Spectral Library Data Dictionary

NASA Planetary Data System

Nov 21, 2025

USER GUIDE

PDS4 Spectral Library Discipline Data Dictionary User's Guide
Last edited: 2025-11-11

CHAPTER

ONE

INTRODUCTION

1. Purpose of this User's Guide
    - This User's Guide provides an overview of the Spectral Library Discipline Data Dictionary. The guide details how to include the dictionary in a PDS4 label, describes the organization of the dictionary's classes and attributes, provides definitions for these classes and attributes, and lists example excerpts from labels that use them.
2. Audience
    - This User's Guide should be useful to data providers intending to archive Spectral Library data with PDS as well as PDS Nodes who are working with these data providers.

CHAPTER

TWO

OVERVIEW OF THE SPECTRAL LIBRARY DISCIPLINE DATA DICTIONARY

The Spectral Library Discipline Data Dictionary contains classes and attributes specific to the Spectral Library discipline.
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CHAPTER

THREE

DOCUMENT OUTLINE

1. [How to Include the Spectral Library Discipline Data Dictionary in a PDS4 Label](#how-to-include-the-Spectral Library-Discipline-data-dictionary-in-a-pds4-label)
2. *Organization of Classes and Attributes*
    1. *Class Organization*
    2. *Attributes by Class*
3. *Definitions*
    1. *Classes (in alphabetical order)*
    2. *Attributes (in alphabetical order)*
4. *Examples*
5. *Edit History*

CHAPTER

FOUR

HOW TO INCLUDE THE SPECTRAL LIBRARY DISCIPLINE DATA DICTIONARY IN A PDS4 LABEL

The dictionary consists of a set of files with names in the form PDS4_SPECLIB_xxxx_yyyy.ext, where

- xxxx = the PDS4 Information Model version, e.g. 1O00
- yyyy = the Spectral Library Discipline Data Dictionary version, e.g. 1500

and the file extensions are

- .csv = A comma-separated value table of dictionary attributes
- .JSON = The dictionary contents in JSON format
- .sch = The dictionary "rules" as an XML Schematron file
- .txt = The report generated when the dictionary was built
- .xml = The PDS4 label that describes this set of files
- .xsd = The dictionary contents as an XML schema file

Only the schema and Schematron files are needed for validating a PDS4 label.

The latest version of this dictionary may be found on the PDS web site at https://pds.nasa.gov/datastandards/dictionaries/index.shtml#speclib.

The following is an example showing the use of this dictionary in a PDS4 label.

```
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1O00.sch" schematypens=
↪"http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/speclib/v1/PDS4_SPECLIB_1O00_1500.sch"␣
↪schematypens="http://purl.oclc.org/dsdl/schematron"?>
<Product_Observational xmlns="http://pds.nasa.gov/pds4/pds/v1"
    xmlns:speclib="http://pds.nasa.gov/pds4/speclib/v1"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:schemaLocation="https://pds.nasa.gov/pds4/pds/v1/PDS4_PDS_1O00.xsd
                        https://pds.nasa.gov/pds4/speclib/v1/PDS4_SPECLIB_1O00_1500.xsd">
```

The following is a schematic example showing the location of every Spectral Library Discipline Data Dictionary class and attribute in a PDS4 label. Note that not all classes and attributes may be mutually compatible, and the example does not include any recursion, even if recursion is allowed.

```
<Observation_Area>
  ...
  <Discipline_Area>
```

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```
    <speclib:Spectral_Library_Product>
      <speclib:processing_description/>
      <speclib:measurement_segments/>
      <speclib:Specimen_Parameters>
        <speclib:specimen_id/>
        <speclib:specimen_name/>
        <speclib:specimen_description/>
        <speclib:source_specimen_id/>
        <speclib:specimen_min_size/>
        <speclib:specimen_min_size_reported_percentile/>
        <speclib:specimen_max_size/>
        <speclib:specimen_max_size_reported_percentile/>
        <speclib:specimen_thin_section_flag/>
        <speclib:specimen_collection_location/>
        <speclib:specimen_owner_location/>
        <speclib:specimen_owner_name/>
        <speclib:specimen_provider_name/>
      </speclib:Specimen_Parameters>
      <speclib:Specimen_Classification>
        <speclib:specimen_type/>
        <speclib:material_common_name/>
        <speclib:material_origin/>
        <speclib:synthetic_type/>
        <speclib:material_state/>
        <speclib:organic_type/>
        <speclib:material_type/>
        <speclib:material_subtype/>
        <speclib:mineral_type/>
        <speclib:mineral_subtype/>
        <speclib:rock_type/>
        <speclib:rock_subtype/>
        <speclib:volatile_type/>
        <speclib:synthetic_processing_description/>
        <speclib:specimen_ph/>
        <speclib:specimen_dilution_method/>
        <speclib:specimen_solute_standard/>
      </speclib:Specimen_Classification>
      <speclib:Measurement_Parameters>
        <speclib:segment_number/>
        <speclib:measurement_type/>
        <speclib:spectral_range_parameter_name/>
        <speclib:spectral_range_min/>
        <speclib:spectral_range_max/>
        <speclib:spectral_range_unit_name/>
        <speclib:spectral_sampling_interval_min/>
        <speclib:spectral_sampling_interval_max/>
        <speclib:spectral_sampling_interval_unit_name/>
        <speclib:spectral_resolution_width_min/>
        <speclib:spectral_resolution_width_max/>
        <speclib:spectral_resolution_width_unit_name/>
        <speclib:measurement_run/>
        <speclib:measurement_location_number/>
```

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```
        <speclib:measurement_locations_per_sample/>
        <speclib:measurement_reference_standard/>
        <speclib:measurement_geometry_type/>
        <speclib:incidence_angle/>
        <speclib:emission_angle/>
        <speclib:phase_angle/>
        <speclib:measurement_source_description/>
        <speclib:measurement_atmosphere_pressure/>
        <speclib:measurement_atmosphere_temperature/>
        <speclib:measurement_atmosphere_relative_humidity/>
        <speclib:measurement_atmosphere_composition/>
        <speclib:measurement_atmosphere_description/>
        <speclib:measurement_date_time/>
        <speclib:data_producer_name/>
        <speclib:data_provider_name/>
        <speclib:measurement_requestor/>
        <speclib:measurement_notes/>
        <speclib:accumulation_time/>
        <speclib:microscope_objective/>
        <speclib:laser_pulses_per_integration/>
        <speclib:laser_attenuation/>
        <speclib:laser_power_sample/>
        <speclib:laser_power_for_calibration_min/>
        <speclib:laser_power_for_calibration_max/>
        <speclib:laser_wavelength/>
        <speclib:laser_pulse_rate/>
        <speclib:laser_averaged_integrations/>
        <speclib:dark_subtraction_flag/>
        <speclib:laser_pulses_discarded/>
        <speclib:laser_integrations_saturated/>
        <speclib:Measurement_Instrument>
          <speclib:instrument_name/>
          <speclib:Internal_Reference>
          </speclib:Internal_Reference>
        </speclib:Measurement_Instrument>
      </speclib:Measurement_Parameters>
      <speclib:Ancillary_Product>
        <speclib:ancillary_product_type/>
        <speclib:Internal_Reference>
        </speclib:Internal_Reference>
      </speclib:Ancillary_Product>
    </speclib:Spectral_Library_Product>
  </Discipline_Area>
  ...
</Observation_Area>
```

The namespace for the Spectral Library Discipline Data Dictionary is http://pds.nasa.gov/pds4/speclib/v1, abbreviated “speclib:”.

