Working with Historical Scanned Film Imagery

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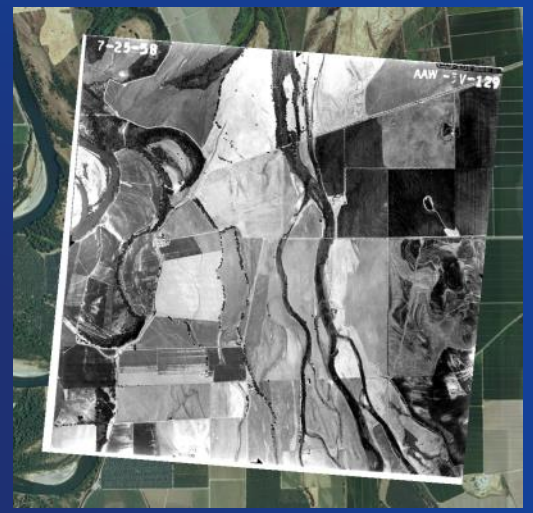
SEE
WHAT
OTHERS
CAN'T

Objectives

- Manage & Share collections of scanned film imagery
- View & use
  - By geography
  - By date, other attributes
- Initial product is mosaic dataset or image service with approximate georeferencing
  - It may be possible to improve accuracy, depending on metadata and project requirements

Historical Imagery

- Film imagery from archives
  - Rolls of aerial film (9”, other)
  - Single frames
  - Panchromatic, True Color, Color IR
  - 1930’s – 2000’s
- Value
  - Water rights
  - Property boundaries
  - Finding unexploded ordnance (UXO)



Data Sources

- Typically scanned by
  - Photogrammetric scanner
  - Table top scanner
- Scan quality sometimes poor
- Orientation & Metadata
  1. Excellent – Output from aerotriangulation (AT)
  2. Good – Digital Index from navigation data (> 1990)
  3. Poor – nothing more than an Index Map
  4. None

More accurate metadata enables both simpler workflows and more accurate results

The focus of this presentation

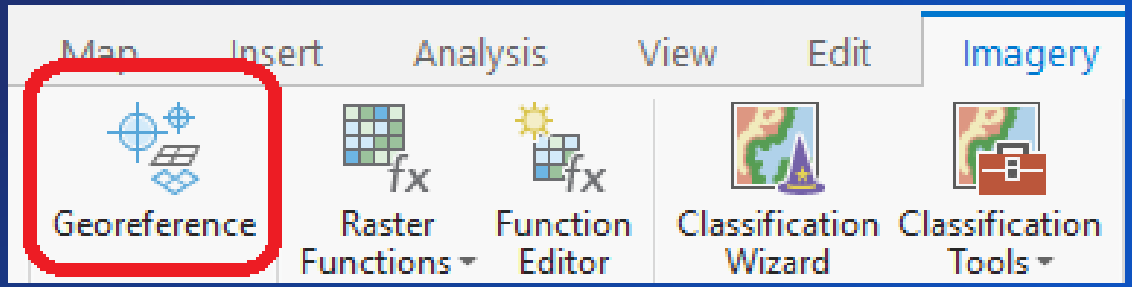
Limited/No orientation data: Consider the *Georeferencing* tools

- **If number of images is small, and if high accuracy is not required, georeferencing tools may be fastest and easiest solution**

