3D DIGITIZATION FOR FACILITATING RESEARCH IN PALEONTOLOGY

A workflow from physical fossil to digital curation

Arianna Harrington, Patricia Holroyd, Doug Boyer

Studying and comparing locality samples

Features

- Large number of bones

Studying and comparing locality samples

Features

- Large number of bones
- Fragmentary

Studying and comparing locality samples

Features

- Large number of bones
- Fragmentary
- Need for repeated side by side comparisons between specimens

Studying and comparing locality samples

Features

- Large number of bones
- Fragmentary
- Need for repeated side by side comparisons between specimens

Studying and comparing locality samples

Risks/Difficulties

- Unwieldy size of bones (big or small)

Studying and comparing locality samples

Risks/Difficulties

- Unwieldy size of bones (big or small)
- Fragile (handling or caliper measures)

Studying and comparing locality samples

Risks/Difficulties

- Unwieldy size of bones (big or small)
- Fragile (handling or caliper measures)
- Loss of association between specimen and number

Studying and comparing locality samples

Risks/Difficulties

- Unwieldy size of bones (big or small)
- Fragile (handling or caliper measures)
- Loss of association between specimen and number
- Communicating observations to collaborators/community

Studying and comparing locality samples

Risks/Difficulties

- Unwieldy size of bones (big or small)
- Fragile (handling or caliper measures)
- Loss of association between specimen and number
- Communicating observations to collaborators/community
- Limited time for borrowing museum specimens

Studying and comparing locality samples

Solution

- 3D digitization and curation in 3D archive (MorphoSource)

MORPHO SOURCE
BY DUKE UNIVERSITY

Studying and comparing locality samples

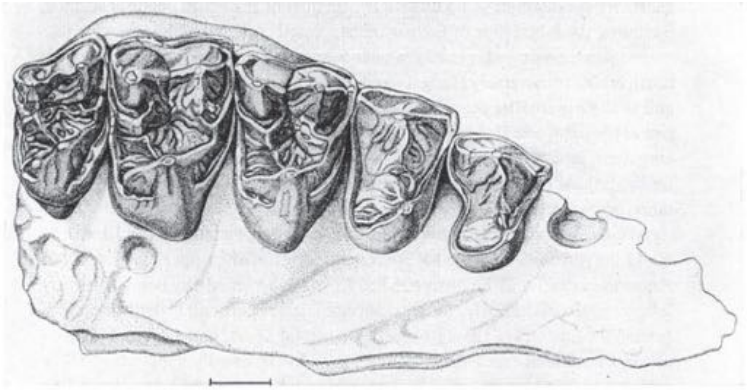
Case study

- Early Eocene Bittercreek Fauna (Savage and Waters, 1978) curated at the UCMP
- Thousands of bones from early Eocene sites in the Washakie Basin, Wyoming
- Collecting started by Don Savage in 1970's
- Continued by Berkeley Crews through 90's
- At least 450 primate bones borrowed by Duke University in 2012

Eocene primates from the UCMP

Importance

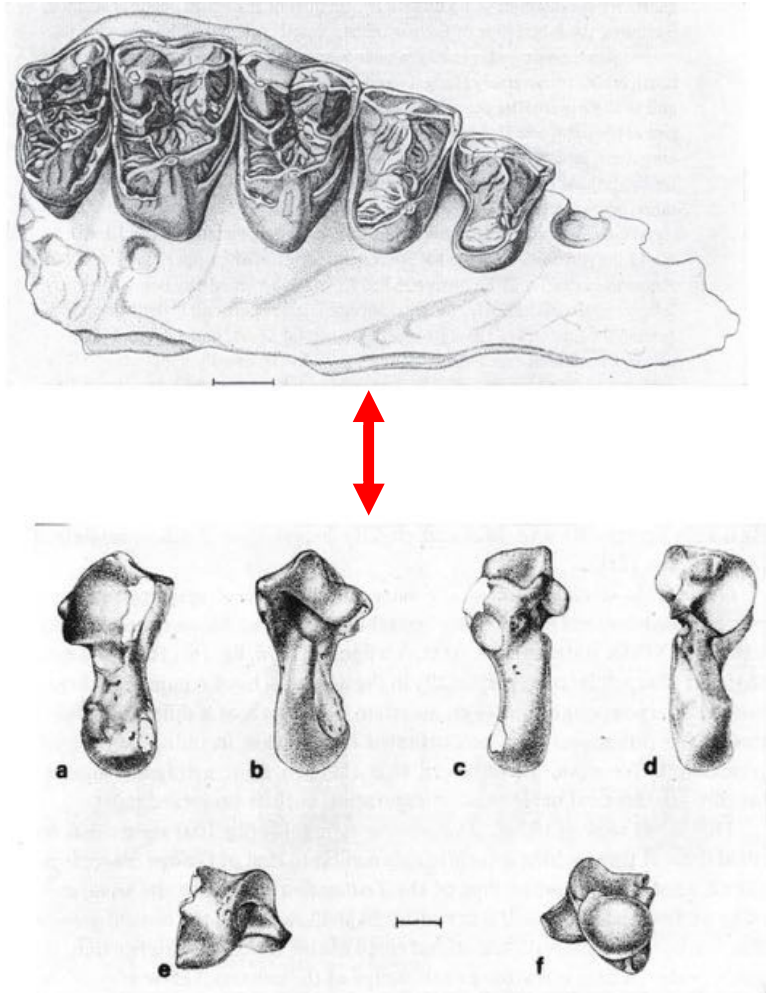
- Postcranial skeleton of early Eocene primates mostly unknown
- Many questions about primate origins remain
- Berkeley sample contains many bones of at least 5 species



Eocene primates from the UCMP

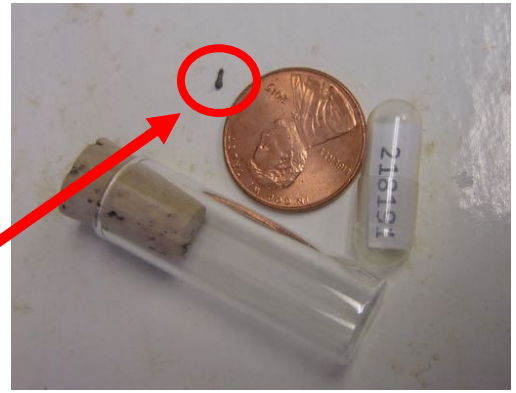
Importance

- Meaningful study requires
  - many measurements and comparisons in order to….
    - sort bones into anatomical element categories, and morph classes
    - Figure out which morphs correspond to which dental classes
    - Assess overall morphological similarities and differences between taxa
- This process is very impractical with physical specimens



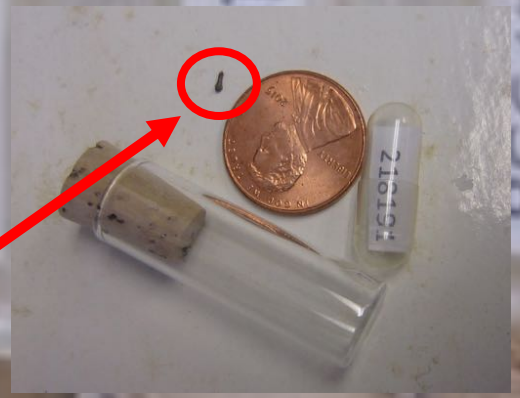
Difficulties

small



Difficulties

small



Difficulties

numerous

small

non-obvious ID

Difficulties

numerous

small

non-obvious ID

Difficulties

numerous

loss danger

Goal

Physical fossil → Digital representation → Digital curation

Planning the process

?

Planning the process

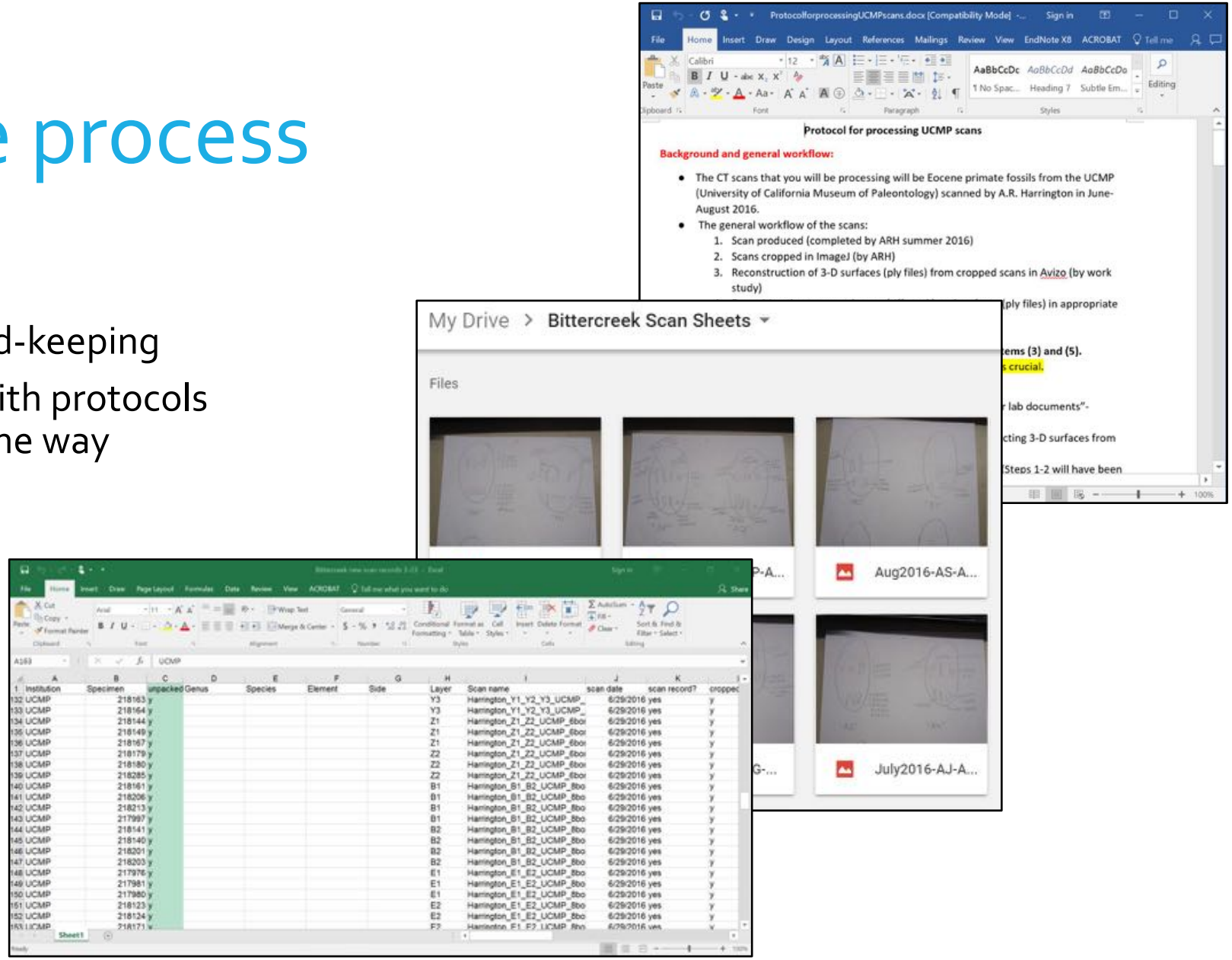
The chosen workflow must be:

1. Efficient
   - Multiple specimens in one scanning event
2. Traceable
   - Must be able to keep track of what specimens are being scanned