CHAPTER

FIVE

ORGANIZATION OF CLASSES AND ATTRIBUTES

5.1 Class Organization

Below is a structured list showing the organization of classes, ordered by appearance in the PDS4 label. Each class name is linked to its complete definition in the *Definitions* section.

- *Spectral_Library_Product*
  - *Specimen_Parameters*
  - *Specimen_Classification*
  - *Measurement_Parameters*
    - *Measurement_Instrument*
      - *Internal_Reference*
  - *Ancillary_Product*
    - *Internal_Reference*

5.2 Attributes by Class

The attributes immediately under each class (if any) are listed below. Both classes and attributes are ordered by appearance in the PDS4 label; however, each class is listed only once, even if that class can appear in more than one place in a PDS4 label. Each class and attribute name is linked to its complete definition in the *Definitions* section.

5.2.1 Spectral_Library_Product (attribute list)

- *processing_description*
- *measurement_segments*

5.2.2 Specimen_Parameters (attribute list)

- *specimen_id*
- *specimen_name*
- *specimen_description*
- *source_specimen_id*
- *specimen_min_size*
- *specimen_min_size_reported_percentile*
- *specimen_max_size*
- *specimen_max_size_reported_percentile*
- *specimen_thin_section_flag*
- *specimen_collection_location*
- *specimen_owner_location*
- *specimen_owner_name*
- *specimen_provider_name*

5.2.3 Specimen_Classification (attribute list)

- *specimen_type*
- *material_common_name*
- *material_origin*
- *synthetic_type*
- *material_state*
- *organic_type*
- *material_type*
- *material_subtype*
- *mineral_type*
- *mineral_subtype*
- *rock_type*
- *rock_subtype*
- *volatile_type*
- *synthetic_processing_description*
- *specimen_ph*
- *specimen_dilution_method*
- *specimen_solute_standard*

5.2.4 Measurement_Parameters (attribute list)

- *segment_number*
- *measurement_type*
- *spectral_range_parameter_name*
- *spectral_range_min*
- *spectral_range_max*
- *spectral_range_unit_name*
- *spectral_sampling_interval_min*
- *spectral_sampling_interval_max*
- *spectral_sampling_interval_unit_name*
- *spectral_resolution_width_min*
- *spectral_resolution_width_max*
- *spectral_resolution_width_unit_name*
- *measurement_run*
- *measurement_location_number*
- *measurement_locations_per_sample*
- *measurement_reference_standard*
- *measurement_geometry_type*
- *incidence_angle*
- *emission_angle*
- *phase_angle*
- *measurement_source_description*
- *measurement_atmosphere_pressure*
- *measurement_atmosphere_temperature*
- *measurement_atmosphere_relative_humidity*
- *measurement_atmosphere_composition*
- *measurement_atmosphere_description*
- *measurement_date_time*
- *data_producer_name*
- *data_provider_name*
- *measurement_requestor*
- *measurement_notes*
- *accumulation_time*
- *microscope_objective*
- *laser_pulses_per_integration*
- *laser_attenuation*

- *laser_power_sample*
- *laser_power_for_calibration_min*
- *laser_power_for_calibration_max*
- *laser_wavelength*
- *laser_pulse_rate*
- *laser_averaged_integrations*
- *dark_subtraction_flag*
- *laser_pulses_discarded*
- *laser_integrations_saturated*

5.2.5 Measurement_Instrument (attribute list)

- *instrument_name*

5.2.6 Internal_Reference (attribute list)

5.2.7 Ancillary_Product (attribute list)

- *ancillary_product_type*

CHAPTER

SIX

DEFINITIONS

6.1 Classes (in alphabetical order)

6.1.1 Ancillary_Product

The Ancillary_Product class identifies an ancillary measurement related to a Spectral Library specimen.

- *go to attribute list*
- Minimum occurrences: 0
- Maximum occurrences: unbounded

6.1.2 Internal_Reference

The Internal_Reference class is used to cross-reference other products in PDS4-compliant registries of PDS and its recognized international partners.

- *go to attribute list*
- Minimum occurrences: 1
- Maximum occurrences: 1

6.1.3 Measurement_Instrument

The Measurement_Instrument class contains attributes that identify the instrument that made the measurement.

- *go to attribute list*
- Minimum occurrences: 1
- Maximum occurrences: 1

6.1.4 Measurement_Parameters

The Measurement_Parameters class contains attributes relevant to a single measurement of a specimen.

- *go to attribute list*
- Minimum occurrences: 1
- Maximum occurrences: unbounded

6.1.5 Specimen_Classification

The Specimen_Classification class provides information about how a specimen has been classified.

- *go to attribute list*
- Minimum occurrences: 1
- Maximum occurrences: 1

6.1.6 Specimen_Parameters

The Specimen_Parameters class provides information about a specimen for which measurements have been made.

- *go to attribute list*
- Minimum occurrences: 1
- Maximum occurrences: 1

6.1.7 Spectral_Library_Product

The Spectral_Library_Product class provides information about a data product in the Spectral Library.

- *go to attribute list*
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2 Attributes (in alphabetical order)

6.2.1 *accumulation_time*

The duration for which a measurement was acquired. If more than one measurement is reported, this value corresponds to the total measurement time across all measurements.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 0

- Maximum occurrences: 1

6.2.2 *ancillary_product_type*

The ancillary_product_type element provides the type of data found in an ancillary product.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Attenuated Total Reflectance Spectroscopy
    - Description: IR spectroscopic technique in which placing a sample next to a high refractive index crystal causes total internal reflection resulting in an evanescent wave that samples shallow properties of the sample
  - Chemical Composition
    - Description: Elemental or oxide abundances for samples
  - Differential Scanning Calorimetry
    - Description: Technique in which the sample is heated and temperature is monitored to evaluate exothermic and endothermic reactions that are indicative of composition
  - Electron Microprobe Analysis
    - Description: Microprobe technique in which the sample is bombarded with electrons, with resultant X-ray emission spectra indicative of sample composition
  - Image
    - Description: An image of the sample
  - Modal Mineralogy
    - Description: Sample mineral abundances defined as weight or volume percentages
  - Raman Spectroscopy
    - Description: Spectroscopic technique based on based on inelastic scattering of monochromatic light, usually from a laser source
  - Reflectance Spectroscopy
    - Description: Spectroscopic technique based on measuring the spectral properties of light scattered from samples
  - Thermogravimetric Analysis
    - Description: Technique in which sample mass is measured as its temperature is increased
  - Transmission Spectroscopy
    - Description: Spectroscopic technique based on measuring the spectral properties of light transmitted through samples
  - X-ray Diffraction
    - Description: X-rays diffracted by a sample as a function of incident angle are used to determine sample crystal structure
  - X-ray Fluorescence
    - Description: Spectroscopic technique in which the sample is bombarded by high-energy X-rays or gamma rays, with fluorescent X-ray emission spectra indicative of sample composition

- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.3 *dark_subtraction_flag*

The dark_subtraction_flag element indicates if a spectrum has been dark subtracted.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - N
    - Description: No, the spectrum was not dark subtracted.
  - Y
    - Description: Yes, the spectrum was dark subtracted.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.4 *data_producer_name*

