National Association of State Boards of Geology (ASBOG®)

PROFESSIONAL GEOLOGISTS CANDIDATE HANDBOOK

ASBOG® is not affiliated with, nor does it provide information for/to, or endorse, any examination preparation course(s), study guide/manuals/aid (i.e., flash cards), or publication other than its own "Professional Geologists Candidate Handbook". This Candidate Handbook is designed to help you prepare for the ASBOG® National Geology Examinations. ASBOG® has not authorized use of its name by any commercial enterprise.

(Revised: January 2016)
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ON HONOR

The English poet, Richard Lovelace, wrote, "I would not love you ne'er so much, loved I not honor more." Robert E. Lee of Confederate fame wrote, "Duty then is the [most sublime] word in the English language…."

Honor is all-important. In the National Association of State Boards of Geology (ASBOG®) examination, it means an honorable endeavor, without collusion. By signing in for the examination, the candidate has pledged that he or she will neither give, nor receive, information concerning an examination question, nor transmit knowledge of examination questions to another.

That there are means now available to ascertain if collusion has taken place, should alert the candidate to an awareness that these means are being used and, should a candidate be found to have engaged in collusion, serious consequences are forthcoming.

Examination questions which have been compromised: (1) seriously impinge on the honor of the one giving or receiving information; (2) would tarnish the value of all examination scores; and (3) greatly diminish the value of registration. Candidates who have given, or received, information may be penalized; the results of their examination voided; and could be denied the opportunity to re-take the examination(s).

In taking the examination, the foremost reason is to become a registered/licensed geologist. Information that you give, or receive from, another may so impact your score that you fail rather than pass.

The honor of the examination is yours to uphold. The choice is yours – make it wisely!

Benjamin S. Persons
BENJAMIN S. PERSONS, P.G., P.E.
ASBOG® Council of Examiners

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INTRODUCTION

The *National Association of State Boards of Geology (ASBOG®)* is an organization through which its State Member Boards may act and counsel together to better discharge their responsibilities. ASBOG® provides a forum to promote, foster, and advance the common interests and purposes of its Member Boards. The supporting membership of ASBOG® is its Member Boards. Member Boards are dues-paying State Boards or other legal entities constituted by States, Territories and the District of Columbia of the United States of America to administer the registration/licensure of geologists.

One of ASBOG®'s principal duties is to develop standardized written examinations for assessing qualifications of applicants seeking licensure as professional geologists. The ASBOG® National Geology Examination development and validation procedures are designed to maximize the fairness and quality of the examinations. State Member Boards of registration/licensure are provided with uniform examinations that are valid measures of competency related to the practice of the profession. This process benefits those candidates who are taking the examinations and enhances the protection of the general public.

The National Geology Examinations are administered by the ASBOG® Member Boards simultaneously in the spring and fall of each year. Currently, ASBOG® provides its Member Boards with two multiple-choice examinations -- the *Fundamentals of Geology (FG)* and the *Practice of Geology (PG)*. The FG and PG examinations have been developed to assess common knowledge and skills related to the practice of geology throughout the nation. The FG examination emphasizes knowledge and skills that are typically acquired in an academic setting and lead to a baccalaureate degree. The PG examination emphasizes skills and knowledge acquired or expanded in a practice or job setting. Individual Member Boards may require additional testing on local geology, statutes, rules and regulations that address state-specific issues.

Italicized words here and elsewhere in this document, except for the opening sentence, refer to terms listed in the Glossary (Appendix 1). Some sentences are in italics for emphasis.

Candidates are reminded that ***ASBOG® is not affiliated with, nor does it provide information for/to, or endorse, any examination preparation course(s), study guide/manuals/aid (e.g., flash cards), or publication other than this "Professional Geologists Candidate Handbook". This Candidate Handbook is designed to help you prepare for the ASBOG® National Geology Examinations. ASBOG® has not authorized use of its name by any commercial enterprise.***

We hope you find the information useful. We extend our best wishes for your success on these examinations and in your practice of geology.

STATE LICENSING REQUIREMENTS

QUALIFICATIONS

The primary purpose of registration/licensure is to safeguard life, health and property and to promote the public welfare. Evaluation of the qualifications of candidates seeking registration/licensure provides the first step toward ensuring that this objective is met. While examinations offer one means of measuring the competency levels of candidates, most jurisdictions also screen candidates on the basis of education and experience requirements set forth in State Laws, Rules, and Regulations. The requirements vary across the nation. As the examination shall be administered only to those candidates who have met the statutory and regulatory prerequisites of the State in which they are seeking registration/licensure, it is important that candidates contact the State Member Board office where they are seeking registration/licensure to obtain information with respect to the specific requirements for that State.

APPLICATION PROCEDURES/FILING DEADLINES

Application forms and instructional information for the examination are available from individual State Member Boards. You should be aware that examination requirements, filing deadlines, and fees vary from State to State. You are responsible for contacting the State Member Board Examination Administrator for this type of information. (**Note:** Some State Member Boards use a professional testing service for examination administration purposes. You will need to confirm what entity is actually handling the administration of your examination.) You are encouraged to allow sufficient time to complete the application process and assemble required data, such as transcripts and letters of recommendation. The State Member Board Examination Administrator will notify you regarding your approval status (i.e., accept/reject).

SPECIAL ACCOMMODATIONS REQUIREMENTS

Candidates with special accommodation requests under the Americans with Disabilities Act (ADA) must apply to and be approved by their State Member Board to take the ASBOG® examinations under special conditions. The candidate must provide the State Member Board with a written statement from a doctor outlining the special needs of the candidate. ASBOG® must be notified ninety (90) days in advance of the date of the examination for which the candidate is requesting the special consideration. For information and assistance regarding needs that fall under the ADA or for more information about disability rights, contact the ADA Information Line at 800/514-0301 (voice) or go to the ADA Web site at *www.ada.gov*.

Candidates with other special accommodation requests should make arrangements with their State Member Board upon application to sit for the ASBOG® examination(s). If special accommodation is not requested in advance, the Examination Administrator cannot guarantee the availability of accommodation on site at the time of testing. Any request for modification to the examination(s) must be submitted in writing by the Examination Administrator and received by ASBOG® no later than ninety (90) calendar days prior to the scheduled examination.

Please note that ASBOG® does not alter, revise nor compromise the contents of its examinations in any way; adjustments are made only in the physical administration of the examinations. The ASBOG® examinations are administered in English only.

EXAMINATION SCHEDULE AND ADMINISTRATION

The ASBOG® National Geology Examinations are given during the spring and fall of each year. Contact the State Member Board Examination Administrator regarding specific dates (especially the deadline you must meet for submission of your application and other credentials to be approved to sit for the examination) and the location. Candidates should understand that the State Member Board may have an earlier cut-off date for submission of examination requests/approval in order to make ASBOG®'s cut-off date for ordering examinations. ASBOG® honors the cut-off date selected by its individual State Member Boards. The FG Examination (total questions = 140) is administered in a four-hour session. The PG Examination (total questions = 110) is also administered during a four-hour session. The FG and PG are separate examinations, and scores are reported for each. Different forms of the examinations are constructed for each administration.

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The FG Examination will start promptly at 8:00 a.m. and end at 12:00 p.m. The PG Examination will start promptly at 1:00 p.m. and end at 5:00 p.m. Ample time for instructions will be allowed prior to the actual start time of each examination. Please be sure to contact your State Member Board Examination Administrator to confirm examination location, arrival time, and whether you will need an admittance pass, etc. *All information will be provided by the individual State Member Board Examination Administrator.*

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DESCRIPTION OF EXAMINATIONS

EXAMINATION VALIDITY

The FG and PG Examinations are developed following guidelines established in the Standards for Educational and Psychological Testing (1999) published by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education. The procedures are designed to maximize the fairness and quality of the examinations.

COUNCIL OF EXAMINERS (COE)

A committee of professional geologists serves as *Subject Matter Experts (SMEs)* on the *Council of Examiners (COE)*. These SMEs represent the profession in terms of geography, ethnicity, gender, and area of practice. They supply the expertise that is essential in developing fair and impartial examinations for measuring competency within the profession.

SMEs attend two COE examination development and validation workshops each year. The COE Workshops are held shortly after the examinations have been administered so that the COE can evaluate statistical information and candidates' comments related to the examinations. The process is designed to maximize the fairness and quality of the examinations as measures of competency.

Examination questions are: (1) based on the results of a *Task Analysis Survey (TAS)*, and are, therefore, representative of the important tasks needed for competent practice in the profession; and (2) written and reviewed by the COE. Statistical analyses are also reviewed by the COE so that any substandard items can be eliminated before generating candidates' final scores. The following sections further outline the process used in developing and validating the FG and PG Examinations.

ASBOG® TEST BLUEPRINTS

ASBOG® conducts a TAS of the profession approximately every five to eight years to maximize the relevance of the examinations for candidates seeking licensure as professional geologists. The TAS is used to verify those tasks performed by the profession related to public protection. The findings are used to develop *test blueprints* (test specifications, content outlines) for constructing examinations and writing questions. The test blueprints list the geologic tasks, and the number of questions for each geologic task, to be included in both the FG and PG examinations. The COE reviews examination questions to verify that each question accurately reflects one or more of the tasks listed in the test blueprints.

The FG and PG test blueprints specify the *domains/content areas* for each examination. The relative importance of different content areas can be determined by reviewing the test blueprints shown in Appendix 2. The construction of the questions differs between the FG and PG examinations. The FG examination emphasizes knowledge and skills that are typically acquired in an academic setting and lead to a baccalaureate degree. The PG examination emphasizes skills and knowledge acquired or expanded in a practice or job setting.

EXAMINATION DEVELOPMENT PROCEDURES

Professional geologists (i.e., SMEs) have spent a considerable amount of time developing the FG and PG Examinations as fair measures of professional competence. As mentioned earlier, questions on the examinations are reviewed by SMEs during regularly scheduled COE Workshops. These SMEs review statistical results for each item as well as written feedback from candidates who have just taken the examinations. This information is extremely valuable in evaluating the accuracy and fairness of each item in the examinations. Both ASBOG® and the individual State Member Boards are always working to improve the quality of the examinations as fair measures of an individual's competence to practice before the public. The following paragraphs provide more detail regarding the development of the ASBOG® National Geology Examinations.

Each FG and PG Examination question written by the SMEs at COE Workshops is subjected to a *minimum* of four peer reviews.

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- The first peer review occurs during the development of the question. During the COE Workshop, each question is written by one or more members of the COE. Each new question is then reviewed independently by three other members of the COE. The purpose of the peer review process is to verify that the keyed answer is the one and only correct answer. This process is also used to make sure that the question is clear and is appropriate for use on the examination.

- All new questions that are accepted are entered into the ASBOG® *Examination Item Bank* and subjected to the second peer review at a subsequent COE Workshop. During this second peer review, the question is evaluated by three members (SMEs) of the COE and checked to verify that typographical errors were not introduced when the question was entered into the question (item) bank. The question is subjected to the third peer review by the COE when it is included in the examination, which is reviewed in its entirety before the actual administration.

