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Standard Guide for Petrographic Examination of Dimension Stone[1]

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1. Scope

1.1 This guide outlines procedures for the petrographic examination of stone specimen material proposed for use as dimension stone used in construction.

1.2 This guide outlines the extent to which petrographic techniques should be used, the selection of petrographic related properties that should be looked for, and the manner in which such techniques may be employed in the examination of dimension stone.

1.3 The rock and mineral names given in Terminology C119 should be used, insofar as they are appropriate, in reports prepared in accordance with this guide.

1.4 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C97 Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone

C99 Test Method for Modulus of Rupture of Dimension Stone

C119 Terminology Relating to Dimension Stone

C120 Test Methods for Flexure Testing of Structural and Roofing Slate

C121 Test Method for Water Absorption of Slate

C170 Test Method for Compressive Strength of Dimension Stone

C217 Test Method for Weather Resistance of Slate

C241 Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic

C406 Specification for Roofing Slate

C503 Specification for Marble Dimension Stone

C568 Specification for Limestone Dimension Stone

C615 Specification for Granite Dimension Stone

C616 Specification for Quartz-Based Dimension Stone

C629 Specification for Slate Dimension Stone

C880 Test Method for Flexural Strength of Dimension Stone

C1353 Test Method for Abrasion Resistance of Dimension Stone Subjected to Foot Traffic Using a Rotary Platform Abraser

C1526 Specification for Serpentine Dimension Stone

C1527 Specification for Travertine Dimension Stone

C1528 Guide for Selection of Dimension Stone

C1799 Guide to Dimension Stone Test Specimen Sampling and Preparation

E883 Guide for Reflected–Light Photomicrography

3. Summary of Guide

3.1 The specific procedures employed in the petrographic examination of any specimen will depend to a large extent on the purpose of the examination and the nature of the specimen. In most cases the examination will require the use of optical microscopy. Complete petrographic examinations for particular purposes and to investigate particular problems may require examination of selected constituents by means of additional procedures, such as X-ray diffraction (XRD) analysis for crystalline structure and mineral identification, differential thermal analysis (DTA) for chemically and physically unstable minerals, infrared spectroscopy, scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX), or other procedures. Although these procedures are beyond the scope of this standard, these additional procedures may be more definitive than visual microscopic methods in certain circumstances.

3.2 Identification of the minerals, composition, rock fabric, and structure of a specimen is a necessary step towards recognition of the properties that may be expected to influence

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

the behavior of the material in its intended use, but identification is not an end in itself. The value of any petrographic examination will depend to a large extent on the representativeness of the specimens 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.

3.3 This guide does not attempt to describe the techniques of petrographic work since it is assumed that the guide will be used by persons who are qualified by education and 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 specimen that may have an effect on performance. For some cases, the petrographer will have had experience adequate to provide detailed interpretation of the petrographic results. For many cases the interpretation will be made, in part, by engineers, familiar with the intended use of the dimension stone. In other cases, interpretation of the findings may require input of others, such as a chemist, qualified to relate the observations to the questions to be answered.

3.4 The petrographer should be familiar with the ASTM standards referenced in 2.1.

4. Significance and Use

4.1 Petrographic examinations are made for the following purposes:

4.1.1 Determine the physical and chemical characteristics (mineralogy, texture, and composition) of the stone specimen that may be observed by petrographic methods and that have a bearing on the performance of the material in its intended use.

4.1.2 Describe and classify the minerals of the specimen.

4.1.3 Classify the stone both commercially and geologically based on Terminology C119, recognizing the differences in nomenclature; and based on the following standards, as appropriate:

Specification C406
Specification C503
Specification C568
Specification C615
Specification C616
Specification C629
Specification C1526
Specification C1527

4.1.4 Determine the relative amounts of the minerals of the specimen and constituents that have a bearing on the performance of the material in its intended use.

4.1.5 Compare characteristics of the stone with specimens from one or more sources, for which test data or performance records are available.

4.2 The petrographer should be told in as much detail as necessary, the purposes and objectives of the examination, the kind of information needed, and the extent of examination desired.

4.2.1 Pertinent background information, including results of prior testing, such as physical and mechanical testing, should be made available. The petrographer's advice and judgment should be sought regarding the extent of the examination. Available physical and mechanical testing may include the following:

Test Methods C97
Test Method C99
Test Method C170
Test Method C880
Test Methods C120
Test Method C121
Test Method C241
Test Method C1353
Test Method C217

4.3 This guide may form the basis for establishing arrangements between a purchaser of consulting petrographic service and the petrographer. In such a case, the purchaser and the consultant should together determine the kind, extent, and objectives of the examination and analyses to be made, and should record their agreement in writing. The agreement may stipulate specific determinations to be made, observations to be reported, funds to be obligated, or a combination of these or other conditions.

4.4 Petrographic examinations provide identification of type and varieties of minerals and structures present in the specimen. However, as noted above, identification of all minerals and structures present in the specimen is not necessarily required.

4.5 The petrographic examination should establish whether the specimen contains chemically unstable minerals or volumetrically unstable materials.

4.6 Petrographic examination should identify weathered or otherwise altered constituents or minerals and describe the extent of that weathering or alteration. Where possible, describe potential aesthetic changes that may occur as a result of weathering.

