# LAPS Laboratory Profile

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Data Description and format for Lab Equipment and Experimental Profile.

Note: the schemata described are drafts.

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## Introduction

This document details schemata and underlying definitions to describe equipment and experiments of the MIT Rock Physics laboratory. It covers part of Task#8 of the CORD MIT-Brown initiative (NSF #6938897, reference). General goal is to describe a common data structure that allows improvement on interlaboratory comparison of equipment, data and experiments.

On an equipment level the resulting Json files can be used to exchange methods, standards and procedures. Such standards will benefit lab managers and users. A second part is concerned with a common experimental data structure with the purpose of interfacing into a newly developed STRABO Experimental database. This database will be beneficial to the entire Geoscience community.

## Technology

There are two major requirements in how to choose an appropriate language to describe proposed profiles:

1. Commonality: the language needs to be commonly used and incorporated in a range of script and computer languages.
2. Web conformity: data should be easily displayed in web-based applications
3. Expandability: descriptions must be open ended and not limited
4. Data Structure: the data must adhere to a given structure

In our view, json fulfills all three requirements. It is used in many web-based applications as means of data exchange. There are libraries available for many languages to digest json data (e.g., C, JavaScript, Python, LabView, MATLAB). Json also offers complex data (objects) and arrays that are not limited in size.

There are several components to any json file:

* **Definitions**: commonly used descriptions of data structures
* **Schema**: the underlying structure of the json file – it can include and refer to definitions. For example, variables (e.g., string, number, array, object), as well as enumerations and required inputs are defined in a schema.
* **Json Data File**: the data file for specific equipment and setup that is derived from schema and definitions. If used in conjunction with a given schema it is guaranteed that the file contains well defined data.

The json file can be used in experimental description and/or data transformation and parsing if needed.

## Laps/Strabo Experimental Schema

The followings schema is the basis of metadata provided by researchers and lab managers to adequately describe all necessary information about a single experiment. Based on previous works and community discussions, the Laps/Strabo work group decided that the metadata should contain information on the following categories [object name in json file]:

* Facility Schema [facility]
* Apparatus Schema [apparatus]
* Data Acquisition [daq]
* Sample and Preparation [sample]
* Experimental procedure [experiment]
* Data Source and Description [data]

### Facility [facility]

Contains information about the experimental facility, such as location and contact information.

#### Table: Facility Schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **name** | **definition** | **type** | **title** | **Notes/Format** | **Description/Enumeration/Sources** |
| ***facility*** | ***facility*** | ***object*** | ***Facility*** |  | ***Facility Information and Contact*** |
| \_address | **location** | object | *Address* |  | Facility Address |
| \_contact | **contact** | object | *Contact* |  | *Facility Contact Information* |
|  |  |  |  |  |  |

### Apparatus [apparatus]

In rock physics, testing devices contain a wide range of equipment in design and measurement capabilities. Any attempt to describe such devices must include an expandable description of its features.

**The apparatus schema is grouped into the following sections:**

#### Apparatus Information

Device under test (DUT) description contains the machine name, type, location and features. In addition, there are schemata for device parameters and limits, and additional documentation (manuals, pictures).

#### Documentation

Standard Metadata to provide System documentations, like Manuals, Photos, Diagrams

#### Table: Apparatus Schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **name** | **definition** | **type** | **title** | **Notes/Format** | **Description/Enumeration/Sources** |
| **apparatus** |  | **object** | **Apparatus Information (DUT)** |  |  |
| \_name |  | *string* | *Apparatus Name* |  |  |
| \_type |  | *string* | *Apparatus Type* |  |  |
| \_location |  | *string* | *Location* |  |  |
| \_id |  | *string* | Apparatus ID | enumeration | *"University Lab", "Government Facility", "Private Industry Lab", "Shared Facility", "Military", “Service Center”, "Other"* |
| \_description |  | string | *Description* | markdown |  |
| \_features | **features** | array | *Apparatus Features:* |  | Select Apparatus Test Capabilities |
|  |  |  |  |  |  |
| **\_parameters** |  | **array** | *Parameters* |  | System Parameters and Limits |
| \_\_type |  | string | Name | enumeration | "Confining Pressure", "Effective Pressure", "Pore Pressure","Temperature","σ1-Displacement","σ2-Displacement","σ3-Displacement","σ1-Load","σ2-Load","σ3-Load","Displacement Rate", "Loading Rate", "Stiffness", "Sample Diameter", "Sample Length", "Permeability" |
| \_\_min |  | string | Minimum |  |  |
| \_\_max |  | string | Maximum |  |  |
| \_\_unit | **unit** | string | Unit |  |  |
| \_\_prefix | **prefix** | string | Prefix | default | “-“ |
| \_\_note |  | string | Detail/Note |  |  |
|  |  |  |  |  |  |
| **\_documents** | **documents** | **object** |  |  |  |
|  |  |  |  |  |  |