- The fourth peer review occurs after the administration of the examinations. ASBOG® encourages candidates to provide comments about specific questions while taking the examinations. Candidate comments become part of the examination review process during the post-examination COE Workshop. The COE reviews all new items and also any items that exhibit unusual statistical properties (i.e., difficult items, items with negative correlations). This review process makes it possible to improve the accuracy of the questions across time.

If the SMEs deem that a particular question has "no correct answer" (based on candidate comments, statistical information, or an evaluation of the accuracy of the question), then the item is not scored. Candidates will not be given credit for an item which has been deemed to have "no correct answer". If the SMEs deem that a particular question has two correct answers (i.e., is a double-keyed question), then candidates who select either answer will be given credit. This process enhances the fairness of the examinations because substandard items (that have no correct answers) are eliminated before calculating candidates' final scores.

SCORING PROCEDURES

Raw scores are calculated by summing the number of correct responses for each candidate. Credit is given for correct responses, while no points are received for incorrect responses. Note that only one response should be marked for each question because questions that contain two or more marked responses or all blank responses (i.e., omitted questions) are scored as incorrect responses. There is no penalty for guessing; therefore, it is to your advantage to answer all questions in the exams.

To assure national uniformity, ASBOG® provides each jurisdiction with a nationally recommended passing score. A *scaled score* of 70 has been established as a standard of *minimum competency* and 100 is the highest score possible. Failing scaled scores range from 0 (no correct responses) to 69 (highest failing score). However, the legal authority for making registration/licensure decisions rests solely with the individual jurisdictions and not with ASBOG®.

Candidates who fail the examinations receive feedback on their performance levels for the content domains listed in the FG and PG Test Blueprints. A "+" indicates acceptable performance in a particular content domain, whereas a "-" shows substandard performance. The feedback is designed to assist candidates in evaluating their proficiency levels in preparation for subsequent examinations.

PASSING SCORES

The passing scores on the ASBOG® FG and PG Examinations reflect minimum competency and are determined using a criterion-referenced procedure which measures a candidate's performance based on a standard established by the COE. The COE evaluates the difficulty levels of the examination items in relation to minimum competency. Passing scores are adjusted (scaled) based on the difficulty level of each question in each examination so that candidates have the same probability of passing any version of the examinations.

ASBOG® does NOT use "fixed-percentage" passing scores such as 70 percent or 75 percent because they fail to consider the difficulty levels of the questions in an examination and their relationship to minimum competency. Similarly, ASBOG® avoids "grading on the curve" because registration/licensure is designed to ensure that practitioners possess enough knowledge to perform professional activities in a way that protects the public welfare. The key issue is whether candidates are competent to practice individually and not whether they are competent compared to other candidates.

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RELEASE OF CANDIDATE SCORES

ASBOG® releases the examination results (by secure, traceable means) only to its State Member Board Examination Administrators (or its authorized testing service) within sixty (60) days following receipt of all of the examination materials back in the ASBOG® office. Candidates shall contact their State Member Board Examination Administrator (or its authorized testing service) to acquire any information regarding examination scores. Under no circumstances does ASBOG®: (1) release examination results directly to the candidate(s); (2) transmit results by e-mail or fax; or (3) release results over the telephone. Further, ASBOG® supports the following testing standard regarding the confidential nature of candidate examination scores: "Test results identified by the names of individual test takers, or by other personally identifying information, should be released only to persons with a legitimate, professional interest in the test taker or who are covered by the informed consent of the test taker or a legal representative, unless otherwise required by law." *(Standards for Educational and Psychological Testing (1999), published by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education, Standard 8.5, p. 87.)*

STASTICAL ANALYSES

Statistical analyses are conducted on each form of the FG and PG Examinations. The statistics are valuable in evaluating the performance of the examinations (i.e., estimated reliability, mean, standard error of measurement etc.). The statistical results indicate whether the examinations are reliable and performing well.

The statistical analyses are also useful for isolating items that possess unusual statistical properties (i.e., very difficult, negative correlations). Items that possess negative correlations reveal that candidates with high test scores did poorer on these items compared to candidates with low test scores. Any items that exhibit negative correlations are reviewed by the COE before scores are finalized and mailed to the State Member Board Examination Administrators.

Sample questions for the FG and PG Examinations are presented in Appendix 3 and 4, respectively. The sample questions do not make up complete examinations; however, they do represent the general content areas and formats. They are presented herein as a guide for your preparation for the examinations. The FG and PG Examinations measure some of the same competencies related to the practice of geology, but construction of the questions differs between the two levels. FG questions are designed primarily to recall factual information; the PG questions are focused on candidates' competencies to apply the basic principles of geology, based mainly on work experience.

EXAMINATION PROCTORED REVIEW AND/OR MANUAL REGRADE

ASBOG® does not independently conduct or provide for post-examination "*manual re-grades*" or proctored "*reviews.*" If a State Member Board is not mandated by law to provide these services, then it is up to the individual State Member Board to establish a policy for such services (i.e., to provide them or not) if they so desire. In this light, it is the State Member Board's call ASBOG® only responds to such requests from the State Member Board Examination Administrators to assist them if they are tasked to provide these services. Any request for a "manual re-grade" or proctored "review" by a candidate shall be made directly to the State Member Board Examination Administrator in writing. The State Member Board Examination Administrator shall then submit a written request to ASBOG® within thirty (30) calendar days after the release of the examination results to the Examination Administrator, accompanied by the prescribed fee(s). The prescribed fee(s) for a post-examination "manual re-grade" or proctored "review" shall be paid directly to ASBOG® by the requesting candidate, or the State Member Board Examination Administrator, and must accompany the written request. The State Member Board Examination Administrator will set the deadline for receipt of such requests from that Member Board's candidates in order to meet the 30-day turn-around to ASBOG®. Only one post-examination "manual re-grade" and/or proctored "review" shall be allowed for each candidate per part, per examination administration.

1. Manual Re-grades

- What you get if you request a "*manual re-grade*": First, the purpose of the "manual re-grade" is to verify the accuracy of a candidate's machine-graded score. The request for a "manual re-grade" does not guarantee that the candidate will receive additional credit and/or a revised grade. Again, the exclusive purpose of the "manual re-grade" is to check the accuracy of the candidate's machine-graded score.

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- The candidate's original answer sheet(s) will be pulled and manually graded to confirm that no computer error has occurred. Upon completion of the "manual re-grade", the candidate's Board Administrator will receive an official letter from ASBOG® with a written summary of the manual re-grade results. Clarified in the letter will be the number of questions that needed to be answered correctly to achieve the passing scaled score and the number of questions actually answered correctly by the candidate. Should a correction be required, the requesting Examination Administrator will be so notified. Otherwise, no additional documentation will be provided. It is the responsibility of the State Member Board Examination Administrator to notify the candidate(s) of the "manual re-grade" results.

2. Proctored Reviews

- What you get if you request a proctored "*review*": ASBOG® will send to the requesting State Member Board Examination Administrator, by secure traceable means (i.e., UPS, FedEx):

  a) a clean, unused copy of the appropriate examination booklet; and
  b) a copy of the requesting candidate's *Item Feedback Form* (which indicates by a "1" or "0" whether the candidate got the question correct or not, respectively).

  (**NOTE:** If a request for a "manual re-grade" is requested at the same time as the proctored "review", the candidate will also be provided a "copy" of the manually graded answer sheet in addition to the above-listed items.)

- The State Member Board Examination Administrator shall instruct the candidate that no notes shall be taken during the post- examination "review" process, nor are they to write on or in the examination booklet or other materials provided.

- The length of time that the candidate will be allowed to complete the "review" process will be determined by the State Member Board Examination Administrator.

- At the conclusion of the proctored "review", the State Member Board Examination Administrator will return to the ASBOG® office, by secure traceable means (i.e., UPS, FedEx), **all** materials provided.

- ASBOG® does NOT allow challenges to individual examination items as part of a post-examination proctored "review", nor does it release the answer key. ASBOG®'s peer review process conducted by its Committee on Examinations/Council of Examiners (COE) and Task Analysis Survey (TAS) process provide a thorough system to verify that the keyed answer is the only correct answer for that question.

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TAKING THE EXAMINATIONS

DISTRIBUTION OF EXAMINATION BOOKLETS

The State Member Board Examination Administrator or Proctor(s) will distribute the examination booklets, answer sheets, ASBOG® mechanical pencils, *Candidate Question Comment Forms* and *Statements of Examination Compliance* to the candidates. All instructions should be read very carefully. Special attention should be given to the language on the front of the examination booklet pertaining to disclosure of proprietary information.

> *Copying, reproduction, taking notes, taking pictures of, or transmitting examination information in any form to another person or device or any action taken to reveal the contents of examinations in whole or in part is unlawful. Removal of the examination booklet from the examination room by unauthorized persons is prohibited.*

Unlawful disclosure is extended to include the use, transmission, or receipt of examination content in any form (verbal, written, electronic, or computerized, etc.) either before, during or after the examination administration.

INSTITUTIONAL CODES (AGI)

Candidates will be asked to provide on their answer sheet, for both the FG and PG examination administrations, the *"Institution Code"* for the college or university from which they received their geoscience degree(s). This information will be used only to provide institutions with aggregate data on how their students – on the average – performed on the National Geology Examination(s). Candidates who do not find their institution(s) on the *Institution Codes List* will be given instructions by the State Member Board Examination Proctor(s) on how to proceed. (There will be a place on the cover of the examination booklet to record the names of each institution.) The *Institution Codes List* with Index is available on the ASBOG® Web site ***(www.asbog.org)*** under Candidate Resources. This list will be updated as changes or new codes are assigned.

ANSWER SHEETS

All examinations are machine-scored. To provide proper scoring of your examination, it is imperative that you listen to the Examination Proctor's instructions and follow the instructions printed on the examination booklet and answer sheets. As a matter of examination security, **please use only the #2 mechanical pencils provided during the examinations**. These pencils change color for different exam administrations for security purposes. The answer spaces must be completely blackened. After completion of the examination, the candidate may keep the mechanical pencil.

Examination items (questions or problems) are generally organized with an introductory statement (the stem) followed by four options (choices to finish the statement in the stem or answers to the problem). In evaluating options, candidates should read all options and then select the best or most appropriate answer from the options given. You must select one of the options given, even if there might be a better response to a question that is not included among any of the options given. No credit is given for multiple answers. There is no penalty for guessing; therefore, it is to the candidate's advantage to answer each question on the examination. If you decide to change an answer, completely erase the first answer. Incomplete erasures and/or stray marks may be read as intended answers. (**Note:** Your sketches, notes, graphical solutions and calculations are NOT considered to be part of your answer and are not inspected or graded. *All work must be turned in with your examination booklet.*)

CANDIDATE QUESTION COMMENT FORM

ASBOG® is always working to improve the quality and reliability of its examinations. Although each examination has gone through an extensive review process by Subject Matter Experts (SMEs) during the Council of Examiners (COE) Workshops, ASBOG® encourages candidates to provide comments about specific questions using the *Candidate Question*

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Comment Form provided. Candidate comments become part of the examination review process during the post-examination COE Workshop. Candidate comments are anonymous and used only to improve the quality of the examination questions. To ensure that there is sufficient time to complete the examination, candidates are reminded to complete the examination first, then go back and address any questions for which they have concerns or comments.

