



A Semantics-based Information Repository for Distributed Scientific Investigations



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<http://sciencedesk.arc.nasa.gov/scidesk/>



Contributors



Core Team

- Dan Berrios
- Robert Carvalho
- David Hall
- Rich Keller
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- Shawn Wolfe

Former Teammates

- Jim Chen
- Mike Compton
- Jon Guice
- Dennis Heher
- Kim Hubbard
- Larry Kiser
- Deepak Kulkarni
- David Nishikawa
- Steve Rich
- Keith Swanson
- Sergey Yentus

Key Science Collaborators

- Brad Bebout (ARC)
- Dave Blake (ARC)
- Dave Des Marais (ARC)
- David McKay (JSC)



Problem:

Capturing the Scientific Record in Distributed Teams



Accurate capture and preservation of the scientific record during an investigation is critical to conducting research, replicating results, & conducting follow-on studies, yet is difficult to achieve:

- Distributed teams
- Wide variety of data sources (sensors, instruments, data analysis software)
- Heterogeneous information formats (image, data)
- Distributed data curation
- Lack of metadata
- Different terminology used by different groups
- Difficult to see the connections between data/information gathered by different people



Semantic Technology Solution



1. Centralize: Store all project information in a common repository (*at least virtually*)
2. Standardize: For each project team, engineer a common information model and vocabulary for expressing and interrelating all project information – not focusing solely on data
3. Contextualize: Annotate the data with ample semantic context to provide a basis for understanding interrelationships

**Develop a Semantically-structured
Information Repository: ScienceOrganizer**



What is ScienceOrganizer?



- **A Web-based collaborative knowledge management tool for distributed teams of scientific investigators**
- **Facilitates information sharing, integration, correlation**
- **Serves as a project information repository / digital library:**
users upload/download heterogeneous project information products – images, datasets, documents, and various types of scientific records (describing samples, field sites, measurements, instruments, etc.)
- **Features contextualized cross-linkage:**
enables rapid access to interrelated information; *permits linking data and observations to scientific hypotheses*
- **Supports inference capabilities:**
permits formal reasoning about the repository contents
- **Functions as a project archive:**
tracks history of project team's fieldwork, labwork, and associated data collection activities



Scientific Activities Supported using ScienceOrganizer



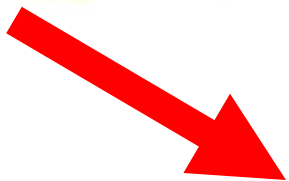
- Collecting scientific field data
- Performing laboratory experiments
- Acquiring data from remote instruments
- Archiving samples and images
- Tracking scientific hypotheses
- Writing scientific papers & proposals
- Conducting education and outreach



**Microbial mat
(algae)**



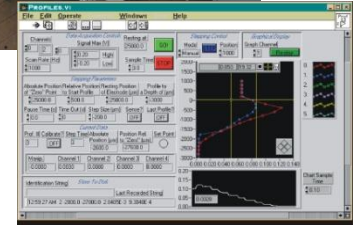
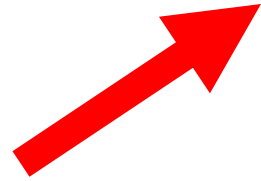
**Collection of
microbial mats
in the field**



Greenhouse Incubator



**Trace gas production and
consumption under
“Early Earth” conditions**



**Detailed studies of
mat biogeochemistry**

- monitoring
- analysis
- experimentation

**geographically-disbursed
team of collaborators**



Preserving the Evidence



- **Mat “4b” is a piece of evidence in the scientific investigation**
- **Want to capture all contextual information about Mat “4b” for use in:**
 - **conducting analyses**
 - **generating hypotheses**
 - **conveying situational information to remote collaborators**
 - **writing papers**
 - **designing follow-on field investigations**



collected-at

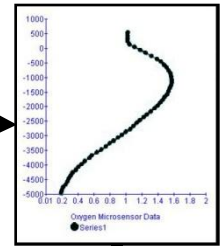
collected-by

stored-in

O₂ Concentration

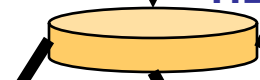


has-measurement



has-culture

measured-with



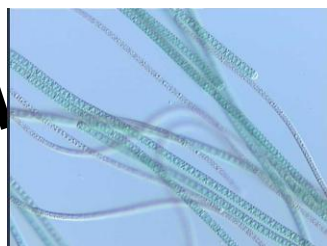
HBC-2 Microbial culture

imaged-with

has-image

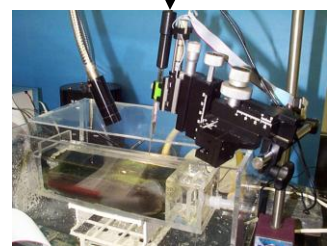
cultivated-by

has-recipe



Culture prep B notes for Lee

Culture recipe





Key Idea



**To facilitate storage, retrieval and
comprehension of scientific data,
capture the**

semantic context

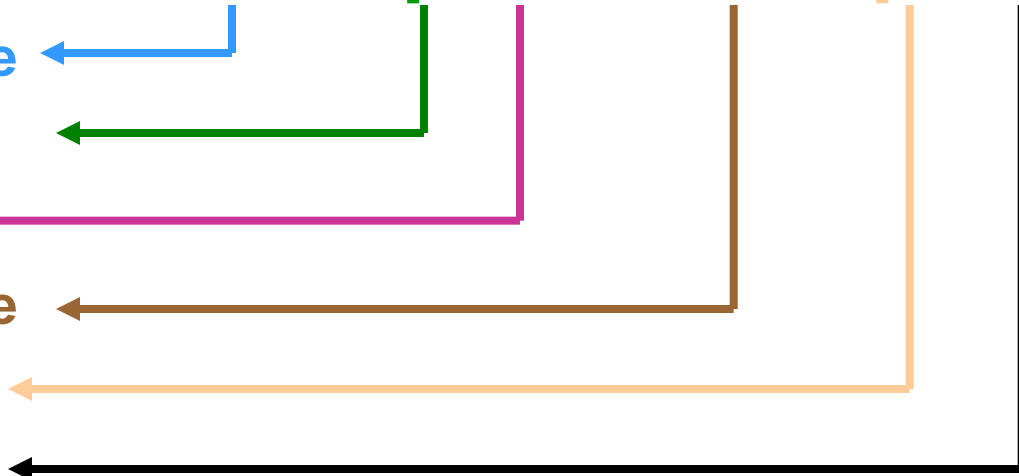
associated with each data product

- **Generally, it isn't!**
- **File naming conventions provide some obscure clues:**

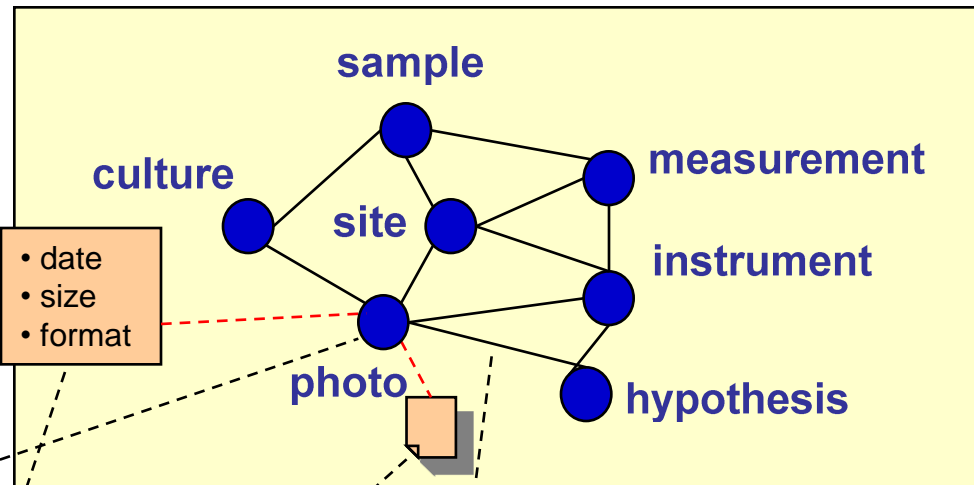
mats/spr4b061502pf.tiff

mats/spr4b061502pf.tiff

- **type of sample**
- **collection site**
- **sample#**
- **collection date**
- **camera filter**
- **image format**



