

Challenges and Obstacles to Digitizing Small Paleontology Collections

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UNIVERSITY OF WYOMING

University of Wyoming Fossil Vertebrate Collection

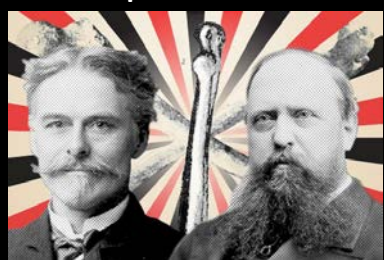


Mesozoic Vertebrates (Dinosaurs and Marine Reptiles)

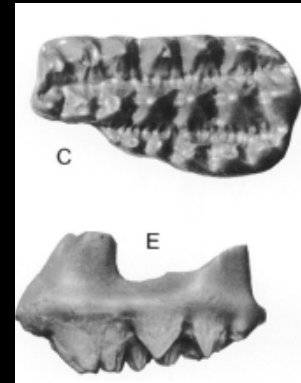
W. H. Reed



E. D. Cope O. C. Marsh

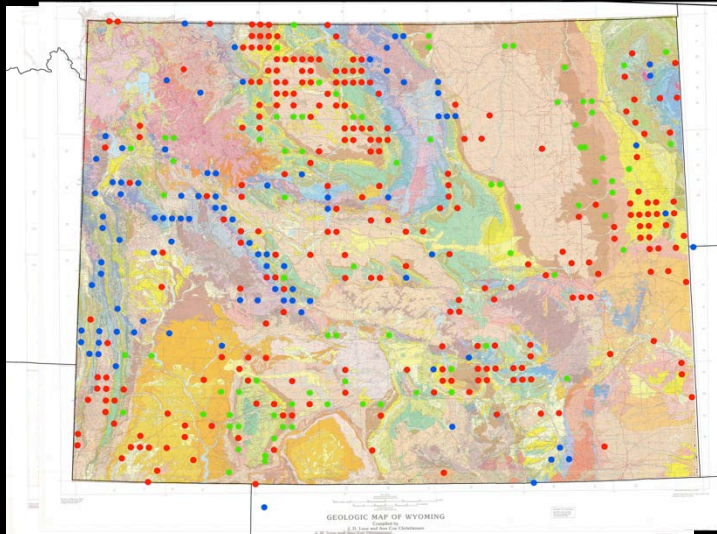
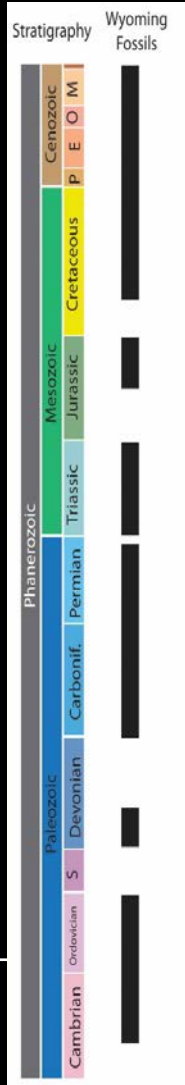


Mesozoic and Paleogene Mammals



Alphadon halleyi,

University of Wyoming Fossil Vertebrate Collection



- 40,000 specimens
- 2.6 Billion Years
- 2,600 Localities
- 1,100 Genera, ~400 Families, ~150 Orders



Challenges

- Paleo- Related
 - Fossils are extremely variable
 - Adaptive Workflows and Multiple Methods
- Small Collections- Related
 - Limited Personnel
 - Limited Funds

Fossils are extremely Data-Rich

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Life
Behavior



Morphology
Pathology
Isotopes
Tooth Wear

Fossils are extremely Data-Rich

Life
Behavior



Death/ Decay/
Scavenging



Morphology
Pathology
Isotopes
Tooth Wear

Scavenging
Weathering
Bioerosion
Epibionts
Breakage
Trampling

Fossils are extremely Data-Rich

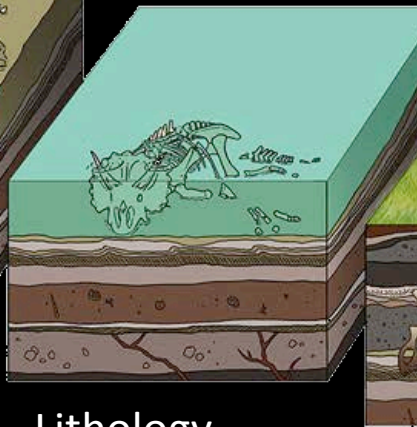
Life
Behavior



Death/ Decay/
Scavenging



Environment/ Rivers/
Sedimentation Rates



Morphology
Pathology
Isotopes
Tooth Wear

Scavenging
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Bioerosion
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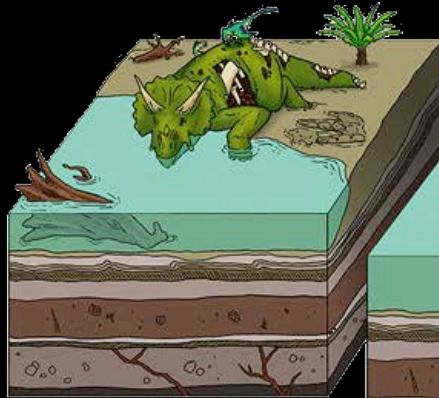
Lithology
Orientation
Rounding
Corrosion

Fossils are extremely Data-Rich

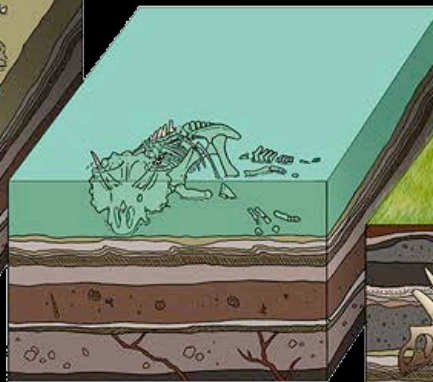
Life
Behavior



Death/ Decay/
Scavenging



Environment/ Rivers/
Sedimentation Rates



Geochemistry
Microbes
Geology



Morphology
Pathology
Isotopes
Tooth Wear

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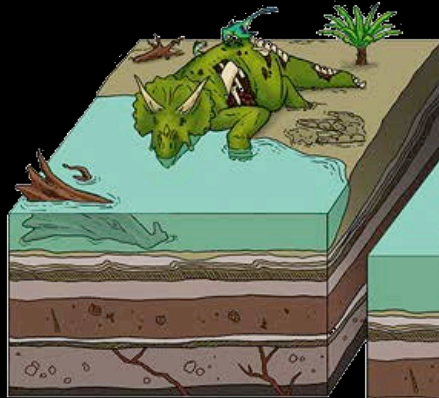
Minerals
Permineralization
Deformation
Replacement