EXAMINATION SECURITY AND COMPLIANCE

➢ References/Hand Instruments

The FG and PG examinations are closed-book examinations. A protractor, straight edge, and engineer's scale may be brought to the examination. Only portable (battery-operated or solar-powered), silent, non-printing, non-alpha programmable calculators are allowed. Graph paper and blank scratch pages provided at the back of the examination booklet may be torn out, if necessary, to be used as work papers. Thumbtacks, cardboard, Meridian Stereographic Nets and tracing paper are **not** necessary. ASBOG® provides #2 mechanical pencils that will be distributed by the Examination Proctor.

Possession of **any** of the following during the examination is prohibited: electronic device (cellular phone, PDA, tape/digital recorder, alpha programmable calculators, camera, scanning pens, iPods, iPads, etc.), notes, sample tests, references, answer keys, manuals or other aids. It is the candidate's responsibility to turn in any of these items to the Proctor before the start of the examination. Calculators, or any other wireless electronic devices, that have e-mail/Internet/text messaging capability shall **NOT** be allowed. *Violation of any of the above-mentioned prohibitions will result in immediate expulsion from the examination site and forfeiture of examination privileges (examination will not be scored) and fees.*

➢ Statement of Examination Compliance

Each candidate will be provided with a *Statement of Examination Compliance* form (see Appendix 5 at the end of this Handbook). It is the candidate's responsibility to read, sign, and return the original *Statement of Examination Compliance* form to the Proctor **before** the start of the examination. Any candidate who fails to complete, sign and return the *Statement of Examination Compliance* shall not be permitted to sit for the examination. Execution of the *Statement of Examination Compliance* confirms that the candidate has read, understands, and agrees to the provisions outlined therein and acknowledges that any breach in examination security/compliance shall include, but is not limited to, expulsion from the examination site, voiding of the examination, and forfeiture of all examination fees.

The following actions/behaviors constitute, in part, prohibited conduct at the examination site:

(1) Impersonating an examination candidate or using false identification to take an examination. Only the person named on the examination application/answer sheet is authorized to take the examination, and his/her correct name must be signed on the examination;

(2) Violation of the policy outlined in "*References/Hand Instruments*" above. It is the candidate's responsibility to turn in any of these items to the Proctor ***before*** the start of the examination.

(3) Copying, recording, taking pictures of, or transmitting examination questions in any form to another person or device or any action taken to reveal the contents of examinations in whole or in part is prohibited;

(4) Looking at another examinee's answer sheet or test booklet or giving oral or written assistance to another candidate during administration of the examination;

(5) Exhibiting irrational or disruptive behavior at the examination site at any time; and

(6) Continuing to fill in answer sheets or answer test questions after time has been called.

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Further, the candidate pledges to neither give, use, obtain, attempt to obtain by any means, nor receive information concerning the whole or any part of an examination (individual examination problems, questions, solutions, or answers), nor to transmit such to any third party, before, during, or after an Examination, whether orally, in writing, by telephone, or on other forms of social media, or otherwise.

STARTING AND COMPLETING THE EXAMINATION

The Examination Proctor will provide instructions as to how to fill in your answer sheet as well as when to open your examination booklet. Be sure to note your start/finish time on the front of your examination booklet. This information has no impact on the scoring of your examination and is only used to evaluate the length of the examinations. You are responsible for returning to the Examination Proctor the numbered examination booklet assigned to you, your answer sheet, Candidate Question Comment Form, and all working papers you may have used during the course of the examination.

PLEASE NOTE

During the administration of the examination, candidates who wish to use the restroom MUST surrender their examination booklet, answer sheet, and any other examination materials in their possession. Removal of the examination booklet from the examination room at any time is prohibited. The candidate **MUST BE ACCOMPANIED INDIVIDUALLY** (i.e, only one candidate may leave at a time) **TO AND FROM** the restroom by either a male or female Examination Proctor/Monitor, as appropriate.

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Appendix 1- Glossary

CANDIDATE COMMENT FORMS. Forms provided to examination candidates as part of the examination process to allow for feedback to ASBOG®. The *Fundamentals of Geology (FG)* forms are "Yellow" and the *Practice of Geology (PG)* forms are "Green". Valid, written comments from a candidate who has already taken the Examinations are always welcome and may become a part of the examination review process during the post-examination *Council of Examiners (COE)* Workshop. Candidate comments are anonymous and used only to improve the quality of the examination items (questions).

COE. See *Council of Examiners*.

COUNCIL OF EXAMINERS (COE). ASBOG® National Examination Committee composed of selected individuals who are *Subject Matter Experts (SMEs)* in their respective domains and who represent a cross-section of geography, gender, area of practice (specialty), experience, and ethnicity. The *COE* meets twice yearly as part of the ASBOG® COE Workshops, usually about three weeks after the administration of the FG and PG examinations; one of the two Workshops is held in conjunction with the ASBOG® Annual Business Meeting each fall.

CRITERION-REFERENCED APPROACH. Psychometric procedure used to determine passing scores that reflect a standard of minimum competency.

DOMAINS/CONTENT AREAS. The subject matter within a profession; for example, geophysics, hydrogeology or field methods in the profession of geology.

EXAMINATION ADMINISTRATOR. The State Member Board, or its authorized testing service, actually responsible for administering (proctoring) the examination. Some State boards use their own staff to proctor the examination; some have a State Department of Testing (bureau/agency), and some use a professional testing service. See *Proctor*.

EXAMINATION ITEM. Question or problem used in an examination.

EXAMINATION ITEM BANK. Data base of examination items which are stored on computer after acceptance by the *COE*.

FUNDAMENTALS OF GEOLOGY (FG) EXAMINATION. ASBOG® National Examination with items related to knowledge and skills acquired in an academic setting that leads to a baccalaureate degree; consists of 140 questions.

KEYED ANSWER (KEY). The one and only correct answer. A new question, developed by one or more of the members of the *COE*, is independently reviewed/critiqued by three other members (*SMEs*). The peer review process verifies the keyed answer. The review also focuses on the quality of the item to ensure the question is clear and is appropriate for use on the examination.

MINIMUM COMPETENCY. The standard used in establishing passing scores on ASBOG® Examinations.

PROCTOR. Individual(s) administering the examination(s). See *Examination Administrator*.

PRACTICE OF GEOLOGY (PG) EXAMINATION. ASBOG® National Examination with items that assess skills and knowledge acquired or expanded through employment, typically after five years of work experience; consists of 110 questions.

RAW SCORE. Unadjusted score on an examination based on the total number of correct responses. If the *COE Subject Matter Experts (SMEs)* deem a particular question to have "no correct answer" (based on candidate comments, statistical information, evaluation of the accuracy of the question, etc.), then that item is not scored (i.e., the FG examination would be graded on the basis of 139 instead of 140 questions. Similarly, the PG examination would be scored on the basis of 109, not 110 questions.) Candidates will not be given credit for an item which has been deemed to have "no correct answer". If the *SMEs* deem that a particular question has two correct answers (i.e., is a double-keyed question), then candidates who select either answer will be given credit. This process enhances the fairness of the examinations because substandard items (that have no correct answers) are eliminated before calculating candidates' final scores.

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APPENDIX 1 - GLOSSARY, CON'T.

SCALED SCORE. Adjusted score, based on the average difficulty level of each examination (FG and PG). A scaled score of 70 has been established as a standard of minimum competency. On all forms of the ASBOG® National Examinations, a scaled score of 70 is the minimum score required to pass and 100 is the highest score possible. Failing scaled scores range between 0 (no correct responses) and 69 (highest failing score).

SME. See *Subject Matter Expert*.

STEM. The introductory portion of an examination item that states a question, states a problem, or presents an incomplete statement.

SUBJECT MATTER EXPERT (SMEs). A geologist who serves on the ASBOG® *Council of Examiners*; *SMEs* represent the profession in terms of geography, ethnicity, gender and area of practice.

TASK ANALYSIS SURVEY (TAS). A survey prepared and conducted by the *Council of Examiners (COE)* to determine the geologic tasks performed by geologists. The survey focuses on tasks that involve protection of the health, safety and welfare of the public. The survey form is mailed to licensed geologists selected at random from the lists of registered/licensed geologists provided to ASBOG® by those Member Board States with geologist registration/licensure laws. (Note: The 2015 *TAS* was distributed in 29 states.) Geologists rate the importance of each task in protecting the health, safety and welfare of the public. Results from the *TAS* determine the number of questions from each geologic task category to be included in both the FG and PG Examinations.

TEST BLUEPRINT. An outline that lists the *domains/content areas* (subject matter) and their percentage weights in the FG and PG Examinations.

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Appendix 2- FG and PG Test Blueprints

Content Domains	FG %	PG %
A. General and Field Geology	**21**	**20**
B. Mineralogy, Petrology, and Geochemistry	**11**	**5**
C. Sedimentology, Stratigraphy, and Paleontology	**12**	**6**
D. Geomorphology, Surficial Processes, and Quaternary Geology	**13**	**8**
E. Structure, Tectonics, and Seismology	**11**	**8**
F. Hydrogeology	**12**	**19**
G. Engineering Geology	**11**	**19**
H. Economic Geology and Energy Resources	**9**	**15**
TOTALS	***100***	***100***

This ASBOG® Fundamentals of Geology (FG) and Practice of Geology (PG) Examination Knowledge Base consists of eight domains which collectively encompass the scientific and practical knowledge needed to become a licensed professional geologist. The Knowledge Base for Domain A encapsulates the general principles and knowledge of general geology and field methods which provide the foundation for the other seven domains; i.e., the other seven domains implicitly include the Knowledge Base for Domain A. Within each domain, the order in which the items are listed does not reflect their relative importance.