Ontology:
Specifies the types of nodes, attributes and links defined for scientific investigation



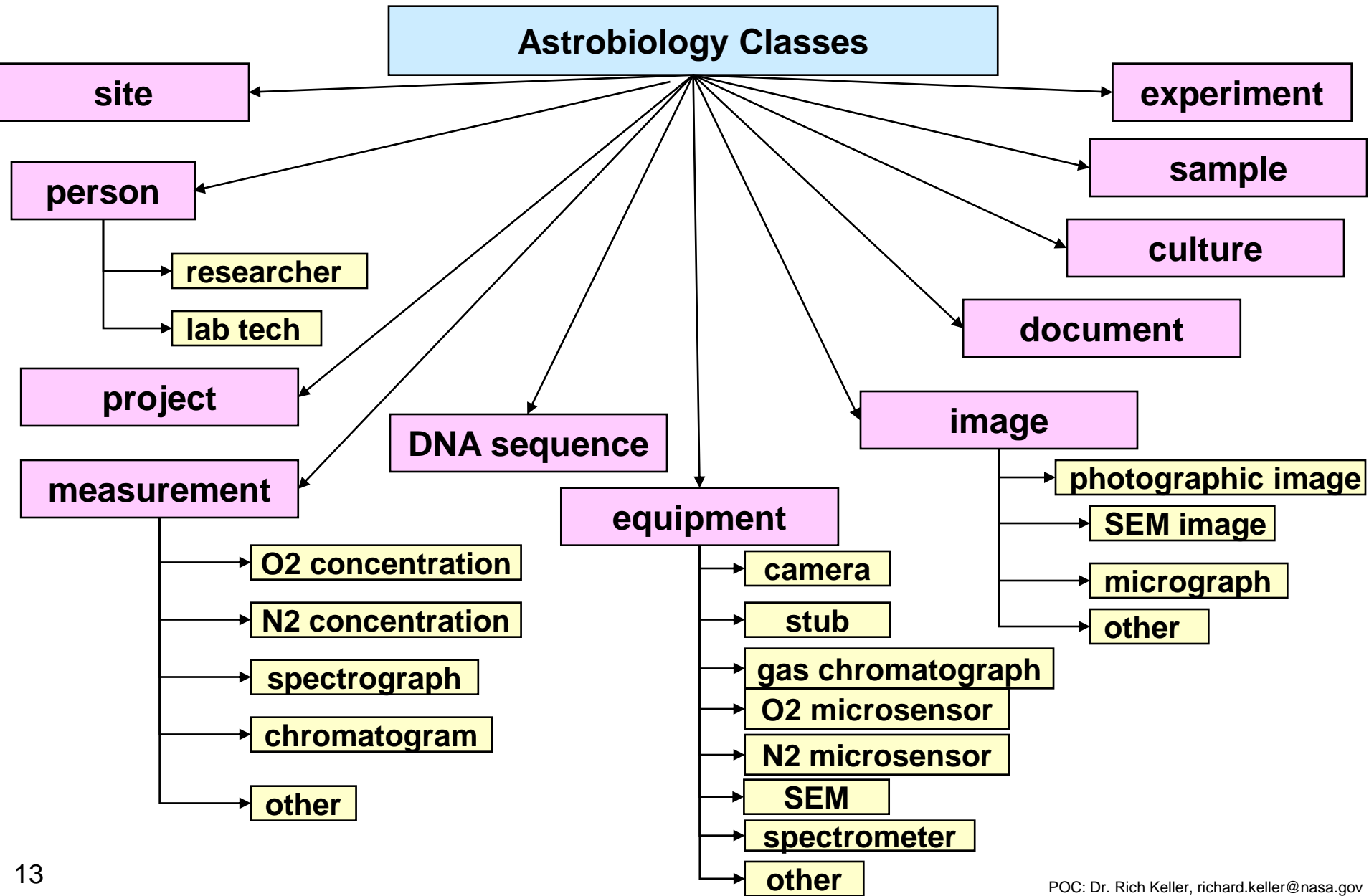
Rules:
Add/modify nodes, links & attributes in the network

- **Nodes:** key info resources or organizational structures (describes people, places, measurements, hypotheses)
 - **Attributes:** properties of resources (metadata)
 - **Links:** relationships among resources (e.g., “measured by”, “supports hypothesis”)
- **Attached files:** electronic products associated with resources (in almost any type of format)



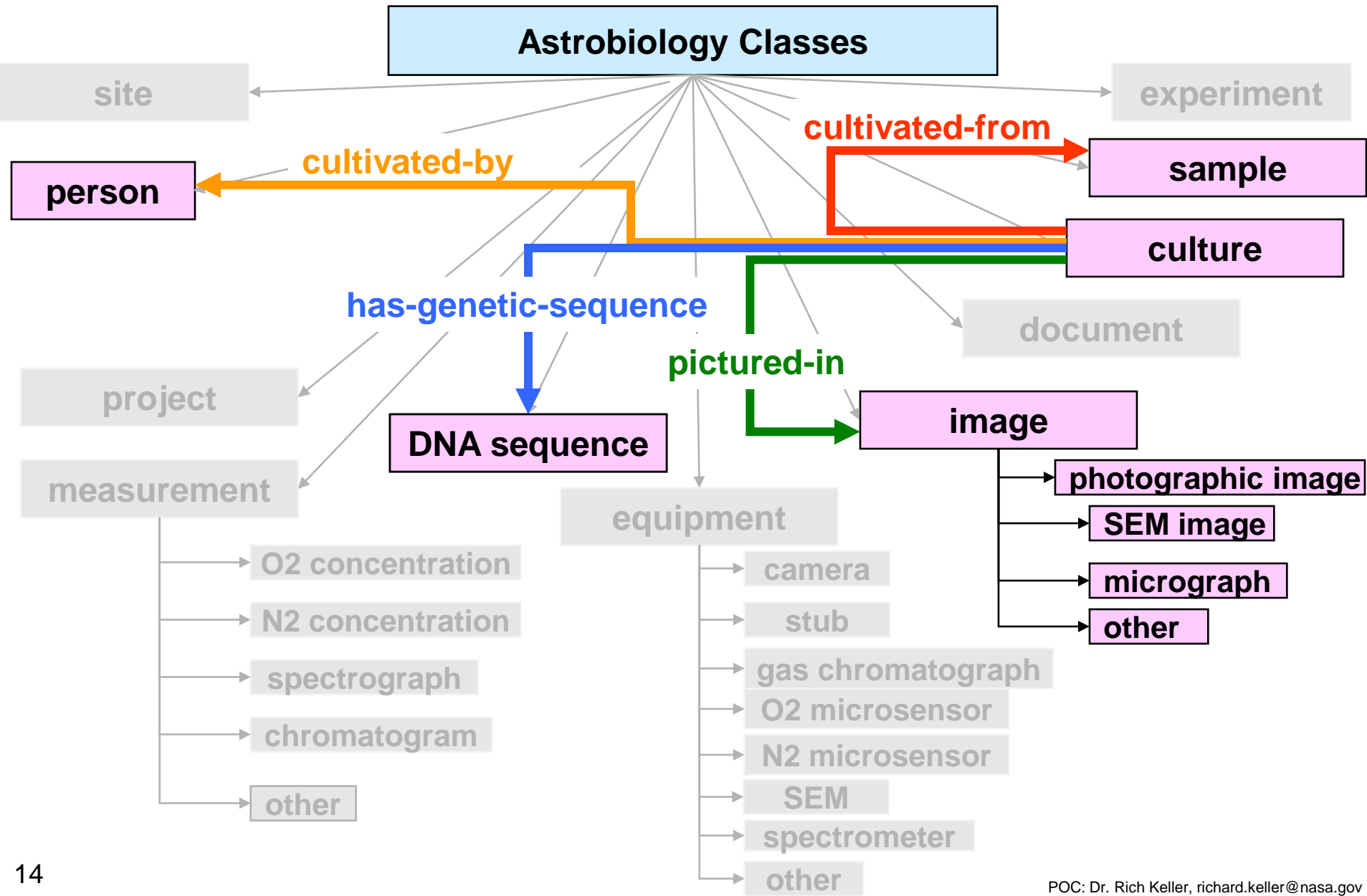
Astrobiology Ontology

(partial)



