

Sample Preparation: X-ray Powder Diffraction

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Sample Preparation: X-ray Powder Diffraction

1 INTRODUCTION

- A. This document provides the procedure for the sample preparation for x-ray powder diffraction (XRD). In x-ray powder diffraction, the material to be examined is typically reduced to a very fine powder and placed in a beam of monochromatic x-rays. Each particle of the powder is a tiny crystal or assemblage of smaller crystals, oriented at random with respect to the incident beam. The result is that every set of lattice planes will be capable of reflection. The material of interest must have a regularly repeating atomic structure and should have been previously described using the Geologically-Derived Materials Examinations Procedures.
- B. This Technical Procedure is implementing through incorporation by reference the ASTM International E3294, Standard Guide for the Forensic Analysis of Geological Materials by Powder X-ray Diffraction. ASTM E3294 is on the Organization of Standard Area Committees (OSAC) Registry of Approved Standards.

2 SCOPE

This document applies to the Geologist-Forensic Examiners and qualified analysts within the Trace Evidence Unit (TEU).

3 EQUIPMENT

- Acetone, laboratory grade (or better)
- Agate mortar and pestle
- Chemical resistant gloves
- Deionized water
- Ethyl alcohol, laboratory grade (or better)
- Glass slides
- Laboratory coat
- Sieve set, to include 200 mesh
- Additional materials may be used at the discretion of the Geologist-Forensic Examiner

4 SAMPLING

- A. The collection and processing of materials with a regularly repeating atomic structure (typically crystalline materials) from submitted items of evidence can be reviewed in the [TRACE-200: Evidence Handling and Processing](#).
- B. At the discretion of the Geologist-Forensic Examiner, the entire sample or component(s) or mixes of components of interest may be analyzed. These materials are prepared for identification as necessary at the discretion of the Geologist-Forensic Examiner. Individual sub-samples may not be representative of the entire specimen. Sub-samples are chosen based on the need to identify a particular component. Refer to ASTM E3294 for more information.

5 PROCEDURE

5.1 Isolated Samples or Samples Which May Be Removed from Their Substrate

- A. The sample or portion of a sample to be analyzed may be ground if necessary. To grind a sample or portion of a sample, transfer the portion to be analyzed to an agate mortar.
 1. Grind the sample or portion of the sample with an agate pestle. Grinding method is determined as appropriate for sample at the discretion of the examiner.
 - i. Dry grinding – the sample is ground between mortar and pestle in air.
 - ii. Wet grinding – the sample is ground between mortar and pestle in a carrying/lubricating medium. Medium should be easily volatilized, for example, acetone, water, or ethyl alcohol. Use enough medium to wet the sample and add more as necessary to keep the sample wet while grinding.
 - a. Take the sample to dryness when grinding is complete.
- B. The sample or portion of a sample to be analyzed may be sieved if necessary. For most samples the portion of the sample which passes through a 200-mesh sieve is most appropriate for optimal XRD signal. Size fraction used is at the discretion of the Geologist-Forensic Examiner and is dependent on the individual sample.
- C. Mount the sample in a holder. The holder used is determined at the discretion of the Geologist-Forensic Examiner as appropriate for the sample.

5.2 Low Background Slide

- A. Evenly distribute the sample on a low background slide in the area illuminated by x-ray beam when the sample is analyzed.
 1. Wet deposition.
 - i. Suspend the sample in a carrying medium. Medium should be easily volatilized, for example, acetone, water, or ethyl alcohol.
 - ii. Place the suspension on a slide.
 - iii. Evaporate the carrying medium.
 2. Dry deposition. Sprinkle the sample onto a slide.

5.3 Well Holder

- A. It is preferable to load the sample from the back side of the well holder.
 1. Remove the back of the sample holder.
 2. Place the holder front side down on a clean glass slide.
 3. Pour the sample into the well and compress with a clean glass slide.
 4. Replace the backing to the holder.
 5. Invert the holder and remove the slide from the front of the holder, being careful not to disturb the surface of the sample.
 6. To front load the well holder:
 - i. Pour the sample into the well holder.

- ii. Flatten the exposed side of the sample by gently compressing with a glass slide.

5.4 Samples Which May Not Be Separated from Their Substrate

- A. Remove portion of sample and attached substrate or use entire sample with substrate for those materials that will fit on the sample holder.
- B. Affix sample and substrate to sample holder.

6 LIMITATIONS

XRD analysis is limited to crystalline substances or materials with regularly repeating atomic structure.

7 SAFETY

- A. Some carrying/lubricating media are classified as hazardous and will be handled and disposed of in accordance with manufacturer's recommendations and the FBI Laboratory Safety Manual.
- B. Universal precautions will be used and at least the minimum appropriate personal protective equipment (PPE) such as laboratory coats and protective gloves will be worn when handling samples.

8 REFERENCES

ASTM International, Standard Guide for the Forensic Analysis of Geological Materials by Powder X-ray Diffraction (E3294).

Buhrke, Victor E., Ron Jenkins, and Deane K. Smith, A practical Guide for the Preparation of Specimens for X-ray Fluorescence and X-ray Diffraction Analysis (New York: Wiley-Vch, 1998).

Cullity, B. D., Elements of X-Ray Diffraction, (Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1978).

Jenkins, Ron, and Robert L. Snyder, Introduction to X-Ray Powder Diffractometry, (New York, New York: John Wiley & Sons, Inc., 1996).

FBI Laboratory Safety Manual (current version)

[GEO-512: Geologically-Derived Materials Examinations](#) (current version)

TRACE-200: Evidence Handling and Processing (current version)

9 REVISION HISTORY

Revision	Issued	Changes
03	01/28/2022	Reformatted entire document including references. Added 'qualified analyst' to Scope.
04	01/02/2025	Added reference to ASTM E3294.