The data_producer_name element provides the name of the creator of the product. For products in RELAB, the value of data_producer_name is always “RELAB”.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.5 *data_provider_name*

The data_provider_name element provides the full name of the person who submitted the product to the library.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.6 *emission_angle*

The emission_angle element provides the angle between the local vertical at the intercept point and a vector from the intercept point to the sensor.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -90
- Maximum value: 90
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.7 *incidence_angle*

The incidence_angle element provides the angle between the local vertical at the intercept point and a vector from the intercept point to the source.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -90
- Maximum value: 90
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.8 *instrument_name*

The instrument_name element provides a descriptive name of the instrument that made a spectral measurement.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 100
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.9 *laser_attenuation*

The laser_attenuation element is the energy of the laser pulse used for sample ablation.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.10 *laser_averaged_integrations*

The laser_averaged_integrations element indicates the number of laser integrations that are averaged. A value of 1 means that the integrations are not averaged.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.11 *laser_integrations_saturated*

The laser_integrations_saturated element lists the number of spectra with at least one peak that saturates the spectrometer.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.12 *laser_power_for_calibration_max*

Maximum laser power, in percent, used during calibration.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 100
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.13 *laser_power_for_calibration_min*

Minimum laser power, in percent, used during calibration.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 100
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.14 *laser_power_sample*

Laser power, in percent, utilized during sample analysis.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 100
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.15 *laser_pulse_rate*

The laser_pulse_rate element indicates the frequency of laser pulses. A laser_pulse_rate of 10 Hz means that the laser fires ten times per second.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.16 *laser_pulses_discarded*

The laser_pulses_discarded element indicates the number of laser pulses discarded.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.17 *laser_pulses_per_integration*

The laser_pulses_per_integration element identifies the number of laser pulses per integration. This value is 1 for single shot spectra.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.18 *laser_wavelength*

Laser wavelength utilized in sample analysis.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.19 *material_common_name*

The material_common_name element gives the specific name of the specimen material, as specifically as it is known. For example, if a specimen is pure olivine, put “Olivine”. If a specimen is a mixture of kaolinite and opal, put “Kaolinite/Opal”. Indicate if “Unidentified”.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 100
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.20 *material_origin*

The material_origin element identifies whether the specimen is natural, synthetic, or natural/doped.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Natural
    - Description: The Natural value indicates that the specimen was not made in a laboratory.
  - Natural-Doped
    - Description: The Natural-Doped value indicates natural rock matrices that have been doped with metal oxides.
  - Synthetic
    - Description: The Synthetic value indicates that the specimen or some portion of a specimen was manufactured, laboratory-generated, or naturally occuring sample that has been significantly modified (e.g. heating irradiation). Grinding and stirring alone do not count as significantly modified.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.21 *material_state*

The material_state element identifies the physical state of the specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Gas
    - Description: The Gas value indicates that the specimen is in the gas state.
  - Liquid
    - Description: The Liquid value indicates that the specimen is in the liquid state.
  - Solid
    - Description: The Solid value indicates that the specimen is in the solid state.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.22 *material_subtype*

The material_subtype element provides an optional descriptor for additional information about the physical state of the specimen, e.g. particulate or nonparticulate.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 10

6.2.23 *material_type*

The material_type element indicates the general type of the specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Amorphous
    - Description: Sample without crystalline structure or long range order, e.g., glass
  - Brine
    - Description: Sample that contains solute in a liquid solvent.
  - Consolidated Mixture
    - Description: Sample that is cemented or otherwise aggregated into a solid mass
  - Element
    - Description: Sample composed of a single element such as metallic iron
  - Ice
    - Description: Solid sample composed of gas or liquid (e.g., water vapor or water) now in solid form
  - Mineral
    - Description: Sample with a given composition within a defined range of compositions and that exhibits a defined crystalline structure
  - Organic
    - Description: Sample composed of organic materials
  - Rock
    - Description: Solid sample composed of one or more minerals
  - Single Particle
    - Description: Sample composed of a single particle
  - Unconsolidated Mixture

    * Description: Sample of loose or disaggregated material that is a mixture of various minerals and/or other compounds

- Minimum Length: 1
- Maximum Length: 30
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.24 *measurement_atmosphere_composition*

The measurement_atmosphere_composition element identifies any gas(es) present in measurement environment.

- PDS4 data type: UTF8_Text_Preserved
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 1000
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.25 *measurement_atmosphere_description*

The measurement_atmosphere_description decribes the atmospheric conditions through which the data was taken.

- PDS4 data type: UTF8_Text_Preserved
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 1000
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.26 *measurement_atmosphere_pressure*

The measurement_atmosphere_pressure element provides the atmospheric pressure of the measurement environment.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: Yes
- Minimum occurrences: 0

- Maximum occurrences: 1

6.2.27 *measurement_atmosphere_relative_humidity*

The measurement_atmosphere_relative_humidity element provides the relative humidity of the measurement environment.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 100
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.28 *measurement_atmosphere_temperature*

The measurement_atmosphere_temperature element provides the temperature of the measurement environment.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.29 *measurement_date_time*

The measurement_date_time element identifies the date and time of the observation and measurement.

- PDS4 data type: ASCII_Date_Time_YMD
- Valid values: N/A
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.30 *measurement_geometry_type*

The measurement_geometry_type element identifies the type of geometry at which a measurement is taken.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Biconical
    - Description: Measurement taken when light is sent in to the specimen at a certain direction and in a cone-like shape and received at a certain direction and in a cone-like shape.
  - Bidirectional
    - Description: Measurement taken when light is sent in to the specimen at a narrow angular range and received over a narrow angular range
  - Directional Hemispherical
    - Description: Measurement taken when light is sent in to the specimen at a certain direction and received in all directions (perhaps in an integrating sphere).
  - Hemispherical Hemispherical
    - Description: Measurement taken when light is sent in to the specimen at all directions and received in all directions (perhaps in an integrating sphere)
  - Unknown
    - Description: The measurement geometry is unknown.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.31 *measurement_location_number*

The measurement_location_number element indicates the location number of spectra collection on the target surface.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.32 *measurement_locations_per_sample*

The measurement_locations_per_sample element indicates the number of measurement locations per sample.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.33 *measurement_notes*

The measurement_notes element contains relevant notes about how a measurement was made.