### Data Acquisition [daq]

Apparatus DAQ Channels (Name, Configuration, Sensors, Calibrations).

**The system sub-schema is grouped into the following sections:**

#### DAQ Information

General Information about the Data Acquisitions system, such as group, name, components, channels, sensors and calibrations

#### Documentation

Standard Metadata to provide supporting documentations, like Manuals, Photos, Diagrams

#### Table: DAQ Schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **name** | **definition** | **type** | **title** | **Notes/Format** | **Description/Enumeration/Sources** |
| **daq** |  | **object** | **DAQ** |  | **Data Acquisition Information** |
| \_name |  | *string* | *DAQ Group Name* |  |  |
| \_type |  | *string* | *DAQ Type* |  |  |
| \_location |  | *string* | *Location* |  |  |
| \_description |  | string | *Description* | markdown |  |
| \_ devices |  | array | *DAQ Devices* | table | List of Data Acquisition Devices |
| \_\_name |  | string | *DAQ Device* | default | “System Default” |
| **\_\_channels** |  | **array** | **Channels** | **tabs** | **DAQ Channels - Sensors - Calibration** |
| \_\_\_header | **header** | object | Header |  |  |
| \_\_\_number |  | string | Channel # | enumeration | “0”,…”32” |
| \_\_\_type |  | string | Type | enumeration | "Calculated", "Analog Input", "Analog Output", "Digital Input", "Digital Output","System Data", "System Clock" |
| \_\_\_configuration |  | string | Configuration | enumeration | "Differential", "Single Ended", "Referenced Single Ended", "Serial", "Parallel", "Single", "Line", "System" |
| \_\_\_note |  | string | Note |  |  |
| \_\_\_resolution |  | string | Resolution [bit] |  |  |
| \_\_\_ range\_low |  | string | DAQ Min |  |  |
| \_\_\_ range\_high |  | string | DAQ Max |  |  |
| \_\_\_rate |  | string | DAQ Max |  |  |
| \_\_\_filter |  | string | Filter |  |  |
| \_\_\_gain |  | string | Gain | enumeration | "x1", "x2", "x5", "x10", "x20", "x25", "x50", "x100" |
| \_\_\_sensor | **sensor** | object | Sensor/Actuator |  |  |
| \_\_calibration | **calibration** | object | Calibration |  |  |
|  |  |  |  |  |  |
| **documents** | **documents** | **object** |  |  |  |
|  |  |  |  |  |  |

### Sample and Preparation [sample]

**The system sub-schema is grouped into the following sections:**

#### Name and Description

fill in text

#### Material (Lithology, Provenance, Mineralogy)

fill in text

#### Properties, Geometry and Treatment

fill in text

#### Documentation

Standard Metadata to provide System documentations, like Manuals, Photos, Diagrams