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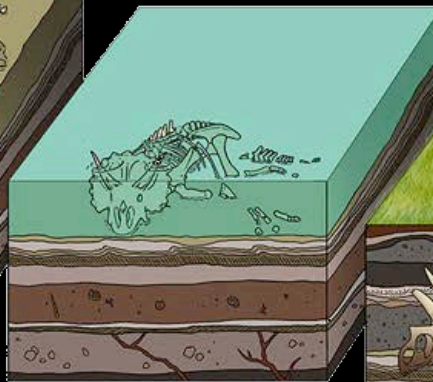
Life
Behavior



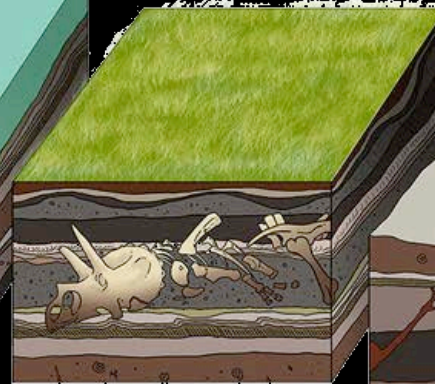
Death/ Decay/
Scavenging



Environment/ Rivers/
Sedimentation Rates



Geochemistry
Microbes
Geology



Excavation
Paleoecology



Morphology
Pathology
Isotopes
Tooth Wear

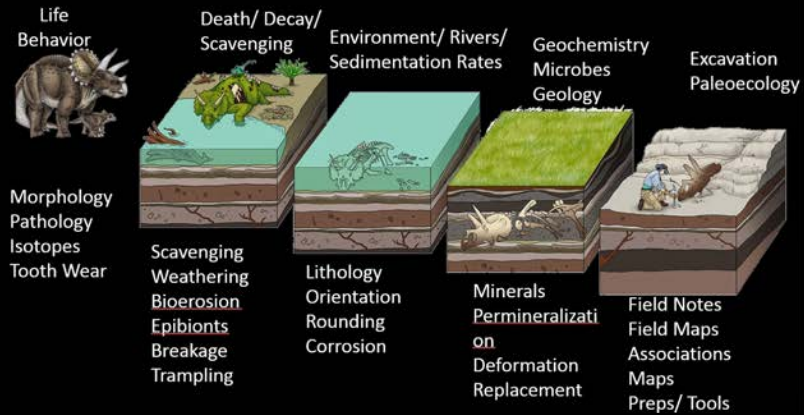
Scavenging
Weathering
Bioerosion
Epibionts
Breakage
Trampling

Lithology
Orientation
Rounding
Corrosion

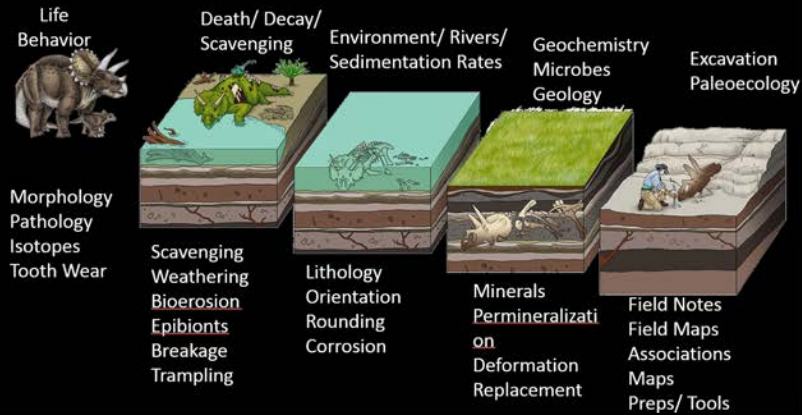
Minerals
Permineralization
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Field Notes
Field Maps
Associations
Maps
Preps/ Tools

Fossils are extremely Data-Rich



Fossils are extremely Data-Rich



Fossil Preparation



Storage



Research



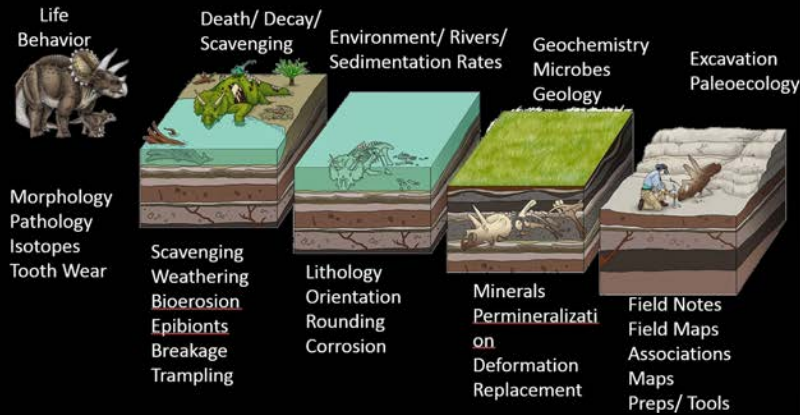
Lab Notes
Consolidate
Tools

Location
Method
Loans

Types
Analyses



Fossils are extremely Data-Rich



Fossil Preparation



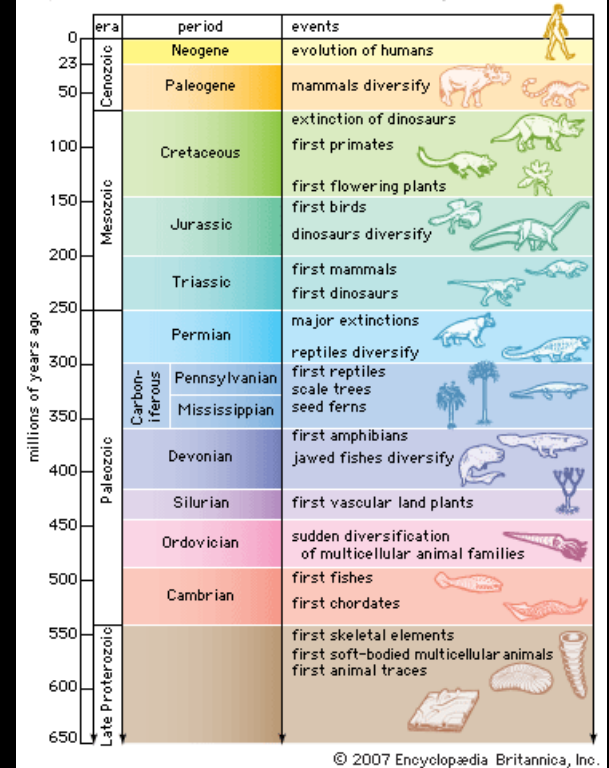
Storage



Research



Major evolutionary events, 650 million years ago to the present



Lab Notes
Consolidate
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Location
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Types
Analyses