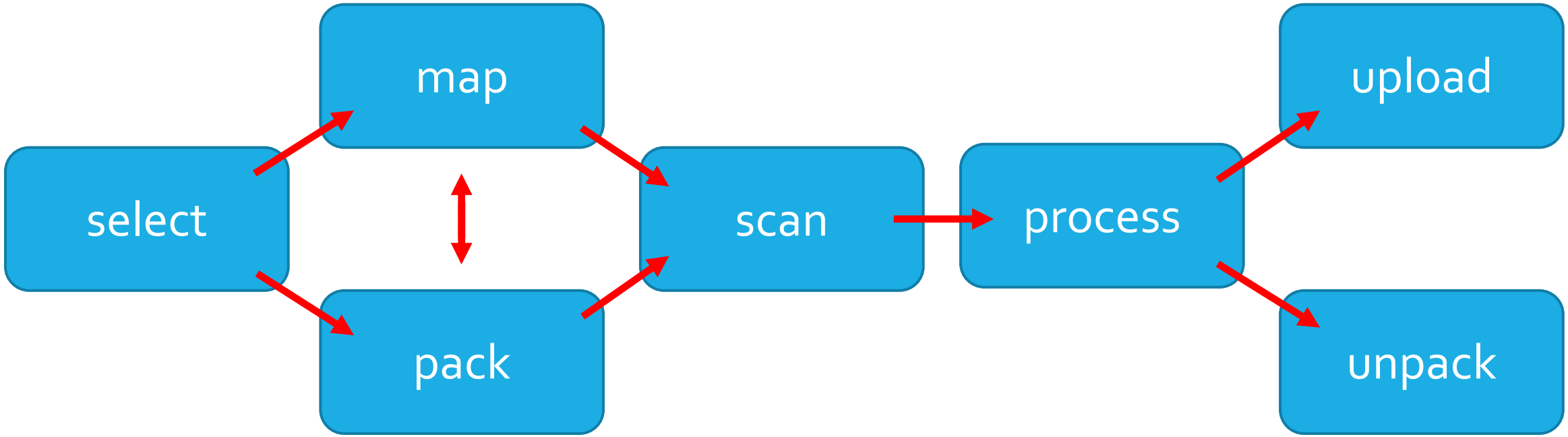
Planning the process

Entails:

- Careful, detailed record-keeping
- Organized workflow with protocols outlined each step of the way



Workflow



Step 1. Selecting Specimens

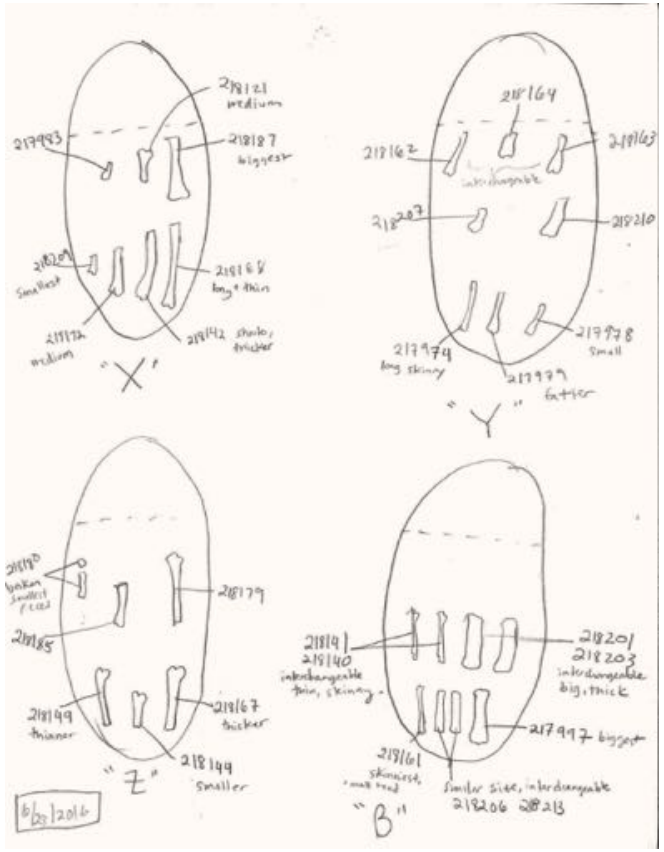
Specimens in batches

- Scan first in the same specimen container, assign specimen numbers later

Specimens in individual vials

- Need to pay attention to specimen ID within one scanning container

Step 2. Map and Pack

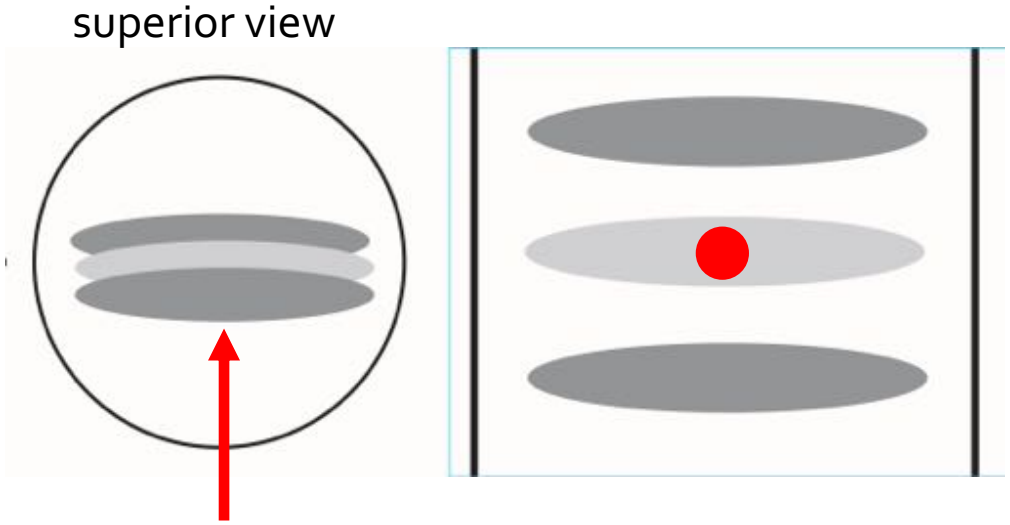


Packing:

- Balance of efficiency and maintenance of identification
- Fossils placed in labeled pill caps placed in a milkshake straw stuffed with cotton, outside of straw labeled
- Straw placed in a vial with clay (ease of loading into scanner, seems to lessen effects of vibrations)