- PDS4 data type: UTF8_Text_Preserved
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 1000
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.34 *measurement_reference_standard*

The measurement_reference_standard element identifies the standard object on which observations are performed in order to calibrate a measurement.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.35 *measurement_requestor*

The measurement_requestor element identifies the individual or laboratory who requested the measurement. The attribute may be present with a null value. A maximum of two names are permitted.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 2

6.2.36 *measurement_run*

The measurement_run element identifies the run number of the measurement in a particular day.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.37 *measurement_segments*

The measurement_segments are the number of individual spectra that were combined to create the final merged spectrum. If the spectrum is not merged from multiple spectra, then the value of measurement_segments is 1.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.38 *measurement_source_description*

The measurement_source_description element identifies the source used for the measurement such as the type of lamp, heating element, laser, or radioactive source.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.39 *measurement_type*

The measurement_type element identifies the type of spectroscopy performed on a specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Attenuated Total Reflectance
    - Description: Attenuated total reflectance (ATR) is a sampling technique used in conjunction with infrared spectroscopy which enables samples to be examined directly in the solid or liquid state without further preparation.
  - Emission
    - Description: The Emission value indicates emission spectroscpy, which examines the wavelengths emitted by atoms or molecules during their transition from an excited state to a lower energy state.
  - LIBS
    - Description: LIBS (Laser-Induced Breakdown Spectroscopy) uses a highly energetic laser pulse as its excitation source to produce emission spectra.
  - Raman
    - Description: The Raman value indicates Raman spectroscopy, which determines information about a material by studying the Raman scattering of monochromatic light off the material.
  - Reflectance
    - Description: The Reflectance value indicates reflectance spectroscopy, the study of light as a function of wavelength that has been reflected or scattered from a material.
  - Transmission
    - Description: The Transmission value indicates transmission spectroscopy, the study of light as a function of wavelength that has been transmitted through a material.
  - X-Ray Absorption Near-Edge Structure
    - Description: The X-ray Absorption Near-Edge Structure value indicates XANES spectroscopy, which determines information about a material by studying the X-ray absorption spectra of electronic transitions within an atomic core.
  - X-Ray Diffraction

        * Description: The X-Ray Diffraction value indicates x-ray diffraction spectroscopy, which studies the diffraction patterns of x-rays scattered off a material.
    - X-Ray Fluorescence
        * Description: The X-Ray Fluorescence value indicates x-ray flourescence spectroscopy, which examines the emission of x-rays from a material previously bombarded with high energy x-rays or gamma rays.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.40 *microscope_objective*

The microscope_objective is the magnification power of the objective lens by power (e.g. 4x, 10x).

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.41 *mineral_subtype*

The mineral_subtype element identifies the mineral subtype of the specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 10

6.2.42 *mineral_type*

The mineral_type element identifies the type of mineral to which the specimen belongs.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Arsenate
    - Description: The Arsenate value indicates the specimen is an arsenate.
  - Borate
    - Description: The Borate valeu indicates the specimen is a borate.
  - Carbonate
    - Description: The Carbonate value indicates the specimen is a carbonate.
  - Chromate
    - Description: The Chromate value indicates the specimen is a chromate.
  - Cyclosilicate
    - Description: The Cyclosiliate value indicates the specimen is a sorosilicate.
  - Halide
    - Description: The Halide value indicates the specimen is a halide.
  - Hydroxide
    - Description: The Hydroxide value indicates the specimen is a hydroxide.
  - Inosilicate
    - Description: The Inosilicate value indicates the specimen is a inosilicate.
  - Iodate
    - Description: The Iodate value indicates the specimen is an iodate.
  - Native Element
    - Description: The Native Element value indicates the specimen is a native element or an alloy.
  - Nesosilicate
    - Description: The Nesosiliacte value indicates the specimen is a nesosilicate.
  - Nitrate
    - Description: The Nitrate value indicates the specimen is a nitrate.
  - Organic Compound
    - Description: The Organic Compound value indicates the specimen is an organic compound.
  - Oxide
    - Description: The Oxide value indicates the specimen is an oxide.
  - Phosphate
    - Description: The Phosphate value indicates the specimen is a sulfate.
  - Phyllosilicate
    - Description: The Phyllosilicate value indicates the specimen is a phyllosilicate.

  - Sorosilicate
    - Description: The Sorosilicate value indicates the specimen is a sorosilicate.
  - Sulfate
    - Description: The Sulfate value indicates the specimen is a sulfate.
  - Sulfide
    - Description: The Sulfide value indicates the specimen is a sulfide.
  - Tectosilicate
    - Description: The Tectosilicate value indicates the specimen is a tectosilicate.
  - Unclassified
    - Description: The Unclassified value indicates that the specimen doesn't fit into any of these categories, but is still a mineral.
  - Vanadate
    - Description: The Vanadate value indicates that the specimen is a vanadate.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: unbounded

6.2.43 *organic_type*

The organic_type element identifies the organic type to which the specimen belongs.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Inorganic
    - Description: The Inorganic value indicates the specimen is not an organic material.
  - Mixture
    - Description: The Mixture value indicates the specimen is a mixture of organic and inorganic material.
  - Organic
    - Description: The Organic value indicates the specimen is an organic material.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.44 *phase_angle*

The phase_angle element provides the angle between incidence and emission vectors.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -180
- Maximum value: 180
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.45 *processing_description*

The processing_description element provides information about how measurement(s) for a particular product were made, in addition to the information given in the Measurement Parameters class. In the case of a product created by merging multiple measurements, this element describes how the merge was done.

- PDS4 data type: UTF8_Text_Preserved
- Valid values: N/A
- Minimum Length: 1
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.46 *rock_subtype*

The rock_subtype element identifies the rock subtype of the specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 10

6.2.47 *rock_type*

The rock_type element identifies the type of rock the specimen is.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Igneous
    - Description: The Igneous value indicates that the specimen is volatile-poor and was formed by the cooling of magma or lava.
  - Metamorphic
    - Description: The Metamorphic value indicates that the specimen was formed by metamorphic processes (e.g., increased temperature and/or pressure conditions that altered the rock composition without melting)
  - Sedimentary
    - Description: The Sedimentary value indicates that the specimen was formed by sedimentary processes (e.g., lithification of unconsolidated material, direct chemical precipitation)
  - Unknown
    - Description: The Unknown value indicates that there is not enough information about the specimen to assign it a rock type
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.48 *segment_number*

The segment_number element identifies which segment of a merged spectrum is described by a Measurement_Parameters class. The first segment is segment number 1. If the spectrum is not merged from multiple segments, then the value of segment_number is 1.

- PDS4 data type: ASCII_NonNegative_Integer
- Valid values: N/A
- Minimum value: 0
- Maximum value: 18446744073709551615
- Regex Pattern: [0-9]+
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.49 *source_specimen_id*

The source_specimen_id element identifies the source specimen from which the observed specimen is derived.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.50 *specimen_collection_location*

The specimen_collection_location element provides the place where the specimen was collected.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.51 *specimen_description*

The specimen_description element provides a short description of the specimen.

- PDS4 data type: UTF8_Text_Preserved
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 1000
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.52 *specimen_dilution_method*

The specimen_dilution_method element describes the method by which dilution was conducted.

- PDS4 data type: UTF8_Text_Preserved
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 1000
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.53 *specimen_id*

The specimen_id element uniquely identifies the specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.54 *specimen_max_size*

The specimen_max_size element identifies the maximum particle size of the observed specimen.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.55 *specimen_max_size_reported_percentile*

The percentile reported by the specimen_max_size element. For example, a specimen_max_size_reported_percentile of 90 indicates that 90 percent of the specimen has a particle size less than or equal to specimen_max_size.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 100
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.56 *specimen_min_size*

The specimen_min_size element identifies the minimum particle size of the observed specimen.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.57 *specimen_min_size_reported_percentile*

The percentile reported by the specimen_min_size element. For example, a specimen_min_size_reported_percentile of 90 indicates that 90 percent of the specimen has a particle size greater than or equal to specimen_min_size.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 100
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.58 *specimen_name*

The specimen_name element identifies the specimen as it is named where it is being kept.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.59 *specimen_owner_location*

The specimen_owner_location element provides the institution or laboratory name where the specimen resides.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.60 *specimen_owner_name*

The specimen_owner_name element identifies the individual or laboratory to whom the specimen belongs.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.61 *specimen_ph*

The specimen_ph element provides the pH of the observed specimen.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 14
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.62 *specimen_provider_name*

The specimen_provider_name element gives the name of the person who provided the specimen for spectral measurement.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.63 *specimen_solute_standard*

The specimen_solute_standard element provides the standard used for the solute.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.64 *specimen_thin_section_flag*

The specimen_thin_section_flag element indicates whether or not the specimen is a thin section.