Fossils are not 3D or 4D but 50+D

- Morphology
- Pathology
- Micro-wear
- Meso-wear
- Elemental
- Isotopic
- Minerals
- Scavenging
- Bioerosion
- Corrosion
- Rounding
- Weathering
- Field Notes
- Quarry Map
- Time Period
- Lithology
- Sediment
- Associations
- Field Notes
- Field Map
- Field #
- Preparations
- Lab Notes
- Lab photos
- Lab #
- Preparators
- Storage
- Georeference
- Identification
- Element Type
- Holotype?
- Publications
- Research Lab
- Loans
- Interactions
- Cast
- File Type
- Consolidants
- Land Owner
- Camera Info
- Scanner Info
- Dates
- Horizon
- Determination
- Notes
- Trampling
- Sorting
- Orientation
- Strike/Dip
- Condition?
- Breakage

Fossils are not 3D or 4D but 50+D

Poses many challenges to consider when attempting to digitize paleo collections?

- Morphology
- Field Notes
- Lab #
- File Type
- Strike/Dip
- Pathology
- Quality Map
- Provenance
- Comments
- Condition?
- Micro-wear
- Time Period
- Storage
- Land Owner
- Breakage
- Meso-wear
- Lithology
- Georeference
- Camera Info
- Elemental
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Fossils are not 3D or 4D but 50+D

Poses many challenges to consider when attempting to digitize paleo collections?

Complicated Workflow

Specimen by Specimen: **Adaptive Workflow**
with several techniques/methods

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Poses many challenges to consider when attempting to digitize paleo collections?

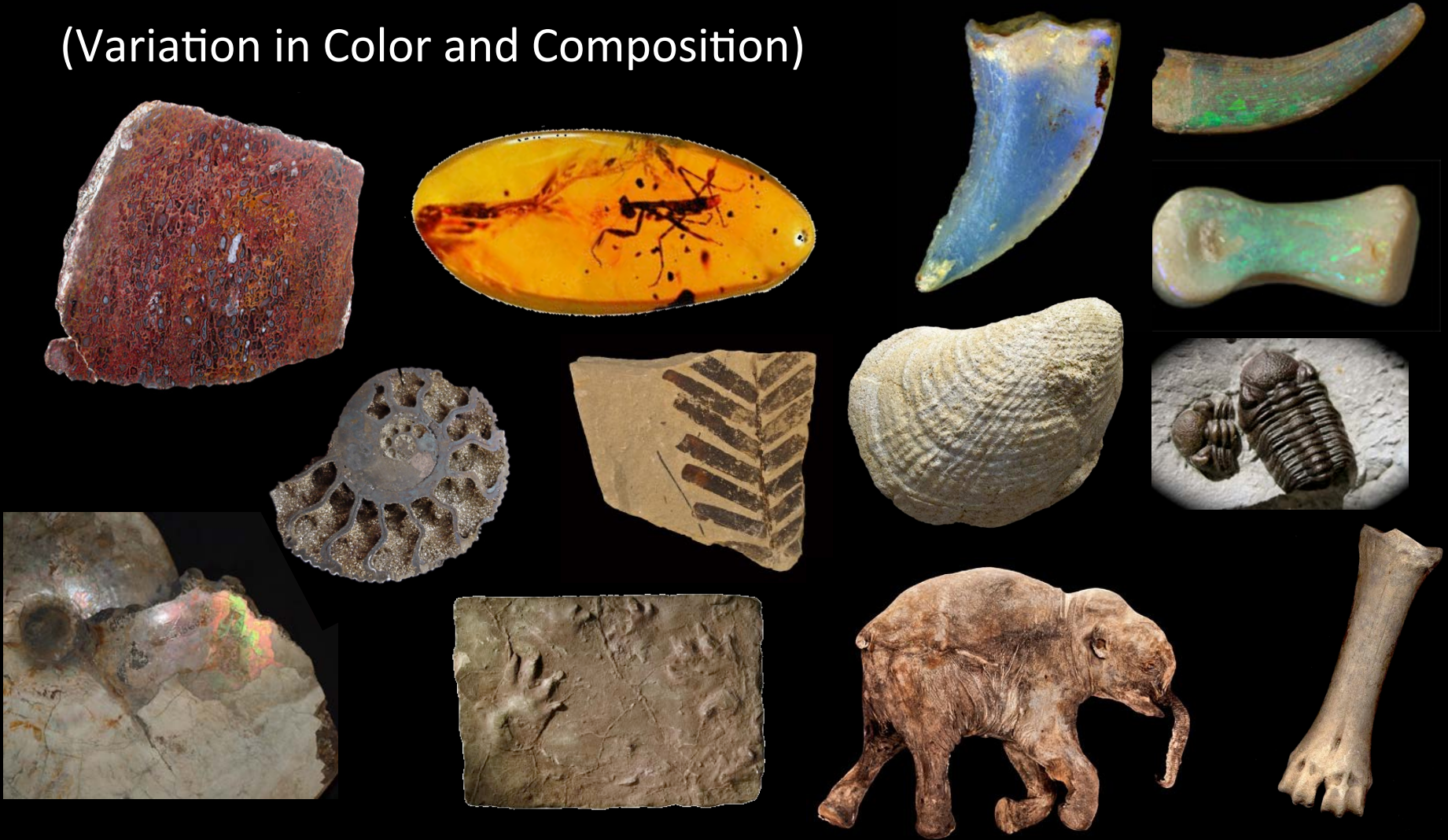
Complicated Workflow

Specimen by Specimen: **Adaptive Workflow**
with several techniques/methods

What do I mean?

Fossilization Process

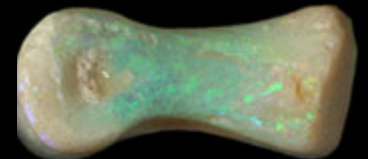
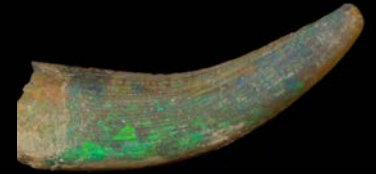
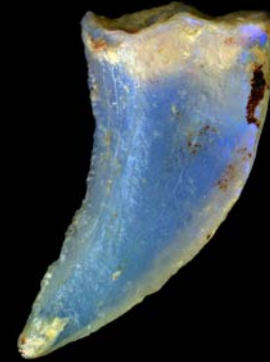
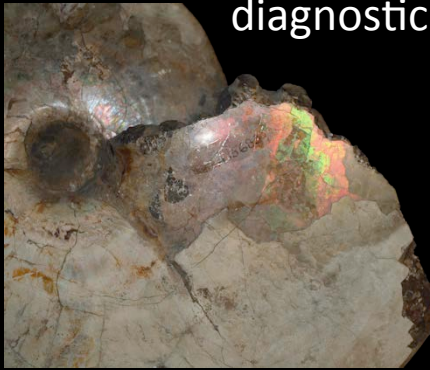
(Variation in Color and Composition)



Fossilization Process

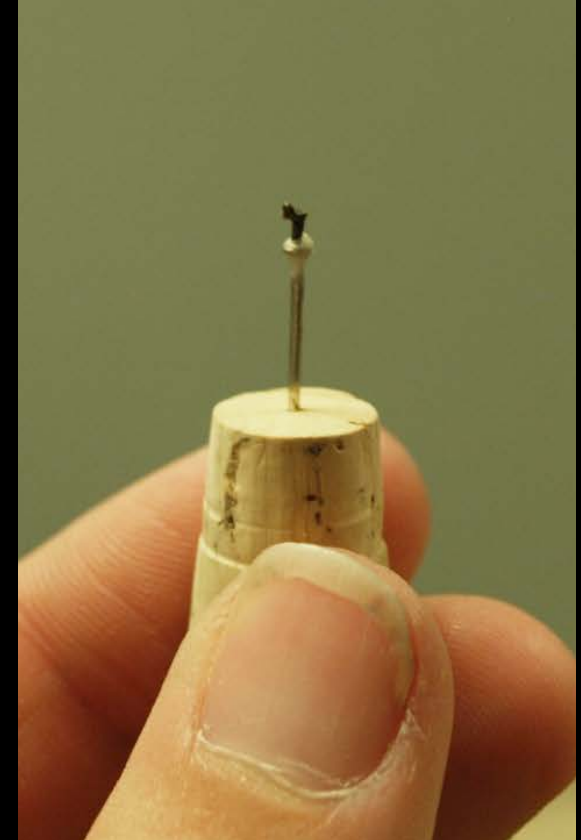
(Variation in Color and Composition)

- Varies across bone, skeleton, assemblage, formation, etc...
- Recording or knowledge of what they are
- Different Backgrounds
- Scanning Artifacts
- Consider important features to capture (iridescence, sutures, diagnostic markings?)



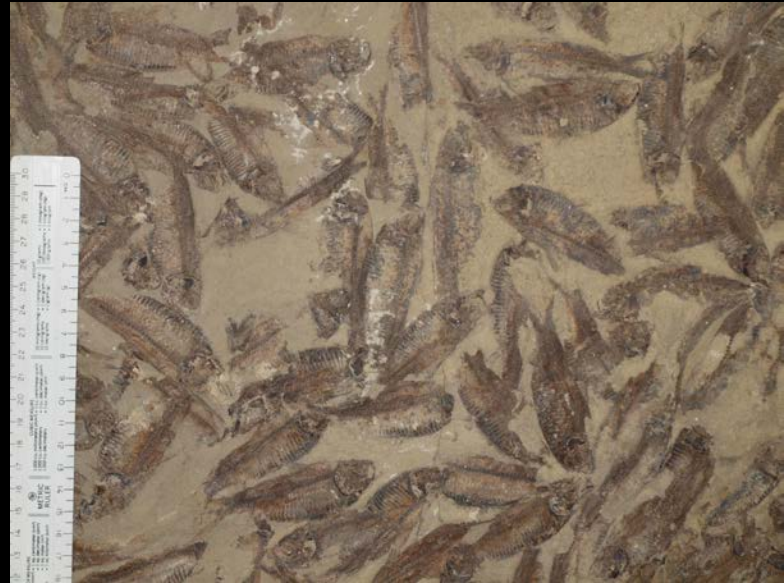
Size Variation

- Extremely Variable
- Dinosaurs to Diatoms
- Matching technology to specimen
- Requires multiple scans/photos
- All the specimen? Part of the specimen?



Shape Variation

- Varies across bone, skeleton, assemblage, formation, etc...
- Extreme Shape variation
- Flat specimens
- How Capture all of it? Do we try?
- 3D scans..stitching



Identification

- Often Difficult
- Not Possible/Diagnostic
- Outdated Nomenclature
- Multiple Specimens
 - Slab
 - Jacket
 - Changes during Prep/research
- Not Linnaean (Morphotypes)



Specimens/Bones/Lots

- How to Best Digitize?
 - Whole Specimen
 - Individual Bones
 - Assemblage?
 - By individual
- Often Changes
 - 3 Femurs identified from one specimen??