#### Table: Sample Schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **name** | **definition** | **type** | **title** | **Notes/Format** | **Description/Enumeration/Sources** |
| ***sample*** | ***sample*** | ***object*** | ***Description*** |  | ***Specimen Description*** |
| **\_material** | **material** | **object** | ***Material*** |  | **Composition, Mineralogy and Provenance** |
| **\_\_material** | **material** | **object** | ***Material Type*** |  | ***Material Type*** |
| **\_\_composition** |  | **array** | **Mineralogy** |  |  |
| \_\_\_phase | **phase** | object | Phase |  |  |
| \_\_\_mineral | **minerals** | string | Mineral |  |  |
| \_\_\_grainsize |  | number | Grain Size [μm] |  |  |
| **\_\_provenance** | **provenance** | **object** | **Provenance** |  |  |
| \_\_texture |  | object | Texture |  |  |
| \_\_bedding |  | string | Bedding |  |  |
| \_\_lineation |  | string | Lineation |  |  |
| \_\_foliation |  | string | Foliation |  |  |
| \_\_fault |  | strinq | Fault |  |  |
|  |  |  |  |  |  |
| \_parameters |  | array | Parameters |  | Sample Parameters (pre experimental) |
| \_\_control |  | string | Variable | enumeration | "Weight", "Connected Porosity", "Unconnected Porosity", "Total Porosity", "Density", "Permeability (Gas)", "Permeability (Water)", "Temperature", "Humidity", "Fluid Saturation", "Stress", "Other" |
| \_\_value |  | string | Value |  |  |
| \_\_error |  | string | Error |  |  |
| \_\_unit | **unit** | string | Unit |  |  |
| \_\_prefix | **prefix** | string | Prefix |  |  |
| \_\_note |  | string | Note (Measurement and Treatment) |  |  |
|  |  |  |  |  |  |
| **documents** | ***documents*** | **object** |  |  |  |
|  |  |  |  |  |  |

### Experimental procedure [experiment]

**The system sub-schema is grouped into the following sections:**

#### Description

General Description of Experiment

#### Author

Dataset Author

#### Details

Type of Experiment and/or Deformation type. Options given here may depend on equipment selection

#### Protocol

Step by Step Objectives and Protocol

#### Documentation

Standard Metadata to provide System documentations, like Manuals, Photos, Diagrams

#### Table: Experiment Schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **name** | **definition** | **type** | **title** | **Notes/Format** | **Description/Enumeration/Sources** |
| ***information*** |  | ***object*** | ***Description*** |  | ***General Description of Experiment*** |
| \_title |  | string | *Title* |  |  |
| *\_project* |  | *string* | *Project* | *enumeration lab specific* | *"Carbon Sequestration", "Crack Healing", "Yield Point Study Carrara", "MSGC", "Calibration", "Pilot", "Training", "Test"* |
| \_exp\_id |  | string | Experimental ID |  |  |
| \_iead |  | string | IEDA ID |  |  |
| start\_date |  | string | Start Date/Time | datetime-local | 02/14/2022, 3:15 PM |
| end\_date |  | string | End Date/Time | datetime-local | 02/14/2022, 3:15 PM |
| \_description |  | string | Experimental Description |  |  |
|  |  |  |  |  |  |
| **author** | **contact** | **object** | **Author** |  | **Dataset Author** |
|  |  |  |  |  |  |
| **details** |  | **object** | **Details** |  | **Type of Experiment and/or Deformation type. Options given here may depend on equipment selection** |
| \_facility |  | string | Facility | read only | root.object.system.facility.id |
| \_apparatus |  | string | Apparatus ID | read only | root.object.system.apparatus.id |
| \_astm |  | string | ASTM Identification or Publication | enumeration | $ref: external reference to ASTM standard testing papers and procedures |
| \_features | features | array | Test Features: |  | System -> Features |
|  |  |  |  |  |  |
| **geometry** |  | **array** | **Geometry** |  | **Sample and Assemblage Geometry** |
| \_order |  | string | # |  |  |
| \_type |  | string | String | enumeration | "Sample", "Jacket", "Forcing Block", "Spacer" |
| \_type |  | string | Type | enumeration | "Solid", "Precut", "Sawcut", "Tensile Split", "Notched", "Gouge" |
| \_geometry |  | string | Geometry | enumeration | "Cylinder", "Rectangular", "Circular", "Precut", "Dogbone", “Split Cylinder”, “Tube” |
| \_material |  | string | Jacket Material | enumeration | "PET", "PVC", "PTFE", "Rubber", "Viton", "Copper", "Iron", "Nickel", "Gold", "Platinum", "Silver", "Alumina", "Porous Alumina", "Zirconia", "PZT" |
| \_dimensions |  | array | Dimensions |  |  |
| \_\_variable |  | string | Variable | enumeration | "Length", "Diameter", "Width", "Span", "Height", "Bore Diameter", "Fault Angle" |
| \_\_value |  | number | Value |  |  |
| \_\_unit | **unit** | string | Unit |  |  |
| \_\_prefix | **prefix** | string | Prefix |  |  |
| \_\_note |  | string | Note |  |  |
|  |  |  |  |  |  |
| **protocol** |  | **array** | **Protocol** |  | **Step by Step Objectives and Protocol** |
| \_description |  | string | Description |  |  |
| \_test |  | string | Step | enumSource | root.object.experiment.details.features |
| \_objective |  | string | Objective |  |  |
| \_ parameters |  | array | Parameter |  |  |
| \_\_control |  | string | Variable | enumeration | "Temperature T", "Confining Pressure Pc", "Pore Pressure Pp", "Time t", "Stress σ1", "Strain ε1", "Strain Rate ε1/dt", "Displacement Δs1", "Force F2", "Stress σ2", "Strain ε2", "Strain Rate ε2/dt", "Displacement Δs2", "Force F2", "Stress σ3", "Strain ε3", "Strain Rate ε3/dt", "Displacement Δs3", "Force F3", "Saturation", "Humidity", "Count" |
| \_\_value |  | number | Value |  |  |
| \_\_unit | **unit** | string | Unit |  |  |
| \_\_note |  | string | Note |  |  |
|  |  |  |  |  |  |
| **documents** | **documents** | **object** |  |  |  |
|  |  |  |  |  |  |