NOTE 1—If the dimension stone will be exposed to freezing and thawing and may become wet or saturated in use, finely porous and highly weathered or otherwise altered minerals should be identified because these materials will be especially susceptible to damage by freezing and thawing.

4.7 Petrographic examination should identify constituents or minerals and the extent to which they may lead to staining and color change of the surface of the stone when the stone is exposed to the weather for exterior use.

4.8 Petrographic examination should identify and estimate proportions of constituents that may be susceptible to deterioration from attack by deicing agents where proposed for use at grade level in freezing environments where deicing salts are anticipated to be used.

4.9 Criteria are available for identifying minerals by their optical properties or by XRD. Criteria are available for identifying rocks by their mineral composition and texture. Examination in both reflected and transmitted light may be necessary to provide data for these identifications. X-ray microanalysis using energy-dispersive X-ray spectrometers with scanning electron microscopy (SEM/EDX) or

wavelength-dispersive X-ray spectrometers in electron microprobes (EMPA/WDX) may provide useful information on the chemical composition of minerals and rocks.

4.10 The objectives for which this guide was prepared, will have been attained if those involved with the evaluation of the specimen have reasonable assurance that the petrographic examination results, wherever and whenever obtained, may confidently be compared.

5. Sampling

5.1 Stone specimens for petrographic examination are best obtained under guidance of a geologist familiar with the requirements of this standard. Information on the exact location from which the specimen was taken and other pertinent data should be recorded or submitted with the specimen. The amount of material actually studied in the petrographic examination will be determined by the nature of the examination to be made and the nature of the material to be examined, as discussed below. It is preferable that the specimens be selected and prepared by the person performing the petrographic examination.

5.2 Specimen(s) provided for examination with unknown origin:

5.2.1 Often. specimens are submitted for petrographic analysis without information as to origin. In this case, report that the origin of the specimen is unknown or attempt to obtain information from the submitter as to country, quarry of origin, and geologic formation.

5.3 Specimen(s) selected from materials submitted for petrographic analysis as well as for physical and mechanical testing:

5.3.1 It is desirable to examine specimens that have been previously tested for physical and mechanical properties, for comparison with non-tested specimens. Petrographic analysis can sometimes explain anomalous physical and mechanical results as well as features that may be of concern, based solely on visual examination.

5.4 Specimen(s) selected from operating quarry for petrographic analysis.

5.4.1 Investigate vertical and lateral variations in the composition, texture, and microstructure of the material comprising the formation.

5.4.2 Examine specimen stone material produced that is representative of material to be used.

5.4.3 Identify visible features and characteristics and their variations to aid purchaser in selecting stone for use.

5.4.4 Provide description or sketch of quarry and proposed extraction location(s), and locations from which specimens for petrographic study were taken.

NOTE 2—Refer to Guide C1799 for additional information on selecting, preparing, and conditioning test specimens.

6. Procedure

6.1 Selection of Specimens for Direct Petrographic Examination:

6.2 Record:

6.2.1 Notes should be taken during the examination. Each specimen should be described; the relevant features may include the following: shape and dimensions of specimen,

6.2.2 Specimen surface textures and finishes,

6.2.3 Crystal or grain size, or both,

6.2.4 Internal structure, including observations of preferred orientation, segregation of grains or crystals, pore space, packing of grains, cementation of grains,

6.2.5 Color,

6.2.6 Rock name and minerals composition,

6.2.7 Significant heterogeneities in appearance,

6.2.8 General physical condition of the specimen (for example, freshness, weathering, alteration),

6.2.9 Presence of discontinuities (for example, rock cleavage, foliation, bedding, layering, fissures, fractures, vugs, stylolites, and fossils), and

6.2.10 Presence of constituents known to be chemically or physically unstable.

7. Report

7.1 State purpose of the examination.

7.2 Summarize the essential data needed to identify the specimen as to source and proposed use, and include a description giving the essential data on characteristics, composition, and properties of the material as revealed by the examination.

7.3 List the test procedures employed, and give a description of the nature and features of each important constituent of the specimen, accompanied by such tables and photographs as may be required.

7.4 Describe petrographic features, mineralogy, and structures observed that may have an effect on the physical, mechanical, and aesthetic performance of the material when used as dimension stone.

7.5 Express the findings and conclusions in terms likely to be intelligible to those who must make decisions as to the suitability of a material for use as dimension stone. Report observations made on features described in Section 6.

7.6 Describe qualitatively and, to the extent practicable, quantitatively, those properties or constituents that are known to have specific unfavorable effects. The unfavorable effects that may be expected to ensue should be mentioned.

NOTE 3—When appropriate, it should be stated that a given specimen was not found to contain any unfavorable features. When such is the case it may also be appropriate, especially if the report of the petrographic examination is not accompanied by reports of results of physical, mechanical, and chemical tests for which numerical limits may be applicable, to add that the material examined is considered to be acceptable for use provided the applicable acceptance tests are made and the results are within the appropriate limits. The report should not, however, contain conclusions other than those based upon the finding of the examination unless the additional data to support such conclusions are included in or with the petrographic report and the petrographer has been authorized to analyze the other relevant non-petrographic data.

7.7 Describe properties and characteristics including those which are likely to be significant relative to the intended use of the dimension stone including anticipated environmental exposure. These may include: