# Storage of Physical Sample Metadata in the Astrobiology Habitable Environments Database (AHED)


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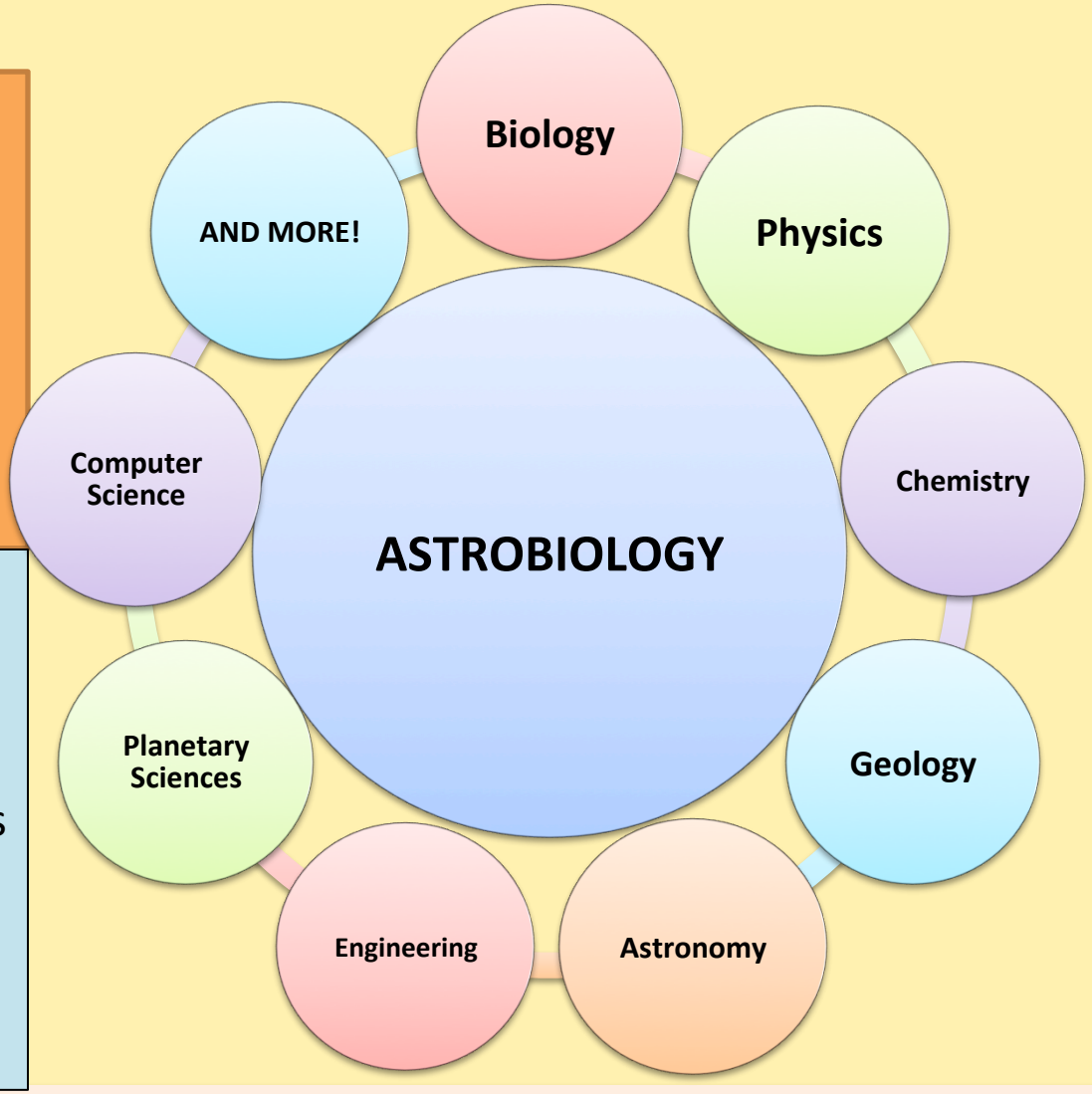
# ASTROBIOLOGY

**Astrobiology studies the origin, evolution, and future of life in the universe**

NASA uses the results of astrobiology research to focus its future missions on targets of opportunity for the discovery of life off Earth.