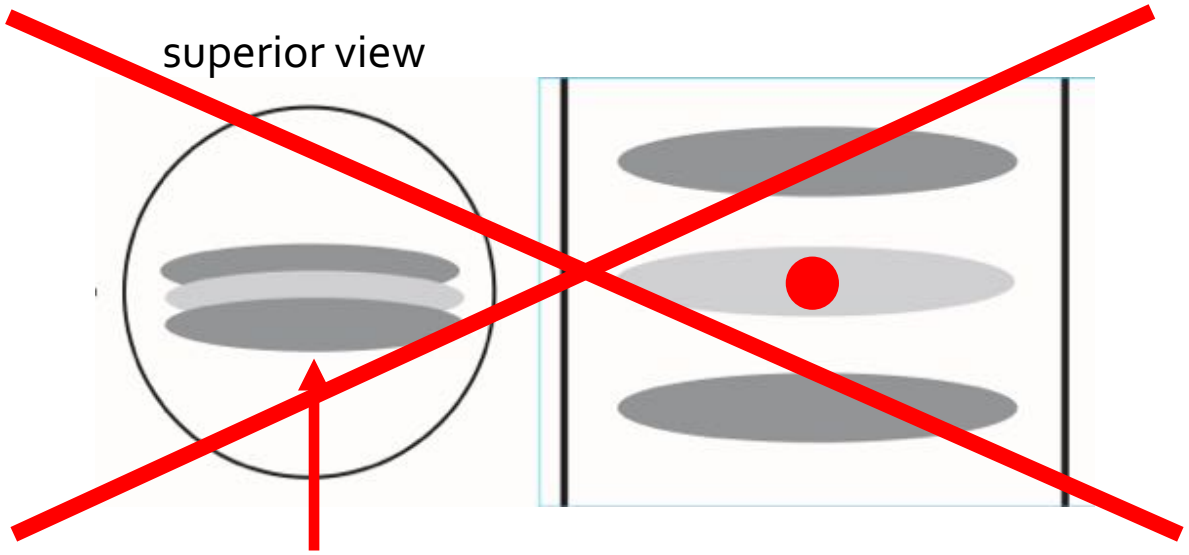
Packing:

- Balance of efficiency and maintenance of identification



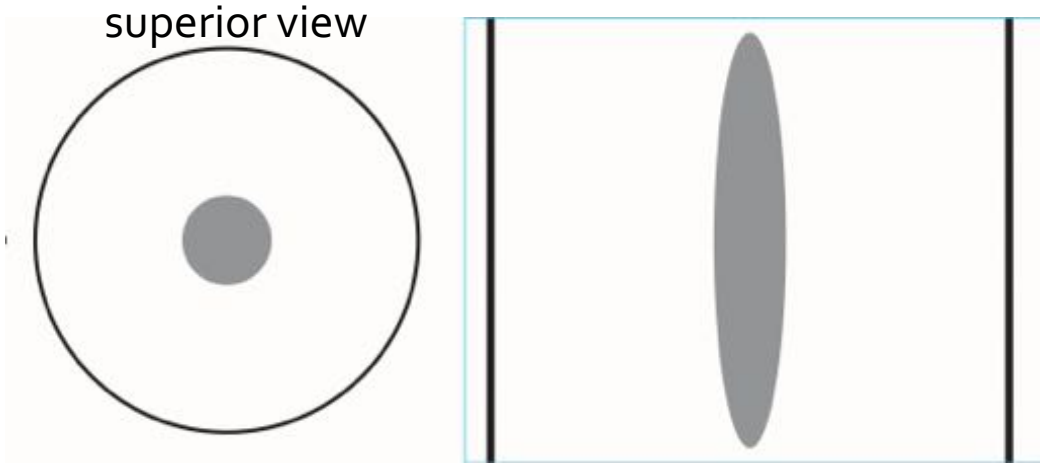
Packing:

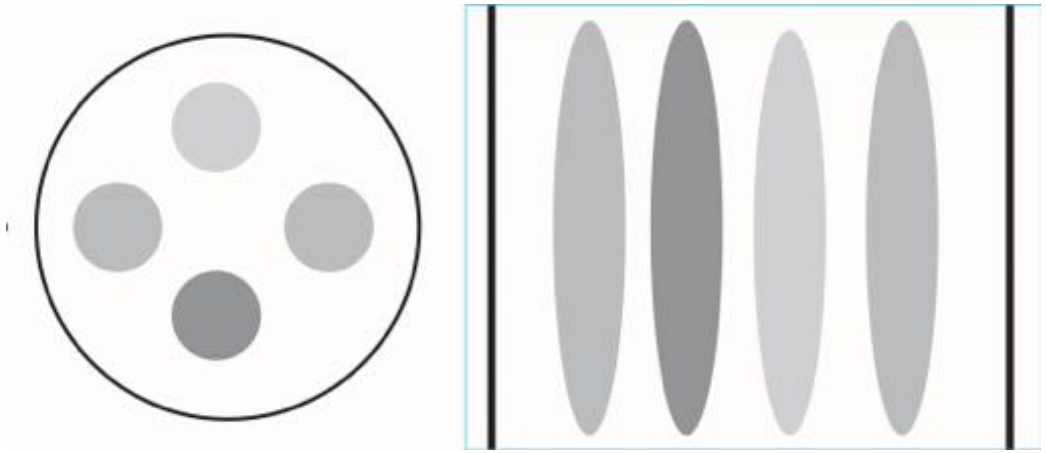
- There are considerations for how specimens should be packed

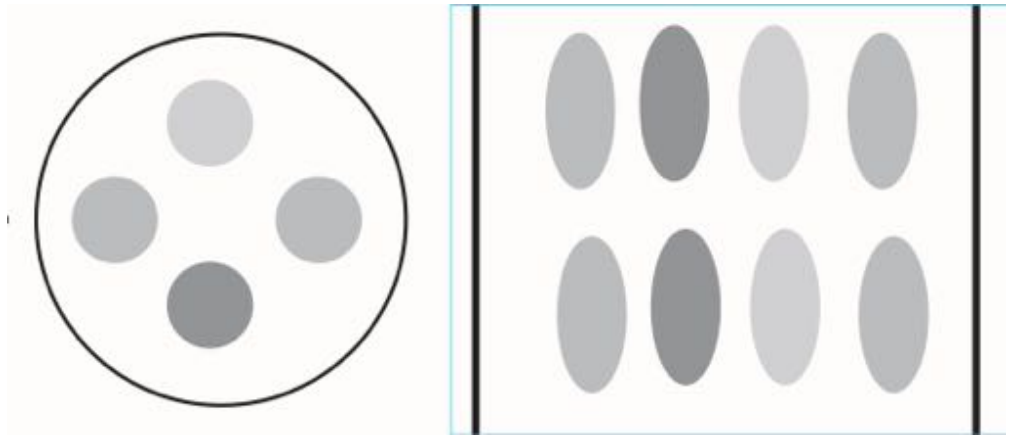


Packing:

