HEALTH CONCERNS AROUND DISSOLVED RADON AND URANIUM IN THE GROUND WATER OF HYLAS, VA

Alicia Garcia
NDSU Geochemistry
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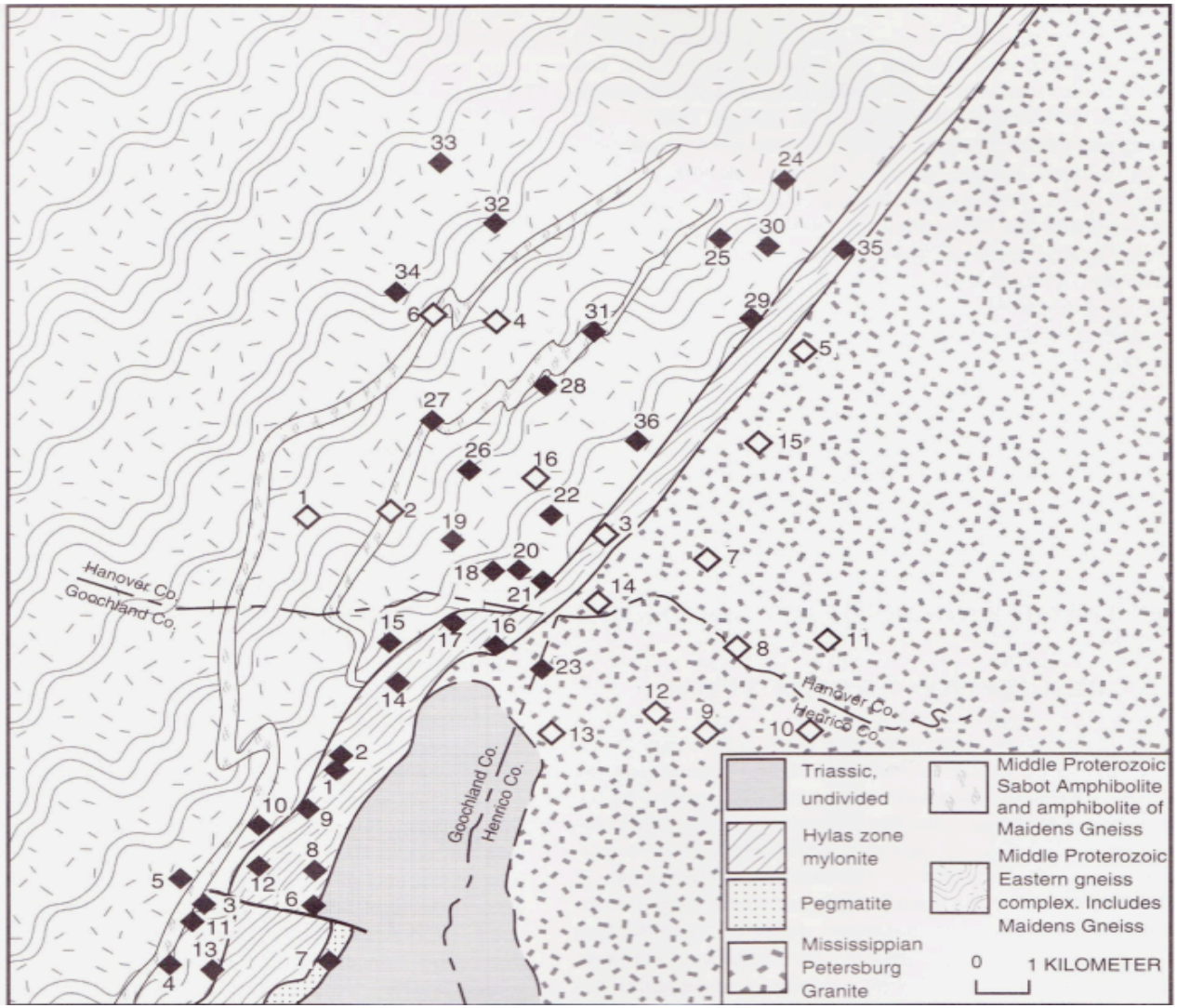
ORIGINAL STUDY OBJECTIVE

- To compare U and ^{222}Rn concentrations and geochemistry of ground water obtained three different rock formations
  - 1. Sheared Mylonitic Rocks
  - 2. Unsheared Granitic and Metamorphic Rocks
  - 3. Weathered Saprolite Overlying 1 and 2
- Examine the effect of rock composition and texture on dissolved ^{222}Rn concentrations
- Primarily test water quality in relation to Radon

- My Goal?