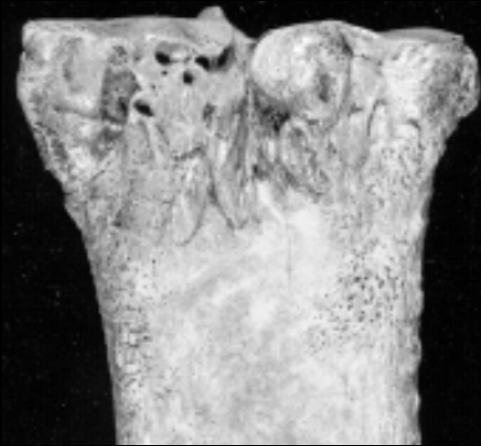
Preparations

- Varied Preparation methods and storage methods
- requires consideration when digitizing



Special Features

- Post Death Modifications
 - Cultural: Cutmarks
 - Scavenging: Bitemarks
 - Taphonomic: Weathering
 - Epibionts
- Pathologies
- Other important characteristics

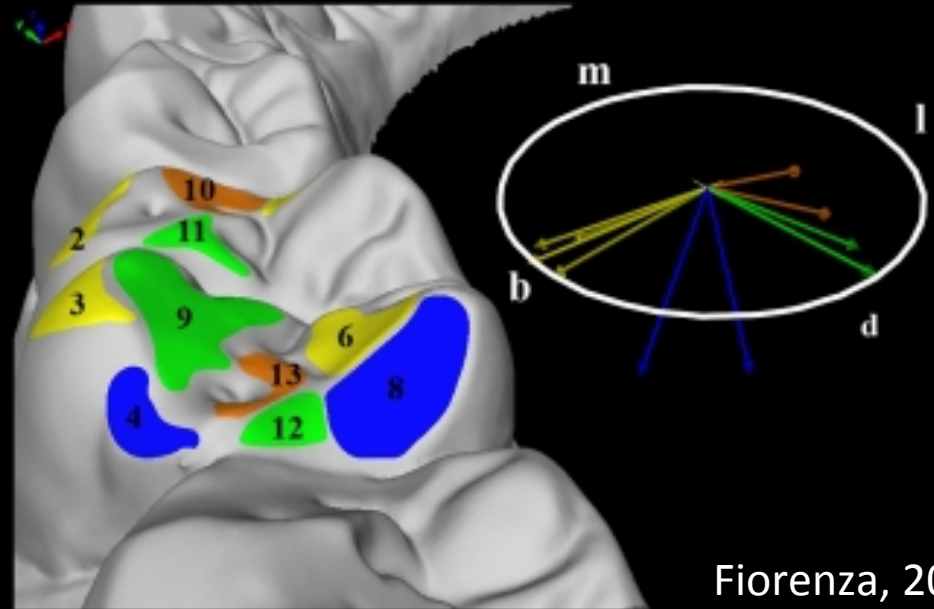


Research

- Holotypes
- Paratypes
- Lithotypes
- Morphotypes

- Analyses noted and Digitized

- Researchers have very different needs and requirements for the specimens...no standardized way

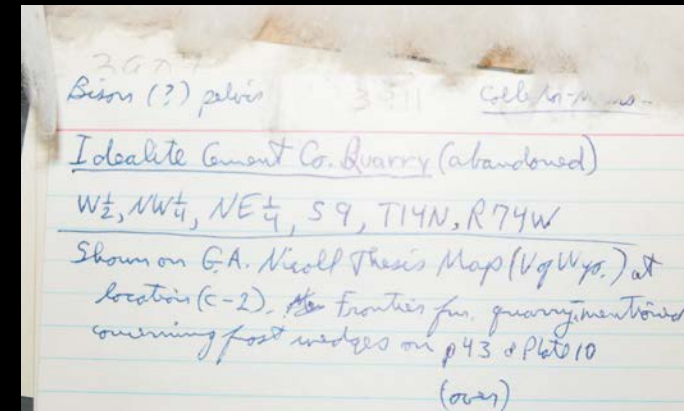
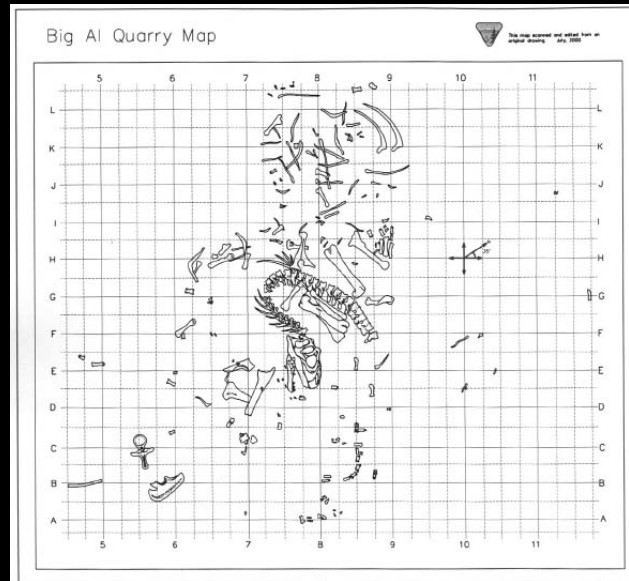


Fiorenza, 2011



Metadata

- Field Data
 - Notes
 - Maps
 - Photos
- Preparation Data
 - Notes
 - Maps
 - Photos
- Curation Data
 - Photos
 - Card Catalogs
 - Identification Notes
- Research Data
 - Analyses
 - Datasheets



- Color
- Composition
- Size
- Shape
- Identifications
- Specimen/Lot Bones
- Special Features
- Preparations
- Metadata

Complicated Workflow

- Color
- Composition
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Specimen by Specimen: Adaptive Workflow
with several techniques/methods

Challenges

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- Small Collections- Related
 - Limited Funds
 - Limited Personnel

Digitization Requires Multiple Methods: EXPENSIVE

Micro-CT



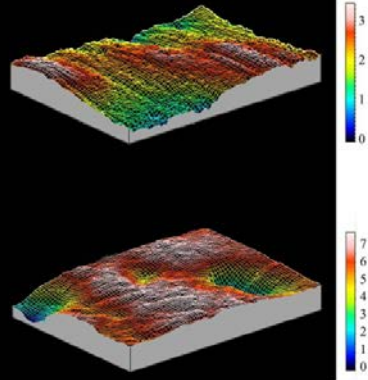
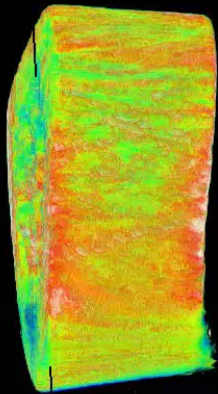
SEM