- There are considerations for how specimens should be packed

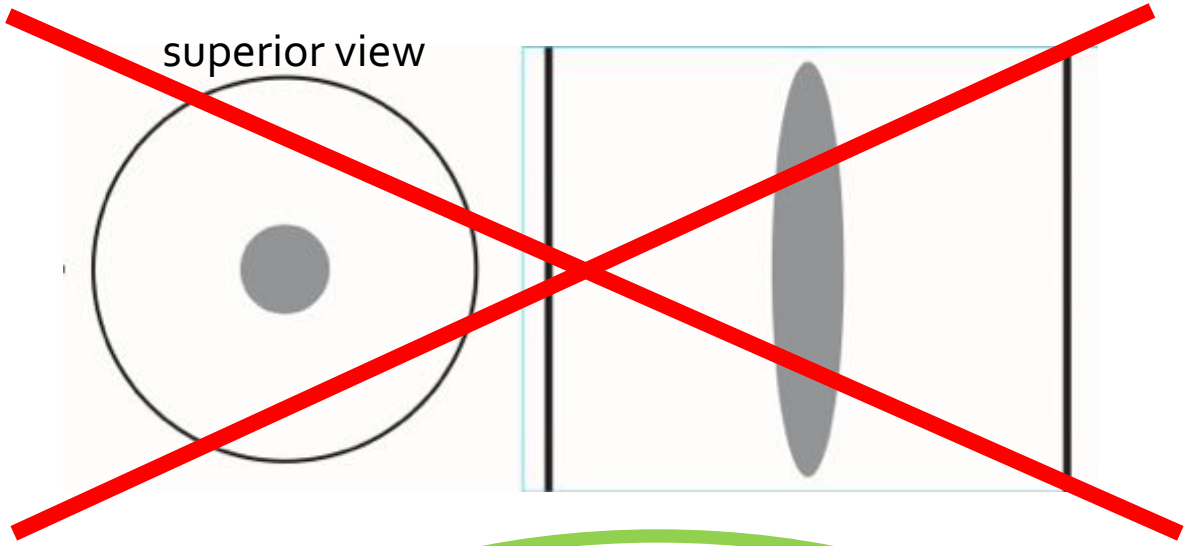


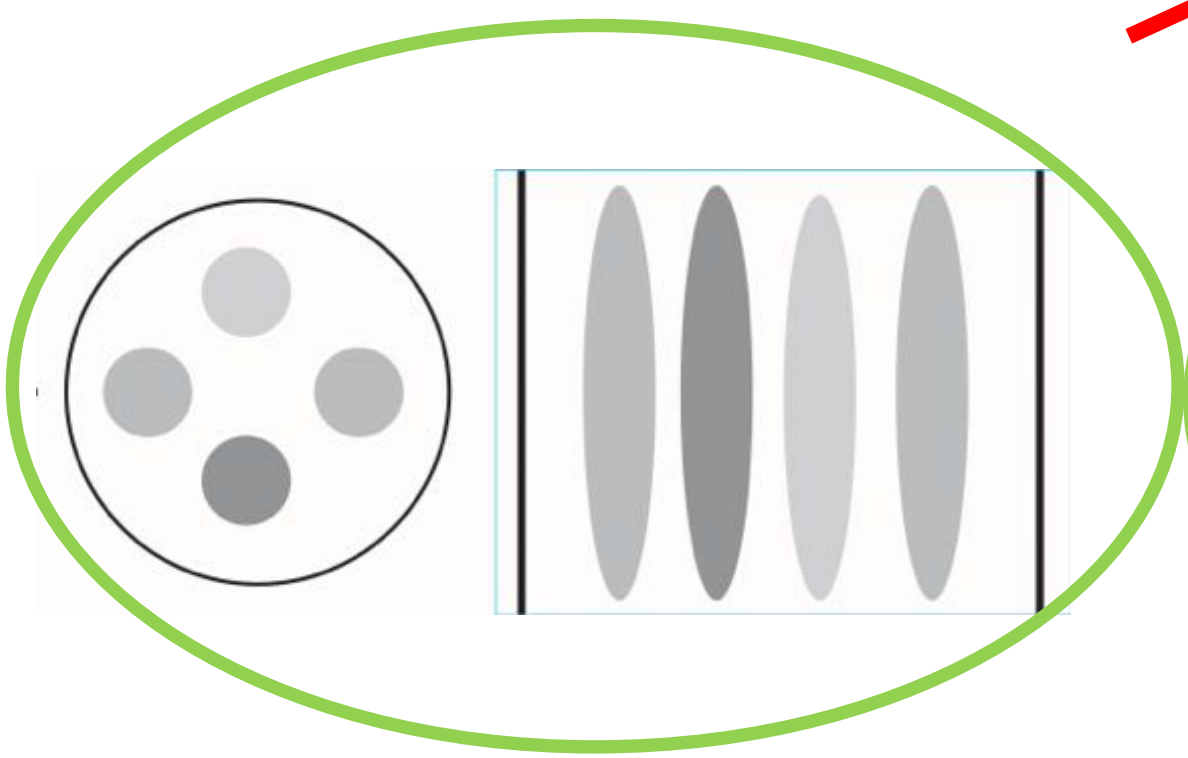


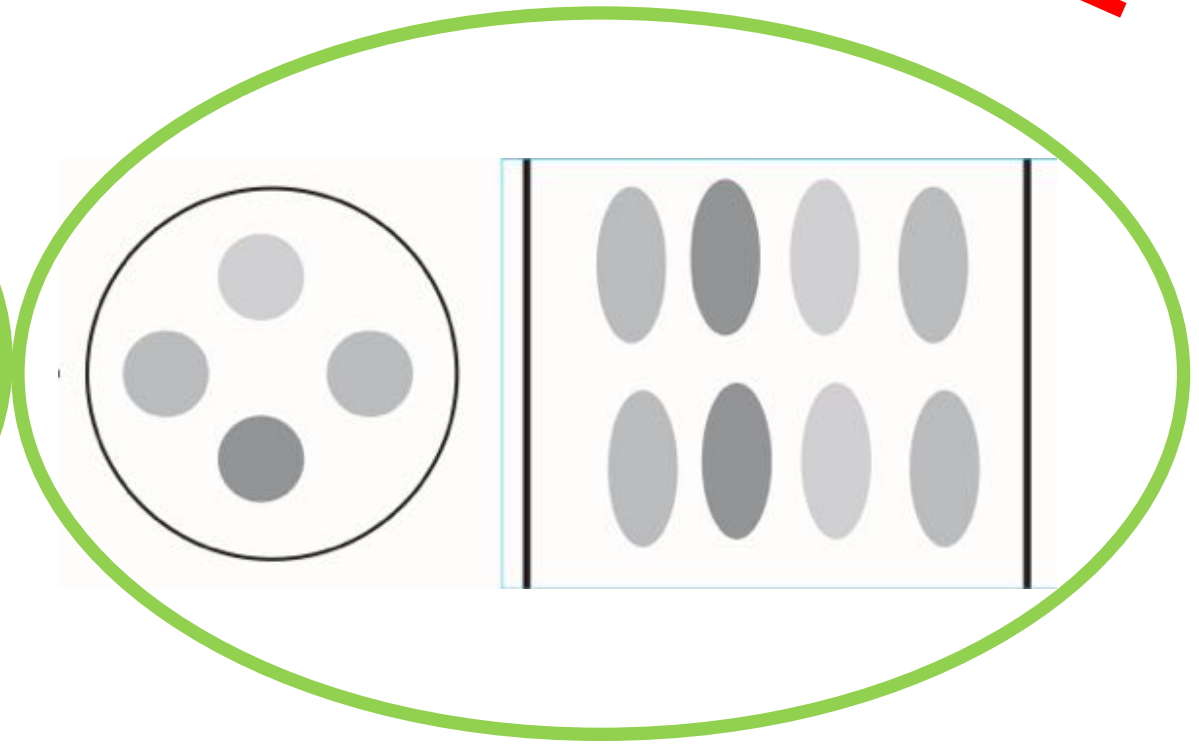


Packing:

