HYDROLOGIC SCIENCES ORAL QUALIFYING EXAMINATION GUIDELINES AND STUDY INFORMATION
FEB 2016

INTRODUCTION

Each doctoral candidate is required to pass 3 steps of the Qualifying Examination at the end of their first year of study. The purpose of this Qualifying Examination is to insure that the student is well prepared and well qualified to begin their doctoral research. The three steps of the qualifying examination are:

- *Component 1: Oral Proficiency Examination*
- *Component 2: Approval of Program of Study*
- *Component 3: Development, presentation, and defense of a detailed doctoral research proposal.*

ORAL PROFICIENCY EXAMINATION DETAILED INFORMATION

The Oral Proficiency Examining Committee administers the examination. The Committee consists of the student's advisor and two members, chosen by the GPHS Director. At least one member should represent a faculty member who teaches one of the Shared Foundation Core Courses.

The examining committee will provide to the student at least two weeks prior to date of the examination a list of example questions and general study areas. The student may choose to select one question from the example list and prepares a 10-15 minute oral response as their first question in the examination. The examining committee will then proceed to oral questioning to assess the student's knowledge and comprehension of the fundamentals of hydrology, focusing in major part on the subject areas found in the Hydrologic Sciences Shared Foundation Core Courses. Typically, the exam will be two hours in length.

The examining committee will provide to the Program Director its written appraisal (see attached form) of the student's qualifications to proceed with his/her doctoral candidacy. If the student receives a passing grade on the exam he/she will be allowed to continue doctoral candidacy. If the student receives a failing grade, the Program Director will inform the student in writing of his/her dismissal from the Graduate Program of Hydrologic Sciences.

<u>**EXAMPLE QUESTIONS**</u>

Candidate MAY choose one question FROM ANY OF THE GENERAL STUDY AREAS for formal response at the oral examination and expect oral questions in all four areas below:

General Study Area: Groundwater

1. What is the main difference between saturated porous media flow and unsaturated media flow? How does the state of fluid saturation affect Darcy's Law?

2. Describe the difference between a confined aquifer and an unconfined aquifer. What differences, if any, will occur during pumping of these two aquifers?

3. What is the Dupuit assumption in ground water flow?

4. Discuss the concept of effective stress and how it affects storage in a confined aquifer.

5. For Darcy's Law: $q = \frac{k\rho g}{\mu}\frac{dh}{dx}$, explain each of the terms, including typical units. For the terms on the right hand side, explain whether they contribute to a driving force or a resisting force.

6. Head measurements in several nearby wells indicate that the direction of **J** (the negative of the gradient) is 20° north of east. A tracer test in the same aquifer has shown that the groundwater flow direction is 30° north of east.

    a. Is the aquifer isotropic or anisotropic?
    b. If the aquifer is anisotropic, which is larger, K_x or K?

7. For each of the following equations, tell whether the aquifer it describes is:

    isotropic/anisotropic
    homogeneous/heterogeneous
    transient/steady state

    a. $\frac{\partial}{\partial x}\left(K\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K\frac{\partial h}{\partial y}\right) = S_s\frac{\partial h}{\partial t}$

    b. $K_x\frac{\partial^2 h}{\partial x^2} + K_y\frac{\partial^2 h}{\partial y^2} = 0$

    c. $\frac{\partial}{\partial x}\left(K_x\frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y\frac{\partial h}{\partial y}\right) = S_s\frac{\partial h}{\partial t}$

General Study Area: Geochemistry

1. Define Bowen's reaction series and explain how the relative rates of mineral weathering relate to Bowen's reaction series.

2. What are Piper Diagrams and what are they used for?

3. Describe the reaction of water and calcite in terms of geochemical reactions

4. What does the electrical conductivity of water sample describe about the ions in solution?

5. What is the difference between "parts per million" and milligrams/liter

6. Why is purging of three well volumes traditionally recommended before geochemical sampling in a well?

7. Describe the sorption process of metal ions on clay surfaces in terms of geochemical reactions.

8. Describe silicate weathering and its reaction products.

9. (a) Why do different primary minerals (igneous minerals) have different weathering rates and is there a pattern? Explain. What would be the compositions of waters resulting from the weathering of the following minerals to kaolinite?
   i. K-feldspar,
   ii. Na-feldspar,
   iii. Ca-feldspar

   (b) Ca-feldspar weathering and calcite weathering produce waters of similar chemical compositions. Are there differences? If so, what are the differences?

10. Explain the Gouy-Chapman Double Layer theory for the distribution of ions between solution and a solid surface. Relate Double Layer theory to the stability of colloids in both low and high ionic strength solutions. Describe one common example of colloid flocculation.

11. Define the term chemical divide and relate the concept to the evolution of water chemistry in closed basin lakes in the arid Western U.S. Assume that Na, Ca, Mg, HCO_3, and SO_4 are present (in variable proportions) in all starting water compositions. What are the possible chemical pathways for the evolution of the water chemistries? What factors might influence the starting water chemistry of any given closed basin lake?

12. Why do stable isotopes fractionate? Explain the latitude effect. How would you expect the local meteoric water line (LMWL) for groundwaters in the Truckee Meadows to plot relative to the global meteoric water line (GMWL)? What factors might influence the $\delta^{18}O$ and δD values of groundwaters and surface waters in the Truckee Meadows?

13. Calculate the solubility product of fluorite at 25ºC and at 50ºC. Is the reaction for fluorite solubility exothermic or endothermic? What is your evidence for determining exothermic vs. endothermic?

Table 2. Thermodynamic data

Formula	Form	*ΔGº,kjoules*	*ΔHº, kjoules*	*Sº,joules*
C	fluorite	-1167.3	-1219.6	68.9
C	aq	-553.6	-542.8	-53.1
F	aq	-278.8	-332.6	-13.8
H	l	-237.1	-285.8	69.9

Table 1. Chemical analyses of waters from the Floridan aquifer in central Florida.

Well	Location	TempºC	Field pH	SiO_2	Ca^{2+}	Mg^{2+}	Na^+	K^+	HCO_3^-	SO_4^{2-}	Cl^-	TDS
1	Polk City	23.8	8.0	12	34	5.6	3.2	0.5	124	2.4	4.5	138
2W	Lakeland	26.3	7.62	18	54	14	6.9	1.0	253	3.6	8.5	238
2S	Ft.Meade	26.6	7.75	16	58	17	6.1	0.7	163	71	9.0	272
3S	Wauchula	25.4	7.69	18	66	29	8.3	2.0	168	155	10	392
4S	Arcadia	26.3	7.44	31	106	60	21	3.7	206	344	28	726

Use the data in Table 1 above to answer the following 2 questions.

1. Is the Arcadia water analysis a good analysis? Show calculations to support your answer.

2. Plot the Arcadia water on a Piper diagram. Show calculations used in plotting.

General Study Area: Fluid Mechanics

1. Describe the terms that compose the Bernoulli equation.

2. Describe the terms in the Manning and Chezy equations.

3. What are the quantitative relationships between Manning's n, the Chezy C, and the Darcy-Weisbach, f?

4. What is Archimedes principle?

5. If one is standing on the bank of a rocky channel, describe a method that could be used to determine whether the flow is supercritical or subcritical without direct measurement.

6. In pipe flow what is meant by the terminology "minor loss?"

General Study Area: Hydrology

1. Define a unit hydrograph and how it is applied.

2. Describe two ways to determine a 25-year 1-hour storm event using 40 years of data.

3. What are differences between the rational method and the SCS curve number method when they are used to calculate peak runoff?

4. Name the principal components of the hydrologic cycle

5. Describe how one typically measures streamflow with a stream gage.