A. General and Field Geology

Knowledge Base

Surface and subsurface exploration techniques and interpretations; Geologic and geophysical tools, application, and interpretation; Earth processes; Surface and subsurface mapping and map applications; Geologic section construction; Photogrammetry, terrain measurement, GPS, and GIS; Remote sensing; Image analysis and interpretation; Scale and scale analysis; Measurement theory, accuracy and precision; Geostatistics; Documentation and record keeping; Modeling concepts; Professionalism and ethics; Project planning, management, organization, and economics; QA/QC (FG/PG)

1. Plan and conduct geological investigations considering human health, safety, and welfare, the environment, regulations, professionalism and ethics, and Quality Assurance/Quality Control (QA/QC). (FG/PG)
2. Compile and organize available information to plan geological investigations. (FG/PG)
3. Collect, describe, and record new geological and geophysical data. (FG/PG)
4. Determine positions, scales, distances, and elevations from remote sensing, imagery, surveys, sections, maps, and GIS. (FG/PG)
5. Prepare, analyze, and interpret logs, sections, maps, and other graphics derived from field and laboratory investigations. (FG/PG)

B. Mineralogy, Petrology, and Geochemistry

Knowledge Base

Rock and mineral identification; Crystal symmetry, systems, and forms; Igneous rocks and processes; Sedimentary rocks and processes; Metamorphic rocks and processes; Geochemical reactions and diagenesis; QA/QC (FG/PG)

Project planning, management, organization, and economics (PG)

6. Plan and conduct mineralogic, petrologic, and geochemical investigations, including the use of field, laboratory, and analytical techniques. (PG)
7. Identify minerals and rocks and their characteristics. (FG)
8. Identify and interpret rock and mineral sequences and associations, and their genesis. (FG)
9. Evaluate geochemical and isotopic data and construct geochemical models related to rocks and minerals. (FG)
10. Determine type, degree, and effects of rock and mineral alteration. (FG/PG)

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C. Sedimentology, Stratigraphy, and Paleontology

Knowledge Base

Stratigraphic principles; Weathering, erosion, transport, and deposition; Depositional environments; Facies analysis; Basin analysis; Sedimentary structures; Diagenesis; Geologic time; Geochronology; Fossil record and evolution; QA/QC (FG/PG)

Project planning, management, organization, and economics (PG)

11. Plan and conduct sedimentologic, stratigraphic, or paleontologic investigations, including the use of field, laboratory, and analytical techniques. (PG)
12. Select and apply appropriate stratigraphic nomenclature and establish correlations. (FG)
13. Identify and interpret sedimentary processes and structures, depositional environments, and sediment provenance. (FG/PG)
14. Identify and interpret sediment and/or rock sequences, positions, and ages. (FG)
15. Identify fossils and interpret fossil assemblages for age, paleoenvironmental interpretations, and/or stratigraphic correlations. (FG)

D. Geomorphology, Surficial Processes, and Quaternary Geology

Knowledge Base

Geomorphic processes; Landform analysis techniques; Sea and lake level change; Glaciation; Weathering; Sediment transport; Groundwater and surface water; Low temperature geochemistry; Human-land interaction; Soil development and classification; Remote sensing; GIS; QA/QC (FG/PG)

Project planning, management, organization, and economics (PG)

16. Plan and conduct geomorphic investigations, including the use of field, laboratory, and analytical techniques. (PG)
17. Identify, classify, and interpret landforms, surficial materials, and processes. (FG)
18. Determine absolute or relative age relationships of landforms, sediments, and soils. (FG)
19. Evaluate geomorphic processes and development of landforms, sediments, and soils, including watershed functions. (FG/PG)
20. Apply remote sensing and GIS techniques to interpret geomorphic conditions and processes. (FG/PG)

E. Structure, Tectonics, and Seismology

Knowledge Base

Fractures, faults, and folds; Rock fabric; Rock mechanics; Structural analysis; Plate tectonics; Tectonic regimes; Volcanism; Structural and seismic history; Paleoseismology; Earthquake processes; QA/QC (FG/PG)

Project planning, management, organization, and economics (PG)

21. Plan and conduct structural, tectonic, or seismic investigations, including the use of field, laboratory, and analytical techniques. (PG)
22. Identify and define structural features and relations, including constructing and interpreting structural projections and statistical analyses. (FG)
23. Interpret deformational history through structural and tectonic analyses. (FG/PG)
24. Develop and apply tectonic models to identify geologic processes and history. (FG/PG)
25. Evaluate earthquake mechanisms and paleoseismic history. (FG/PG)

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F. Hydrogeology

Knowledge Base

Groundwater and surface water systems and processes; Aquifer characterization; Hydrogeologic modeling; Low temperature aqueous geochemistry; Contaminant transport and geochemistry; Isotopic and tracer studies; Hydraulic properties of fluids and earth materials; Site investigation methods, tools, and applications; Geophysical techniques; Landform analysis; Weathering; QA/QC (FG/PG)

Well drilling; Well design and construction; Soil and water remediation techniques; Water resources management and protection; Project planning, management, organization, and economics (PG)

26. Plan and conduct hydrogeological, geochemical, and environmental investigations, including the use of field, laboratory, and analytical techniques. (PG)
27. Define and characterize hydraulic properties of saturated and vadose zones. (FG)
28. Design groundwater monitoring, observation, extraction, production, or injection wells. (PG)
29. Evaluate water resources, assess aquifer yield, and determine sustainability. (FG/PG)
30. Characterize water quality and assess chemical fate and transport. (FG/PG)
31. Manage, develop, protect, or remediate surface water or groundwater resources. (PG)

G. Engineering Geology

Knowledge Base

Landform analysis techniques; Soil and rock weathering; Groundwater and surface water systems and processes; Low temperature geochemistry; Human-land interaction; Soil and rock mechanics; Soil and rock classification and engineering properties; Geologic hazards; Hazard and risk analyses; Cost/benefit analyses; Site investigation methods, tools, and applications; Geophysical techniques; QA/QC (FG/PG)

Land restoration and hazard mitigation; Mine closure; Image analysis and interpretation; Remote sensing; GIS; Earth and rock construction methods; In-situ and laboratory testing; Project planning, management, organization, and economics (PG)

32. Plan and conduct environmental and engineering geological investigations, including the use of field, laboratory, and analytical techniques. (PG)
33. Identify and evaluate engineering and physical properties of earth materials. (FG/PG)
34. Provide recommendations for engineering design, land use decisions, environmental restoration, and watershed management. (PG)
35. Identify, map, and evaluate geologic, geomorphic, and seismic hazards. (FG/PG)
36. Interpret land use, landforms, and geological site characteristics using imagery, maps, records, and GIS. (FG/PG)
37. Develop plans and recommendations for hazard mitigation, and land and watershed restoration. (PG)

H. Economic Geology and Energy Resources

Knowledge Base

Exploration and development techniques; Geophysical techniques; Petrophysical techniques; Geochemical analysis; Geostatistical analysis; Mineralization processes; Characteristics of mineral deposits; Energy resource systems; Characteristics of hydrocarbon traps; Industrial minerals, coal, and earth materials; Exploration risk and economics; Resource/reserve assessment; Safety hazards and risk analysis; Professionalism and ethics; QA/QC (FG/PG)

Exploration drilling techniques; Drill program design and management; Assaying; Land restoration and hazard mitigation; Mine and well decommissioning; Project planning, management, organization, and economics (PG)

38. Plan and conduct mineral or energy resource exploration, evaluation, and environmental programs, including the use of field, laboratory, and analytical techniques. (PG)
39. Compile and interpret the data necessary to explore for mineral and energy resources. (FG/PG)
40. Estimate the distribution of resources based on surface and subsurface data. (FG/PG)
41. Undertake economic evaluation and reserve assessment. (PG)
42. Determine quantity and quality of resources. (FG/PG)
43. Perform geological studies for design, abandonment, closure, waste management, and reclamation and restoration of energy development or mineral extraction operations. (PG)

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Appendix 3- FG Sample Questions and Answer Key

1. When water contacts pyrite at the earth's surface, the runoff is commonly:

A) acidic
B) basic
C) oxygenated
D) nitrogen-rich

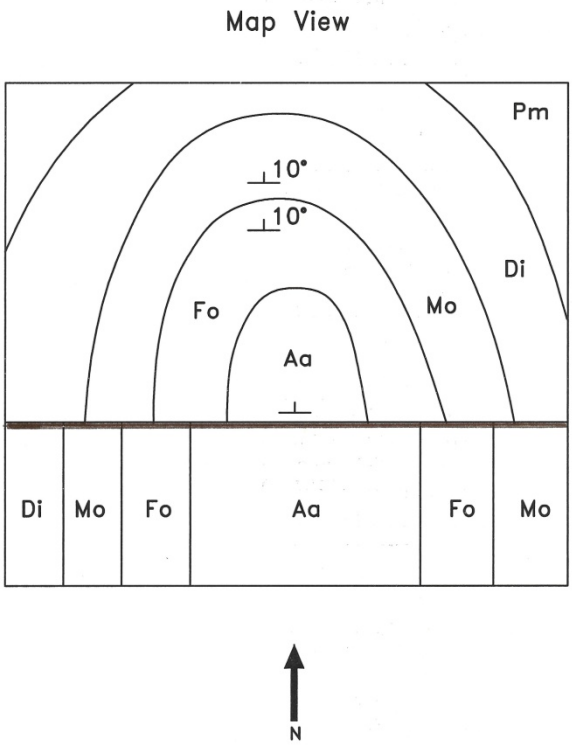

Figure 13

2. What is the correct order of the ages of the units from the oldest to the youngest on the geologic map in Figure 13?

A) Aa, Fo, Mo, Di, Pm
B) Di, Mo, Fo, Aa, Pm
C) Pm, Di, Mo, Fo, Aa
D) Pm, Aa, Fo, Mo, Di

3. In an eolian sand aquifer, hydraulic conductivity would be expected to generally:

A) increase upward
B) increase downward
C) be uniform
D) be lowest in the middle of the unit

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4. Which of the following pairs likely would be composed of sediments with DIFFERENT grain size and sorting characteristics?

A) outwash plain - end moraine
B) esker - kame
C) tuff - tephra
D) barchan dune - parabolic dune

5. It has been determined that a prospective strippable reserve contains 1000 acres (1 acre = 43,560 sq. ft.) of lignite in beds averaging 20 feet in thickness. Assume specific gravity of 1.28 (80 lbs/ft^3). What is the reserve in tons?

A) 362,880,000
B) 3,484,800
C) 6,696,600,000
D) 34,848,000

6. The scale for describing the effects or damage caused by an earthquake at a given geographic location is called the:

A) Bernoulli scale
B) Richter scale
C) Modified Mercalli scale
D) Moment Magnitude scale

7. Which statement best describes the effect of diagenesis on the overall quality of an oil/gas reservoir?

A) Diagenesis enhances reservoir quality.
B) Diagenesis diminishes reservoir quality.
C) Diagenesis may enhance or diminish reservoir quality.
D) Diagenesis has little or no effect on reservoir quality.