### Data Source and Description [data]

The system sub-schema is grouped into the following sections:

#### Reference Keys

Read only keys to provide information for all other schema

#### Datasets

A compilation for datasets associated with the test. This does not contain the actual data, but rather pointers to data location (local or online)

#### Table: Data Schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **name** | **definition** | **type** | **title** | **Notes/Format** | **Description/Enumeration/Sources** |
| ***keys*** |  | ***object*** | ***Reference Keys*** |  | ***References for User, Equipment, Sample and Experiment*** |
| \_user |  | string | *User ID* | readonly | root.object.experiment.author.id |
| \_experiment |  | string | *Experiment ID* | *readonly* | *root.object.experiment.information.exp\_id* |
| *\_sample* |  | *string* | *Sample ID* | *readonly* | *root.object.sample.description.id* |
| *\_machine* |  | *string* | *Machine ID* | *readonly* | *root.object.system.apparatus.id* |
|  |  |  |  |  |  |
| **datasets** |  | **array** | ***Datasets*** |  | **Parameters, Analytical Data, Microstructures, Time Series Data** |
| \_data |  | *string* | *Data* | enumeration | "Parameters", "Pore Fluid", "Time Series", "Sample Description", "Imaging", "EBSD", "WDS", "Thin Section", "Raman", "Infrared Spectroscopy", "TEM", "CL", "Profilometry", "Acid Etching", "Evaporative Grid", "Neutron Diffraction", "X-Ray Spectra", "X-Ray Graphs", "Thermal Etching", "Fiducal Marks", "XRCT", "CT Scan", "SEM", "EDS", "EDX", "Optical Microscopy", "Infrared", "Raman", "XRD", "XRF", "Confocal Microscopy", "Photoelasticity", "Polarized Microscopy", "Fluorescence" |
| \_type |  | *string* | Machine ID | enumeration | *"Picture", "Video", "Data", "Software", "Other"* |
| \_source |  | string | *File Upload* | text/html | base64 |
| \_format |  | string | *Format* | enumeration | "text", "csv", "zip", "rar" |
| \_id |  | string | *Picture/Data ID* |  |  |
| \_path |  | string | *File Path* | url |  |
| \_rating |  | string | Data Quality | starrating | "Low", "Acceptable", "Good", "Very Good", "Exceptional" |
| \_description |  | string | *Description* |  |  |
|  |  |  |  |  |  |
| \_headers |  | array | Data Headers | “data”: “Time Series” | Time Series Headers |
| \_\_header | **header** | object | Header |  |  |
| \_\_type |  | string | Type | enumeration | "Analog Input", "Analog Output", "Digital Input", "Digital Output", "System Data", "System Clock", "Calculated" |
| \_\_number |  | string | Channel # | enumeration | “0”,… “32” |
| \_\_note |  | string | Note |  |  |
| \_\_rating |  | string | Data Quality | enumeration | "Low", "Acceptable", "Good", "Very Good", "Exceptional" |
|  |  |  |  |  |  |
| \_parameters |  |  |  | “data”: “Parameters” |  |
| \_\_control |  | string | Data | enumeration | "Weight", "Connected Porosity", "Unconnected Porosity", "Length", "Diameter", "Width", "Span", "Height", "Bore Diameter", "Fault Angle", "Total Porosity", "Density", "Gas Permeability", "Fluid Permeability", "Final Strain ε", "Corrected Strain Rate ε/dt", "Final Displacement Δs", "Maximum Force F", "Maximum Stress σ", "Yield Stress σ", "Machine Stiffness N/mm", "Roughness", "Friction Parameter", "Unconfined Compressive Strength (UCS)", "Ultimate Tensile Strength", "Ultimate Shear Strength", "True Tension Strength", "Compressive Strength (σ2=σ3)", "Compressive Strength (σ1=σ2)", "True Triaxial Strength", "Yield Strength", "Tensional Strength", "Torsion Strength", "Flow Strength", "Fracture Strength" |
| \_\_value |  | string | Value |  |  |
| \_\_error |  | string | Error |  |  |
| \_\_unit | **unit** | string | Unit |  |  |
| \_\_prefix | **prefix** | string | Prefix |  |  |
| \_\_note |  | string | Note |  |  |
|  |  |  |  |  |  |
| \_ fluid |  | object | Pore Fluid | “data”: "Pore Fluid" | Pore Fluid Composition and Chemistry |
| \_\_phases | **phase** | array | Phase |  |  |
| \_\_\_composition |  | string | Chemistry Data | enumeration | “Chemistry”, “None” |
| \_\_\_solutes |  | array | Chemistry | “composition”: "Chemistry" | Add Solutes |
| \_\_\_\_items | **solute** | object | Part |  |  |
|  |  |  |  |  |  |