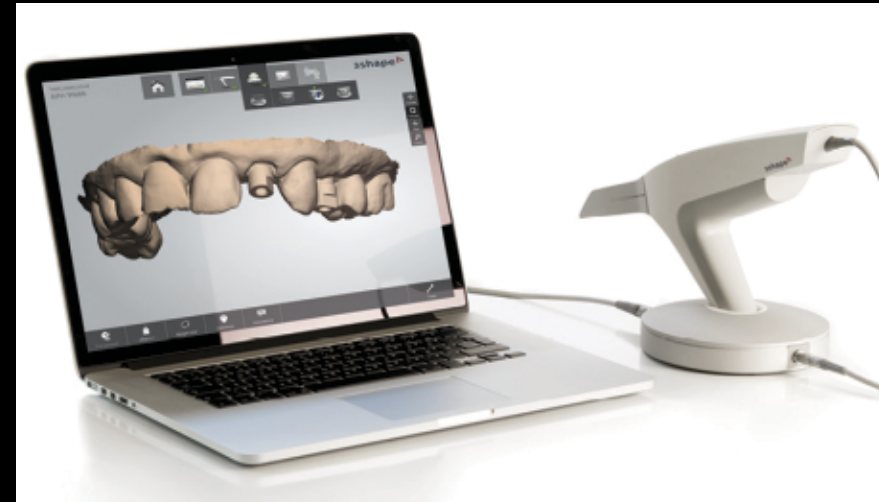
Next-Engine (Laser)



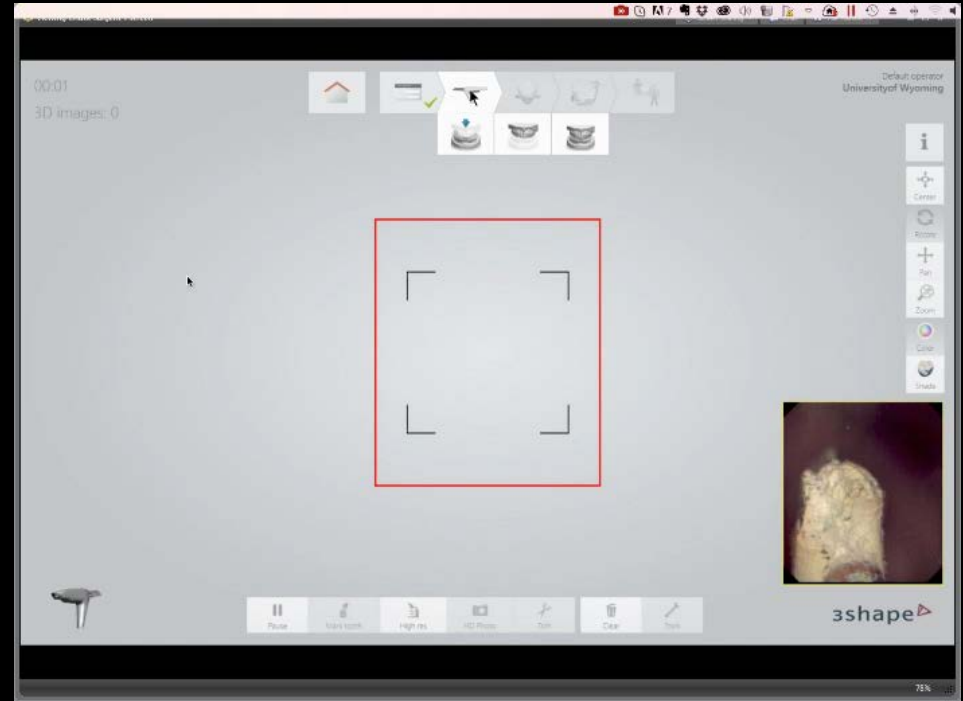
Photogrammetry



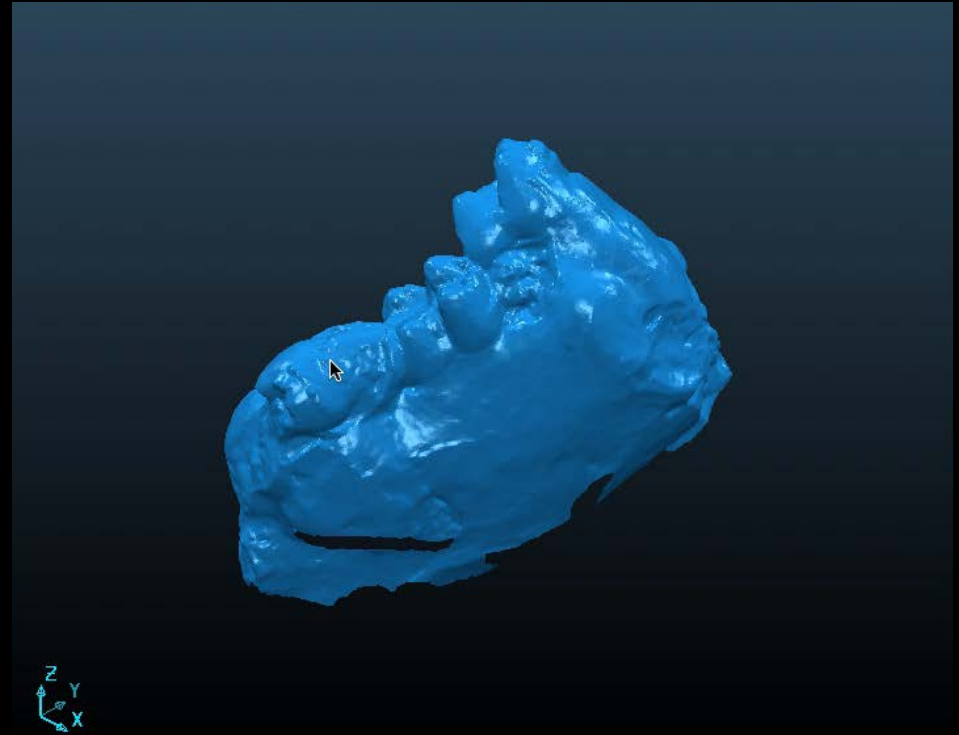
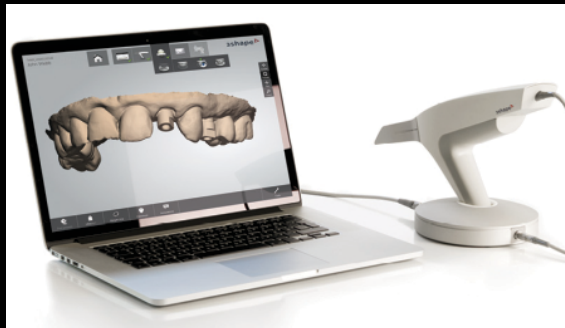
Obstacle: Cheaply Digitizing (3D Scanning) across multiple scales