- **Manage using Mosaic Dataset**
  - ***Raster Dataset* Raster Type**

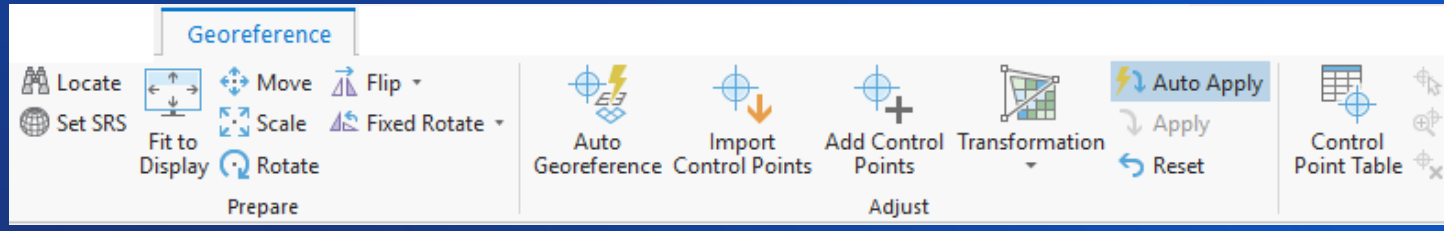
- **Use directly in ArcGIS Pro**

  (and/or) Publish as Image Service



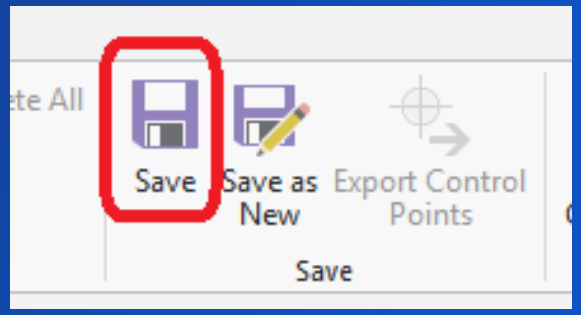
Georeferencing Tools - Details

- Set TIF images to ReadOnly



- Use ArcGIS Georeferencing Tool
  - Manually position
  - Manually add **Tie Points** using imagery base map
  - 5 to 8 are sufficient to begin, distributed across image
  - Start with 1st order transformation
  - Automated mode may work (if similar base imagery is available)
  - Spline transformation will be necessary to fit terrain
  - **Accuracy will be limited!**

- Use “Save” to save transform to apply to the original image
  - “Save As New” (rectify and output) is NOT typically recommended

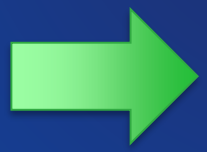


Georeferencing Tools

Historical color infrared photography courtesy of USDA

Metadata about image orientation drives the workflow

- **Excellent – Output from AT software (*Match-AT, ISAT*)**
  - **Use mosaic dataset w/ proper raster type → this *Historical* workflow not required**
- **Good – Digital Index from navigation data (> 1990), camera calibration report**
  - **Proceed directly to *Frame Camera* raster type workflow**
- **Poor – e.g. Index Map**
- **None**



Continue with this *Historical* workflow, unless a small # of images and Georeferencing tools are adequate.

NOTE: This refers only to the objective of **approximate georeferencing**. Proceeding from there into **Ortho Mapping** workflow may be part of the complete project.

Scanned Film (Historical) Imagery

Ortho Mapping

- **Build Frames & Cameras tables with estimated values**

This is the “Historical Imagery workflow”

- **Run Ortho Mapping workflow –**
  - **Compute fiducials**
  - **Aerial triangulation, block adjustment**
  - **Add ground control (as possible, e.g. *ad hoc* tie points from basemap)**
  - **Apply DTM, optional Color Correction, Seamlines**

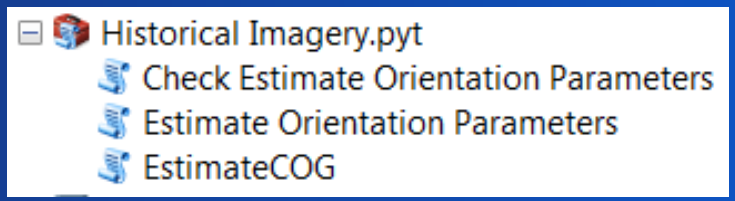
Then you continue with the “Ortho Mapping workflow”

- **Mosaic dataset to orthorectify images on-the-fly**
  - **Use directly, or create outputs if desired: Orthomosaic, Digital Surface Model (DSM)**

High Level Workflow (large/multiple projects → automation)

1. Scan
2. Compile metadata, create feature class with approximate photo centers
3. Calculate approximate orientation

   Several steps involved; See GP Tools available for download: http://www.esriurl.com/HistoricalTools

