RTH 102-93

RECOMMENDED PRACTICE FOR PETROGRAPHIC EXAMINATION OF ROCK CORES

1. Scope

1.1 This recommended practice outlines procedures for the petrographic examination of rock cores whose engineering properties can be determined by selected tests. The specific procedures employed in the petrographic examination of any sample will depend to a large extent on the purpose of the examination* and the nature of the sample. Complete petrographic examination may require use of such procedures as light microscopy, X-ray diffraction analysis, differential thermal analysis, infrared spectroscopy, or others; in some instances, such procedures are more rapid and more definitive than are microscopical methods. Petrographic examinations are made for the following purposes:

(a) To determine the physical and chemical properties of a material, by petrographic methods, that have a bearing on the quality of the material for its intended use.

(b) To describe and classify the constituents of the sample. (Note 1)

(c) To determine the relative amounts of the constituents of the sample, which is essential for proper evaluation of the sample, when the constituents differ significantly in properties that have a bearing on the quality of the material for its intended use.

NOTE 1--It is recommended that the rock and mineral names in "Descriptive Nomenclature of Constituents of Natural Mineral Aggregates" (ASTM Designation: C 294) be used insofar as they are appropriate in reports prepared according to this recommended practice.

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*The practices described herein are applicable to the examination of rock cores from rock used as foundation or other similar purposes. However, if the cores are from rock proposed to be quarried for use as concrete aggregate or erosion control, reference should be made to ASTM C 295 or D 4992, respectively.

1.2 Detection of structural features and identification of the constituents of a sample are usually necessary steps toward recognition of the properties that may be expected to influence the behavior of the material in its intended use. However, the value of any petrographic examination will depend to a large extent on the representativeness of the samples examined, the completeness and accuracy of the information provided to the petrographer concerning the source and proposed use of the material, and the petrographer's ability to correlate these data with the findings of the examination.

1.3 This recommended practice does not attempt to outline the techniques of petrographic work since it is assumed that the method will be used by persons who are qualified by education and/or experience to employ such techniques for the recognition of the characteristic properties of rocks and minerals and to describe and classify the constituents of a sample. It is intended to outline the extent to which such techniques should be used, the selection of properties that should be looked for, and the manner in which such techniques may best be employed in the examination. These objectives will have been attained if engineers responsible for the application of the results of petrographic examinations have reasonable assurance that such results, wherever and whenever obtained, may confidently be compared.

2. Sampling and Examination Procedure

2.1 The purpose in specifying a sampling procedure is to ensure the selection of an adequate group of test specimens from each mechanically different rock type that forms an essential part of the core or cores that will be tested. The sampling procedure should also be guided by the project objectives and directed at obtaining the properties of the rock that eventually will comprise the roof, side walls, foundation, or other specific parts of the project structure. Samples for petrographic examination should be taken by or under the direct supervision of a geologist familiar with the requirements of the project. The exact location from which the sample was taken, the geology of the site, and other pertinent data should be submitted with the sample. The amount of material actually studied in the petrographic examination will be determined by the nature of the material to be examined. Areas to be studied should be sampled by means of cores drilled through the entire depth

required for project investigation. Drilling of such cores should be in a direction that is essentially normal to the dominant structural feature of the rock. Massive material may be sampled by "NX"(2-1/8-in.-diam) (54-mm-diam) cores. Thinly bedded or complex material should be represented by cores not less than 4 in. (100 mm) in diameter, preferably 6 in. (150 mm). There should be an adequate number of cores to cover the limits of the rock mass under consideration.

2.2 The following is considered a preferable but not a mandatory procedure. A petrographer should inspect all of the rock core before any tests are made. Each core should be logged to show footage of core recovered, core loss, and location; location and spacing of fractures and parting planes; lithologic type or types; alternation of types; physical conditions and variations in conditions; toughness, hardness, coherence; obvious porosity; grain size, texture, variations in grain size and texture; type or types of breakage. If the surface of the core being examined is wetted, it is usually easier to recognize significant features and changes in lithology. Most of the information usually required can be obtained by careful visual examination, scratch and acid tests, and hitting the core with a hammer. A preliminary analysis of the test results may indicate that the results from one or another of the subdivisions are not significantly different and the groups may be combined. On the other hand, the analysis may disclose significant differences within a given group of specimens and a further subdivision may be required. Most rock is anisotropic and, if the core stock and sample procedure permit, a group of specimens should be obtained from the three mutually perpendicular directions. Usually these directions are oriented with respect to some petrographic property of the rocks such as bedding, schistosity, cleavage, or fabric. In bedded rock the greatest difference in properties occurs in specimens taken perpendicular and parallel to the bedding, and generally this type of rock is sampled only in these two directions. The petrographic examination may disclose mineral components that are soluble or that expand or soften in water, as for example, bentonites or other clays. The intent of this inspection is to provide a basis for the selection of samples for engineering tests. This basis will be rock types, amounts of rock types,

differences within a rock type, etc. At this point, the petrographer, in conjunction with the project leader, should select the sections of core(s) that will be subjected to engineering tests. The detailed petrographic examination will usually be made on unused portions of some or all of the test pieces so that the petrographic data can be matched to the engineering data. This matching should mean that, in addition to petrographic characterization, the petrographic data should serve as a basis for understanding the physical test data within and between sample groups.

