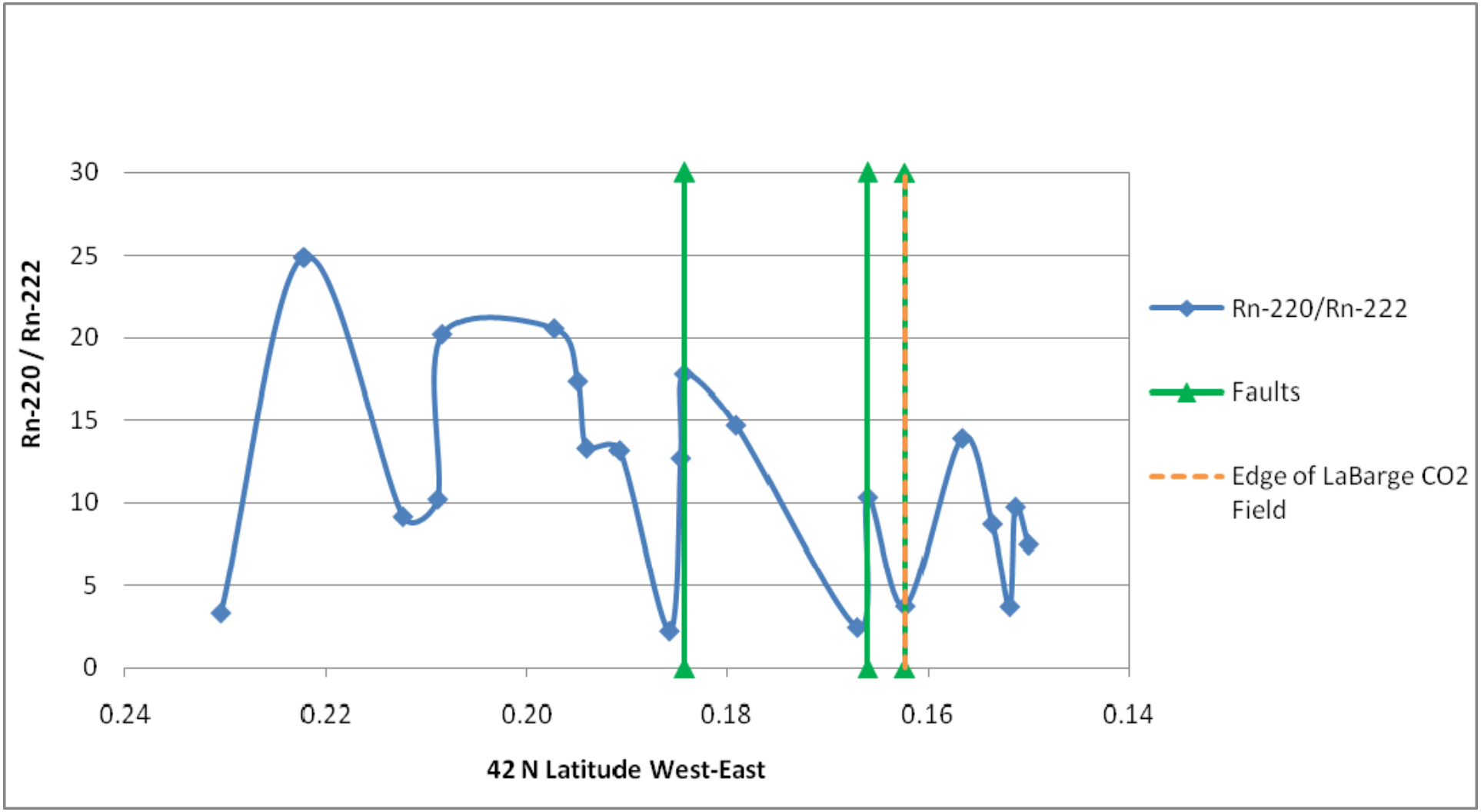
High : 255

Low : 0

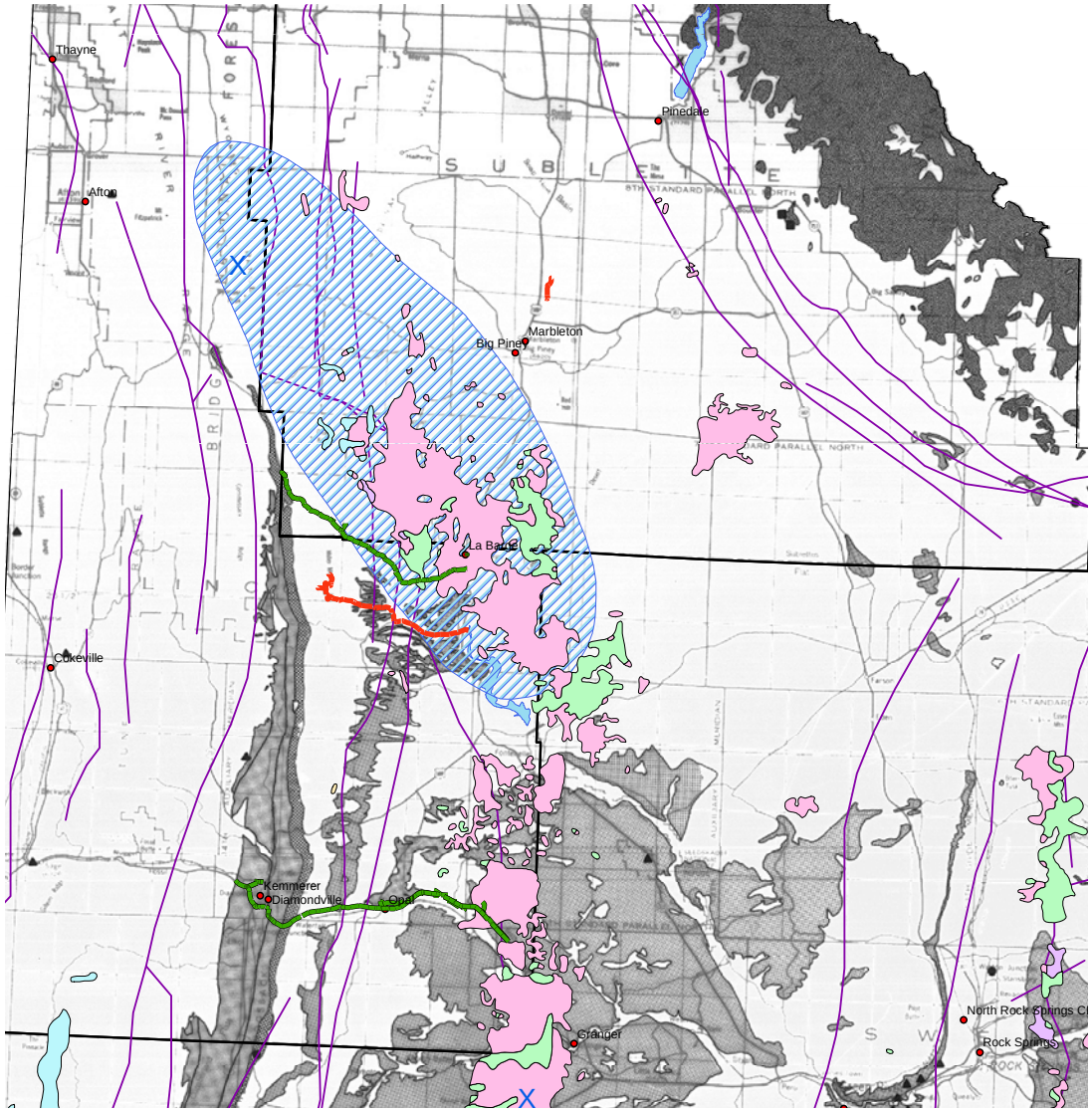
CO_2 flux on Transect Across West Flank of LaBarge CO_2 Field, Moxa Arch in SW Wyoming



($^{220}Rn/^{222}Rn$) on Transect Across West Flank of LaBarge CO_2 Field, Moxa Arch in SW Wyoming



LaBarge CO_2 Field, Moxa Arch in SW Wyoming



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- Faults
- Counties

Background Gamma Value

High : 255

Low : 0

Discussion – Task 2.0
Field Measurements in Wyoming

Major accomplishment(s)