STUDY AREA



Location of Study Area

PHREEQC PROCEDURE

- Took the averages of the major ions, elements and trace elements and ran them through the program
  - Some of the elements weren't detected in the study
  - For the trace elements, many didn't have an average because they were all less than a certain amount
    - I took the value it was less than as my input
  - Some of the elements they tested were not listed in PHREEQC database

GRANITIC RESULTS (1)

pH = 5.7
HCO_3 = 62ppm
DO = 4.9ppm
TDS = 113.5 ppm

Phase	SI	log IAP	log KT	
Al(OH)3(a)	-3.15	8.28	11.43	Al(OH)3
Albite	-5.27	-23.88	-18.61	NaAlSi3O8
Alunite	-5.24	-5.46	-0.21	KAl3(SO4)2(OH)6
Anhydrite	-3.91	-8.25	-4.34	CaSO4
Anorthite	-10.33	-30.31	-19.99	CaAl2Si2O8
Aragonite	-3.17	-11.45	-8.28	CaCO3
Barite	-1.09	-11.22	-10.13	BaSO4
Ca-Montmorillonite	-1.44	-47.84	-46.40	Ca0.165Al2.33Si3.67O10(OH)2
Calcite	-3.02	-11.45	-8.43	CaCO3
Celestite	-4.18	-10.80	-6.62	SrSO4
Chalcedony	0.05	-3.61	-3.66	SiO2
Chlorite(14A)	-31.02	40.94	71.96	Mg5Al2Si3O10(OH)8
Chrysotile	-19.48	13.91	33.39	Mg3Si2O5(OH)4
CO2(g)	-0.95	-2.30	-1.35	CO2
Dolomite	-6.67	-23.54	-16.87	CaMg(CO3)2
Fe(OH)3(a)	-2.05	2.84	4.89	Fe(OH)3
Fluorite	-2.25	-12.97	-10.72	CaF2
Gibbsite	-0.37	8.28	8.65	Al(OH)3
Goethite	3.50	2.84	-0.66	FeOOH
Gypsum	-3.67	-8.25	-4.58	CaSO4:2H2O
H2(g)	-19.40	-22.51	-3.11	H2
H2O(g)	-1.76	-0.00	1.76	H2O
Halite	-8.74	-7.18	1.56	NaCl
Hausmannite	28.85	34.56	63.41	Mn3O4
Hematite	8.96	5.68	-3.28	Fe2O3
Illite	-3.77	-45.32	-41.56	K0.6Mg0.25Al2.3Si3.5O10(OH)2
Jarosite-K	-13.30	-21.77	-8.47	KFe3(SO4)2(OH)6
K-feldspar	-3.34	-24.64	-21.30	KAlSi3O8
K-mica	1.48	15.58	14.10	KAl3Si3O10(OH)2
Kaolinite	1.07	9.33	8.27	Al2Si2O5(OH)4
Manganite	-10.59	14.75	25.34	MnOOH

GRANITIC RESULTS (2)

Melanterite	-7.22	-9.55	-2.33	FeSO4:7H2O
O2(g)	-47.64	-50.46	-2.82	O2
Pyrochroite	-10.15	5.05	15.20	Mn(OH)2
Pyrolusite	-18.46	24.45	42.92	MnO2
Quartz	0.51	-3.61	-4.12	SiO2
Rhodochrosite	-2.99	-14.08	-11.10	MnCO3
Sepiolite	-12.76	3.25	16.01	Mg2Si3O7.5OH:3H2O
Sepiolite(d)	-15.41	3.25	18.66	Mg2Si3O7.5OH:3H2O
Siderite	-1.91	-12.75	-10.83	FeCO3
SiO2(a)	-0.82	-3.61	-2.79	SiO2
Smithsonite	-3.74	-13.64	-9.90	ZnCO3
Strontianite	-4.73	-14.00	-9.27	SrCO3
Talc	-15.81	6.68	22.49	Mg3Si4O10(OH)2
Willemite	-8.73	7.39	16.12	Zn2SiO4
Witherite	-5.82	-14.42	-8.59	BaCO3
Zn(OH)2(e)	-6.00	5.50	11.50	Zn(OH)2