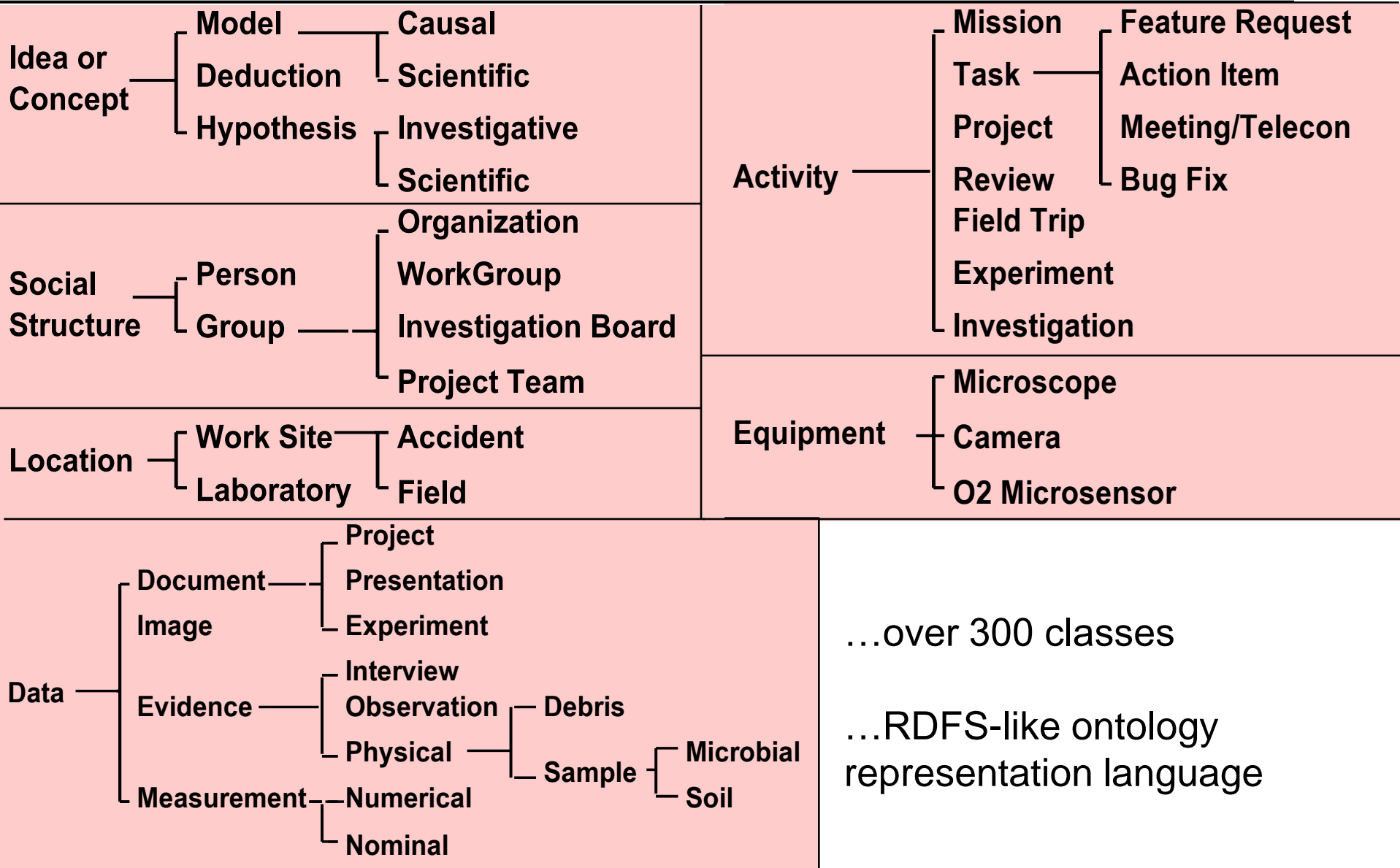


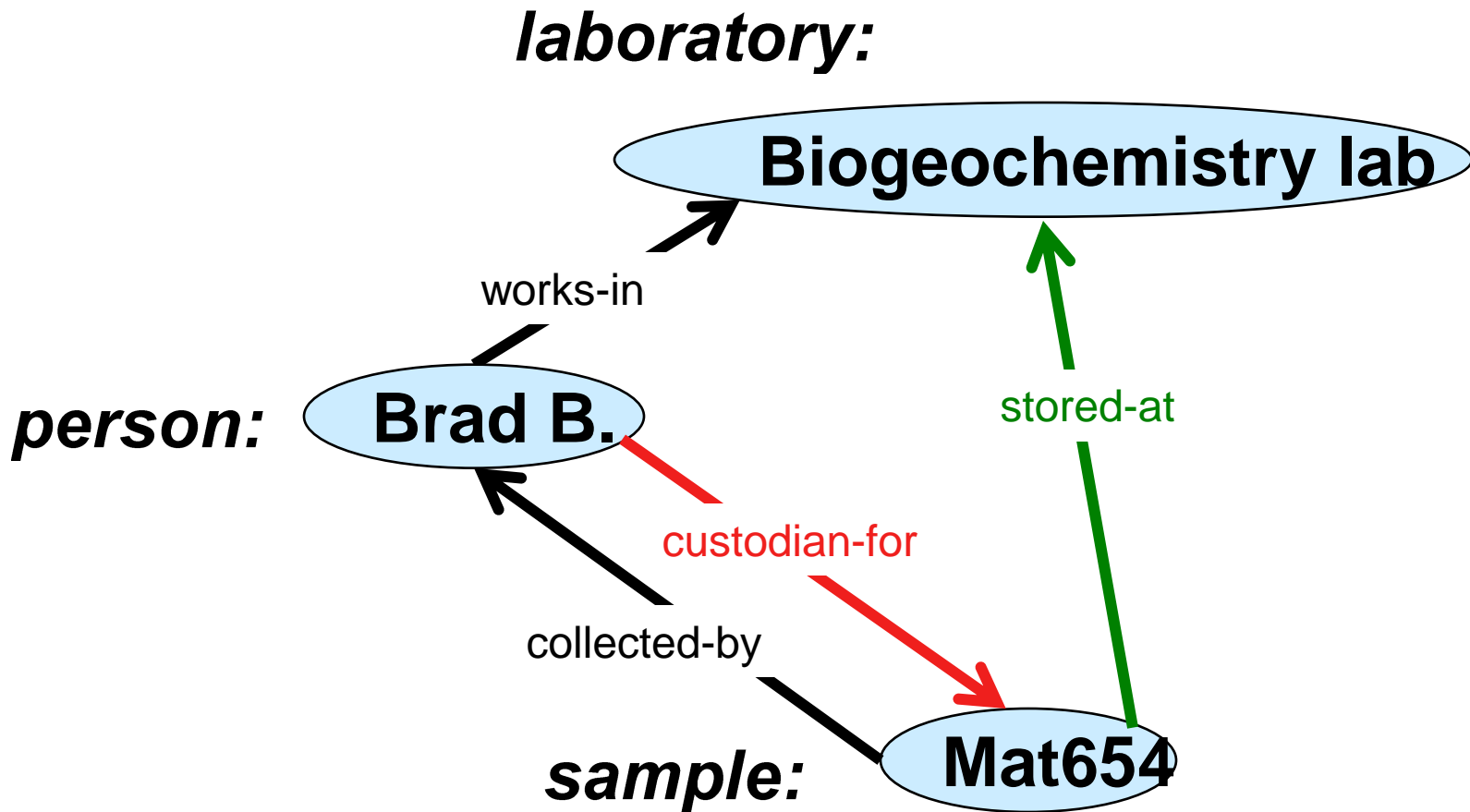
Relationships between Classes





Unified Master Ontology





If sample S is collected-by person P, and S has no custodian, then P is custodian-for S

