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# **Spectral Library Data Dictionary**

**NASA Planetary Data System**

**Nov 20, 2025**



# USER GUIDE

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PDS4 Spectral Library Discipline Data Dictionary User's Guide  
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## 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.



## 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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## 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*



## 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. 1000
- 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_1000.sch" schematypens=
  ↪ "http://purl.oclc.org/dsdl/schematron"?>
<?xml-model href="https://pds.nasa.gov/pds4/speclib/v1/PDS4_SPECLIB_1000_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_1000.xsd
    https://pds.nasa.gov/pds4/speclib/v1/PDS4_SPECLIB_1000_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:”.



## 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*

## 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 occurring 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 describes 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 spectroscopy, 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 fluorescence 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 value 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 Cyclosilicate 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 Nesosilicate 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





## 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>
    </speclib:Specimen_Classification>
  </speclib:Spectral_Library_Product>
</Discipline_Area>

```

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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:slgt34::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>
    </speclib:Specimen_Classification>
  </speclib:Spectral_Library_Product>
</Discipline_Area>

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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\_frankspectrum::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>
  <speclib:measurement_segments>4</speclib:measurement_segments>
  <speclib:Measurement_Parameters>
    <speclib:segment_number>1</speclib:segment_number>
    <speclib:Measurement_Instrument>
      <speclib:instrument_name>McPherson VUVAS 234/302</speclib:instrument_name>
      <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_
↪parameter_name>
    <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_
↪standard>
    <speclib:measurement_geometry_type>Biconical</speclib:measurement_geometry_type>
    <speclib:incidence_angle unit="deg">0</speclib:incidence_angle>
    <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>
        <reference_type>is_instrument</reference_type>

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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_
↪parameter_name>
  <speclib:spectral_range_min>0.250221</speclib:spectral_range_min>
  <speclib:spectral_range_max>0.359638</speclib:spectral_range_max>
  <speclib:spectral_range_unit_name>micrometers</speclib:spectral_range_unit_name>
  <speclib:measurement_reference_standard>Spectralon</speclib:measurement_reference_
↪standard>
  <speclib:measurement_geometry_type>Biconical</speclib:measurement_geometry_type>
  <speclib:incidence_angle unit="deg">0</speclib:incidence_angle>
  <speclib:emission_angle unit="deg">30</speclib:emission_angle>
  <speclib:phase_angle unit="deg">30</speclib:phase_angle>
  <speclib:measurement_atmosphere_pressure unit="Pa">95000</speclib:measurement_
↪atmosphere_pressure>
  <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>
    <speclib:instrument_name>Analytical Spectral Devices LabSpec 4</
↪speclib:instrument_name>
    <Internal_Reference>
      <lid_reference>urn:nasa:pds:context:instrument:psf.asd-labspec4</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>0.360000</speclib:spectral_range_min>
  <speclib:spectral_range_max>1.800000</speclib:spectral_range_max>
  <speclib:spectral_range_unit_name>micrometers</speclib:spectral_range_unit_name>
  <speclib:measurement_reference_standard>Spectralon</speclib:measurement_reference_
↪standard>
  <speclib:measurement_geometry_type>Biconical</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">180</speclib:phase_angle>
  <speclib:measurement_atmosphere_pressure unit="Pa">95000</speclib:measurement_
↪atmosphere_pressure>

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    <speclib:measurement_atmosphere_temperature unit="degC">25</speclib:measurement_
↪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>
    <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
↪parameter_name>
    <speclib:spectral_range_min>1.800300</speclib:spectral_range_min>
    <speclib:spectral_range_max>20.019000</speclib:spectral_range_max>
    <speclib:spectral_range_unit_name>micrometers</speclib:spectral_range_unit_name>
    <speclib:measurement_reference_standard>Infragold</speclib:measurement_reference_
↪standard>
    <speclib:measurement_geometry_type>Bidirectional</speclib:measurement_geometry_
↪type>
    <speclib:incidence_angle unit="deg">0</speclib:incidence_angle>
    <speclib:emission_angle unit="deg">30</speclib:emission_angle>
    <speclib:phase_angle unit="deg">30</speclib:phase_angle>
    <speclib:measurement_atmosphere_pressure unit="Pa">700</speclib:measurement_
↪atmosphere_pressure>
    <speclib:measurement_atmosphere_temperature unit="degC">25</speclib:measurement_
↪atmosphere_temperature>
    <speclib:measurement_date_time>2019-07-04</speclib:measurement_date_time>
    <speclib:data_producer_name>Melissa Lane; Alessandro Maturilli</speclib:data_
↪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>

```

## EDIT HISTORY

*See also: [SPECLIB change log](#).*  
2025-11-11 Daniel Scholes