- Field techniques established
- Yellowstone field work complete, preliminary findings suggest weak inverse relationship between ($^{220}Rn/^{222}Rn$) and CO_2 flux
- Completed first field season at natural CO_2 field (LaBarge) in SW Wyoming. CO_2 flux and ($^{220}Rn/ ^{222}Rn$) are lower over the LaBarge Field and generally higher beyond the margin of the Field and across faulted & fractured areas
- Ongoing field work at Thermopolis

Major issues/problems

- High rate of breakage and damage to our field equipment, especially the Rn and CO_2 flux meters. PIs instituting a more formalized approach to equipment use

Discussion – Task 3.0
Geochemical Laboratory Testing

<u>Goal</u>: Systematic lab evaluation of subsurface geochemistry and Rn & CO_2 flux measurements.

Subtask 3.1. Laboratory tests of Rn and grain size

Subtask 3.2. Report of Rn vs. grain size lab tests.

Subtask 3.3. Lab tests of effects of CO_2-H_2O-rock reaction.

Subtask 3.4. Report of CO_2-H_2O-rock reaction

Discussion – Task 3.0
Geochemical Laboratory Testing

Responsible parties

- Faculty: Kaszuba and Sims
- Student: Carberry

Task Status: 1% complete

Discussion – Task 3.0
Geochemical Laboratory Testing

Major accomplishment(s)

- Identified student to work on project
- Collected and processed rock samples

Major issues/problems

- Delayed start while new undergraduate student, Matt Carberry, came on board.

Discussion – Task 4.0
Synthesize Results of Field & Lab Tests

Subtask 4.1. Develop model and method.

Subtask 4.2. Final report synthesizing results of field and laboratory tests.

Discussion – Task 4.0
Synthesize Results of Field & Lab Tests

Responsible parties

- Faculty: Kaszuba and Sims
- Students: Moloney, Pluda, Marcon, Carberry

Task Status: 0% complete

Major accomplishment(s)

- None to date

Major issues/problems

- None to date

Project Milestones

Milestone	Planned Completion Date	Actual Completion Date
Update Project Management Plan	1-Mar-10	25-Feb-2010
HQ Milestone: Project Kick-off Meeting	31-Mar-10	29-Mar-2010
Obtain & calibrate radon and CO_2 analyzers	30-Jun-10	Apr-2010
HQ Milestone: Educational Program Instituted	30-Jun-10	23-Feb-2010
Begin 1st set of Field Measurements	1-Jul-10	24-May-2010
HQ Milestone: Semi-Annual Progress Report	30-Sep-10	30-Oct-2010

Project Milestones

Milestone	Planned Completion Date	Actual Completion Date
Begin 1st set of Laboratory Tests of Rn and Grain Size	1-Nov-10	
Annual progress report submitted	1-Mar-11	
HQ Milestone: Yearly Review Meeting	31-Mar-11	
Develop initial model	30-Jun-11	
Complete 75% of Field Measurements	30-Sep-11	
Begin 1st set of Laboratory Tests of Effects of CO_2-H_2O-Rock Reaction	1-Nov-11	

Project Milestones

Milestone	Planned Completion Date	Actual Completion Date
Annual progress report submitted	1-Mar-12	
HQ Milestone: Yearly Review Meeting	31-Mar-12	
Submit report for Laboratory Tests of Rn and Grain Size	30-Jun-12	
Submit report for Laboratory Tests of Effects of CO_2-H_2O-Rock Reaction	30-Sep-12	
Final report submitted	30-Nov-12	

Anticipated Efforts for the Coming Year

- Complete MS thesis for Yellowstone work
- Complete MS thesis for Thermopolis work
- Continue field measurement of natural CO_2 fields
- Begin laboratory tests of Rn and grain size
- Begin laboratory tests of effects of CO_2-H_2O-rock reaction.

PI Contact Information

- If you have any questions or would be interested in collaboration please contact

  John Kaszuba (John.Kaszuba@uwyo.edu)

  Ken Sims (ksims7@uwyo.edu)