MYLONITIC RESULTS

Phase	SI	log IAP	log KT	
Anhydrite	-3.49	-7.83	-4.34	CaSO4
Aragonite	-1.85	-10.13	-8.28	CaCO3
Barite	-0.97	-11.09	-10.12	BaSO4
Calcite	-1.70	-10.13	-8.43	CaCO3
Celestite	-3.84	-10.46	-6.62	SrSO4
→ Chalcedony	0.15	-3.51	-3.66	SiO2
Chrysotile	-13.09	20.25	33.34	Mg3Si2O5(OH)4
CO2(g)	-1.55	-2.91	-1.36	CO2
Dolomite	-3.90	-20.78	-16.88	CaMg(CO3)2
Fe(OH)3(a)	0.24	5.14	4.89	Fe(OH)3
Fluorite	1.20	-9.51	-10.71	CaF2
Goethite	5.81	5.14	-0.67	FeOOH
Gypsum	-3.25	-7.83	-4.58	CaSO4:2H2O
H2(g)	-21.00	-24.11	-3.11	H2
H2O(g)	-1.75	-0.00	1.75	H2O
Halite	-8.54	-6.97	1.56	NaCl
Hausmannite	-21.29	42.01	63.30	Mn3O4
Hematite	13.58	10.27	-3.31	Fe2O3
Jarosite-K	-8.74	-17.25	-8.50	KFe3(SO4)2(OH)6
Manganite	-7.84	17.50	25.34	MnOOH
Melanterite	-7.23	-9.56	-2.32	FeSO4:7H2O
O2(g)	-44.30	-47.12	-2.82	O2
Pyrochroite	-8.20	7.00	15.20	Mn(OH)2
Pyrolusite	-14.84	28.00	42.85	MnO2
→ Quartz	0.61	-3.51	-4.12	SiO2
Rhodochrosite	-1.63	-12.73	-11.10	MnCO3
Sepiolite	-8.35	7.65	16.00	Mg2Si3O7.5OH:3H2O
Sepiolite(d)	-11.01	7.65	18.66	Mg2Si3O7.5OH:3H2O
Siderite	-1.03	-11.86	-10.83	FeCO3
SiO2(a)	-0.72	-3.51	-2.79	SiO2
Smithsonite	-2.60	-12.50	-9.90	ZnCO3
Strontianite	-3.50	-12.77	-9.27	SrCO3
Talc	-9.21	13.23	22.44	Mg3Si4O10(OH)2
Willemite	-5.13	10.96	16.08	Zn2SiO4
Witherite	-4.80	-13.40	-8.59	BaCO3
Zn(OH)2(e)	-4.27	7.23	11.50	Zn(OH)2