If person P is custodian-for sample S, and P works-in laboratory L, then S is stored-at L



SemanticOrganizer's Browser-based Interface

(Algae Mat Sample Node: Spring-M4-b)



create new nodes create new links search for nodes icon identifies node type modify node metadata

Links to Related Nodes

semantic links

related nodes (click to navigate)

Focal Node

Node Metadata

| | | | | | |
|------------|------------|-------------|--------------------|-------------|--------------------|
| New Item | Search | Home | Go To | Logout | Help |
| View Links | Edit Links | Modify Item | Modify Permissions | Delete Item | Duplicate Item |
| | | | | | Put Item In Folder |

- Spring-M4-b (open all | [close all](#))
 - Associated Project (1 Projects)
 - EMERG
 - Collected At (1 Field Sites)
 - Spring Beach (tidal)
 - Collected By (1 Persons)
 - Bebout, Brad
 - Collected During (1 Field Trips)
 - Baja June 1999
 - Has Custodian (1 Persons)
 - Hogan, Mary
 - Has Measurement (1 Measurements)
 - ExpID#131791-3
 - Has Sequence Info (1 DNA Sequences)
 - 16S3 rRNA sequence
 - Pictured In (1 Images)
 - SprM4b excised**
 - Source Of (1 Cultures)
 - HBC-X2

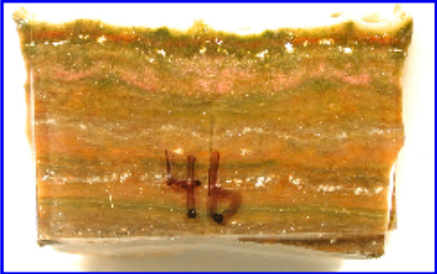
| | |
|--|--|
| ★ Mat Sample: Spring-M4-b | |
| Item ID# 132888 updated 2001/05/23 10:52AM PDT | |
| Send this Item's web address via Email | |
| Description | Vibrant yellow-orange slimy mat, approx. 10" square 1cm thick. |
| Collection Date | 03/22/2001 |
| Collection Time | 14:30:00 |
| Sample Type | benthic streamer mat |
| Microorganisms | Synechococcus ("lividus"-type) |
| Laboratory Preservative | alcohol |
| Preservative Field Dilution | .2 % |
| Preservative Buffer | RB-5 ChlorAC |
| Sample Container Type | tupperware |
| Storage | greenhouse co |
| Water Temperature | 27 °C |
| Water pH | 7.0 |
| Notes | Excised from a sandy site. |
| Write Permission | ● Bebout, Brad |
| Read Permission | ● EMERG |

| | | | | | |
|----------------------------|----------------------------|----------------------|--------------------------------|------------------------------------|-----------------------------|
| New Item | Search | Home | Go To | Logout | Help |
| View Links | Edit Links | | Modify Item | Modify Permissions | Delete Item |
| | | | Duplicate Item | Put Item In Folder | |

- [-] SprM4b excised (open all | [close all](#))
 - [-] **Camera Used** (1 Cameras)
 - [-] [Brad's Digital Olympus](#)
 - [-] **Image Of** (1 Samples)
 - [-] ☆ [Spring-M4-b](#)
 - [-] **Imaged By** (1 Persons)
 - [-] ● [Bebout, Brad](#)

Photo: SprM4b excised

Item ID# 132919 updated 2003/06/14 04:28PM PDT
 Send this Item's web address via [Email](#)



Click image to view at ACTUAL size.
 Right Click (or click and hold on Macintosh) to download image.

[Click here to download associated jpg file](#)

[Help with downloading](#)
[Annotate Image](#)

Caption Sample exhibits classic layering associated with mats from the Baja region.

Image Date 03/22/2001

Notes Original photo stored in N239 room 433.

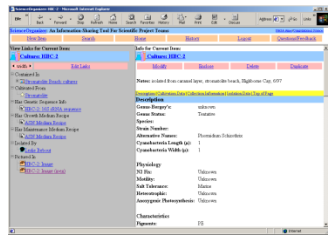
Write Permission ● [Bebout, Brad](#)

Read Permission ● [EMERG](#)

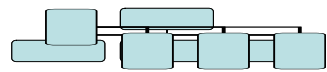
Architecture

Interface Layer

Node Browser Interface

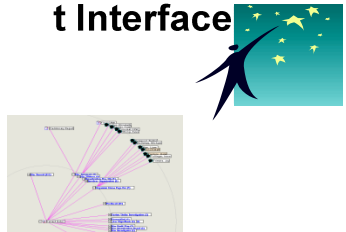


Structure Editors/Viewers

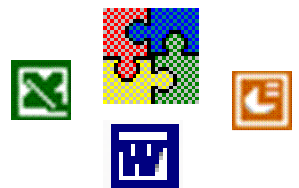


Radial Network Browser

Programmatic/Agent Interface



Microsoft Office Macro Integration



Representation & Reasoning Layer

Email Ingestor
(email & attachments)

Semantic Repository
(items, links, attribute values)

Ontology
(item types, link types, attributes, rules)

Semantic Annotation

WordNet thesaurus

Inference Engine

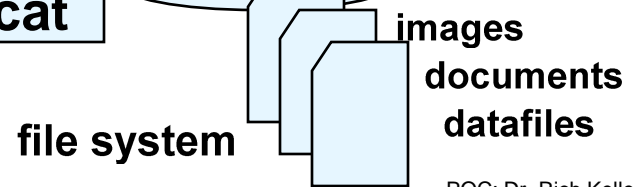
Implementation Layer

Java servlets

Apache-Tomcat

MySQL Database

Jess





Some Notable Features



- Text and Semantic search
- Email discussion list integration
- Automated semantic hyperthreading
- Microsoft office integration
- Collaborative image annotation
- Interoperation w/external agents



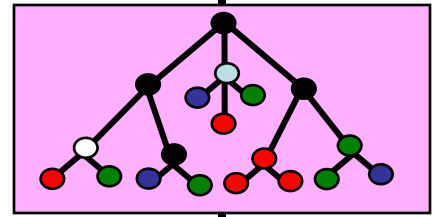
Operational Status



- System deployed initially in 2001
- Over 400 registered individual users from over 50 organizations within NASA at peak
- Over 30 projects hosted
- Over 45,000 nodes & 160,000 links in repository
 - Over 10,000 electronic files stored (documents, image, datasets)
 - Over 10,000 archived email messages

**customization
capability**


SemanticOrganizer




*Application-specific
Information model
(ontology)*

DesignOrganizer

NewBusinessOrganizer

1  **ScienceOrganizer**

2  **InvestigationOrganizer**

3 **SoftwareOrganizer**

- NASA Astrobiology Inst.
- Mobile Agents Simulation
- NIH Malaria Study
- MARTE Analog Mars Mission
- MER Mars Rover Mission
- Mars Meteorite Team
- MBARI MB'06 Field Campaign

- Columbia Accident Investigation.
- CONTOUR Accident Investigation
- Helios Accident Investigation
- Shuttle "Return-to-Flight"
- Moffett Airshow Mishap

- CEV Software V&V



ScienceOrganizer Deployments



Astrobiology Field and Lab Science



NIH-NASA African Malaria Study



Electron Microscopy Image Archive (Martian Meteorites)



Simulated Mars Surface Exploration



Monterey Bay Oceanographic Campaign



MARTE Mars Analog Drilling Mission



Mars Exploration Rovers Hypothesis Management (prototype)

Web Site <http://sciencedesk.arc.nasa.gov>

Paper

Keller et al.: “SemanticOrganizer: A Customizable Semantic Repository for Distributed NASA Project Teams”, International Semantic Web Conference, Hiroshima, Japan, November 2004.