- PDS4 data type: ASCII_Short_String_Collapsed
- Valid values:
  - N
    - Description: No, the specimen is not a thin section.
  - Y
    - Description: Yes, the specimen is a thin section.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.65 *specimen_type*

The specimen_type element gives one or two terms that classify the origin of the specimen.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Lunar Meteorite
    - Description: The Lunar Meteorite value means the specimen is a sample from a lunar meteorite.
  - Mars Meteorite
    - Description: The Mars Meteorite value means the specimen is a sample from a Mars meteorite.
  - Other Meteorite
    - Description: The Other Meteorite value means the specimen is a sample from a meteorite that is not a lunar or Mars meteorite.
  - Returned Asteroid Sample
    - Description: The Returned Asteroid Sample value means the specimen is an asteroid sample returned by a mission.
  - Returned Lunar Sample
    - Description: The Returned Lunar Sample value means the specimen is a lunar sample returned by a mission.
  - Synthetic Sample
    - Description: The Synthetic Sample value means the specimen is manufactured, laboratory-generated, or a naturally occurring sample that has been significantly modified (e.g. heating, irradiation). Grinding and stirring alone do not count as significantly modified.
  - Terrestrial Sample
    - Description: The Terrestrial value means the specimen is a terrestrial sample.

- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 2

6.2.66 *spectral_range_max*

The spectral_range_max element identifies the maximum value at which a given data item was sampled. For example, a spectrum that was measured in the 0.4 to 3.5 um spectral range would have a spectral_range_max value of 3.5.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.67 *spectral_range_min*

The spectral_range_min element identifies the minimum value at which a given data item was sampled. For example, a spectrum that was measured in the 0.4 to 3.5 um spectral range would have a spectral_range_min value of 0.4.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: 0
- Maximum value: 1.7976931348623157e+308
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.68 *spectral_range_parameter_name*

The spectral_range_parameter_name element identifies the name of the parameter which determines the sampling interval of the measurement.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Angle
    - Description: The Angle value means the spectrum is a function of angle.
  - Energy

        * Description: The Energy value means the spectrum is a function of energy.
    - Frequency
        * Description: The Frequency value means the spectrum is a function of frequency.
    - Time
        * Description: The Time value means the spectrum is a function of time.
    - Wavelength
        * Description: The Wavelength value means the spectrum is a function of wavelength.
    - Wavenumber
        * Description: The Wavenumber value means the spectrum is a function of wavenumber.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.69 *spectral_range_unit_name*

The spectral_range_unit_name element identifies the unit of measure for the values specified by spectral_range_min and spectral_range_max.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 1
- Maximum occurrences: 1

6.2.70 *spectral_resolution_width_max*

The spectral_resolution_width_max element identifies the full width at half maximum (FWHM) of a spectral band in a given spectrum. If all bands are the same width, spectral_resolution_width_min and spectral_resolution_width_max will have the same value.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.71 *spectral_resolution_width_min*

The spectral_resolution_width_min element identifies the full width at half minimum (FWHM) of a spectral band in a given spectrum. If all bands are the same width, spectral_resolution_width_min and spectral_resolution_width_max will have the same value.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.72 *spectral_resolution_width_unit_name*

The spectral_resolution_width_unit_name element identifies the unit of measure for the values specified by spectral_resolution_width_min and spectral_resolution_width_max.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.73 *spectral_sampling_interval_max*

The spectral_sampling_interval_max element identifies the maximum distance between band centers in a given spectrum. If all band centers are equally spaced, spectral_sampling_interval_min and spectral_sampling_interval_max will have the same value.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.74 *spectral_sampling_interval_min*

The spectral_sampling_interval_min element identifies the minimum distance between band centers in a given spectrum. If all band centers are equally spaced, spectral_sampling_interval_min and spectral_sampling_interval_max will have the same value.

- PDS4 data type: ASCII_Real
- Valid values: N/A
- Minimum value: -1.7976931348623157e+308
- Maximum value: 1.7976931348623157e+308
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.75 *spectral_sampling_interval_unit_name*

The spectral_sampling_interval_unit_name element identifies the unit of measure for the values specified by spectral_sampling_interval_min and spectral_sampling_interval_max.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.76 *synthetic_processing_description*

The synthetic_processing_description element describes how a synthetic specimen has been processed.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values: N/A
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.77 *synthetic_type*

The synthetic_type element identifies the process by which the specimen was produced synthetically.

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Entirely Synthetic
    - Description: Sample that is entirely human-made
  - From Natural
    - Description: A natural product chemically or mineralogically altered by a laboratory treatment (e.g., heating). Does not include size and magnetic separates of natural samples or washing by water.
  - Hardware
    - Description: Portions of an instrument, e.g., portions of a spectrometer that contribute to a spectroscopic signature and thus need to be characterized
  - Natural and Synthetic
    - Description: Sample that is a mixture of human-made and naturally occurring components
- Minimum Length: 1
- Maximum Length: 255
- Nillable: No
- Minimum occurrences: 0
- Maximum occurrences: 1

6.2.78 *volatile_type*

The volatile_type element indicates whether the material was volatile-poor (less than 2.0% loss on ignition) or volatile-rich (greater than 2.0% loss on ignition).

- PDS4 data type: UTF8_Short_String_Collapsed
- Valid values:
  - Poor
    - Description: The Poor value indicates the specimen had less than 2.0% loss on ignition.
  - Rich
    - Description: The Rich value indicates the specimen had greater than 2.0% loss on ignition.
  - Unknown
    - Description: The Unknown value indicates the specimen's volatile type is unknown.
- Minimum Length: 1
- Maximum Length: 255
- Nillable: Yes
- Minimum occurrences: 0
- Maximum occurrences: 1