How does life begin and evolve?

Does life exist elsewhere in the Universe?

What is the future of life on Earth and beyond?

**"Astrobiology is MULTIDISCIPLINARY in content and INTERDISCIPLINARY in its execution"**

**(The NASA Astrobiology Roadmap, Des Marais *et al.*, 2008)**

# What is AHED?

*Astrobiology Habitable Environments Database*

- A repository containing scientific datasets from multiple astrobiology project teams
- Use cases:
  - As a science team's private repository
  - As a repository for sharing data with other specified individuals or teams
  - As a field-wide repository for sharing data with the entire community
  - As an educational outreach portal
- (But can it serve all these purposes??)

# The AHED Team

- Consolidated group of astrobiologists from different active research teams at NASA Ames Research Center
  - Brad M. Bebout, Leslie E. Bebout, Thomas F. Bristow, David J. Des Marais, Angela M. Detweiler, Michael D. Kubo, Barbara Lafuente, Niki Parenteau
- Assisted by :
  - data scientist: Rich Keller
  - database developer: Nate Stone
- Funded by:
  - NASA Science-Enabling Research Activity (SERA) Project of the NASA Science Mission Directorate

# Motivation for AHED Development

- Federal government has a responsibility to share data gathered with taxpayer money (Office of Science and Technology Policy Memo: February 22, 2013)
  - NASA has increasingly required internal and external PIs applying for NASA funding to formulate data management plans.
  - Uneven application of these requirements:
    - Planetary science missions (yes) ✔
    - Earth science missions (yes) ✔
    - Human exploration missions (mixed) –
    - Aeronautics (no) ✗
    - Astrobiology Program (no) ✗
- Premise: synergy and information sharing propels the science forward
  - Inspired by successes with genome databases, biodiversity databases, mineralogy databases, others

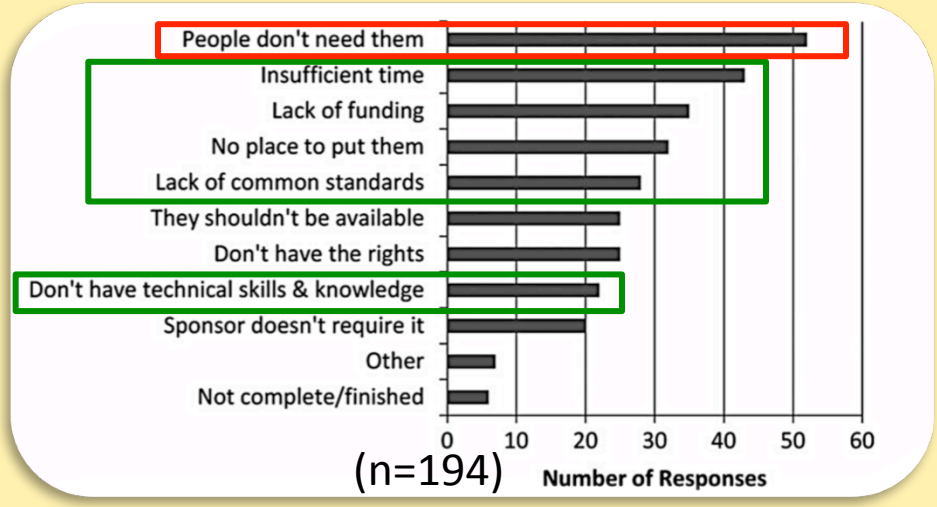
# Data sharing in Astrobiology


## Benefits of data sharing/archiving:

- ✓ Reanalysis of data to verify results
- ✓ Reinterpretation of data with a different approaches
- ✓ Data integrity and preservation
- ✓ Eliminates data redundancy
- ✓ Training tool for future researches