Honors



Winner, Best paper award, 2004 International Semantic Web Conference



Finalist in the 2003 NASA Software of the Year Competition and recipient of a Space Act Award for significant technical contribution to NASA.



Winner of a 2004 NASA Turning Goals Into Reality Award for outstanding accomplishment in supporting the Columbia Accident Investigation Board



Finalist in the 2004 Semantic Web Challenge Competition



- **Mars Exploration Rover application:**
Science Hypothesis Organizer
- **ScienceOrganizer Features:**
 1. Text and Semantic search
 2. Email discussion list integration
 3. Automated semantic hyperthreading
 4. Microsoft office integration
 5. Collaborative image annotation
 6. Interoperation w/external agents



MER Science Hypothesis Organizer Objective



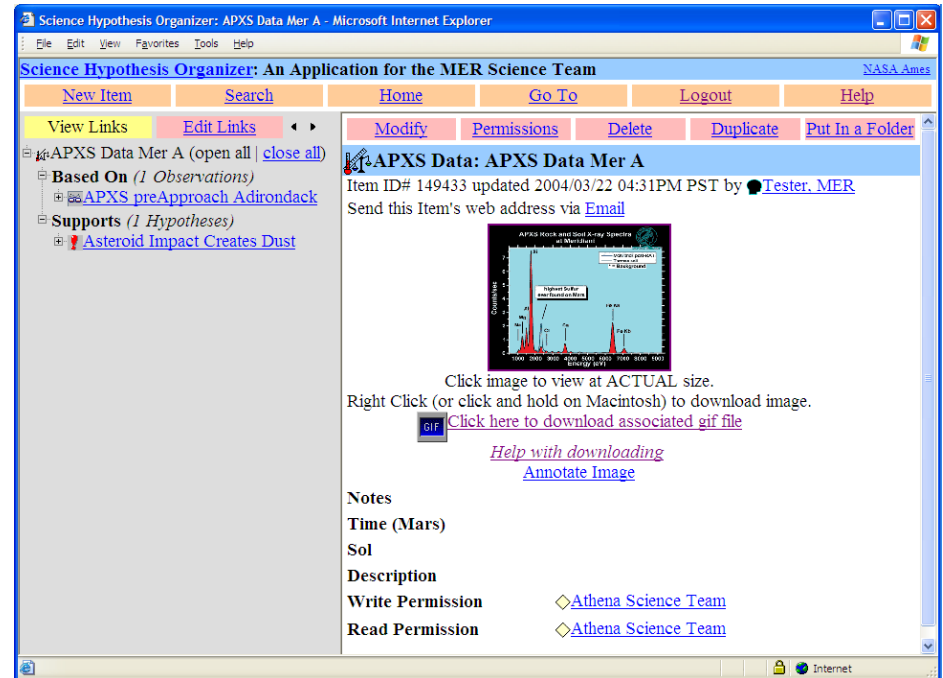
Improve MER science return by facilitating the science team's hypothesis formation process

Motivation:

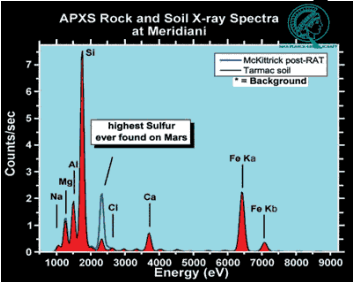
- Hypothesis formation and testing are fundamental drivers for MER science
- Hypothesis formation and reasoning processes are informal and managed in an *ad hoc* fashion
- No representation of the process is formally captured for later analysis or critical reflection
- No centralized catalog of active hypotheses and scientific evidence

Permits MER scientists to store/track hypotheses & relate them to:

- observations
- data products
- documents
- & other files stored in mission data systems