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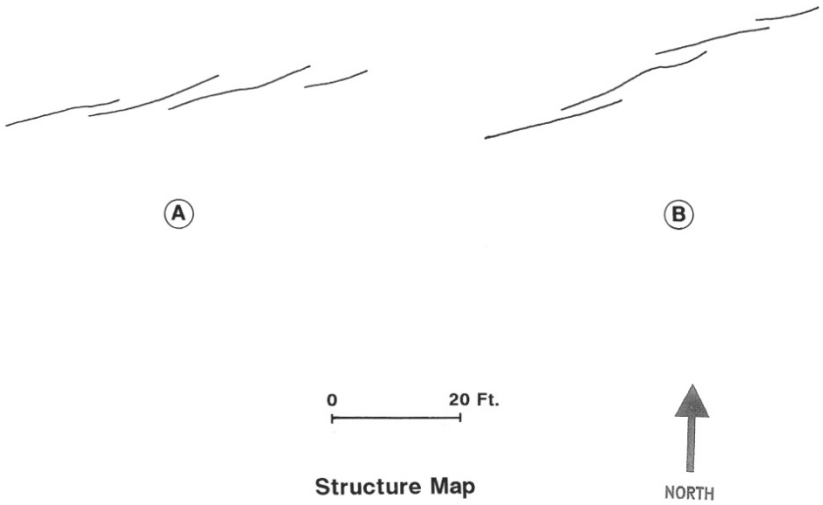

Figure 24

8. Incipient lateral displacement across a narrow zone is often defined by the appearance of Riedel fractures on the ground. Two typical patterns of Riedel fractures are shown in Figure 24. With respect to the patterns shown:

A) A is right-stepping and indicates right lateral movement
B) B is left-stepping and indicates vertical movement
C) A is right-stepping and indicates left lateral movement
D) A and B are both right-stepping

9. The rate of production from a subsurface reservoir is most directly related to:

A) porosity
B) permeability
C) compactness
D) grain size

10. What is the best radiometric dating technique to determine the age difference between two Miocene-age volcanic ash deposits separated by 500 feet vertically?

A) Potassium-Argon
B) Carbon-Carbon
C) Uranium-Lead
D) Uranium Series

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11. What geophysical method would generally be most effective to map deeply buried (1500' deep) bedrock pediments?

A) ground penetrating radar
B) electrical resistivity
C) seismic refraction
D) seismic reflection

12. A groundwater model is considered calibrated when:

A) the model grid and layers match the constructed conceptual model
B) the groundwater flux into the model equals the groundwater flux out of the model
C) hydraulic heads and fluxes reproduce the system modeled within an acceptable tolerance
D) the chosen model boundaries express the nature of the physical boundaries

13. A rock described as argillaceous:

A) contains flattened pebbles
B) is clay-rich
C) displays a satin luster
D) is composed of coarse mica

14. The creation of new oceanic crust is balanced by:

A) the Earth's expansion
B) the Earth's crust buckling up so the earth remains a constant size
C) an equal amount of old ocean crust being subducted
D) an equal amount of continental crust being subducted

15. When collecting duplicate samples to validate the quality of the laboratory results, the geologist should always:

A) identify the duplicate samples
B) use a sequential numbering system
C) be sure that the duplicates cannot be identified by the lab
D) be sure that the duplicates were sampled at different times

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16. A stream crosses a strike-slip fault with no deviation in its course. Which of the following statements must be true?

A) The fault is active.
B) The stream crossed the fault since the last fault movement.
C) Strike-slip faults do not affect stream course.
D) Rock units are the same on both sides of the fault.

17. The horizontal scale of a cross-section is 1:24,000; the vertical scale is 1 inch equals 1000 feet. The vertical exaggeration is:

A) 2x
B) 12x
C) 24x
D) 0.5x

18. A topographic map shows several circular depressions in a limestone region. What are these features called?

A) fensters
B) kettles
C) dolines
D) potholes

19. A cross-stratified sand lens that contains thin streaks of mud in the ripple troughs is called:

A) lenticular bedding
B) wavy bedding
C) graded bedding
D) flaser bedding

20. In which of the following areas are the largest volumes of andesite lava commonly extruded?

A) along continental rift valleys
B) where oceanic lithosphere is subducting beneath continental crust
C) within oceanic plates overlying mantle plumes
D) along zones of lithosphere plate separation (oceanic ridges)

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21. Which of the following safety factor (SF) values for slope stability shows that a slope is considered stable:

A) between zero (0) and one (1)
B) between zero (0) and minus one (-1)
C) greater than one (1)
D) less than minus one (-1)

22. The effects of solution during diagenesis can be seen in:

A) imbricate structures
B) flute marks
C) mud interclasts
D) stylolites

23. Limestones containing appreciable amounts of clay are represented graphically on a lithologic log by:

A) using the standard limestone symbol
B) modifying the limestone symbol by adding a short dash within each box
C) modifying the limestone symbol by adding dots within each box
D) modifying the limestone symbol from a rectangle to a parallelogram

24. You find that in developing a GIS product with several layers of information, there is an apparent conflict between the USGS topographic map completed in 1975 data layer and recently acquired geologic data layer information with GPS locational control, the problem is likely to be:

A) the ARC/INFO software program is unable to handle scanned or digitized topography
B) mistakes in the 1975 topographic map
C) failure to make adjustments relative to the 1983 North American Datum (NAD)
D) conflict between scanned and digitized information

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25. An esker is a:

A) more or less linear ridge formed at the end of a glacial advance
B) streamlined glacial landform
C) conical hill composed predominantly of sand and gravel
D) sinuous ridge subparallel to glacial flow composed predominantly of sand and gravel

26. Biostratigraphic zones are employed to establish:

A) continuity of formations
B) age equivalence within sedimentary sequences
C) absolute ages of successive formations
D) sedimentary provenance active during deposition

27. What Liquid Limit (LL) and Plasticity Index (PI) values would be associated with a soil classified CH?

A) LL = 12 and PI = 38
B) LL = 63 and PI = 38
C) LL = 63 and PI = 11
D) LL = 40 and PI = 11

28. Lithostratigraphic sequences can be used to interpret:

A) geologic history
B) isolated outcrops
C) earthquake probability
D) absolute ages of successive formations

29. Which of the following anions is the least reactive and most persistent tracer of a geochemical contaminant plume?

A) CO_3^{-2}
B) HCO_3^{-1}
C) Cl^{-1}
D) PO_4^{-3}

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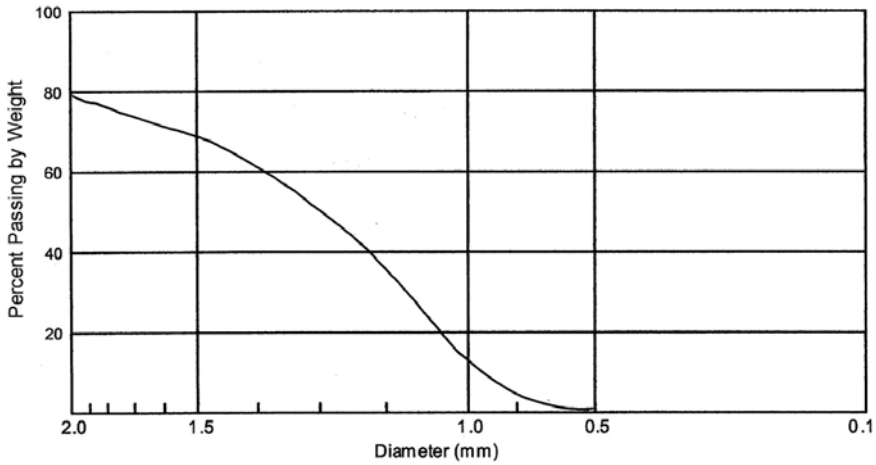

Figure 85

30. The grain-size distribution curve illustrated in Figure 85 indicates that the sand is:

A) poorly sorted
B) poorly graded
C) uniformly sorted
D) well sorted

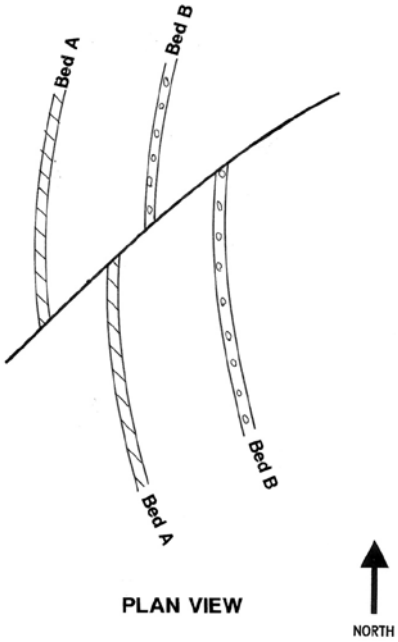

Figure 29

31. If the beds are vertical, Figure 29 represents what type of fault?

A) thrust fault
B) reverse fault
C) right-lateral fault
D) left-lateral fault

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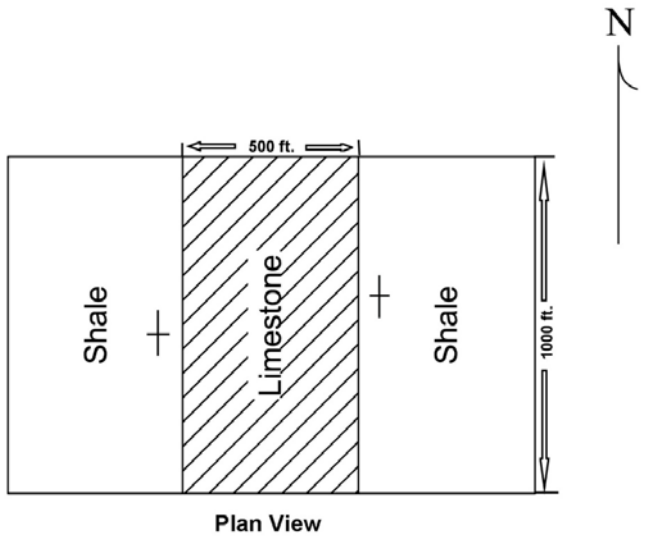

Figure 83

32. What is the approximate total volume of limestone which can be quarried from the property shown in Figure 83, if the mining extends to a depth of 350 feet?