- There are considerations for how specimens should be packed

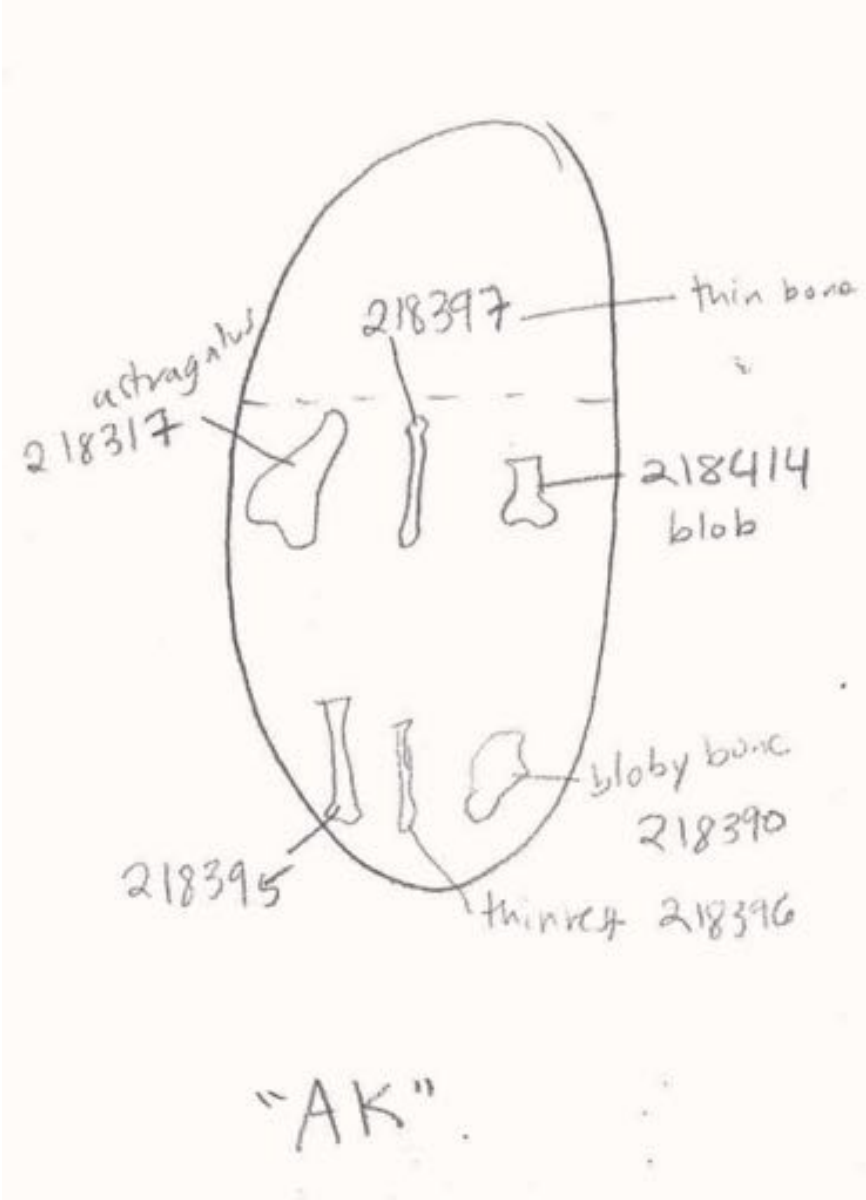






Mapping

- Prioritize identification, accuracy
- Maps were photographed and uploaded to Google Drive ("insurance")