Hypothesis: Mars surface dust formed from meteor impact



APXS data



Adirondack pancam

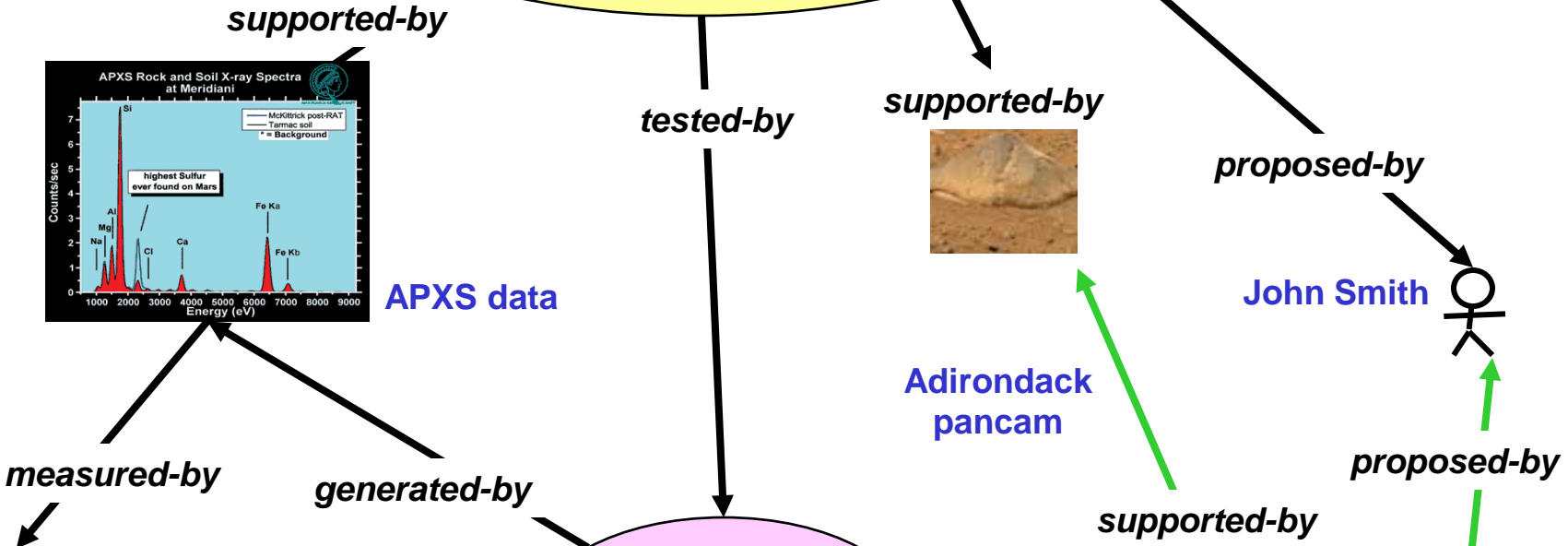


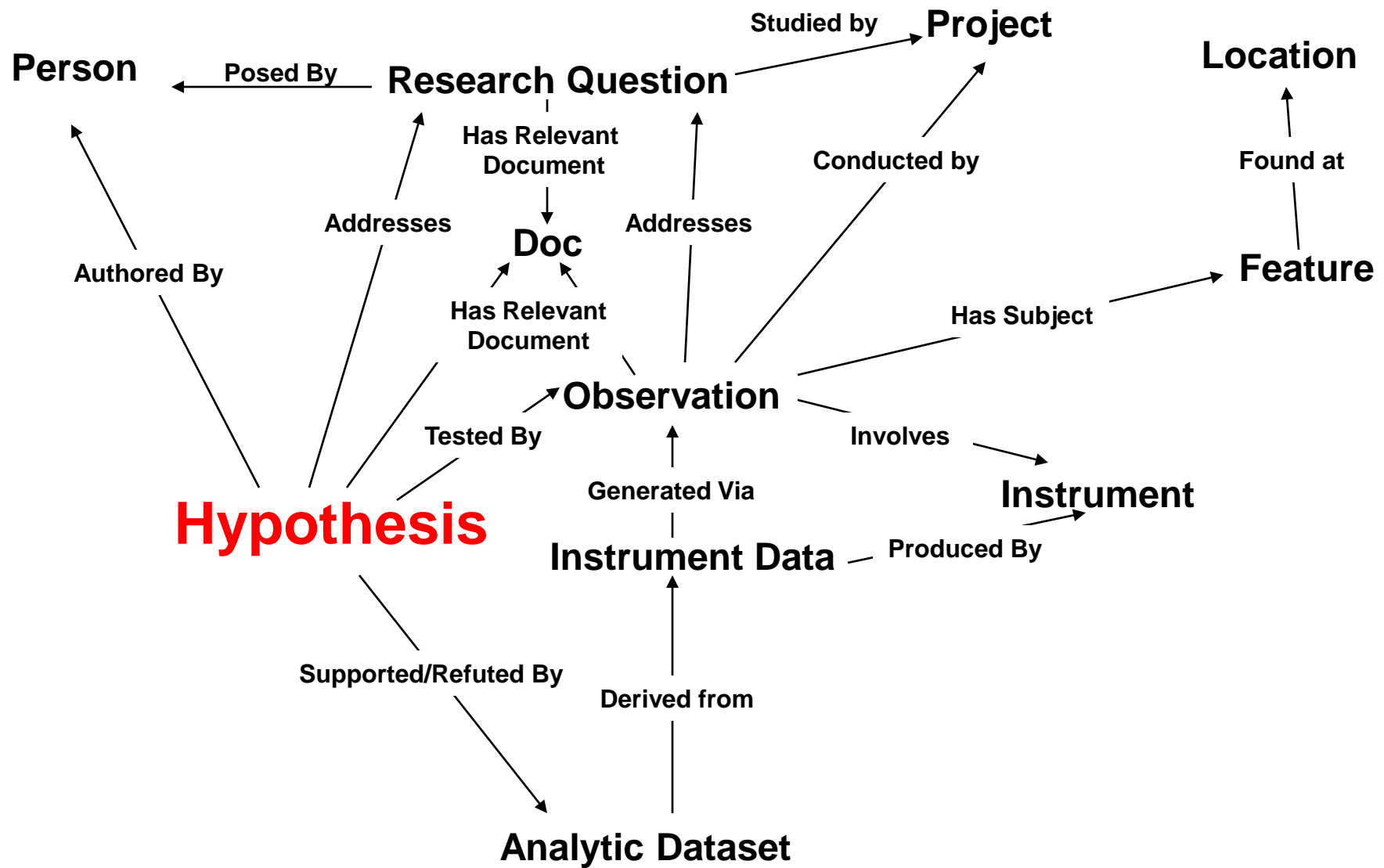
APXS instrument

APXS observation

Hypothesis: Soil is a duracrust of fine sand of aeolian dust & mafic volcanic rock fragments

John Smith







MER SHO Object Hierarchy



- All Items**
 - Analytic Dataset
 - Email Message
 - Feature
 - Hypothesis
 - Institution
 - Location
 - Mailing List
 - MER Participant
 - Observation
 - Project
 - Research Question
 - Target
 - Item (other)

- All Instrument Data**
 - All Images**
 - Hazcam Image
 - Micrograph
 - Navcam Image
 - Pancam Image
 - Image (other)
 - All Measurements**
 - APXS Data
 - Mini-TES Data
 - Mossbauer Data
 - Measurement (other)
 - Instrument Data (other)

- All Documents**
 - Meeting Notes
 - Presentation
 - Research Paper
 - Document (other)
- All Instruments**
 - APXS
 - Camera
 - Mini-TES
 - Mossbauer
 - RAT
 - Rover
 - Instrument (other)

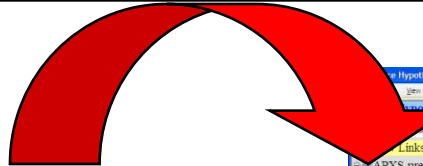


MER SHO Screenshots



Hypothesis

Observation Request



Science Hypothesis Organizer: Asteroid Impact Creates Dust - Microsoft Internet Explorer

Science Hypothesis Organizer: An Application for the MER Science Team

View Links Edit Links

Asteroid Impact Creates Dust (open all)

- Authored By (1 Participants)
 - Sims, Michael
- Explores (1 Research Questions)
 - Origin of martian dust
- Refuted By (1 Instrument Data/0 Analyses)
 - MER CIP Image
- Relevant Document (1 Documents)
 - Origins of Dust on Extrasolar Planets
- Supported By (1 Instrument Data/0 Analyses)
 - APXS Data Mer A
- Tested In (1 Observations)
 - APXS preApproach Adirondack

Hypothesis: Asteroid Impact Creates Dust

Item ID# 150594 updated 2004/03/19 09:01AM PST by Tester, MER

Send this Item's web address via [Email](#)

Tests

The primary test of this hypothesis is based on APXS analyses of the reddish dust. A chondritic abundance and the presence of nickel would be an indicator of exogenic influx.

Description

Asteroid impacts pulverized surface rocks to form the dust visible on the surface of Mars

Suggested Measurements/Observations

APXS and Mossbauer analyses of the reddish dust for meteoritic abundances of Ni.

MER Observation Requests

[APXS preApproach Adirondack](#)

Author

Sims, Michael

Notes

Write Permission

[Athena Science Team](#)

Read Permission

[Athena Science Team](#)

Hypothesis Organizer: APXS preApproach Adirondack - Microsoft Internet Explorer

Science Hypothesis Organizer: An Application for the MER Science Team

Links Edit Links

APXS preApproach Adirondack (open all)

- Addresses (1 Research Questions)
 - Origin of martian dust
- Conducted By (1 Projects)
 - Athena Science Team
- Has Subject (1 Features)
 - Adirondack Rock
- Relevant Document (1 Documents)
 - Origins of Dust on Extrasolar Planets
- Resulted In (4 Instrument Data)
 - APXS Data Mer A
 - Flazcam Adirondack Image
 - MER CIP Image
 - MERSpace Test
- Tests (1 Hypotheses)
 - Asteroid Impact Creates Dust

Observation: APXS preApproach Adirondack

Item ID# 149372 updated 2004/03/19 09:02AM PST by Tester, MER

Send this Item's web address via [Email](#)

Subject Feature

[Adirondack Rock](#)

Description

Use the APXS to analyze the composition of Martian dust. The results of the analysis should tell us if elements known to be exogenous to Mars are present, discounting the thermal cycle erosion theory and supporting Asteroid Impact theory.

Tests

APXS the dust.

Research Question

[Origin of martian dust](#)

Methods

APXS

Proposed Analysis

Status

Awaiting sequencing

Participants

Notes

Write Permission

[Athena Science Team](#)

Read Permission

[Athena Science Team](#)

APXS Data Product

Science Hypothesis Organizer: APXS Data Mer A - Microsoft Internet Explorer

Science Hypothesis Organizer: An Application for the MER Science Team

New Item Search Home Go To Logout Help

View Links Edit Links

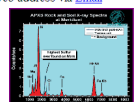
APXS Data Mer A (open all)

- Based On (1 Observations)
 - APXS preApproach Adirondack
- Supports (1 Hypotheses)
 - Asteroid Impact Creates Dust

APXS Data: APXS Data Mer A

Item ID# 149433 updated 2004/03/22 04:31PM PST by Tester, MER

Send this Item's web address via [Email](#)



Click image to view at ACTUAL size.
Right Click (or click and hold on Macintosh) to download image.
[Click here to download associated gif file](#)

[Help with downloading](#)
[Annotate Image](#)

Notes

Time (Mars)

Sol

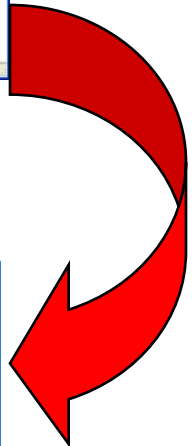
Description

Write Permission

[Athena Science Team](#)