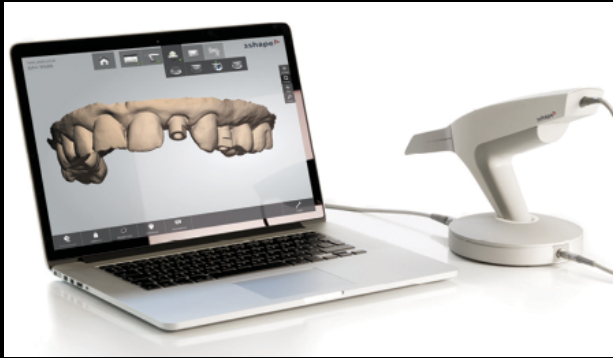
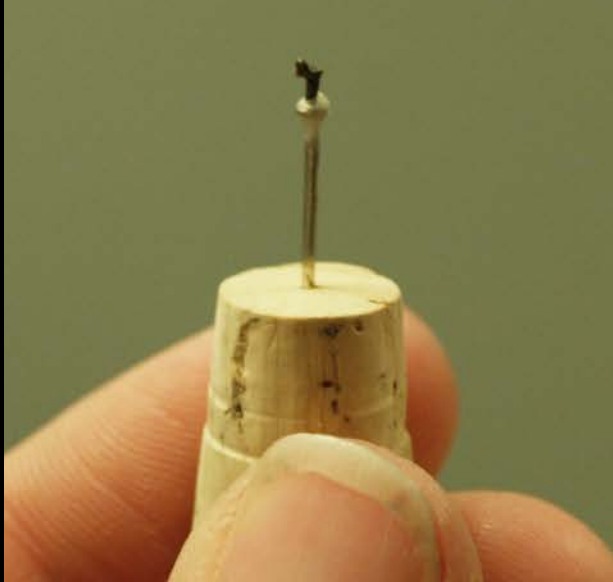
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Obstacle: Cheaply Digitizing (3D Scanning) across multiple scales



My Proposed Plan for Digitization Methods...

Untested at a large Scale

My Proposed Plan for Digitization Methods...

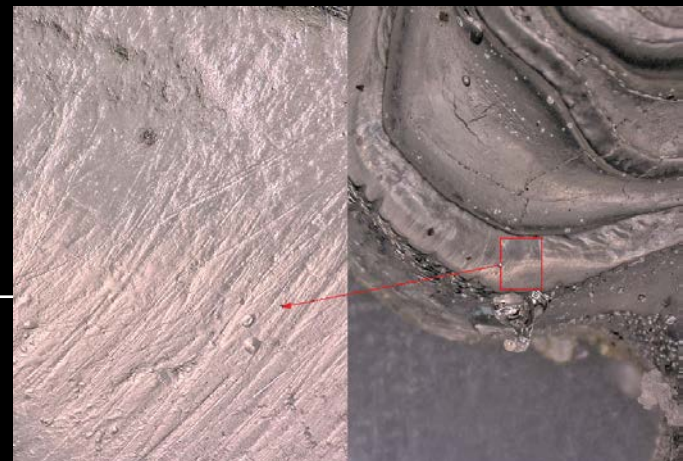
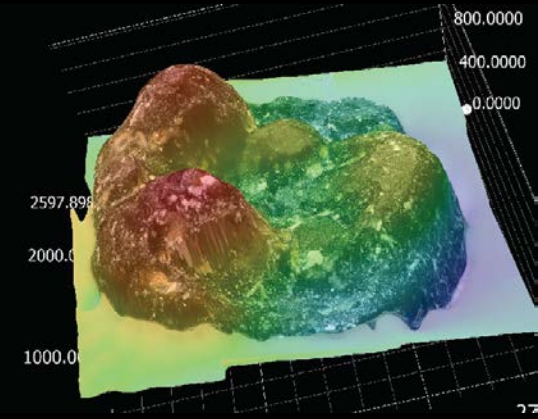
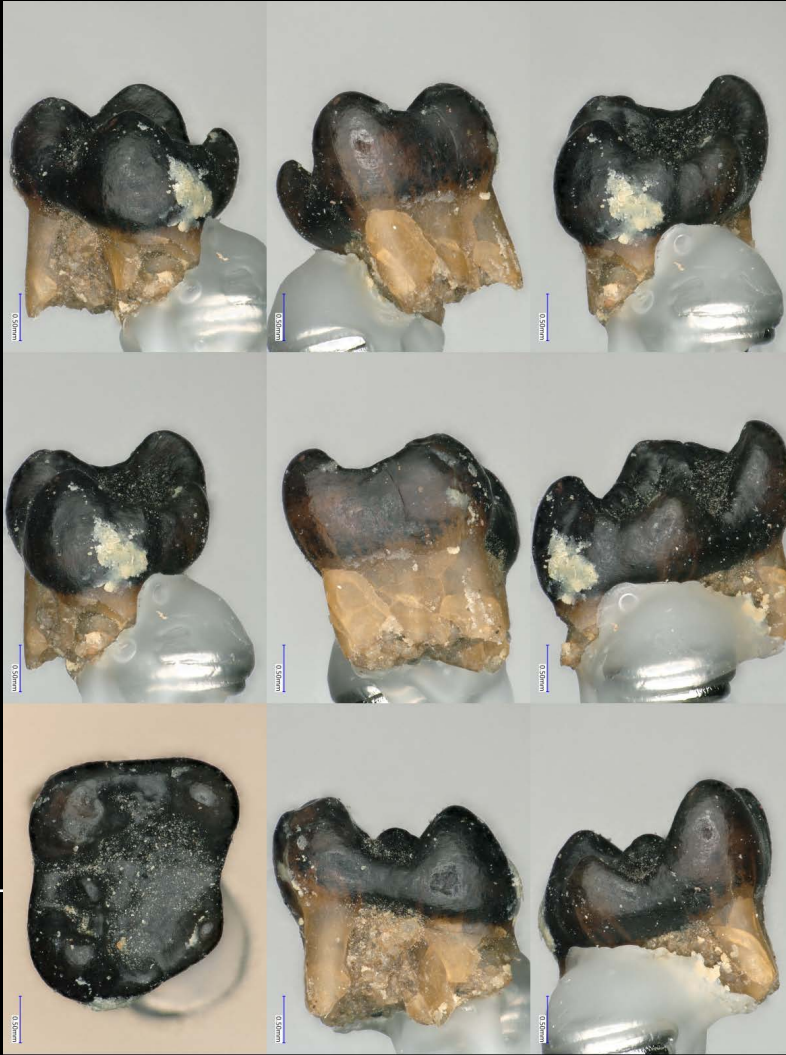
- Digitize by 3 Size Groups

My Proposed Plan for Digitization Methods...

