
Spectral Library Data Dictionary

NASA Planetary Data System

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USER GUIDE

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PDS4 Spectral Library Discipline Data Dictionary User's Guide
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**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. 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 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
- Nullable: 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
- Nullable: 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
- Nullable: 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_
  <speclib:Internal_Reference>
    <lid_reference>urn:nasa:pds:context:instrument:relab.bd-vnir</lid_reference>
    <reference_type>is_instrument</reference_type>
  </speclib:Internal_Reference>
  <speclib:Measurement_Instrument>
    <speclib:measurement_type>Reflectance</speclib:measurement_type>
    <speclib:spectral_range_parameter_name>Wavelength</speclib:spectral_range_
  <speclib: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_
  <speclib: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_
  <speclib: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>
    <speclib:Internal_Reference>
      <lid_reference>urn:nasa:pds:relab:data_ancillary_chemistry:rs-cmp-048-
  <specimenchemistry</lid_reference>
    <speclib:reference_type>data_to_ancillary_data</speclib:reference_type>
  </speclib:Internal_Reference>
    <speclib:ancillary_product_type>Chemical Composition</speclib:ancillary_product_
  <speclib: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_<br/>
  ↵location>  

    <speclib:specimen_owner_location>Brown University, Dept. Earth, Environmental and<br/>
  ↵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_<br/>
  ↵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_<br/>
  ↵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_<br/>
  ↵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<br/>
  ↵"/><br/>
    <speclib:measurement_atmosphere_description>Ambient</speclib:measurement_<br/>
  ↵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_
<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_
      <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_
      <speclib:specimen_owner_location>Mount Holyoke College</speclib:specimen_owner_
      <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_
        <speclib: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_
      <speclib:spectral_range_min>320</speclib:spectral_range_min>
      <speclib:spectral_range_max>2540</speclib:spectral_range_max>
    </speclib:Measurement_Parameters>
  </speclib:Spectral_Library_Product>
</Discipline_Area>

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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:dataAncillaryImage:px-ecs-022-n-
onshallow14mm dish</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_
    <speclib: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_
    <speclib: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_
        <speclib:reported_percentile>
            <speclib:specimen_collection_location>Alfa Aesar 00170</speclib:specimen_
        <speclib: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_
        <speclib: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>
```

**CHAPTER
EIGHT**

EDIT HISTORY

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