## Definitions

Definitions are frequently used metadata objects referred to from the main schema

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **facility** | **object** | **Facility Information** |  |  |
| \_institute |  | *string* | *Institute Name* |  |  |
| \_department |  | *string* | *Department* |  |  |
| \_name |  | *string* | *Name* |  |  |
| \_type |  | *string* | Type | enumeration | *"University Lab", "Government Facility", "Private Industry Lab", "Shared Facility", "Military", “Service Center”, "Other"* |
| \_id |  | string | ID | *SERIF/EPOS* |  |
| \_website |  | string | *Website* | url |  |
| \_description |  | string | *Description* |  |  |
|  |  |  |  |  |  |
|  | **location** | **object** | **Location** |  |  |
| \_street |  | string | Street + Number |  |  |
| \_building |  | string | Building-Apartment |  | required |
| \_postcode |  | string | Postal Code |  |  |
| \_city |  | string | City |  | required |
| \_state |  | string | State |  | required |
| \_country |  | string | Country |  |  |
| \_latitude |  | string | Latitude (decimal degree) |  |  |
| \_longitude |  | string | Longitude (decimal degree) |  |  |
|  |  |  |  |  |  |
|  | **contact** | **object** | **Contact** |  |  |
| \_firstname |  | string | First Name |  | required |
| \_lastname |  | string | Last Name |  | required |
| \_affiliation |  | string | Affiliation | enumeration | "Student", "Researcher", "Lab Manager", "Principal Investigator", "Technical Associate", "Faculty", "Professor", "Visitor", "Service User", "External User" |
| \_email |  | string | Email |  |  |
| \_ phone |  | string | Phone |  |  |
| \_website |  | string | Website |  |  |
| \_id |  | string | ORCID ID | ORCID/Scopus |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | **features** | **array** | ***Features*** |  |  |
| \_ |  | string |  | checkbox | "Loading", "Unloading", "Heating", "Cooling", "High Temperature", "Ultra-High Temperature", "Low Temperature", "Sub-Zero Temperature", "High Pressure", "Ultra-High Pressure", "Hydrostatic Tests", "HIP", "Synthesis", "Deposition/Evaporation", "Mineral Reactions", "Hydrothermal Reactions", "Elasticity", "Local Axial Strain", "Local Radial Strain", "Elastic Moduli", "Yield Strength", "Failure Strength", "Strength", "Extension", "Creep", "Friction", "Frictional Sliding", "Slide Hold Slide", "Stepping", "Pure Shear", "Simple Shear", "Rotary Shear", "Torsion", "Viscosity", "Indentation", "Hardness", "Dynamic Tests", "Hydraulic Fracturing", "Hydrothermal Fracturing", "Shockwave", "Reactive Flow", "Pore Fluid Control", "Pore Fluid Chemistry", "Pore Volume Compaction", "Storage Capacity", "Permeability", "Steady-State Permeability", "Transient Permeability", "Hydraulic Conductivity", "Drained/Undrained Pore Fluid", "Uniaxial Stress/Strain", "Biaxial Stress/Strain", "Triaxial Stress/Strain", "Differential Stress", "True Triaxial", "Resistivity", "Electrical Resistivity", "Electrical Capacitance", "Streaming Potential", "Acoustic Velocity", "Acoustic Events", "P-Wave Velocity", "S-Wave Velocity", "Source Location", "Tomography", "In-Situ X-Ray", "Infrared", "Raman", "Visual", "Other" |
|  |  |  |  |  |  |