[Aydinoglu *et al.*, 2014]

## Barriers to data sharing/archiving:




[Aydinoglu *et al.*, 2014]

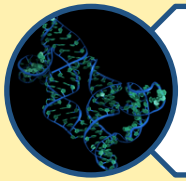
**AHED**

*A Platform Form Sharing Astrobiology Datasets*

# AHED Pilot Databases

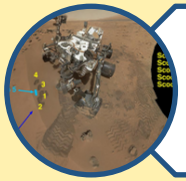
**PLRP - Pavillon Lake Research Project DB**

- **536 records**
- Microbialite and water samples



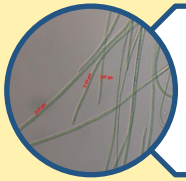
**Direct molecular evolution sequence DB**

- **43 records**
- Sequence data from in-Vitro evolution experiments



**CheMin DB**

- **12 records**
- Data from CheMin instrument (MSL-Curiosity)

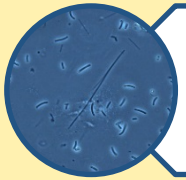


**ES Culture Collection DB**

- **9 records**
- Data from isolated cyanobacteria and heterotrophs

**CROMO: Serpentinizing System DB**

- **106 records**
- Drill samples from serpentinizing systems



**Lipid Biomarker DB**

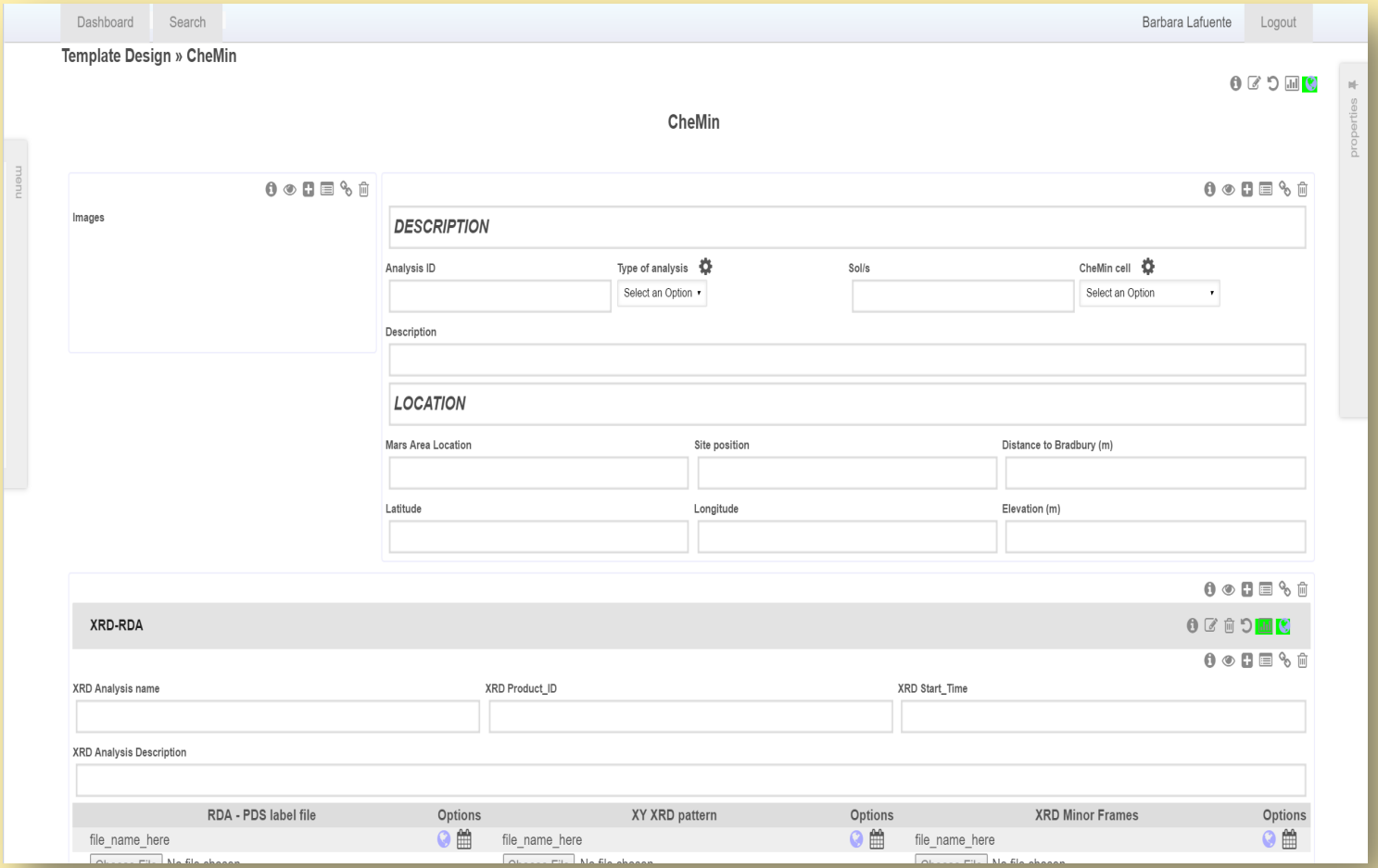
- **2 records**
- Lipids from pure cultures of microbes