A) 2,500,000 yd^3
B) 4,500,000 yd^3
C) 6,500,000 yd^3
D) 8,500,000 yd^3

33. If the net volume of precipitation entering a drainage basin exceeds the surface water volume coming out with no change in surface storage, then:

A) water is recharging the groundwater system
B) water is discharging from the groundwater system
C) evapotranspiration rates have decreased
D) groundwater storage remains constant because of loss of water to evapotranspiration

34. Which of the following is NOT commonly a natural constituent of groundwater?

A) iron
B) carbonate
C) chloride
D) nitrate

35. An uplifted block bounded by normal faults is known as a(n):

A) atoll
B) guyot
C) graben
D) horst

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36. Your client calls you to sample a series of monitor wells that they installed on their property. Your review of the geologic setting determines that the wells are located such that no contamination could be detected. You should:

A) notify the Board
B) refuse the job
C) inform the client about the problem
D) sample the wells as requested

You have been continually advancing in your profession and have now been offered the position as Regional Geologist for the State Department of Economic Development in the Corner Bay area. This new assignment places you in charge of Environmental Protection, responsible for all environmental protection; economic development and civil development activities, including all construction, transportation, mining and public services activities for the region. In preparation for your new assignment, you visit the local library and find the attached abstract and geologic map about the area. Based upon a careful analysis of the material provided, answer the following questions

The Story of Corner Bay

Explorer Joe, Professor of History
Corner State University, Bay-Delta

Corner Bay is a unique angular bay along the western coast of the mainland that is best known as the first landing site for the early explorers to the country. Historical accounts tell of a major ship anchorage in the area that is now Cove Swamp. Limited archaeological/historical investigations have yielded numerous artifacts of not only the explorer's use of the area, but evidence of early native marine activities. The prevailing weather pattern brings warm Maritime air masses over the lowlands which contribute 125 in/yr. of annual precipitation. By the time the air reaches the Running Ridges, annual rainfall has reduced to 45 in/yr. and at Glenn Peak Fire Station (elevation 4,678 ft.MSL) rainfall equals 34 in/yr. Evapotranspiration follows a similar pattern, being 98 in/yr. in the lowlands, 42 in/yr. at the Running Ridges and 29 in/yr. at Glenn Peak. Soils formed in the lowlands are classified as ultisols, while those formed on the slopes below Glenn Peak are alfisols. Land uses in the lowlands are characteristically tropical fruit production while those on the mountain slopes are grain crops and timber farming. The lowlands form a gentle plain that slopes toward the northeast at about 3% (3 ft/100ft grade). This gentle plain is backed by a series of rocky ridges that trend toward the northwest. A series of parallel ridges, known as the Running Ridges, forms the southeastern boundary of the lowlands. Numerous small streams that carry water to the Loop River have been dammed for the production of hydropower. Historical surveys in the region have located at least 7 abandoned grist mills on tributaries to Loop River from Running Ridges. Glenn Peak forms a dominating topographic backdrop to Corner Bay, with its rugged crags and bare rock spires. Glenn Peak is a world famous climbing mountain, known to be extremely difficult and dangerous to climb. Two streams draining from Glenn Peak have been dammed to provide hydropower for rock saws at a large quarry in the X-Ray Granite. The modern population center in Corner Bay, Bay-Delta, is a major international trade city and manufacturing center with the largest port facilities in the region. The geology of the region is given on the following page.

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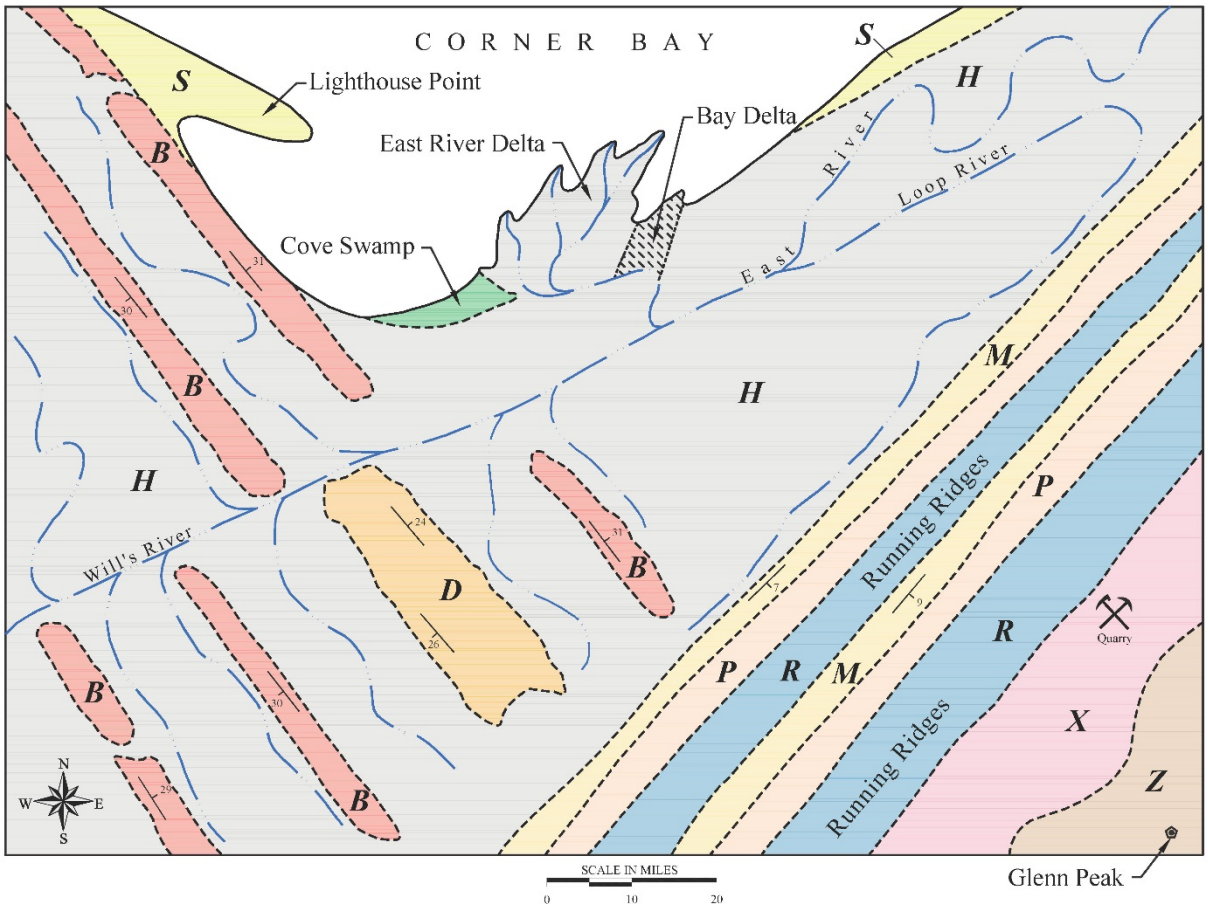

UNIT	DESCRIPTION
Unit B	**Beeswax Sandstone-** (Mississippian) well sorted, angular, quartz sandstone, very well cemented, massive with widely spaced fractures.
Unit D	**Dogtooth Formation-** interbedded gray to black shale and sandstone with occasional shell hash (clastic limestone) lenses.
Unit H	**Holiday Formation-** (Miocene to Recent) interbedded fluvial and tidal flat sands, silts and muds.
Unit M	**Midway Formation-** poorly sorted, angular to rounded, coarse to fine, quartz sandstone, moderately well cemented, normal sedimentary contact with Unit P above.
Unit P	**Pinkeye Mudstones-** (Jurassic) organic rich siltstone to clay beds with irregular linear coal seams, numerous tree fossils and petrified wood, becoming a marl at the top, grades into the Running Ridges Limestone above.
Unit R	**Running Ridges Limestone-** massive limestone composed of microscopic calcite crystals at the base grading upward into fossiliferous limestone containing large well preserved fossils at the top.
Unit S	**Singing Sands-** well sorted, rounded to well-rounded quartz sand, uncemented.
Unit X	**X-Ray Granite-** coarse crystalline, white, probably Precambrian
Unit Z	**Zebra Complex-** complex pink to gray, coarse crystalline, distinct but highly contorted bands of mafic (dark) minerals, weathers into complex irregular topography.

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37. What is the correct stratigraphic column for the Corner Bay area (oldest on the bottom and youngest on the top):

A	B	C	D
X	S	S	H
Z	H	H	S
B	R	R	R
D	P	P	M
M	M	M	P
P	B	B	B
R	D	D	D
H	Z	X	X
S	X	Z	Z

38. Deep exploration holes drilled at the quarry in the X-Ray granite (Unit X) intersected the Running Ridges Limestone (Unit R). Based on this drill hole data, what is the best interpretation of the Unit R-Unit X contact?

A) normal fault
B) thrust fault
C) dextral fault
D) sinistral fault

39. The contact between the Holiday Formation (Unit H) and the Beeswax Sandstone (Unit B) is a(n):

A) fault contact
B) intrusive contact
C) normal stratigraphic
D) angular unconformity

40. The quarry located in the X-Ray Granite is a dimension stone quarry. This suggests that the X-Ray Granite

A) is massive and unfractured
B) is highly fractured
C) is deeply weathered
D) has closely spaced joint sets

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APPENDIX 3 - FG Sample Questions and Answer Key

FG Sample Items - Answer Key

1. A
2. A
3. C
4. A
5. D
6. C
7. C
8. C
9. B
10. A
11. D
12. C
13. B
14. C
15. C
16. B
17. A
18. C
19. D
20. B
21. C
22. D
23. B
24. C
25. D
26. B
27. B
28. A
29. C
30. A
31. D
32. C
33. A
34. D
35. D
36. C
37. C
38. B
39. D
40. A

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Appendix 4- PG Sample Questions and Answer Key

1. You have received a map from a client. You determine a 150-foot property line measures 3 inches on the map. You need a final scale at 1 inch = 20 feet (1:240). What percentage of enlargement or reduction is needed?

A) 250% enlargement
B) 250% reduction
C) 500% enlargement
D) 500% reduction

2. A remote sensing procedure that would be best suited for detecting temperature variations in buried karst terrain is:

A) side looking airborne radar
B) near-infrared photography
C) false color infrared imagery
D) long-wave infrared scanning imagery

3. The following measured section was made in a semiarid region where Tertiary volcanism has been extensive. The section is described from top (Unit 4) to bottom (Unit 1). What can be concluded about the origin of the soil horizon (Unit 4)?

<u>Unit 4:</u> 1 ft Soil, red-brown, sandy, abundant quartz grains and red microcline, some quartz silt and montmorillonite (smectite).
<u>Unit 3:</u> 20 ft Basalt, upper 2 ft weathered irregular and altering to clay with abundant vertical fissures filled with clay and residual soil. Rock is easily broken with a hammer, but becomes hard below 2 ft. About 3 ft below top and extending downward for 5 ft is a zone containing vesicles which at top are oriented nearly horizontal but at the base are essentially vertical. A representative sample taken from the unit indicates the following: Texture: aphanitic to porphyritic, uniform throughout. Mineralogy: 20% labradorite, lath-like crystals about 2 mm long; 10% hornblende, thin crystals about 3 mm long; 70% matrix, finely crystalline, not glassy.
<u>Unit 2:</u> 5 ft Clay, silty, red, swells noticeably when wet, grades downward into rubble composed of fragments of weathered, dark gray granite.
<u>Unit 1:</u> 15 ft Rock, dark gray, generally aphanitic texture, with very finely crystalline ground mass containing few crystals identified as microcline, biotite, and albite.