Step 3. Micro CT Scan

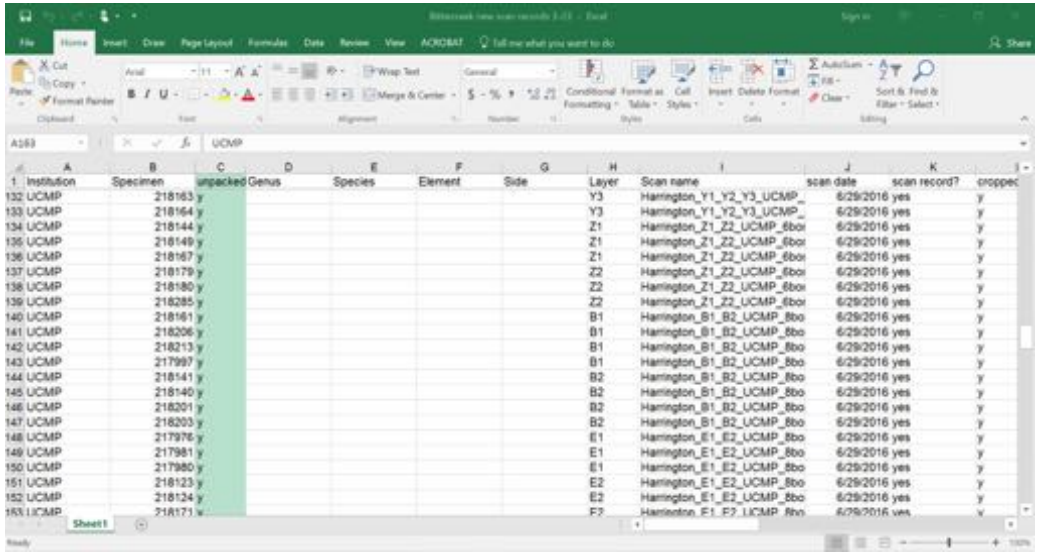
- Naming of files should be consistent
  - Ex: Harrington_AK1_UCMP_omomyid_3bones
- Keeping of good scanning records begins here
  - Ex: lab scan records, project-specific scan records

Step 3. Micro CT Scan

Example scan record

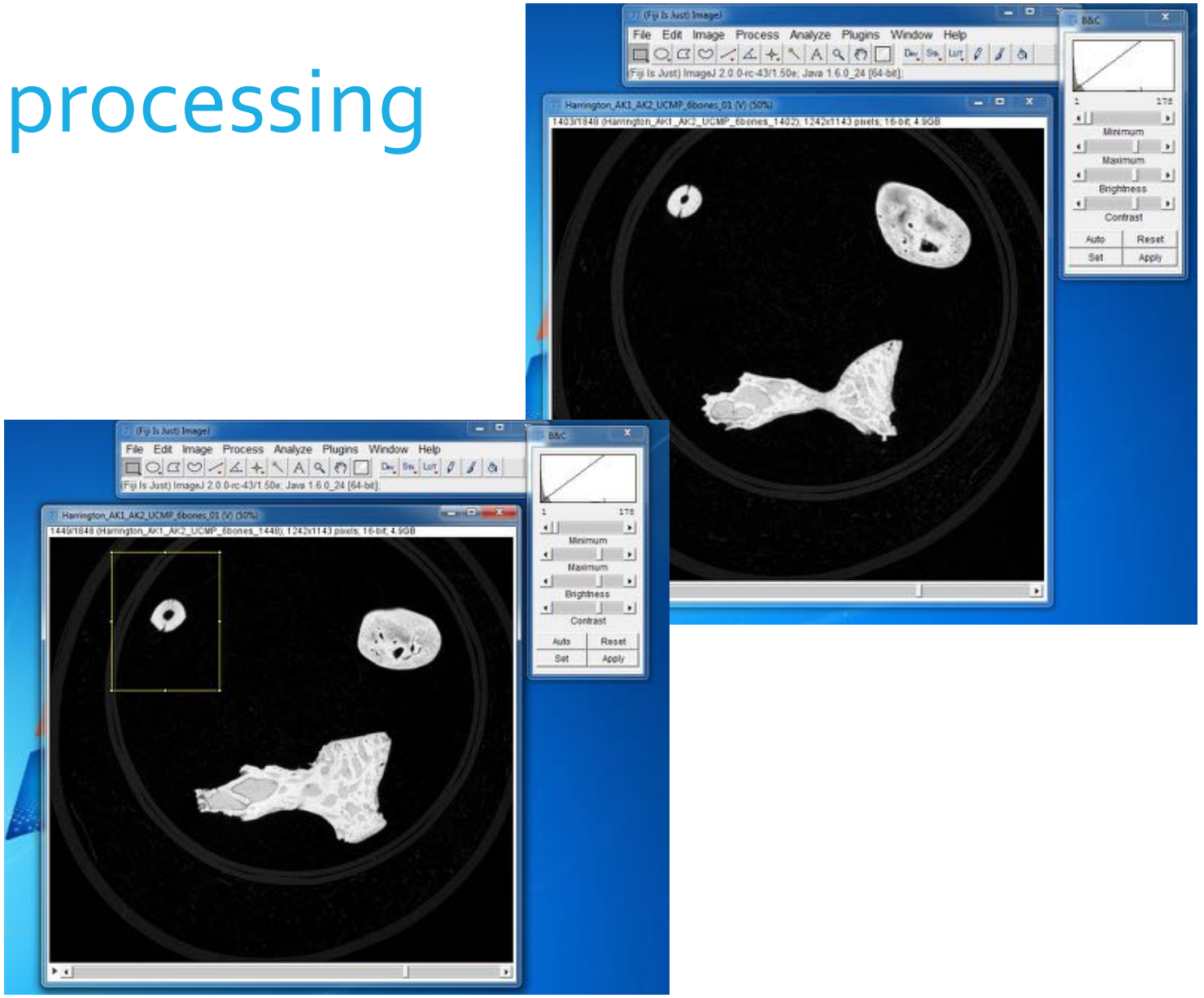
- Every critical step is indicated by a y/n column

- Example: unpacked, layer, scan name, scan date, scan record, cropped, metadata copied, transferred for processing, transferred to Boyer drive, uploaded to MorphoSource