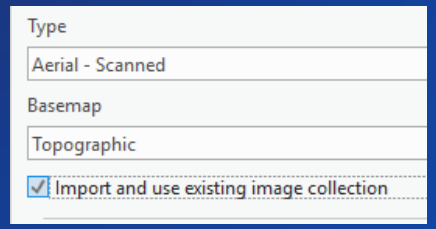


4. Mosaic Dataset

   Frame Camera Raster Type

5. Ortho Mapping workflow

   Increased accuracy – orthorectified products

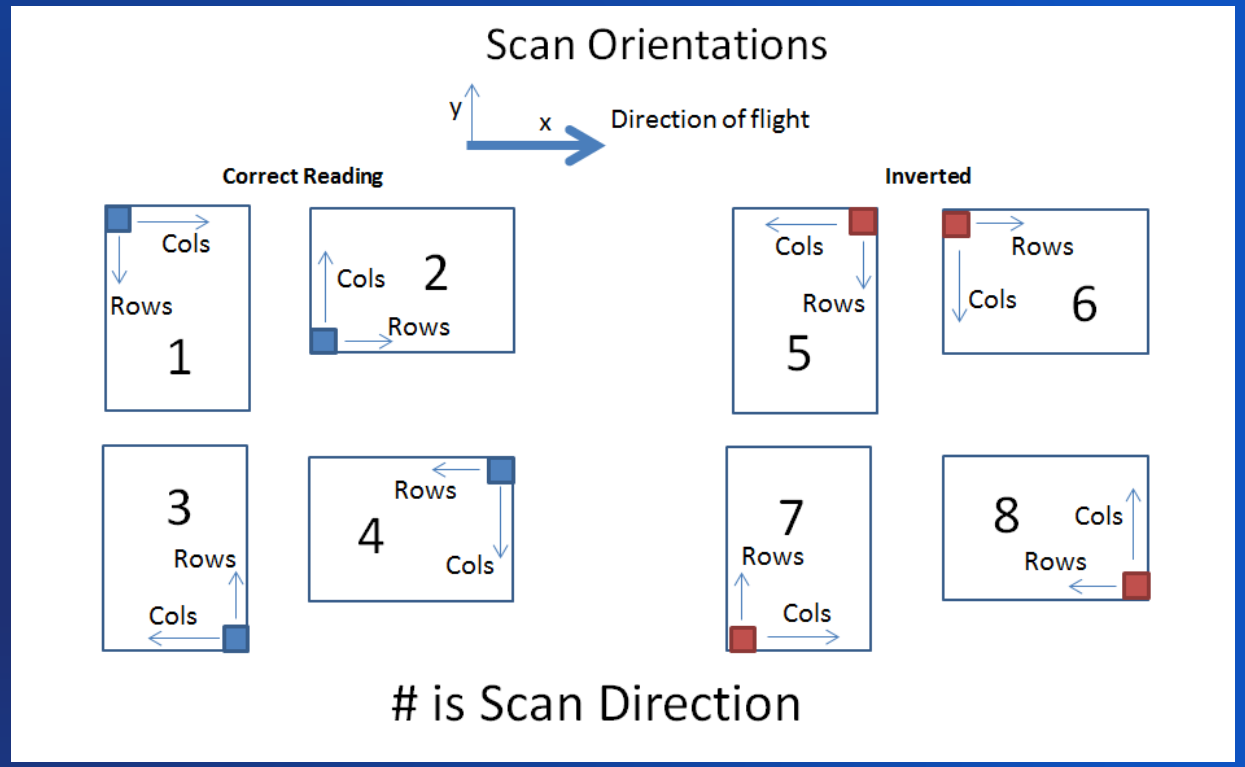


6. Use directly in ArcGIS Pro, and/or Publish as Image Service

(1) Scanning & Optimum Format

- **Scan at about 20 microns**
- **Record scan direction →**
- **Optimize Compression**
  - **TIF with JPEG compression** (Q80 ~ 5x)
  - **If color use JPEG_YCbCr** (Q80 ~ 8x)
- **No need to generate statistics**
- **Generate Pyramids**
  - **Often Internal** (GDALaddo)
- **To optimize format use *CopyRaster* or *Optimize Rasters***