CHAPTER

SEVEN

EXAMPLES

Example PDS4 label snippet from urn:nasa:pds:relab:data_reflectance:c0at03::1.1:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>AT-TXH-003</speclib:specimen_id>
      <speclib:specimen_name>Antigorite</speclib:specimen_name>
      <speclib:specimen_min_size unit="micrometer">0</speclib:specimen_min_size>
      <speclib:specimen_max_size unit="micrometer">125</speclib:specimen_max_size>
      <speclib:specimen_collection_location xsi:nil="true" nilReason="unknown"/>
      <speclib:specimen_owner_location>Brown University, Dept. Earth, Environmental and␣
↪Planetary Sciences</speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Takahiro Hiroi</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Terrestrial Sample</speclib:specimen_type>
      <speclib:material_origin>Natural</speclib:material_origin>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Mineral</speclib:material_type>
      <speclib:material_subtype>Particulate</speclib:material_subtype>
      <speclib:mineral_type>Phyllosilicate</speclib:mineral_type>
      <speclib:mineral_subtype>Antigorite</speclib:mineral_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>RELAB Bidirectional Spectrometer</speclib:instrument_
↪name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
      <speclib:spectral_range_min>500</speclib:spectral_range_min>
      <speclib:spectral_range_max>1000</speclib:spectral_range_max>
```

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```
      <speclib:spectral_range_unit_name>nm</speclib:spectral_range_unit_name>
      <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
      <speclib:incidence_angle unit="deg">15</speclib:incidence_angle>
      <speclib:emission_angle unit="deg">0</speclib:emission_angle>
      <speclib:phase_angle unit="deg">15</speclib:phase_angle>
      <speclib:measurement_atmosphere_relative_humidity xsi:nil="true" nilReason="unknown
↪"/>
      <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_
↪atmosphere_description>
      <speclib:measurement_date_time>1994-12-25</speclib:measurement_date_time>
      <speclib:data_producer_name>RELAB</speclib:data_producer_name>
      <speclib:data_provider_name>RELAB</speclib:data_provider_name>
      <speclib:measurement_requestor>Takahiro Hiroi</speclib:measurement_requestor>
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:relab:data_reflectance:c0mb56::1.1:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>MB-TXH-056</speclib:specimen_id>
      <speclib:specimen_name>Murray</speclib:specimen_name>
      <speclib:specimen_description>Carbonaceous Chondrite, CM2 , M. Zolensky sample</
↪speclib:specimen_description>
      <speclib:specimen_min_size unit="micrometer">0</speclib:specimen_min_size>
      <speclib:specimen_max_size unit="micrometer">100</speclib:specimen_max_size>
      <speclib:specimen_collection_location>Murray Co. , Kentucky</speclib:specimen_
↪collection_location>
      <speclib:specimen_owner_location>Brown University, Dept. Earth, Environmental and␣
↪Planetary Sciences</speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Takahiro Hiroi</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Other Meteorite</speclib:specimen_type>
      <speclib:material_origin>Natural</speclib:material_origin>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Rock</speclib:material_type>
      <speclib:material_subtype>Particulate</speclib:material_subtype>
      <speclib:rock_type>Sedimentary</speclib:rock_type>
      <speclib:rock_subtype>Carbonaceous Chondrite</speclib:rock_subtype>
      <speclib:rock_subtype>CM2</speclib:rock_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>RELAB Bidirectional Spectrometer</speclib:instrument_
↪name>
```

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```
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
      <speclib:spectral_range_min>500</speclib:spectral_range_min>
      <speclib:spectral_range_max>1420</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>nm</speclib:spectral_range_unit_name>
      <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
      <speclib:incidence_angle unit="deg">10</speclib:incidence_angle>
      <speclib:emission_angle unit="deg">0</speclib:emission_angle>
      <speclib:phase_angle unit="deg">10</speclib:phase_angle>
      <speclib:measurement_atmosphere_relative_humidity xsi:nil="true" nilReason="unknown
↪"/>
      <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_
↪atmosphere_description>
      <speclib:measurement_date_time>1994-12-09</speclib:measurement_date_time>
      <speclib:data_producer_name>RELAB</speclib:data_producer_name>
      <speclib:data_provider_name>RELAB</speclib:data_provider_name>
      <speclib:measurement_requestor>Takahiro Hiroi</speclib:measurement_requestor>
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:relab:data_reflectance:c3rs48::1.1:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>RS-CMP-048</speclib:specimen_id>
      <speclib:specimen_name>Gorlovka slab</speclib:specimen_name>
      <speclib:specimen_description>Ordinary Chondrite, H3-4, Sample #15179   USSR-AS,␣
↪Fall-Black</speclib:specimen_description>
      <speclib:specimen_collection_location>Ukraine, USSR</speclib:specimen_collection_
↪location>
      <speclib:specimen_owner_location>Brown University, Dept. Earth, Environmental and␣
↪Planetary Sciences</speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Carle M. Pieters</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Other Meteorite</speclib:specimen_type>
      <speclib:material_origin>Natural</speclib:material_origin>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Rock</speclib:material_type>
      <speclib:material_subtype>Nonparticulate</speclib:material_subtype>
      <speclib:material_subtype>Slab</speclib:material_subtype>
      <speclib:rock_type>Sedimentary</speclib:rock_type>
```

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```
      <speclib:rock_subtype>Ordinary Chondrite</speclib:rock_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>RELAB Bidirectional Spectrometer</speclib:instrument_
↪name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
      <speclib:spectral_range_min>310</speclib:spectral_range_min>
      <speclib:spectral_range_max>2600</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>nm</speclib:spectral_range_unit_name>
      <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
      <speclib:incidence_angle unit="deg">30</speclib:incidence_angle>
      <speclib:emission_angle unit="deg">0</speclib:emission_angle>
      <speclib:phase_angle unit="deg">30</speclib:phase_angle>
      <speclib:measurement_atmosphere_relative_humidity xsi:nil="true" nilReason="unknown
↪"/>
      <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_
↪atmosphere_description>
      <speclib:measurement_date_time>1988-07-13</speclib:measurement_date_time>
      <speclib:data_producer_name>RELAB</speclib:data_producer_name>
      <speclib:data_provider_name>RELAB</speclib:data_provider_name>
      <speclib:measurement_requestor>Carle M. Pieters</speclib:measurement_requestor>
    </speclib:Measurement_Parameters>
    <speclib:Ancillary_Product>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:relab:data_ancillary_chemistry:rs-cmp-048_
↪specimenchemistry</lid_reference>
        <reference_type>data_to_ancillary_data</reference_type>
      </Internal_Reference>
      <speclib:ancillary_product_type>Chemical Composition</speclib:ancillary_product_
↪type>
    </speclib:Ancillary_Product>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:relab:data_reflectance:c4ls05::1.1:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>LS-CMP-005-C</speclib:specimen_id>
      <speclib:specimen_name>72415,64 olivine separate &lt;45 um</speclib:specimen_name>
```