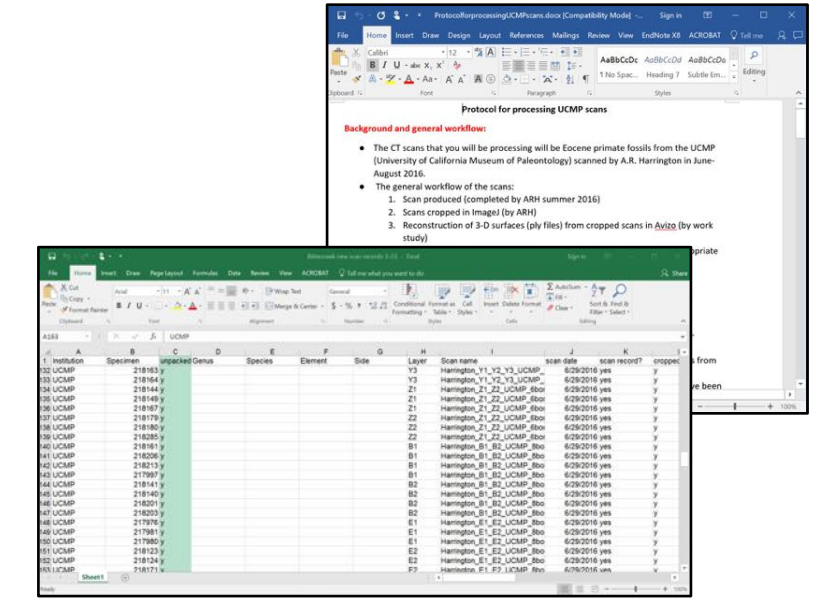
Step 4. Digital processing

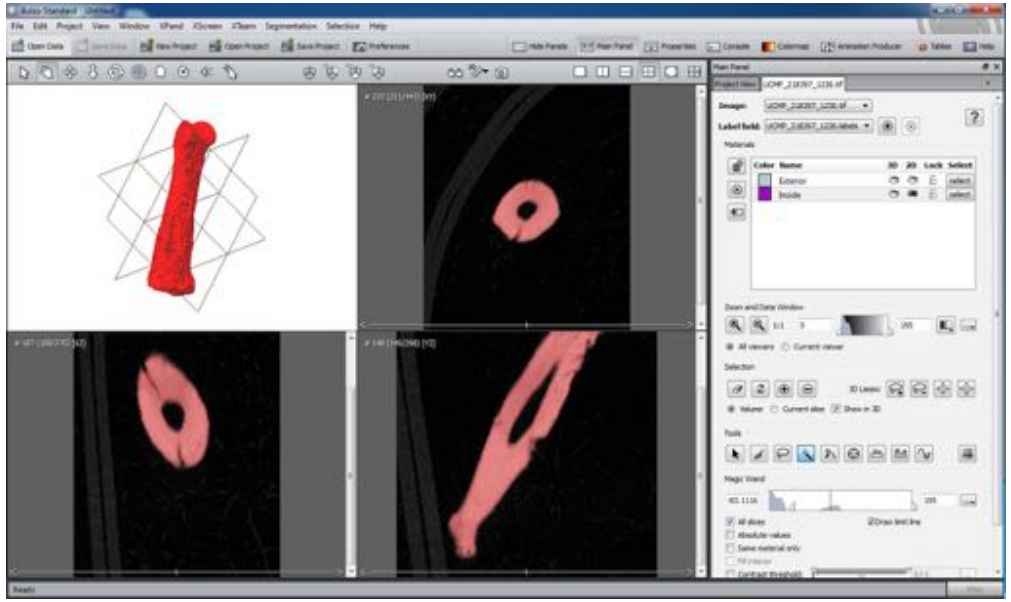
- Image J
  - Check for scan/reconstruction quality
  - Identify specimens
  - Crop out region of interest (ROI)
  - Save as tiff stack with specimen name
    - Ex: UCMP218281_0000.tif

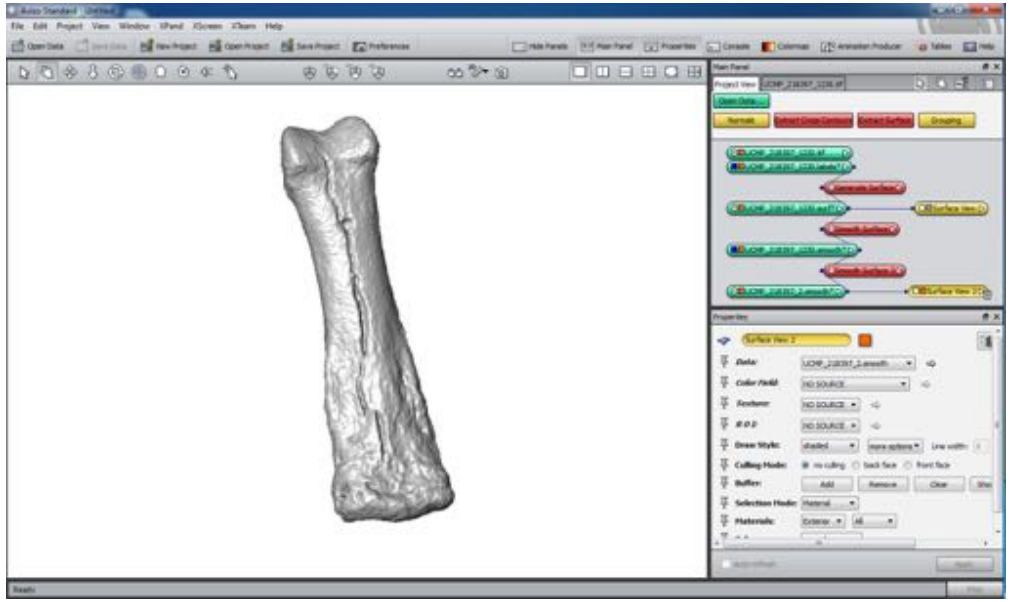


Step 4. Digital processing

- Avizo
  - Making mesh files from the tiff stacks
    - Products: 2 mesh files, 2 jpeg images







Step 5a. MorphoSource upload

- Upload to a project with information on fields such as:
  - Institution code, specimen number, specimen repository URL, institution, locality
  - Publication status, copyright, description, bibliographic references, grants, scanning facility, scanning parameters (voxel size, amperage, volts, and projections)

Step 5b. Unpacking specimens

- With care and in reference to the maps and 3D digitized specimens

Step 6. Return physical specimens, work on and share digital specimens with collaborators

Acknowledgements

- iDigBio & workshop organizers for invitation to participate
- NSF