Read Permission

[Athena Science Team](#)





Text Search



microbial

Search within Names Files Fields

Find Now **... or** Restrict Fields

Select type(s) to search:

- | | | |
|--|--|---|
| <input type="checkbox"/> All Items <input type="checkbox"/> Culture <input type="checkbox"/> DNA Sequence <input type="checkbox"/> Email Message <input type="checkbox"/> Experiment Log <input type="checkbox"/> Field Site <input type="checkbox"/> Field Trip <input type="checkbox"/> Gas Sample <input type="checkbox"/> Global Control <input type="checkbox"/> GreenHouse Table Pass <input type="checkbox"/> Institution <input type="checkbox"/> Laboratory <input type="checkbox"/> Mailing List <input type="checkbox"/> Mat Sample <input type="checkbox"/> Model <input type="checkbox"/> Note <input type="checkbox"/> Person <input type="checkbox"/> Sediment Sample <input type="checkbox"/> Stromatolite Sample <input type="checkbox"/> Study Area <input type="checkbox"/> Test Point <input type="checkbox"/> URL <input type="checkbox"/> Water Sample <input type="checkbox"/> Item (other) | <input type="checkbox"/> All Images <input type="checkbox"/> Micrograph <input type="checkbox"/> Photo <input type="checkbox"/> Phylogenetic Tree <input type="checkbox"/> SEM Image <input type="checkbox"/> Image (other) | <input type="checkbox"/> All Documents <input type="checkbox"/> Culture Recipe <input type="checkbox"/> Equipment Document <input type="checkbox"/> Experiment Document <input type="checkbox"/> Figure <input type="checkbox"/> Presentation/Poster <input type="checkbox"/> Project Document <input checked="" type="checkbox"/> Publication <input type="checkbox"/> Trip Document <input type="checkbox"/> Document (other) |
| <input type="checkbox"/> All Groups <input type="checkbox"/> Project <input type="checkbox"/> Workgroup | <input type="checkbox"/> All Measurements <input type="checkbox"/> Acetylene Reduction <input type="checkbox"/> Ammonium <input type="checkbox"/> Biomarker Analysis <input type="checkbox"/> Carbon Isotope <input type="checkbox"/> Carbon Monoxide <input type="checkbox"/> Dissolved Inorganic Carbon <input type="checkbox"/> Dissolved Organic Carbon <input type="checkbox"/> Fluorescence <input type="checkbox"/> Hydrogen Sulfide <input type="checkbox"/> Hydrogen <input type="checkbox"/> Light <input type="checkbox"/> Mat Image <input type="checkbox"/> Methane <input type="checkbox"/> Nitrate <input type="checkbox"/> Orthophosphate <input type="checkbox"/> Oxygen <input type="checkbox"/> pH <input type="checkbox"/> Salinity <input type="checkbox"/> Temperature <input type="checkbox"/> Volatile Sulfur <input type="checkbox"/> Measurement (other) | <input type="checkbox"/> All Equipment <input type="checkbox"/> Camera <input type="checkbox"/> Flow Box <input type="checkbox"/> Fluorometer <input type="checkbox"/> Gas Chromatograph <input type="checkbox"/> H Microsensor <input type="checkbox"/> H2S Microsensor <input type="checkbox"/> Ion Chromatograph <input type="checkbox"/> Light Microsensor <input type="checkbox"/> Mass Spectrometer <input type="checkbox"/> O2 Microsensor <input type="checkbox"/> pH Meter <input type="checkbox"/> pH Microsensor <input type="checkbox"/> Refractometer <input type="checkbox"/> SEM <input type="checkbox"/> Spectrophotometer <input type="checkbox"/> Thermometer <input type="checkbox"/> Tray <input type="checkbox"/> Equipment (other) |

Enter criteria for Field-Restricted Search. [Help with Restructuring Fields](#)

Fill in any Fields you want to restrict during search.
 You can specify a range for numbers, dates, and time.
 Leave blank any fields you do not care about or are unsure about.

Publication Name: microbial

Publication Title

Publication Type
 no value selected
 journal article
 conference paper
 magazine article

Publication Status
 draft
 final

Acceptance Status
 unsubmitted
 in review
 accepted
 rejected

Author
 No Value Given
 Albert, Dan
 Baumgartner, Laura Kathleen
 Bebout, Brad [Help with selecting multiple entries](#)

Project
 No Value Given
 Ames Exobiology Culture Collection
 EMERG [Help with selecting multiple entries](#)
 Microb. Ecol. / Biogeochem. Lab Meeting

Journal

Issue

Pages

Conference/Workshop Proceedings Title

Edited Collection Title

- Search by semantic pattern (patterns involving extended chains of nodes, links, and values)

- Executed by matching pattern against the instance nodes and links in the semantic network

“Find all DNA Sequences associated with Stromatolite Samples collected at the Field Site named “Stromatolite Beach””

The screenshot shows a web application interface for semantic search. At the top, there are navigation tabs: Home, New Item, Search, Logout, and Help. Below the tabs are buttons for 'Perform Search' and 'Start Over'. The main area displays the search query: 'Your query so far...' followed by 'DNA Sequence 1' (circled in red) and 'Stromatolite Sample 1' (circled in red). Below the query, there are form fields for 'Set item to:' (HBC-1: 16S rRNA sequence) and 'Set item to:' (Core T-1B). The interface is divided into two main sections: 'Sequence For' and 'Field Site Info'. The 'Sequence For' section includes fields for Name, Sequence Origin, Gene, Sequencing Laboratory, Sequencing Method (Both strands sequenced, One strand sequenced), Sequencing Date (mm/dd/yyyy), Reading Direction (bidirectional, 5 --> 3, 3 --> 5), Best BLAST Hit Data (%, Genus, Species, Taxa), and Notes. The 'Field Site Info' section includes 'Collected At' (Field Site 1), 'Has Sequence Info' (DNA Sequence 1), and 'Field Site 1: Stromatolite Beach' (circled in red). There are buttons for 'Add New Link', 'Edit', 'Unset', and 'Set Field(s)'. At the bottom, it shows '0 Search Results' and a timestamp: 'Search started on Apr 16, 2004 4:00:33 PM'.



Email Discussion List Integration



ScienceOrganizer: An Information-Sharing Tool For Scientific Project Teams

NASA Ames/Computational Science

[New Item](#)

[Find Items](#)

[Home](#)

[Go To](#)

[Logout](#)

[Help](#)

- View Links [Edit Links](#)
- March Baja trip logistics (open all | [close](#))
 - Followed By (1 Email Messages)
 - [Greenhouse Mat Experiment and T](#)
 - Preceded By (1 Email Messages)
 - [Re: Baja, again](#)
 - Sent By (1 Persons)
 - [Des Marais, David](#)
 - Sent To (1 Persons/Mailing Lists)
 - [EMERG General Mailing List](#)
 - Other Permissible Links...
 - Contained By (0 Email Message Fo (other) Folders)
 - [Discusses \(0 Items\)](#)
 - Is Discussed In (0 Email Messages)
 - Next (0 Email Message Folders)
 - ScienceOrganizer Home Page For (0 Persons)
 - Unspecified (0 Items)

[Modify Item](#) [Modify Permissions](#) [Delete Item](#) [Duplicate Item](#) [Put Item In Folder](#)

Email Message: March Baja trip logistics

Item ID# 60371 updated 8/1/02@11:14AM
 Send this Item's web address via [Email](#)

'From:' Line David Des Marais <d-desmarais@mail.arc.nasa.gov>
Sender [Des Marais, David](#)
'To:' Line emerg@sciencedesk.arc.nasa.gov, "David A. Stahl" <d-stahl@nwu.edu>, "John R. Spear" <John.Spear@Colorado.EDU>, SOGIN@evol5.mbl.edu
Recipients [EMERG General Mailing List](#)
Date sent
Date received 2001-02-16 00:00:00
Body

Dear Group,

We are still looking forward to a March 5 to 18 schedule for the Baja trip. Last week, our Mexican research permit was recommended forward from SEMARNAP, Mexico's Department of the Environment and Fisheries, to SRe, their State Department. This week, the State Department reviewed the package, received inputs from other relevant agencies, and made additional requests from me with which I have now complied. I expect that we will receive final approval within days.