|  | **prefix** | **string** | **Prefix** | enumeration | "1E+1", "1E+2", "1E+3", "1E+4", "1E+5", "1E+6", "-", "1E-1", "1E-2", "1E-3", "1E-4", "1E-5", "1E-6" |
|  |  |  |  |  |  |
|  | **unit** | **string** | **Unit** | enumeration | "degC", "degK", "sec", "min", "hour", "Volt", "mV", "Amperage", "mA", "Ohm", "Pa", "MPa", "GPa", "bar", "kbar", "N", "kN", "g", "mg", "μg", "m", "cm", "mm", "μm", "Hz", "kHz", "MHz", "Pa·s", "Darcy", "mDarcy", "m-1", "m2", "milistrain", "mm·sec-1", "N·sec-1", "sec-1", "kN·mm-1", "%", "count", "cc", "mm3" |
|  |  |  |  |  |  |
|  | **sample** | **object** |  |  |  |
| \_name |  | string | *Name* |  |  |
| \_igsn |  | string | IGSN # |  |  |
| \_id |  | string | Sample ID |  |  |
| \_description |  | string | Description |  |  |
| \_parent |  | object | Parent Sample | reference | #/definitions/sample |
|  |  |  |  |  |  |
|  | **calibration** | **object** | **Calibration** |  |  |
| \_info |  | info | Information |  | Data can be entered as Pairs: Calibration Table-Input:Unit; Linear Regression1 Input@0:Input/Unit; Linear Regression2 u=(x\*a0+a1)\*a2+a3; Polynomial-Base:Exponent); Frequency Response Table-Frequency:Amplitude |
| \_template |  | string | Template | enumeration | "Input:Unit", "Input@0:Input/Unit", "(a0:a1)(a2:a3)", "Base:Exponent", "Frequency:Amplitude" |
| \_input | unit | string | Input |  |  |
| \_unit | unit | string | Unit |  |  |
| \_excitation |  | string | Excitation |  |  |
| \_date |  | string | Date | datetime-local | YYYY-MM-DD HH:SS (02/14/2022, 3:15 PM) |
| \_note |  | string | Calibration Note |  |  |
| \_data |  | array | Data | table |  |
| \_\_a |  | string | A |  |  |
| \_\_b |  | string | B |  |  |
|  |  |  |  |  |  |
|  | **sensor** | **object** | **Sensor/Actuator** |  | Sensor or Actuator Information |
| \_template |  | string | IEEE Sensor Template | enumeration | "Accelerometer & Force", "Charge Amplifier (w/ attached accelerometer)", "Charge Amplifier (w/ attached force transducer)", "Microphone with built-in preamplifier", "Microphone Preamplfiers (w/ attached microphone)", "Microphones (capacitive)", "High-Level Voltage Output Sensors", "Current Loop Output Sensors", "Resistance Sensors", "Bridge Sensors", "LVDT/RVDT Sensors", "Strain Gage", "Thermocouple", "Resistance Temperature Detectors (RTDs)", "Thermistor", "Potentiometric Voltage Divider" |
| \_detail |  | string | Sensor/Actuator | enumeration | "Clock", "LVDT", "Load Cell", "Capacitive Load Cell", "Pressure Transducer", "Thermocouple", "Hall Sensor", "P-Wave Sensor", "S-Wave Sensor", "Encoder", "Strain Gauge", "Thermistor", "Force Gauge", "DCDT","pH-Meter", "Flow Meter", "--", "Linear Motor", "Servo Motor", "Step Motor", "Actuator", "Heater", "Power", "Trigger" |
| \_type |  | string |  | enumeration | "Active", "Passive" |
| \_id |  | string | Manufacturer ID |  |  |
| \_model |  | string | Model # |  |  |
| \_version |  | string | Version Letter |  |  |
| \_number |  | string | Version # |  |  |
| \_serial |  | string | Serial # |  |  |
|  |  |  |  |  |  |
|  | **igneous\_lithology** | **string** |  | enumeration | pull list form external reference |
|  | **metam\_lithology** | **string** |  | enumeration | pull list form external reference |
|  | **sed\_lithology** | **string** |  | enumeration | pull list form external reference |