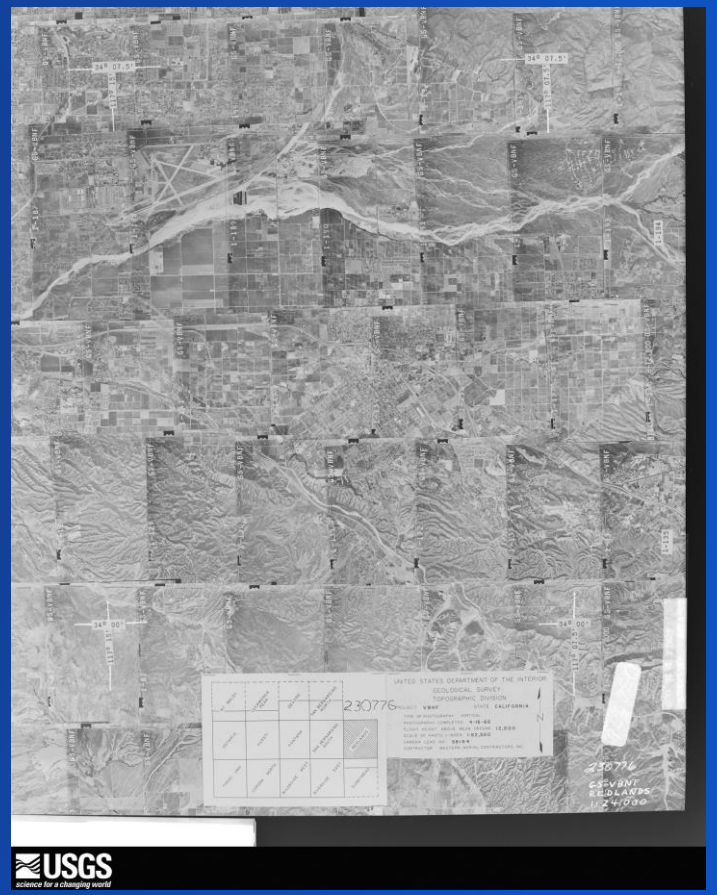
http://esriurl.com/OptimizeRasters



(2) Compilation of Metadata & Digitization of Approximate Photo Centers

- **Photo Index or Print Laydown**
  - Digitize locations and frame numbers by run & film number
  - Build feature class → (x,y) point for approximate photo center
  - "How??" will depend on your data. Easiest method typically to:
    - Scan & georeference the Photo Index/Print Laydown
    - Manually create points for photo centers
  - Populate "Key Historic Imagery Parameters" Table (next slide)

- **Film Report**
  - Include other metadata about the flight – date, type of film, etc.



(2) continued: Build “Key Historic Imagery Parameters” Table

For “Historical Imagery.pyt” - Required fields

Approximate X,Y (Geometry)

‘Raster’ field: path and file name to each scanned file

PhotoScaleF – Scale factor e.g. 5000 for 1:5000

FocalLength - In microns; e.g. 152400 for 6 inch

ScanDirection – per previous diagram

Frame – As a 4 digit string, e.g. 0023 (not stored as an integer)

Run – Flightline identifier (As a string)

Film – Film roll number or ID (As a string)

Required

COG (course over ground) – this will be calculated

ScanResolution – in microns. If not known, can be estimated as 0.24/Min(Cols,Rows)

FrameSize – in microns e.g. 180000 for 18cm. If undefined then assumed to be 23cm

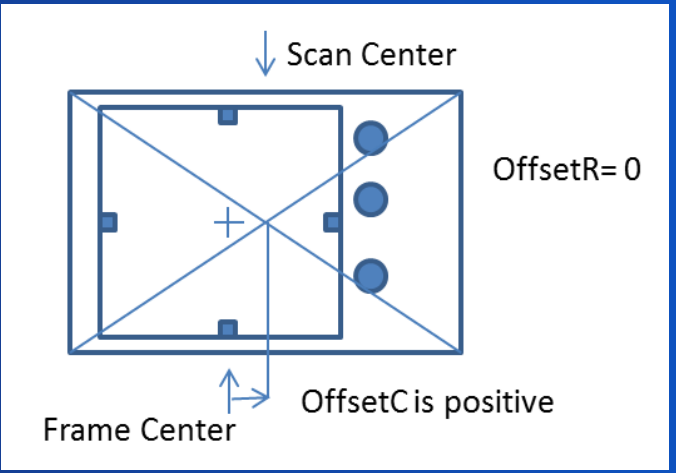
(2) continued: Build “Key Historic Imagery Parameters” Table

For “Historical Imagery.pyt” - Optional fields

Cols,Rows – Number of Cols and Rows of the image.

Will be obtained from Image if not defined; caution about performance

OffsetC, OffsetR - in microns. This is the offset of the camera center from the center of the scan. If undefined then assumed to be 0.



Fiducials (coordinates in camera coordinate system)

Other parameters optional – from Film Report

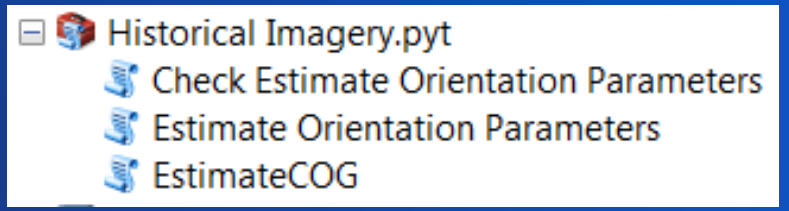
e.g. AcquisitionDate, ScanDate, ScannerModel, FilmType, etc.