Accordingly, if you feel that making plane reservations now will save you more funds than you might lose with a postponement, please go ahead and make those reservations.

TRAVELING TO MEXICO

If you are taking a plane flight to join the trip, you are a member of the "Airplane Group." You should plan to meet in San Diego on March 5 and ride down together in a passenger van rented from Pearson Ford in San Diego. It might not be necessary for the Airplane Group to rendezvous with the Ames Group, unless some of you want to transfer equipment to our vans for customs declaration. We currently are holding a 12 passenger van in my name, but I must transfer that reservation to someone in the "Airplane" group as soon

Email Body

Links

Enhanced email indexing via semantic linkage

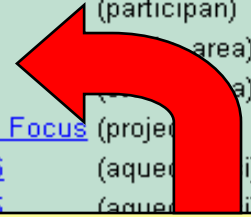


Automated Semantic Hyperthreading

[Concept Extraction from Email] (experimental)



| Email body (extract) | Relevancy rank | Node | Type |
|---|----------------|-----------------------------------|--------------|
| <p>"FIELD OBJECTIVES</p> <p>This field trip will address a number of objectives that include those of the Ecogenomics project as well as those associated with previously-funded grants. Accordingly, we will be performing biogeochemical measurements and collect samples for various analyses back at our respective laboratories...</p> | 1.063660 | Spear, John | (participan) |
| | 1.063660 | Stahl, David | (participan) |
| | 1.063660 | Bebout, Brad | (participan) |
| | 1.036137 | Ames | (area) |
| | 1.036137 | Baja | (a) |
| | 1.031293 | Ecogenomics Focus | (projec) |
| | 1.020290 | Pond 5 near 6 | (aque) |
| | 1.020290 | Pond 4 near 5 | (aque) |



Straw **sampling** Protocols

In situ **measurements** of fluxes:

... **number** of diel **periods** : 2 (once in **5**, once in [Pond 5 near 6](#))

... **number** of chambers: 6 (3 **mats**, three **blanks**)

... **sampling** times: 0600h, 0900h, 1200h, 1500h, 1800h, 2100h, 0000h, 0300h

... Water **volume taken** per **sampling time** : 5

... Gas **volume taken** per **sampling** interval 5

...SAMPLING

We recognize that the acquisition and preservation of samples will be a major objective of this trip. We had good preferences during our November meeting

2. Relevancy ranking score computed:

- based on heuristic combination of factors

[Pond 4 near](#)

| | | |
|----------|------------------------------------|--------------|
| 1.009677 | visscher, Pieter | (participan) |
| 1.009677 | Hoehler, Tori | (participan) |
| 1.009677 | Hogan, Mary | (participan) |
| 1.009677 | Garcia-Pichel, Fer | (participan) |
| 1.009677 | Dillon, Jesse | (participan) |
| 1.009677 | Turk, Kendra | (participan) |
| 1.009677 | Miller, Scott | (participan) |

1. Text marked up to identify:

- nouns matching node names/types
- verbs corresponding to links
- references to attribute values
- WordNet synonyms/hyponyms used to enable inexact semantic matching



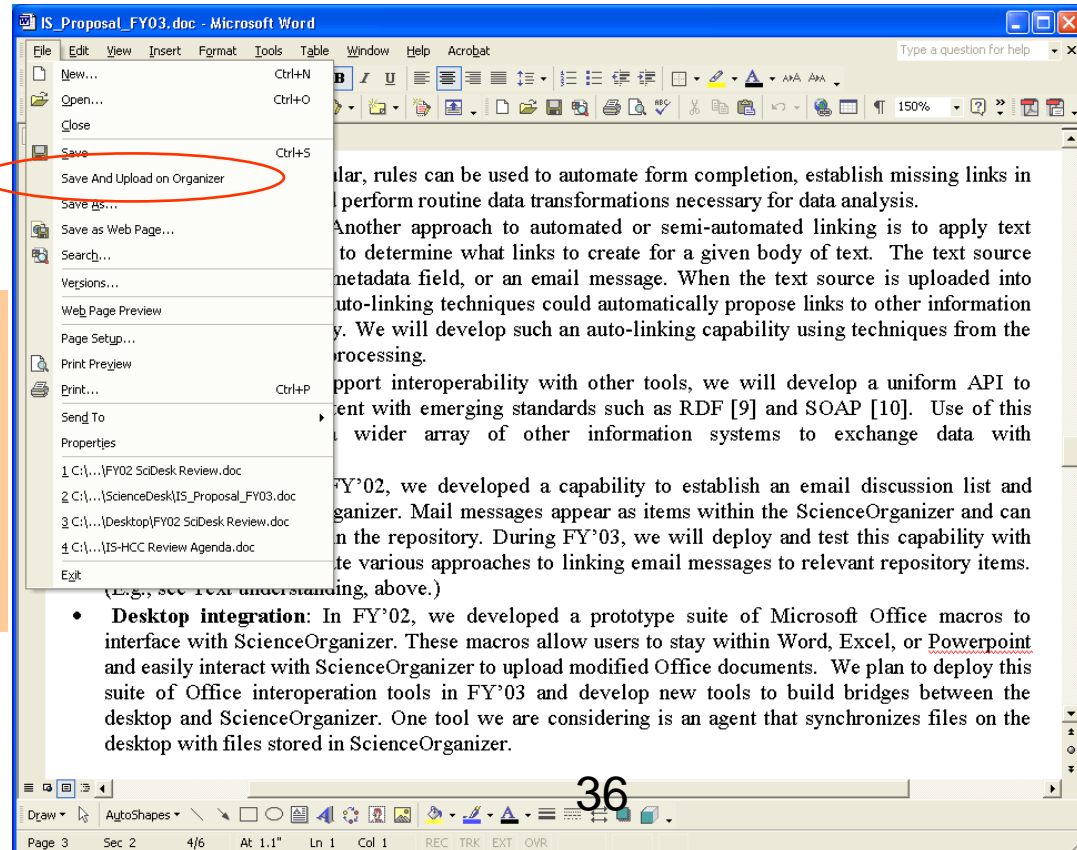


Microsoft Office Interoperation



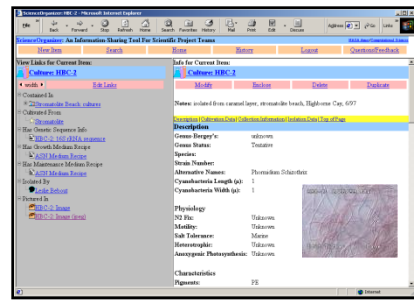
- Developed suite of Microsoft Office macros to enable direct upload and subsequent modification of documents without leaving Office application

“Save and upload to Organizer”



- Macro communicates w/server
- User fills out metadata using standard Organizer form on creation
- Subsequent saves are transparent

Collaborative Whiteboarding & Annotation Tool



SemanticOrganizer

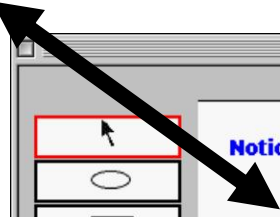


Image Frame

Tue Mar 07 17:15:11 PST 2000 HBC-2 Culture

Participants

hgreenleaf
rkeller

Notice the long filamentous strand clusters here.

What's going on here?

HBC-2: 2/26/99 40x

Edit Title: Page 1

Clear All
Clear Last
Hide

Connection Status:
Online:
Sign Off
Quit

Floor Status:
Not In Control:
Request Floor
Load Image



Interoperation w/ External Agents & Systems via API