|  | **epos\_lithology** | **string** |  | enumeration | pull list form external reference |
|  | **minerals** | **string** |  | enumeration | pull list form external reference |
|  | **soil** | **string** |  | enumeration | pull list form external reference |
|  | **commodities** | **string** |  | enumeration | pull list form external reference |
|  | **standards** | **string** |  | enumeration | "Other","Austin Chalk","Berea Sandstone","Carrara Marble","Indiana Limestone","Frederick Maryland Diabase","Heavitree Quartzite","Solnhofen Limestone","Simpson Quartzite","Black Hills Quartzite","Sioux Quartzite","Cheshire Quartzite","Arkansas Novaculite, Westerley Granite" |
|  |  |  |  |  |  |
|  | **documents** | **array** | **Documents** |  |  |
| \_type |  | string | Type | enumeration | "Manual","Diagram","Picture","Video","Data","Software","Other" |
| \_format |  | string | Format | enumeration | "jpg","png","txt","csv","zip","rar" |
| \_path |  | string | File Path | url |  |
| \_description |  | string | Description |  |  |
| \_upload |  | string | Upload | Manuals/Drawings, etc | base64 (not recommended for large data) |
|  |  |  |  |  |  |
|  | **phase** | **object** | **Phase** |  |  |
| \_component |  | string | Component |  |  |
| \_fraction |  | number | Fraction |  |  |
| \_activity |  | number | Activity |  |  |
| \_fugacity |  | string | Fugacity |  |  |
| \_unit |  | string | Unit | enumeration | "Vol%","Mol%","Wt%","MPa" |
|  |  |  |  |  |  |
|  | **solute** | **object** | **Solute** |  |  |
| \_component |  | string | Component | enumeration | "pH","pOH","Na+","K+","Ca++","Mg++","Sr++","HCO3-","TOC","TIC","CO2(gas)","CO2(sol)","Resitivity","Temperature" |
| \_value |  | string | Value |  |  |
| \_error |  | string | Error |  |  |
| \_unit |  | string | Unit | enumeration | "Vol%","Mol%","Wt%","Mol/L","mMol/L","S/Mol","log [C]","deg C" |
|  |  |  |  |  |  |
|  | **material** | **object** | **Material Type** |  |  |
| \_type |  | string |  | enumeration | "Glass", "Ice", "Ceramic", "Plastic", "Metal", "Soil", "Mineral", "Igneous Rock", "Sedimentary Rock", "Metamorphic Rock", "Epos Lithologies", "Standards", "Commodity" |
| \_name |  | string | Name | enumeration | $ref depends on \_type |
| \_state |  | string | State | enumeration | "Homogeneous","Heterogeneous","Powder/Gauge","Discontinuous","Continuous","Composite" |
| \_note |  | string | Note |  |  |
|  |  |  |  |  |  |
|  | **provenance** | **object** | **Provenance** |  |  |
| \_formation |  | string | Formation |  |  |
| \_member |  | string | Member Name |  |  |
| \_submember |  | string | Sub Member Name |  |  |
| \_source |  | string | Source | enumeration | "Surface", "Quarry", "Well" |
| \_well\_id |  | string | Well ID |  |  |
| \_well\_depth |  | number | Depth (Log) |  |  |
| \_location | **location** | object |  |  |  |
|  |  |  |  |  |  |
|  | **header** | **object** | **Header** |  |  |
| \_type |  | string |  | enumeration | “Time”,"Temperature","Pressure","Strain","Displacement","Stress", "Load","Electrical","Chemistry","Other" |
| \_spec\_a | Time | string | Specifier A | enumeration | "Absolute","Relative" |
|  | Temperature |  |  |  | "Room","Sample","Furnace","Fluid","Pore","Vessel" |