The soil horizon (Unit 4), was derived from weathering:

A) of Unit 3, in a humid climate
B) of Unit 3, in a semiarid climate
C) and transported from another source
D) of another basalt flow

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4. A small oil field is located on the crest of a large anticline. A regional reverse fault is mapped along the flank of the anticline. At shallow depths in five out of the twenty wells, faults intersected by the bore holes caused 100 to 200 feet of missing section. A reasonable interpretation of the structure is:

A) normal faulting in a tensional setting
B) reverse faulting in a compressional setting
C) compressional faulting and folding followed by shallow normal faulting
D) compressional faulting and folding followed by shallow reverse faulting

5. You are the geologist in responsible charge of designing a foundation exploration drilling program to be carried out in an area underlain by unconsolidated sediments containing large, granitic boulders. The site is known to be uncontaminated. Of the following, which would most likely be the fastest and most efficient drilling method?

A) solid-stem auger drilling
B) mud-rotary drilling
C) direct-push drilling
D) cable-tool drilling

6. Porosity and permeability are important in petroleum reservoir development. Choose the correct statement for a well sorted sandstone reservoir.

A) porosity is always permeable
B) smaller grain size usually means greater porosity and greater permeability
C) greater grain size usually means greater porosity and permeability
D) permeability is always present with porosity

7. What is the difference in orientation between a transverse and a longitudinal cross section of a structure such as an embankment?

A) A transverse section is perpendicular to the longest dimension of the structure and a longitudinal section is parallel to the longest dimension of a structure.
B) A transverse section is parallel to the longest dimension of the structure and a longitudinal section is perpendicular to the longest dimension of a structure.
C) A transverse section cuts the major features of the structure at an acute angle and a longitudinal section parallels the major features of the structure.
D) A transverse section is parallel to the longest dimension of the structure and a longitudinal section is parallel to the shortest dimension of a structure.

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8. You have been retained to identify the extent of groundwater contamination resulting from a truck rollover accident with a release of 1,000 gallons of trichloroethylene (TCE) two days ago. A large municipal well field, located about 1.5 miles from the accident site, produces groundwater from a carbonate aquifer. Regional stratigraphy, based on published sources and the well field stratigraphic logs, is characterized by: 0-20 ft below ground surface (bgs), unconsolidated sand and silty sand; 20-35 ft bgs, hard, blue-green clay; 35-100 ft bgs, weathered, fractured limestone. Water levels in the surficial aquifer are reported to be about 12 ft bgs. Monitoring wells installed at the accident site should be screened from:

A) 75-100 ft bgs
B) 5-15 ft bgs
C) 10-20 ft bgs
D) 15-40 ft bgs

9. In exploring a site for evidence of past surficial fault rupture, which of the following fault types is LEAST likely to be found in a 10-foot deep backhoe trench dug across a projected fault trace?

A) steeply dipping normal fault
B) shallowly dipping thrust fault
C) shallowly dipping blind thrust
D) steeply dipping reverse fault

10. Which of the following is NOT part of a RCRA subtitle D landfill closure and post-closure?

A) groundwater monitoring
B) installation and maintenance of a low permeability landfill cap
C) constructing a contoured crest with slopes less than 5%
D) limiting or controlling access

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11. On large construction projects, aggregate for Portland cement concrete is often locally derived. You are the project geologist. There are two potential sources to be explored. One source is a rather pure quartzite with clean but moderately to widely spaced fractures. The other source contains abundant chert with closely to moderately spaced fractures, and some rhyolite with opaline fracture fillings. The cherty source is nearer to the project site and appears to be easier to develop. Time is critical. Without even the time to do a petrographic microscope examination of thin sections from artificially aged concrete samples from each aggregate source, which aggregate source should you recommend and why?

A) The cherty source because it is easier to develop.
B) The cherty source because haul distance is less.
C) The quartzite source because the natural fracture spacing will make it easier to process the material.
D) The quartzite source because of the potential for alkali-aggregate reaction from the cherty source.

12. Quality control is a(an):

A) state-of-the-art industry standard designed to control appropriate inquiry into the reproducibility of test results.
B) plan which details how a system shall function to assure that standards of quality are being met.
C) prescribed set of activities that monitor and correct system functions to ensure quality standards are consistently being met.
D) unbroken paper trail used to document the quality of procedures relating to a facility, project, or service from the cradle to the grave.

13. Which of the following compounds would NOT be found in an analysis of groundwater contaminated only by leaded gasoline?

A) ethyl benzene
B) tetra ethyl lead
C) xylene
D) methyl tertiary butyl ether

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14. An oil well at elevation 9,575 ft., in the Desolation Formation, has been economically depleted. Management has decided to plug and abandon the well. Which of the following plugging procedures should be followed?

A) The well should be cemented from total depth to ground surface.
B) A granular bentonite plug should be placed over the production interval with a steel cap welded at the surface.
C) At a minimum, the well should be sealed in compliance with the controlling agencies' requirements.
D) A bridge plug should be set over the productive interval.

15. An alluvial aquifer is known to exist to a depth of 100 feet below ground surface (ft. bgs). The water table is 50 ft. bgs. The transmissivity of the aquifer has been determined to be 1,000 ft^2/day. The slope of the water table is 0.001 ft/ft. What is the average Darcy velocity of groundwater movement?

A) 1.0 ft/day
B) 0.02 ft/day
C) 0.2 ft/day
D) 0.01 ft/day

16. You are the consulting geologist for the State Board of Facilities, reviewing the plans for a new administrative building. The architect proposes to use a coarse crystalline, dark gray rock containing exposed pyrite crystals as the exterior facade. You should FIRST:

A) approve the rock for the building
B) determine the rock strength properties
C) assess the weathering properties of the rock
D) assess the cost of the rock for this building

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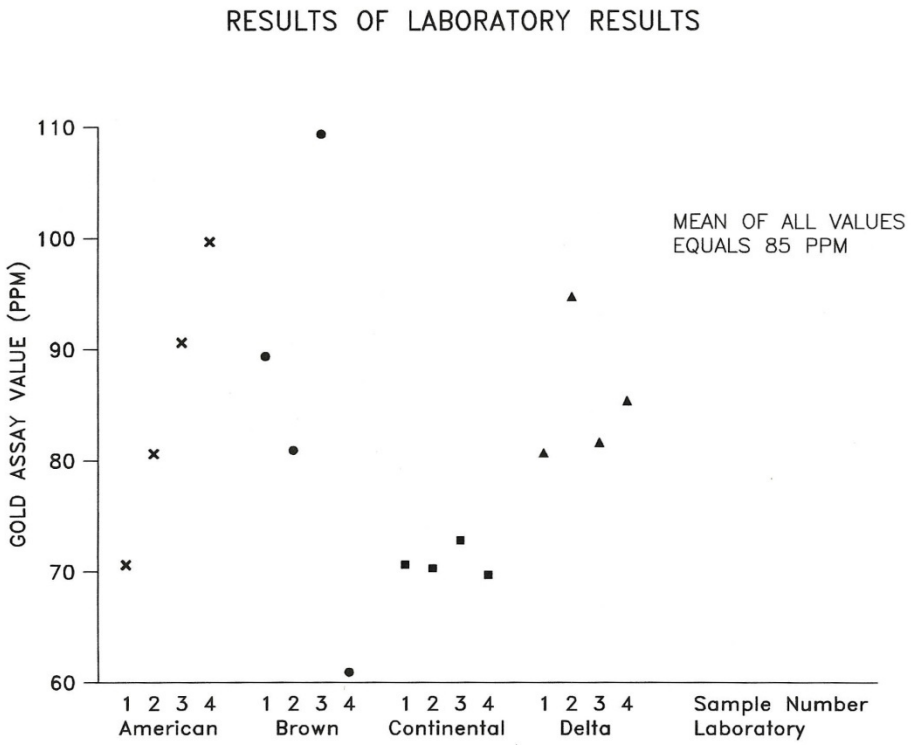

Figure 125

17. A sample of gold ore prepared as a standard reference is blended and carefully divided into 16 samples. One sample per month was sent to four different analytical laboratories for analysis, such that each laboratory analyzed a total of four samples.

The results of the analyses are given in the table and plotted on Figure 125:

GOLD CONCENTRATION (ppm)

Laboratory	Month 1	Month 2	Month 3	Month 4
American	70.3	80.5	90.1	99.9
Brown	89.6	81.3	109.8	59.8
Continental	71.4	70.6	72.9	69.5
Delta	75.4	99.7	81.3	85.7

Based on these results, which laboratory is the most consistent?

A) American
B) Brown
C) Continental
D) Delta

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18. Which suite of analytical parameters would you recommend to best monitor post-closure groundwater quality at a closed copper mining facility?

A) total dissolved solids (TDS), pH, 8 metals per Resource Conservation and Recovery Act (8 RCRA metals)
B) methane, pH, 8 RCRA metals, and total organic carbon (TOC)
C) methane, TDS, pH, and 8 RCRA metals
D) pH, 8 RCRA metals, total organic halides (TOX), and hydrogen sulfide

19. A placer gold deposit has been discovered at two sites in the outcrop of a paleochannel located in a region that has been tectonically deformed and metamorphosed. Further exploration for gold in this deposit should be based on an interpretation of the:

A) direction of channel flow prior to tectonic and metamorphic alteration
B) channel geometry within the altered terrain
C) tectonic history of the region
D) geochemical and mineralogical alteration caused by metamorphism

20. You have been asked to locate a public water supply well in a shallow, sand aquifer. Your locations are limited to three choices, all associated with land-use restrictions:

Site 1 is 300 feet upgradient of a multi-acre, cattle feedlot.
Site 2 is centered in an established residential neighborhood with 1/2-acre unsewered lots.
Site 3 is 1,000 feet upgradient from a newly developed industrial park.

In what order would you rank (best to worst) these three sites for installation of the new well?

A) 1, 3, 2
B) 3, 2, 1
C) 3, 1, 2
D) 1, 2, 3

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21. A slow leak in the underground piping at a service station has resulted in a release of gasoline into the subsurface and the state environmental regulatory agency has been notified. The line has been repaired, all visually impacted soil in the immediate vicinity of the leak has been removed. A careful inventory reconciliation indicates that over time, up to 1,500 gallons of gasoline may have been lost. The water table is expected to occur 8 to 12 feet below ground surface. Which of the following actions should be taken FIRST?

A) Check for soil contamination and remove any additional contaminated soil.
B) Check for contamination dissolved in groundwater, and begin pump-and-treat remediation.
C) Check for the presence of free product, and begin recovery of free product.
D) Check for the presence of microbial population, and initiate enhancement of natural biodegradation.