- Digitize by 3 Size Groups
 - Small specimens .25mm – 5cm



Keyence VHX-5000
(60-80K Dollars)



My Proposed Plan for Digitization Methods...

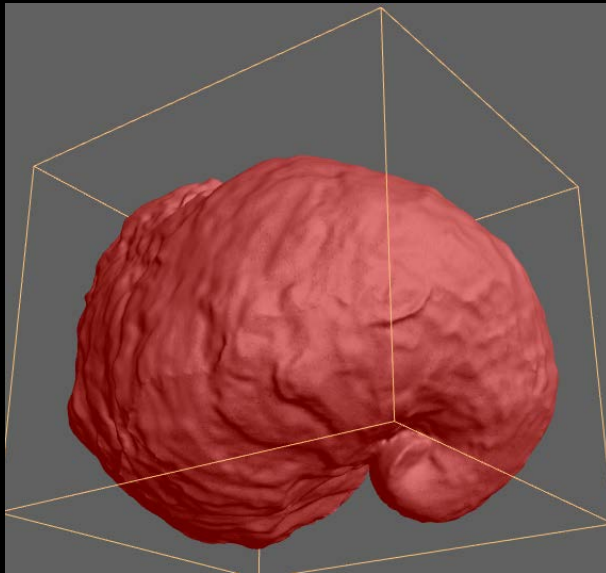
- Digitize by 3 Size Groups
 - Small specimens .25mm – 5cm
 - Medium Group: 5cm-1meter



David Scanner
(3-5k Dollars)



High-Resolution
Digital Camera



My Proposed Plan for Digitization Methods...

- Digitize by 3 Size Groups
 - Small specimens .25mm – 5cm
 - Medium Group: 5cm-1meter
 - Large Size Class: Larger than 1 meter



Structure Sensor for
Ipads
(350 Dollars)



High-Resolution
Digital Camera



Obstacle: Specialized Personnel

- Adaptive workflows
 - Imaging Backgrounds
 - Matching imaging/scanning technique with specimen
 - Adjusting to limit spectral artifacts
 - Knowledge of important features to Digitize
 - Work with a variety of scanning methods and techniques
- Knowledge/Experience
 - Identification of Specimens
 - Software Experience
 - Use of specialized equipment/software



Obstacle: Limited Funds

- LIMITED Specialized Personnel
 - Can work with Adaptive workflows
 - Work with multiple techniques/ digitization methods
 - Expensive...few of them
 - Volunteers...requires a lot of training!
 - Volunteer Retention
- LIMITED Specialized Equipment
 - More than 1 type of imaging/ scanning device
 - Expensive! Constraints on Purchasing Power
 - Technical Software...or lots of it
 - Data Storage Issues



Goal of Digitization in Small Collections?

- Remote Research?
- Search tool for visits?
- Internal Purposes only?>
- Outreach?
- Digitize all or limited # specimens?

- Make it Worth the Effort

- Consider Future Use?
 - What will be important/
obsolete 5, 10, 20 years into
future



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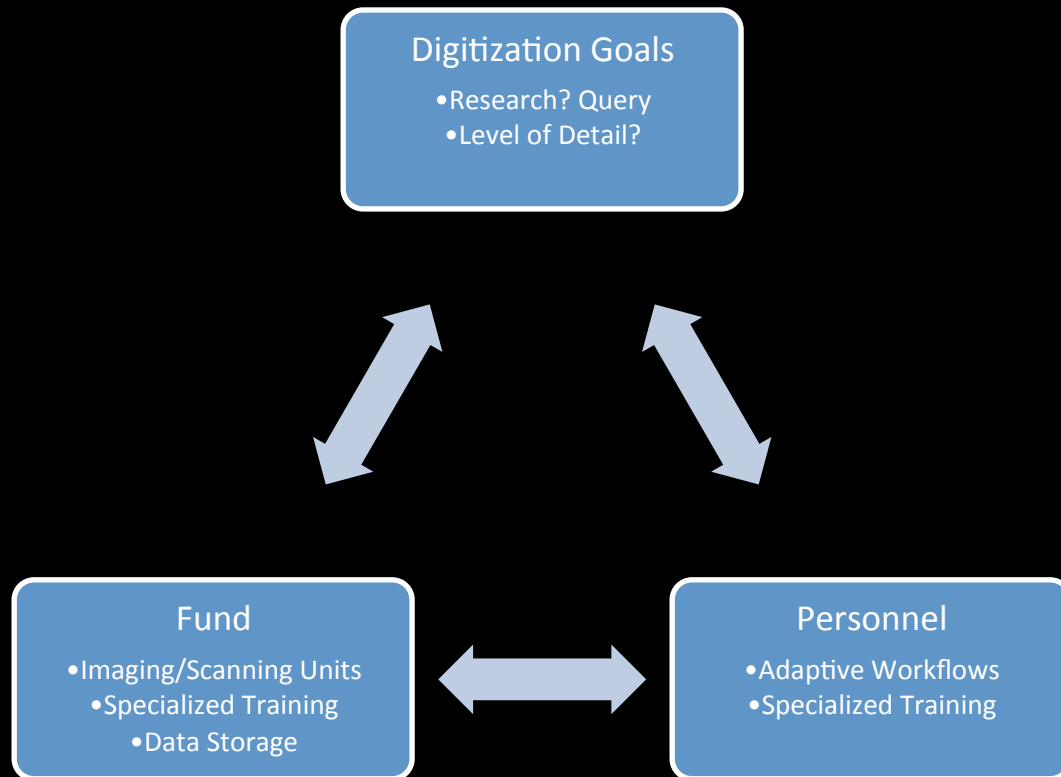
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Goal Effects: Level of Effort, Time, Money, Detail

Balance of Resources



Worth it!



Archaeotherium mortoni
'Terminator Pig'

Thank you!