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```
      <speclib:specimen_description>Silicate (Neso) , Dunite Olivine, Clear crystal␣
↪separate from bulk olivine sample</speclib:specimen_description>
      <speclib:source_specimen_id>LS-CMP-005</speclib:source_specimen_id>
      <speclib:specimen_min_size unit="micrometer">0</speclib:specimen_min_size>
      <speclib:specimen_max_size unit="micrometer">45</speclib:specimen_max_size>
      <speclib:specimen_collection_location>Apollo 17</speclib:specimen_collection_
↪location>
      <speclib:specimen_owner_location>Brown University, Dept. Earth, Environmental and␣
↪Planetary Sciences</speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Carle M. Pieters</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Returned Lunar Sample</speclib:specimen_type>
      <speclib:material_origin>Natural</speclib:material_origin>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Mineral</speclib:material_type>
      <speclib:material_subtype>Particulate</speclib:material_subtype>
      <speclib:material_subtype>Particulate Ground Sorted</speclib:material_subtype>
      <speclib:mineral_type>Nesosilicate</speclib:mineral_type>
      <speclib:mineral_subtype>Olivine</speclib:mineral_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>RELAB Bidirectional Spectrometer</speclib:instrument_
↪name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
      <speclib:spectral_range_min>300</speclib:spectral_range_min>
      <speclib:spectral_range_max>2600</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>nm</speclib:spectral_range_unit_name>
      <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
      <speclib:incidence_angle unit="deg">30</speclib:incidence_angle>
      <speclib:emission_angle unit="deg">0</speclib:emission_angle>
      <speclib:phase_angle unit="deg">30</speclib:phase_angle>
      <speclib:measurement_atmosphere_relative_humidity xsi:nil="true" nilReason="unknown
↪"/>
      <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_
↪atmosphere_description>
      <speclib:measurement_date_time>1989-12-19</speclib:measurement_date_time>
      <speclib:data_producer_name>RELAB</speclib:data_producer_name>
      <speclib:data_provider_name>RELAB</speclib:data_provider_name>
      <speclib:measurement_requestor>Carle M. Pieters</speclib:measurement_requestor>
```

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```
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:relab:data_reflectance:s1gt34::1.1:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>GT-CMP-034</speclib:specimen_id>
      <speclib:specimen_name>T2 Glass 250</speclib:specimen_name>
      <speclib:specimen_description>40 % T0 60% T4</speclib:specimen_description>
      <speclib:specimen_min_size unit="micrometer">125</speclib:specimen_min_size>
      <speclib:specimen_max_size unit="micrometer">250</speclib:specimen_max_size>
      <speclib:specimen_collection_location>JSC</speclib:specimen_collection_location>
      <speclib:specimen_owner_location>Brown University, Dept. Earth, Environmental and␣
↪Planetary Sciences</speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Carle M. Pieters</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Synthetic Sample</speclib:specimen_type>
      <speclib:material_origin>Synthetic</speclib:material_origin>
      <speclib:synthetic_type>Entirely Synthetic</speclib:synthetic_type>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Amorphous</speclib:material_type>
      <speclib:material_subtype>Particulate</speclib:material_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>RELAB Bidirectional Spectrometer</speclib:instrument_
↪name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
      <speclib:spectral_range_min>600</speclib:spectral_range_min>
      <speclib:spectral_range_max>2600</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>nm</speclib:spectral_range_unit_name>
      <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
      <speclib:incidence_angle unit="deg">30</speclib:incidence_angle>
      <speclib:emission_angle unit="deg">0</speclib:emission_angle>
      <speclib:phase_angle unit="deg">30</speclib:phase_angle>
      <speclib:measurement_atmosphere_relative_humidity xsi:nil="true" nilReason="unknown
↪"/>
```

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```
      <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_
↪atmosphere_description>
      <speclib:measurement_date_time>1985-08-12</speclib:measurement_date_time>
      <speclib:data_producer_name>RELAB</speclib:data_producer_name>
      <speclib:data_provider_name>RELAB</speclib:data_provider_name>
      <speclib:measurement_requestor>Carle M. Pieters</speclib:measurement_requestor>
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:relab:data_reflectance:kopx22n::1.0:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>PX-ECS-022-N</speclib:specimen_id>
      <speclib:specimen_name>Hershell diopside 38-63 um wet-sieved</speclib:specimen_
↪name>
      <speclib:specimen_min_size unit="micrometer">38</speclib:specimen_min_size>
      <speclib:specimen_max_size unit="micrometer">63</speclib:specimen_max_size>
      <speclib:specimen_collection_location>Hershel, Ontario</speclib:specimen_
↪collection_location>
      <speclib:specimen_owner_location>Mount Holyoke College</speclib:specimen_owner_
↪location>
      <speclib:specimen_owner_name>Elizabeth C. Sklute</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Terrestrial Sample</speclib:specimen_type>
      <speclib:material_origin>Natural</speclib:material_origin>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Mineral</speclib:material_type>
      <speclib:material_subtype>Particulate</speclib:material_subtype>
      <speclib:mineral_type>Inosilicate</speclib:mineral_type>
      <speclib:mineral_subtype>Pyroxene Clinopyroxene Diopside</speclib:mineral_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>RELAB Bidirectional Spectrometer</speclib:instrument_
↪name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
      <speclib:spectral_range_min>320</speclib:spectral_range_min>
      <speclib:spectral_range_max>2540</speclib:spectral_range_max>
```

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```
      <speclib:spectral_range_unit_name>nm</speclib:spectral_range_unit_name>
      <speclib:measurement_reference_standard>Spectralon</speclib:measurement_reference_
↪standard>
      <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
      <speclib:incidence_angle unit="deg">45</speclib:incidence_angle>
      <speclib:emission_angle unit="deg">-10</speclib:emission_angle>
      <speclib:phase_angle unit="deg">55</speclib:phase_angle>
      <speclib:measurement_source_description>Xenon/Halogen</speclib:measurement_source_
↪description>
      <speclib:measurement_atmosphere_relative_humidity>35</speclib:measurement_
↪atmosphere_relative_humidity>
      <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_
↪atmosphere_description>
      <speclib:measurement_date_time>2021-10-06</speclib:measurement_date_time>
      <speclib:data_producer_name>RELAB</speclib:data_producer_name>
      <speclib:data_provider_name>RELAB</speclib:data_provider_name>
      <speclib:measurement_requestor>Elizabeth C. Sklute</speclib:measurement_requestor>
    </speclib:Measurement_Parameters>
    <speclib:Ancillary_Product>
      <Internal_Reference>
        <lid_reference>urn:nasa:pds:relab:data_ancillary_image:px-ecs-022-n_
↪onshallow14mmdish</lid_reference>
        <reference_type>data_to_ancillary_data</reference_type>
      </Internal_Reference>
      <speclib:ancillary_product_type>Image</speclib:ancillary_product_type>
    </speclib:Ancillary_Product>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:xas_synthesized_glasses:data:cr_xas_h081::1.0:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>H081</speclib:specimen_id>
      <speclib:specimen_name>Glass Sample H081</speclib:specimen_name>
      <speclib:specimen_description>Sample H081: SiO2 wt% = 45.9, Mg# = 51.0, Na2O+K2O =␣
↪2.5</speclib:specimen_description>
      <speclib:specimen_thin_section_flag>Y</speclib:specimen_thin_section_flag>
      <speclib:specimen_collection_location>Laboratory Sample</speclib:specimen_
↪collection_location>
      <speclib:specimen_owner_location>The University of Tennessee, Knoxville,␣
↪Department of Earth and Planetary Sciences</speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Molly McCanta</speclib:specimen_owner_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Synthetic Sample</speclib:specimen_type>
      <speclib:material_origin>Synthetic</speclib:material_origin>
      <speclib:synthetic_type>Entirely Synthetic</speclib:synthetic_type>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
```

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```
      <speclib:material_type>Amorphous</speclib:material_type>
      <speclib:material_subtype>Nonparticulate</speclib:material_subtype>
    </speclib:Specimen_Classification>
    <speclib:measurement_segments>1</speclib:measurement_segments>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>1</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>Beamline 13-ID-E (with Si311 Detector)</
↪speclib:instrument_name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:aps.beamline13ide</lid_
↪reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>X-Ray Absorption Near-Edge Structure</
↪speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Energy</speclib:spectral_range_parameter_
↪name>
      <speclib:spectral_range_min>5909</speclib:spectral_range_min>
      <speclib:spectral_range_max>6203</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>eV</speclib:spectral_range_unit_name>
      <speclib:data_producer_name>Molly McCanta</speclib:data_producer_name>
      <speclib:data_provider_name>Molly McCanta</speclib:data_provider_name>
      <speclib:accumulation_time unit="min">66</speclib:accumulation_time>
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