# AHED Databases built upon Open Data Repository

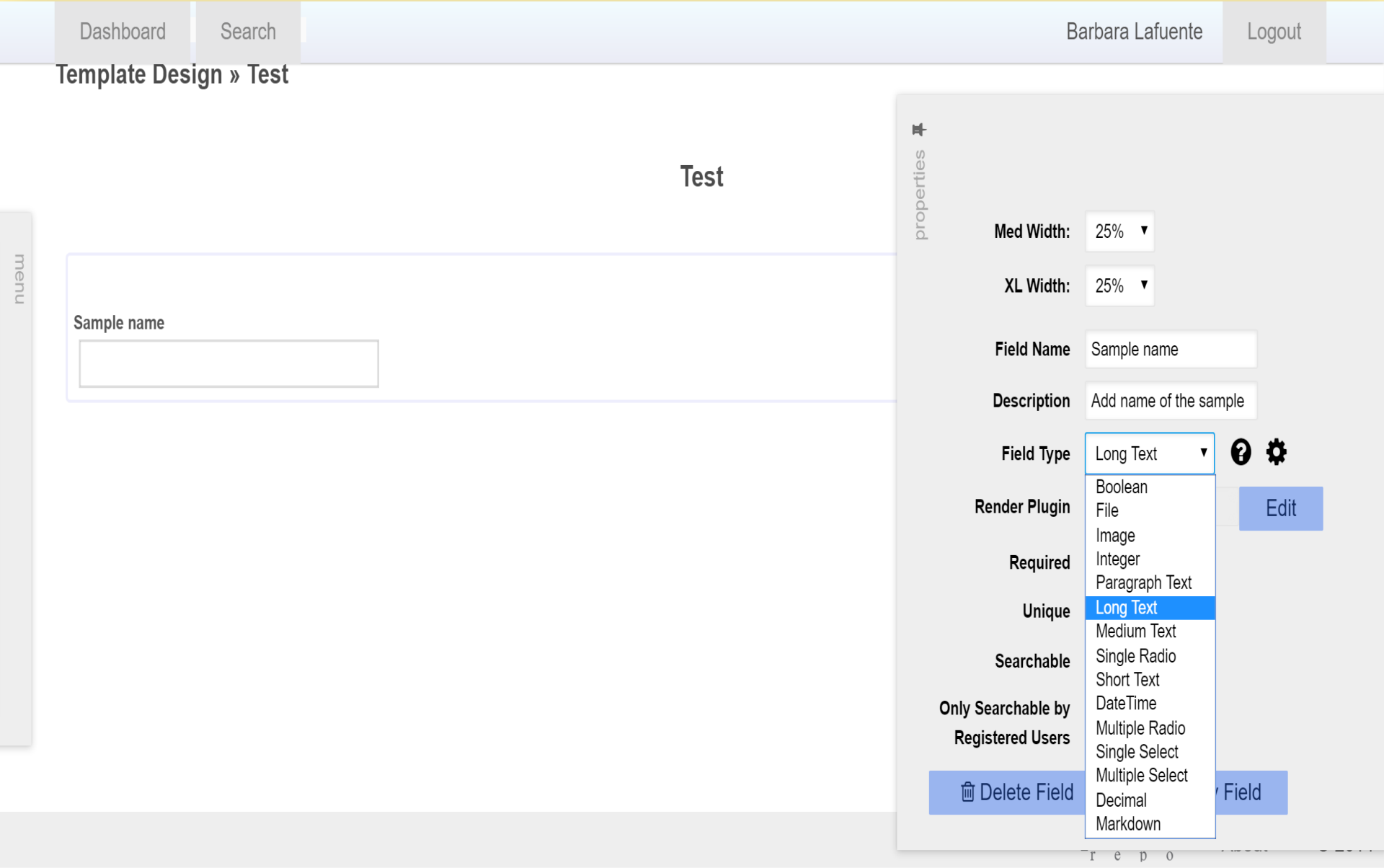
- A scientific data repository system developed by the University of Arizona
- Allows scientific teams to design, develop, and deploy web-based data repositories
- Simple drag-and-drop database template authoring & web layout, coupled with Excel-based data uploading capabilities