|  | Pressure |  |  |  | "Barometric","Confining","Pore","Effective","Differential" |
|  | Strain, Displacement |  |  |  | "Total","Axial","Radial","Shear","Average","Area","Volumetric","σ1","σ2","σ3" |
|  | Stress, Load |  |  |  | "Axial","Radial","Shear","Normal","Differential","Average","σ1","σ2","σ3" |
|  | Electrical |  |  |  | "Conductivity","Resistivity","Capacity","Spontaneous Potential" |
|  | Chemistry |  |  |  | "Pore Fluid","Fluid" |
|  |  |  |  |  |  |
| \_spec\_b | Time | string | Specifier B | enumeration | "Total","Differential" |
|  | Temperature | string |  |  | "Top","Bottom","Internal","External","Average" |
|  | Pressure | string |  |  | "Vessel","Intensifier","Upstream","Downstream" |
|  | Strain | string |  |  | "Sample","Internal","External","Rate" |
|  | Displacement | string |  |  | "Sample","Internal","External","Rate","Pore Pressure Intensifier","Confining Pressure Intensifier","Pore Volume","Confining Volume" |
|  | Stress, Load | string |  |  | "Sample","Internal","External" |
|  | Electrical | string |  |  | "Sample","Pore Fluid","Total" |
|  | Chemistry | string |  |  | "pH","pOH","Na+","K+","Ca++","Mg++","Sr++","HCO3-","TOC","TIC","CO2(gas)","CO2(sol)" |
|  |  |  |  |  |  |
| \_spec\_c |  | string | Other Specifier |  |  |
| \_unit | Time | string | Unit | enumeration | "sec","min","hour","day","ysec","msec","%","UTC","dd-mm-yyyy","mm/dd/yy","hh-mm-ss" |
|  | Temperature | string |  |  | "deg C","deg K","deg F" |
|  | Pressure, Stress | string |  |  | "bar","kPa","MPa","GPa","PSI" |
|  | Strain | string |  |  | "%","mStrain","Strain","1/sec" |
|  | Displacement | string |  |  | "%","μm","mm","m","mm/s" |
|  | Load | string |  |  | "N","KN" |
|  | Electrical | string |  |  | "μVolt","mVolt","Volt","S","S/m","F","Ω","Ωm" |
|  | Chemistry | string |  |  | "mol/L","mMol/L","ppm","cc" |
|  |  |  |  |  |  |
|  | **features** | **array** |  |  |  |
| \_ |  | string |  | enumeration | "Loading","Unloading","Heating","Cooling","High Temperature","Ultra-High Temperature","Low Temperature","Sub-Zero Temperature","High Pressure","Ultra-High Pressure","Hydrostatic Tests","HIP","Synthesis","Deposition/Evaporation","Mineral Reactions","Hydrothermal Reactions","Elasticity","Local Axial Strain","Local Radial Strain","Elastic Moduli","Yield Strength","Failure Strength","Strength","Extension","Creep","Friction","Frictional Sliding","Slide Hold Slide","Stepping","Pure Shear","Simple Shear","Rotary Shear","Torsion","Viscosity","Indentation","Hardness","Dynamic Tests","Hydraulic Fracturing","Hydrothermal Fracturing","Shockwave","Reactive Flow","Pore Fluid Control","Pore Fluid Chemistry","Pore Volume Compaction","Storage Capacity","Permeability","Steady-State Permeability","Transient Permeability","Hydraulic Conductivity","Drained/Undrained Pore Fluid","Uniaxial Stress/Strain","Biaxial Stress/Strain","Triaxial Stress/Strain","Differential Stress","True Triaxial","Resistivity","Electrical Resistivity","Electrical Capacitance","Streaming Potential","Acoustic Velocity","Acoustic Events","P-Wave Velocity","S-Wave Velocity","Source Location","Tomography","In-Situ X-Ray","Infrared","Raman","Visual","Other" |
|  |  |  |  |  |  |
|  |  |  |  |  |  |