Example PDS4 label snippet from urn:nasa:pds:frankenspectra_database:data_frankenspectra:fe-metal_aa70_frankenspectrum::1.0:

```
<Discipline_Area>
  <speclib:Spectral_Library_Product>
    <speclib:Specimen_Parameters>
      <speclib:specimen_id>Fe-metal_AA-70</speclib:specimen_id>
      <speclib:specimen_description>Shatterboxed "dust" sample less than 10 um</
↪speclib:specimen_description>
      <speclib:specimen_min_size unit="micrometer">0</speclib:specimen_min_size>
      <speclib:specimen_max_size unit="micrometer">5.023000</speclib:specimen_max_size>
      <speclib:specimen_max_size_reported_percentile>90</speclib:specimen_max_size_
↪reported_percentile>
      <speclib:specimen_collection_location>Alfa Aesar 00170</speclib:specimen_
↪collection_location>
      <speclib:specimen_owner_location>Planetary Science Institute (Tucson, AZ)</
↪speclib:specimen_owner_location>
      <speclib:specimen_owner_name>Planetary Geosciences Lab (PSI)</speclib:specimen_
↪owner_name>
      <speclib:specimen_provider_name>Alfa Aesar</speclib:specimen_provider_name>
    </speclib:Specimen_Parameters>
    <speclib:Specimen_Classification>
      <speclib:specimen_type>Synthetic Sample</speclib:specimen_type>
```

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```
      <speclib:material_common_name>Fe-metal</speclib:material_common_name>
      <speclib:material_origin>Synthetic</speclib:material_origin>
      <speclib:synthetic_type>Entirely Synthetic</speclib:synthetic_type>
      <speclib:material_state>Solid</speclib:material_state>
      <speclib:organic_type>Inorganic</speclib:organic_type>
      <speclib:material_type>Element</speclib:material_type>
      <speclib:material_subtype>Particulate</speclib:material_subtype>
      <speclib:mineral_type>Native Element</speclib:mineral_type>
    </speclib:Specimen_Classification>
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      <speclib:segment_number>1</speclib:segment_number>
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        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:lasp.mcpherson-vuvas</lid_
↪reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
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      <speclib:spectral_range_min>0.120000</speclib:spectral_range_min>
      <speclib:spectral_range_max>0.250000</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>micrometers</speclib:spectral_range_unit_name>
      <speclib:measurement_reference_standard>Spectralon</speclib:measurement_reference_
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      <speclib:measurement_geometry_type>Biconical</speclib:measurement_geometry_type>
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      <speclib:emission_angle unit="deg">30</speclib:emission_angle>
      <speclib:phase_angle unit="deg">30</speclib:phase_angle>
      <speclib:measurement_atmosphere_pressure unit="Pa">0.06666</speclib:measurement_
↪atmosphere_pressure>
      <speclib:measurement_atmosphere_temperature unit="degC">25</speclib:measurement_
↪atmosphere_temperature>
      <speclib:measurement_date_time>2023-04-13</speclib:measurement_date_time>
      <speclib:data_producer_name>Greg Holsclaw</speclib:data_producer_name>
      <speclib:data_provider_name>Melissa Lane</speclib:data_provider_name>
      <speclib:measurement_notes>
                Illumination type: 30 watt deuterium arc lamp (0.12-0.45 um); quartz-
↪tungsten-halogen lamp (0.15-0.6 um) using fiber optic cable; spectral sampling of 2 nm
            </speclib:measurement_notes>
    </speclib:Measurement_Parameters>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>2</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>Ocean Optics UV-Flame</speclib:instrument_name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:pgl.ocean_optics-uvflame</lid_
↪reference>
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```
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
      <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
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      <speclib:spectral_range_max>0.359638</speclib:spectral_range_max>
      <speclib:spectral_range_unit_name>micrometers</speclib:spectral_range_unit_name>
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      <speclib:measurement_atmosphere_temperature unit="degC">25</speclib:measurement_
↪atmosphere_temperature>
      <speclib:measurement_atmosphere_relative_humidity>25</speclib:measurement_
↪atmosphere_relative_humidity>
      <speclib:measurement_date_time>2020-11-07</speclib:measurement_date_time>
      <speclib:data_producer_name>Neil Pearson</speclib:data_producer_name>
      <speclib:data_provider_name>Melissa Lane</speclib:data_provider_name>
      <speclib:measurement_notes>
                Illumination type: deuterium arc lamp (0.2-0.5 um); quartz halogen␣
↪source (0.4-0.88 um) using fiber optic cable; FWHM for instrument: 1.4 nm
            </speclib:measurement_notes>
    </speclib:Measurement_Parameters>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>3</speclib:segment_number>
      <speclib:Measurement_Instrument>
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↪speclib:instrument_name>
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          <lid_reference>urn:nasa:pds:context:instrument:psf.asd-labspec4</lid_reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
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      <speclib:spectral_range_min>0.360000</speclib:spectral_range_min>
      <speclib:spectral_range_max>1.800000</speclib:spectral_range_max>
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      <speclib:measurement_reference_standard>Spectralon</speclib:measurement_reference_
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      <speclib:measurement_geometry_type>Biconical</speclib:measurement_geometry_type>
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      <speclib:measurement_atmosphere_pressure unit="Pa">95000</speclib:measurement_
↪atmosphere_pressure>
```

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↪atmosphere_temperature>
      <speclib:measurement_date_time>2019-03-14</speclib:measurement_date_time>
      <speclib:data_producer_name>Ed Cloutis</speclib:data_producer_name>
      <speclib:data_provider_name>Melissa Lane</speclib:data_provider_name>
      <speclib:measurement_notes>
                Illumination type: quartz-tungsten halogen light source; spectral␣
↪sampling of 1 nm
            </speclib:measurement_notes>
    </speclib:Measurement_Parameters>
    <speclib:Measurement_Parameters>
      <speclib:segment_number>4</speclib:segment_number>
      <speclib:Measurement_Instrument>
        <speclib:instrument_name>Bruker VERTEX 80v</speclib:instrument_name>
        <Internal_Reference>
          <lid_reference>urn:nasa:pds:context:instrument:psl.bruker-vertex80v</lid_
↪reference>
          <reference_type>is_instrument</reference_type>
        </Internal_Reference>
      </speclib:Measurement_Instrument>
      <speclib:measurement_type>Reflectance</speclib:measurement_type>
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      <speclib:spectral_range_min>1.800300</speclib:spectral_range_min>
      <speclib:spectral_range_max>20.019000</speclib:spectral_range_max>
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      <speclib:measurement_reference_standard>Infragold</speclib:measurement_reference_
↪standard>
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↪type>
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      <speclib:measurement_date_time>2019-07-04</speclib:measurement_date_time>
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↪producer_name>
      <speclib:data_provider_name>Melissa Lane</speclib:data_provider_name>
      <speclib:measurement_notes>
                Illumination type: external, water-cooled Globar; spectral sampling of 2␣
↪cm-1
            </speclib:measurement_notes>
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>
```

CHAPTER

EIGHT

EDIT HISTORY

See also: *SPECLIB change log*.
2025-11-11 Daniel Scholes