# Database Templates

- Each template encodes the set of metadata fields to be stored in an AHED database record



# Template design



# Problems with AHED

- Each AHED database developed independently
- Even though some similar types of data are being stored in the different AHED databases, it is not possible to:
  - Search across databases
  - Discover data in other databases

**Lack of standardization in:**

- **Field naming**
- **Data typing**

# Standardization issues mirrored in Astrobiology data cataloguing practices

- Astrobiology researchers conduct both field-based and laboratory-based research, during which physical samples are collected, processed, and catalogued.
- great disparity in practices employed by different teams or individuals
- no specific standards available to guide the collection and recording of astrobiology sample data.

# AHED Metadata Standardization Effort

Develop standardized:

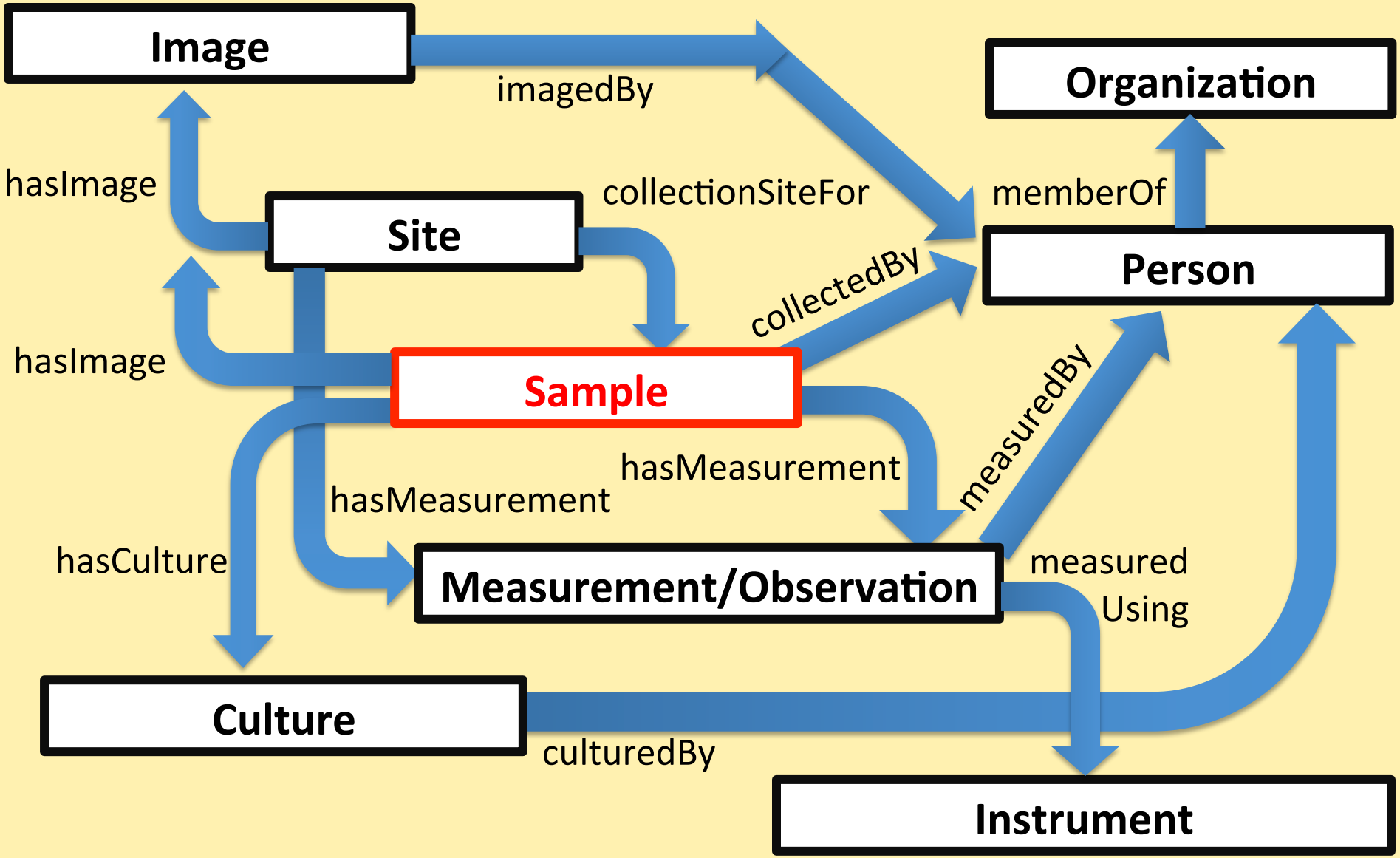
- Template types
- Template field naming and field datatypes
- Template metadata values

**Standardized Metadata Model**

# Template Types

- Metadata previously mixed in a single template was segregated into multiple logical groupings describing:
  - Site
  - Sample
  - Measurement/Observation
  - Image
  - Instrument
  - Culture
  - Person
  - Organization

# Metadata Model



# Template development process

- Weekly meetings to develop consensus on template definitions
- For each data field, must define:
  - Field name
  - Field type
    - Text, integer/float, choice, file, pointer
  - Field Inclusion Status
    - Required
      - sample type
      - sample label
      - sample collection date
    - Recommended: desirable
      - sample collection time
    - As needed: project-specific needs
      - sample collection method
  - Choice values
    - e.g.: **site characterization**: lacustrine, marine intertidal, marine, coastal, open ocean, hot spring, arid, hyperarid, cave, well, hypersaline, estuarine, evaporite, mine, subsurface, deep subsurface, acid mine drainage, riverine, spring, poza

# Challenges to Data Sharing

- Astrobiology is broad and multi-disciplinary
- Teams studying many different phenomena
- Teams collecting many different types of samples
- Will one team's very specific data be useful to another?
- How to standardize data collection so that it will be of value across such heterogenous teams?
- How to motivate scientists to share data when it may advance a competitor's research?
- Need to develop consensus with broader Astrobiology community!