***Frame Camera* Raster Type will add to attribute table**

Not included in the sample workflow

(3) Calculate Approximate Orientation

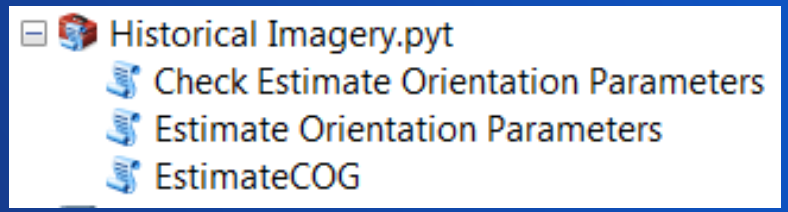
- **Geoprocessing Tools in “Historical Imagery.pyt”**



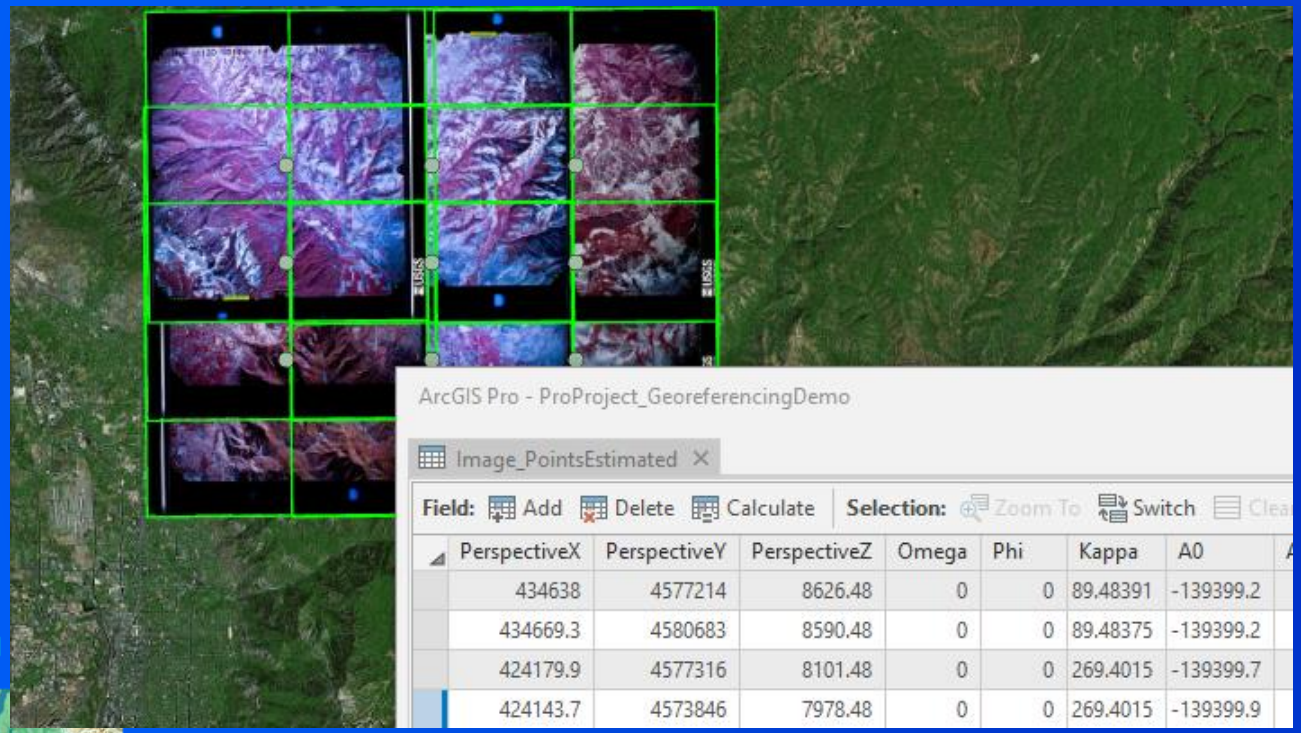
- **Will build table(s) required as input to the *Frame Camera* Raster Type**
  - ***Frames Table and Cameras Table* corresponding to Exterior orientation and Interior orientation**
  - **Can be separate tables, or combined into one**

See in ArcGIS Help System:
http://esriurl.com/FrameSchema
http://esriurl.com/CameraSchema

(3) Continued - Calculate Approximate Orientation



- Run *EstimateCOG* → Input KHIP table
  - This populates Course Over Ground field
- Run *Check Estimate Orientation Parameters*
  - This verifies required data is populated before beginning a lengthy run
- Run *Estimate Orientation Parameters*
  - This builds single Frame & Camera Table required as input to *Frame Camera* Raster Type (workflow step 4)