pH = 6.5

HCO_3 = 99.3ppm

DO = 3.7ppm

TDS = 175 ppm

METAMORPHIC RESULTS

pH = 5.9
HCO_3 = 55.5ppm
DO = 6.3ppm
TDS = 110.7 ppm

Phase	SI	log IAP	log KT	
Anhydrite	-3.84	-8.18	-4.34	CaSO4
Aragonite	-2.93	-11.22	-8.29	CaCO3
Barite	-1.06	-11.18	-10.11	BaSO4
Calcite	-2.78	-11.22	-8.44	CaCO3
Celestite	-4.26	-10.88	-6.62	SrSO4
Chalcedony	-0.01	-3.66	-3.65	SiO2
Chrysotile	-17.14	16.14	33.27	Mg3Si2O5(OH)4
CO2(g)	-1.19	-2.56	-1.36	CO2
Dolomite	-5.88	-22.77	-16.89	CaMg(CO3)2
Fe(OH)3(a)	-1.42	3.47	4.89	Fe(OH)3
Fluorite	-3.86	-14.56	-10.70	CaF2
Goethite	4.16	3.47	-0.69	FeOOH
Gypsum	-3.59	-8.18	-4.58	CaSO4:2H2O
H2(g)	-19.80	-22.91	-3.11	H2
H2O(g)	-1.73	-0.00	1.73	H2O
Halite	-8.85	-7.29	1.56	NaCl
Hausmannite	-27.43	35.74	63.17	Mn3O4
Hematite	10.29	6.93	-3.35	Fe2O3
Jarosite-K	-12.19	-20.73	-8.55	KFe3(SO4)2(OH)6
Manganite	-10.13	15.21	25.34	MnOOH
Melanterite	-7.22	-9.54	-2.32	FeSO4:7H2O
O2(g)	-46.52	-49.34	-2.83	O2
Pyrochroite	-9.89	5.31	15.20	Mn(OH)2
Pyrolusite	-17.65	25.11	42.76	MnO2
Quartz	0.44	-3.66	-4.11	SiO2
Rhodochrosite	-2.96	-14.06	-11.10	MnCO3
Sepiolite	-11.34	4.65	15.99	Mg2Si3O7.5OH:3H2O
Sepiolite(d)	-14.01	4.65	18.66	Mg2Si3O7.5OH:3H2O
Siderite	-1.74	-12.58	-10.84	FeCO3
SiO2(a)	-0.88	-3.66	-2.78	SiO2
Smithsonite	-3.66	-13.57	-9.91	ZnCO3
Strontianite	-4.65	-13.92	-9.27	SrCO3
Talc	-13.58	8.81	22.38	Mg3Si4O10(OH)2
Willemite	-8.09	7.95	16.04	Zn2SiO4
Witherite	-5.63	-14.22	-8.59	BaCO3
Zn(OH)2(e)	-5.69	5.81	11.50	Zn(OH)2

PRELIMINARY OBSERVATIONS

- My results were different from theirs
  - More than SiO_2 precipitated
  - Simulating weathering?
  - Relationship between Rock Types and U Concentrations
    - These bedrocks may be U-containing rocks naturally
      - Poses a threat

URANIUM AND RADON

- Average ^{222}Rn in ground water samples
  - Granite: 14,900 pCi/L
  - Mylonite: 5,800 pCi/L
  - Metamorphic: 550 pCi/L
- EPA MCL = 300 pCi/L

- Average U in ground water samples
  - Granite: 0.5ppb
  - Mylonite: 0.6ppb
  - Metamorphic: 0.1ppb
- EPA Standard: 20ppb

DISCUSSION

- As more Ferric Oxide precipitate, more surfaces are exposed for adhesion of U(VI)
  - Uranyl ion combines with CO_3 → adhesion to Ferric Oxides
- This adhesion give U time to decay to form ^{222}Rn
- Raises many Concern
  - Weathering increase, so does ^{222}Rn
  - Health risks
  - Safe Drinking Water?

CONCERNS

- The activity of Radon in the sampled groundwater poses a risk to those using this as a source of drinking water
  - 1996 vs 2012
  - Ingesting vs inhalation.
  - Fear the Radon gas in homes
- EPA Standards
  - According to the Safe Drinking Water Act (revised 1996) 2 options to lower Radon in drinking water
    - Based on States'
    - choice

CONCERNS

- Health Risks Associate with Radon
  - Lung Cancer (primary)
  - Emphysema
  - Pulmonary fibrosis
  - Chronic interstitial pneumonia
  - Silicosis
  - Respiratory lesions

CONCLUSIONS

- Appears to be a connection between rock type and amount of dissolve Radon present in the substrate
  - In relation to U
    - Shearing vs. non shearing (Mylonite)
- The drinking water should be carefully monitored.
- Look more into the relationship between rock type and radionuclides

SOURCES

- Stanton, M. R., Wanty, R. B., Lawrence, E. P., & Briggs, P. H. (1996) Dissolved Radon and Uranium, and Ground-Water Geochemistry in an Area near Hylas, Virginia. *U.S. Geological Survey Bulletin 2070*
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- EPA (April 12, 2012) Radon. Retrieved from http://www.epa.gov/radiation/radionuclides/radon.html#affecthealth