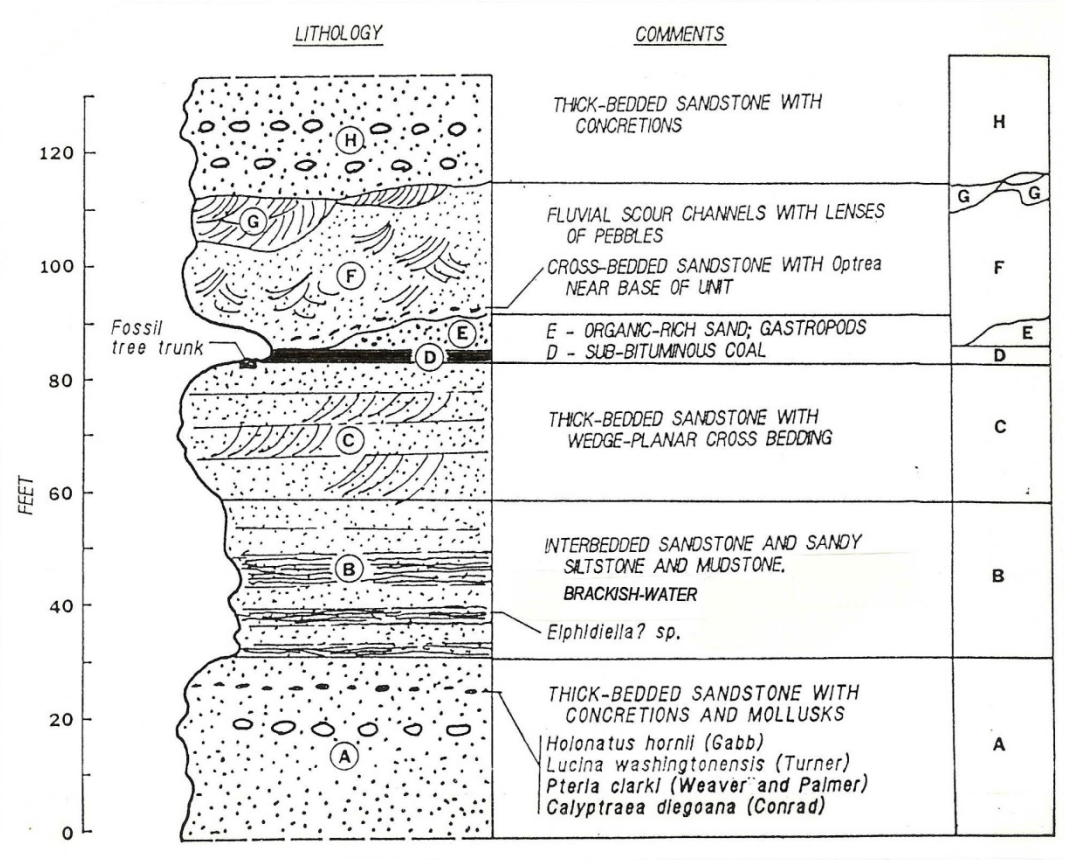

Figure 103

22. With respect to Figure 103, the sequence A-D represents:

A) massive submarine slides
B) regression
C) transgression
D) lacustrine deposits

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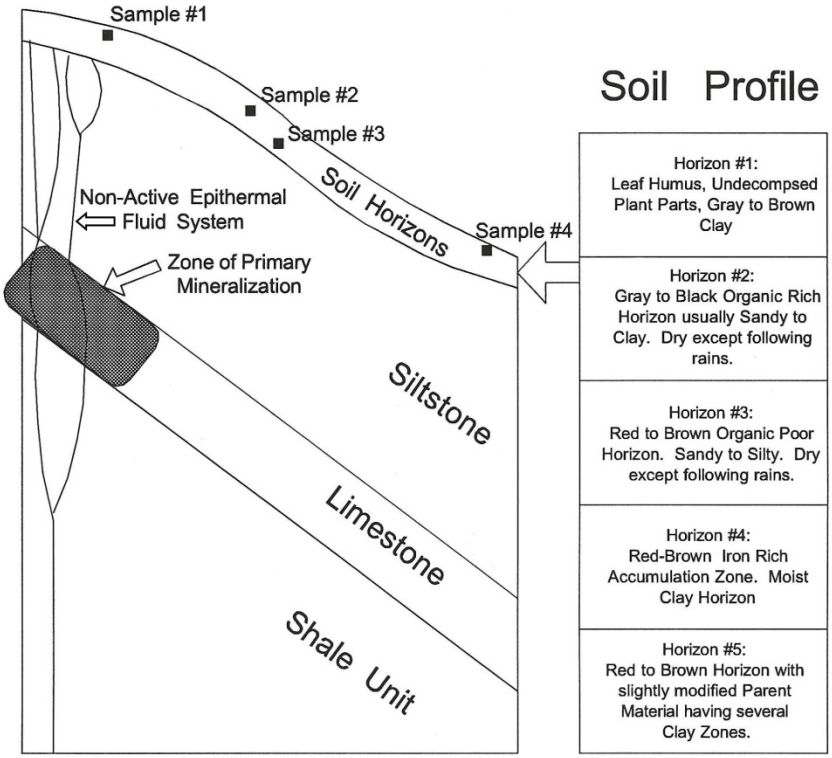
23. You will be mapping unconsolidated deposits for gravel exploration. Which method is LEAST appropriate for locating potential deposits?

A) aerial photography interpretation
B) analysis of surface resistivity measurements
C) magnetometry interpretation
D) test boring logging



Generalized Cross Section Through Hillside

Sample #1: Collected from Soil Horizon #2
Sample #2: Collected from Soil Horizon #3
Sample #3: Collected from Soil Horizon #4
Sample #4: Collected from Soil Horizon #2

Figure 54

24. You are conducting a soil geochemistry survey. There is a mineralized zone shown in Figure 54. The soil profile indicates the location of samples within the soil horizons developed in the area. The mineralized zone has elevated levels of Au, Ag, As, and Hg. Of the four possible sampling sites indicated, which one is the best choice to determine if concentrations of these metals have elevated values in the soil?

A) Sample 1
B) Sample 2
C) Sample 3
D) Sample 4

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25. A tailings storage facility at an operating gold mine has been constructed using a starter dam. Annual precipitation in the area averages over 40 inches. No active faults are known in the immediate vicinity of the facility. Which monitoring program provides the highest degree of dam safety?

A) a seepage collection system that monitors seepage volume and quality on a continuous basis for cyanide
B) network of groundwater wells constructed upgradient and downgradient of the facility to monitor groundwater quality and water levels on a quarterly basis
C) a combination of visual inspections of the facility on a weekly basis and monitoring of vibrating wire piezometers and survey monuments on a monthly basis, plus continuous monitoring of seepage in a seepage collection system
D) a visual monitoring program to inspect the tailings storage facility for seeps, settlement, and cracking on a weekly basis

26. You have identified a paleosol horizon that has developed on Ordovician bedrock that was originally deposited in a marine environment. The Ordovician rocks are unconformably overlain by a thin succession of Pennsylvanian coal-bearing strata. The Paleozoic succession is covered by glacial-related Quaternary deposits.

The age of the paleosol is:

A) Post-Ordovician to Pre-Pennsylvanian
B) Permian
C) Post-Pennsylvanian to pre-Quaternary
D) Cambrian

27. Important descriptive, <u>NOT</u> interpretive, seismic reflection patterns are:

A) cross-bedding and offshore bars
B) onlap and offlap
C) sequence boundaries and parasequence sets
D) transgressions and regressions

28. Which isotope dating is best to determine the age of a mid-Eocene tuff?

A) tritium-deuterium dating
B) uranium-lead dating
C) potassium-argon dating
D) carbon-carbon dating

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29. The use of bentonite-cement grout to seal a monitor well results in a seal that is:

A) more permeable than a bentonite grout
B) more permeable than the sand pack
C) less susceptible to cracking than neat cement grout
D) more susceptible to failure than a bentonite grout above the water table

30. You are performing a geomorphological appraisal to identify fluvial hazards at the foundation site of a proposed bridge pier in a large perennial stream in mountainous terrain. The stream is entrenched in competent bedrock and is backfilled by an appreciable thickness of coarse alluvium and debris. Which of the following fluvial hazards has the greatest potential to affect the future integrity of the bridge and will receive the greatest attention during design development?

A) channel migration
B) channel bed scour during flooding
C) upstream nickpoint migration
D) channel aggradation

31. A client asked you to prepare a report describing the geologic constraints affecting the design and construction of a large underground structure. The client has limited your budget for exploration and you cannot be certain that the subsurface conditions exposed by borings are consistent across the site. You should:

A) avoid any reference to any possible condition that cannot be supported by your data.
B) describe the nature of your uncertainty along with possible consequences of your incomplete understanding of the subsurface conditions.
C) refuse to complete your report until the client agrees to fund the additional exploration you require.
D) structure the report to emphasize the probability that your data and conclusions are adequate, but use language that will limit your liability if different conditions are encountered during construction.

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APPENDIX 4- PG Sample Questions and Answer Key

PG Sample Items - Answer Key

1. A
2. D
3. C
4. C
5. B
6. C
7. A
8. C
9. C
10. C
11. D
12. C
13. D
14. C
15. B
16. C
17. C
18. A
19. B
20. C
21. C
22. B
23. C
24. C
25. C
26. A
27. B
28. C
29. C
30. B
31. B

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Appendix 5- Statement of Examination Compliance

Please read carefully this *Statement of Examination Compliance* in its entirety and sign on the line provided to acknowledge your understanding of, and concurrence with, this agreement.

IF THIS AGREEMENT IS NOT COMPLETED, SIGNED AND RETURNED WHEN REQUESTED BY THE PROCTOR, YOU WILL NOT BE PERMITTED TO TAKE THE EXAMINATION.

By signing this *Statement of Examination Compliance*, you agree that the following actions/behaviors constitute prohibited conduct at the examination site:

(1) Impersonating an examination candidate or using false identification to take an examination. Only the person named on the examination application/answer sheet is authorized to take the examination, and his/her correct name must be signed on the examination;

(2) Possession of **any** of the following during the examination is prohibited: electronic device (cellular phone, PDA, tape/digital recorder, alpha programmable calculators, camera, scanning pens, etc.), notes, sample tests, references, answer keys, manuals or other aids. It is the candidate's responsibility to turn in any of these items to the Proctor before the start of the examination. Calculators, or any other wireless electronic devices, that have e-mail/Internet/text messaging capability shall **NOT** be allowed. Violation of any of the above-mentioned prohibitions will result in immediate expulsion from the examination site and forfeiture of examination privileges (examination will not be scored) and fees.

(3) Copying, reproduction, taking notes, or taking pictures for the purpose of transmitting examination information in any form to another person or device or any action taken to reveal the content of examinations in whole or in part is prohibited. Removal of the examination booklet from the Examination room at any time is prohibited.

(4) Looking at another examinee's answer sheet or examination booklet or giving oral or written assistance to another candidate during administration of the examination;

(5) Exhibiting irrational or disruptive behavior at the examination site at any time; and

(6) Continuing to fill in answer sheets or answer test questions after time has been called.

Further, I pledge to neither give, use, obtain, attempt to obtain by any means, nor receive information concerning the whole or any part of an examination (individual examination problems, questions, solutions or answers), nor to transmit such to any third party, before, during, or after an *Examination*, whether orally, in writing, by telephone, during any Internet "chat room" sessions or otherwise.

* * * *