3. Apparatus and Supplies

3.1 The apparatus and supplies listed in the following subparagraphs (a) and (b) comprise a recommended selection which will permit the use of all of the procedures described in this recommended practice. All specific items have been used in connection with the performance of petrographic examinations by the procedures described herein; it is not, however, intended to imply that other items cannot be substituted to serve similar functions. Whenever possible the selection of particular apparatus and supplies should be left to the judgment of the petrographer who is to perform the work so that items obtained will be those with which he has the greatest experience and familiarity. The minimum equipment regarded as essential to the making of petrographic examinations are those items, or equivalent apparatus or supplies that will serve the same purpose, that are indicated by asterisks in the lists in subparagraphs (a) and (b).

(a) Apparatus and Supplies for Preparation of Specimens:

(1) Rock-Cutting Saw,* preferably with a 20-in. (508-mm) diameter blade or larger.

(2) Horizontal Grinding Wheel,* preferably 16 in. (400 mm) in diameter.

(3) Polishing Wheel, preferably 8 to 12 in. (200 to 300 mm) in diameter.

(4) Abrasives:* silicon carbide grit Nos. 100, 220, 320, 600, and 800; optical finishing alumina.

(5) Geologist's pick or hammer.

(6) Microscope Slides,* clear, noncorrosive, 25 by 45 mm in size.

(7) Canada Balsam,* neutral in xylene or other material to cement cover slips.

(8) Xylene.*

(9) Mounting Medium,* suitable for mounting rock slices for thin sections.

(10) Laboratory Oven.*

(11) Plate-Glass Squares,* about 12 in. (300 mm) on an edge for thin-section grinding.

(12) Micro Cover Glasses,* No. 1 noncorrosive, square, 12 to 12 mm, 25 mm, etc.

(13) Plattner mortar.

(b) Apparatus and Supplies for Examination of Specimens:

(1) Polarizing Microscope* with mechanical stage; low-, medium-, and high-power objectives, and objective centering devices; eyepieces of various powers; full- and quarter-wave compensators; quartz wedge.

(2) Microscope Lamps* (preferably including a sodium arc lamp).

(3) Stereoscopic Microscope* with objectives and oculars to give final magnifications from about 7X to about 140X.

(4) Magnet,* preferably Alnico, or an electromagnet.

(5) Needleholder and Points.*

(6) Dropping Bottles, 60-ml capacity.

(7) Forceps, smooth straight-pointed.

(8) Lens Paper.*

(9) Immersion Media,* n = 1.410 to n = 1.785 in steps of 0.005. (Note 2)

(10) Counter.

(11) Photomicrographic Camera and accessories. (Note 3)

(12) X-ray diffractometer.

(13) Differential thermal analysis system.

(14) Infrared absorption spectrometer.

NOTE 2--It is necessary that facilities be available to the petrographer to check the index of refraction of the immersion media. If accurate identification of materials is to be attempted, as for example the differentiation of quartz and chalcedony or the differentiation of basic from intermediate volcanic glass, the indices of refraction of the media need to be known with precision. Media will not be stable for very long periods of time and are subject to considerable variation due to temperature change. In laboratories not provided with close temperature control, it is often necessary to recalibrate immersion media several times during the course of a single day when accurate identifications are required. The equipment needed for checking immersion media consists of an Abbe Refractometer. The refractometer should be equipped with compensating prisms to read indices for sodium light from white light, or it should be used with a sodium arc lamp.

NOTE 3--It is believed that a laboratory that undertakes any considerable amount of petrographic work should be provided with facilities to make photomicrographic records of such features as cannot adequately be described in words. Photomicrographs can be taken using standard microscope lamps for illumination; however, it is recommended that whenever possible a zirconium arc lamp be provided for this purpose. For illustrations of typical apparatus, reference may be made to the paper by Mather and Mather.[1]

4. Report

4.1 First and foremost the report should be clear and useful to the engineer for whom it is intended. It should identify samples, give their source as appropriate, describe test procedures and equipment used as appropriate, describe the samples, and list the petrographic findings. Tabulations of data and photographs should be included as needed. Results that may bear on the engineering test data and the potential performance of the material should be clearly stated and their significance should be emphasized. It may also be appropriate to mention past performance records of the same or similar mate-

[1]This recommended practice is modified from the "Method of Petrographic Examination of Aggregates for Concrete," by Katharine Mather and Bryant Mather. Proceedings, American Society for Testing Materials, ASTM, Vol 50, 1950, pp 1288-1312.

rials if such information is available. In general, the report should be an objective statement. If any opinion is presented it should be clearly indicated to be an opinion. Finally, the petrographic report should make recommendations if and as appropriate.

5. References

5.1 ASTM Standards

C 294 (RTH 116) Descriptive Nomenclature for Constituents of Natural Mineral Aggregate

C 295 Guide for Petrographic Examination of Aggregates for Concrete

D 4992 Practice for Evaluation of Rock to be Used for Erosion Control