Approximate Orientation

Historical Imagery Tools

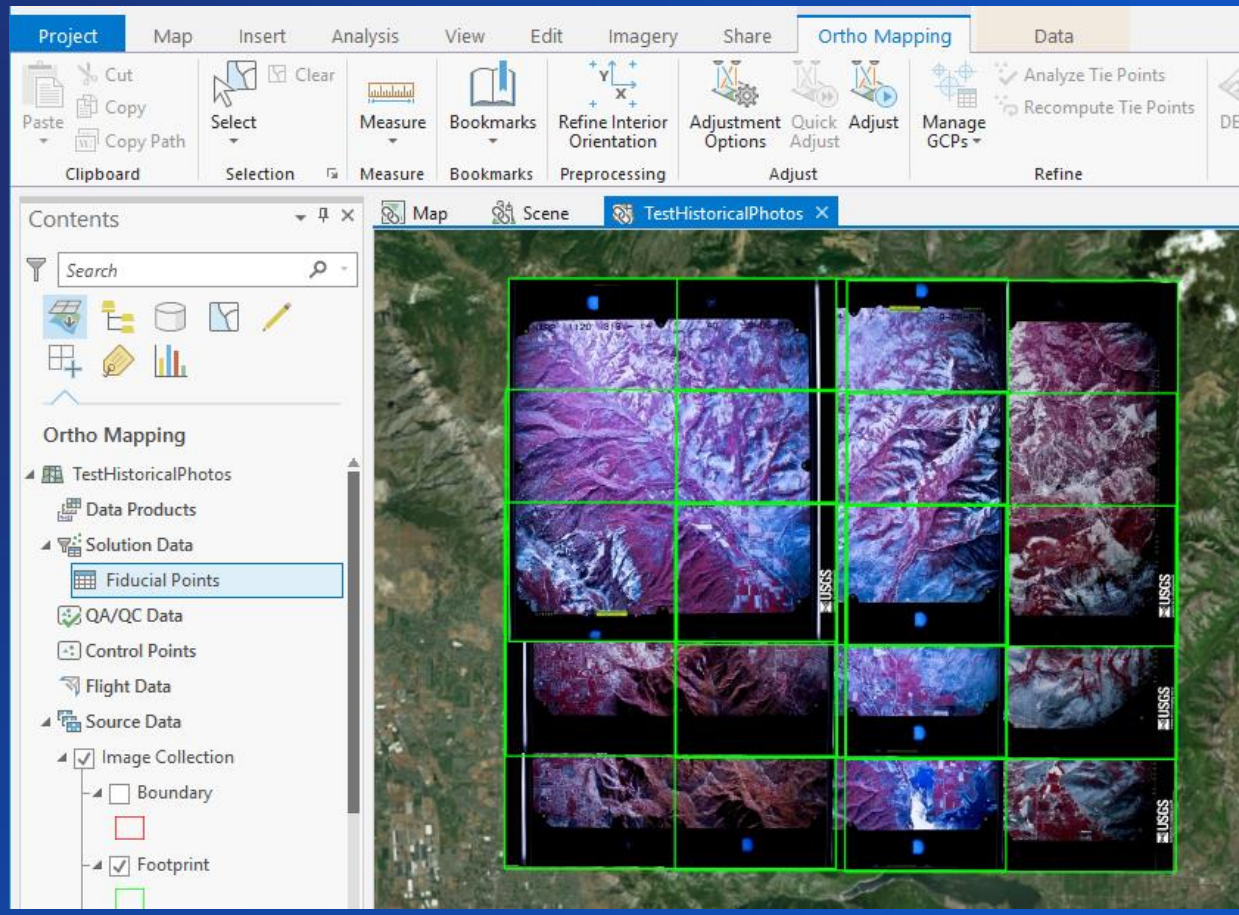
(4) (Optional) Create Mosaic Dataset

- Use *Frame Camera* Raster Type
  - Input Frame+Camera table as input
- Calculate footprints by Geometry, shrink ~200 m, clip to footprints
- Set Mosaic Method = Closest to Center

- Alternative: Proceed directly to Ortho Mapping, and input Frames and Cameras tables

(Workflow step 5) Ortho Mapping workflow

- Calculate fiducials (if in cameras table for this camera)
- Aerial Triangulation (AT) & Block Adjustment
  - Estimates for interior and exterior orientation parameters
- Uses best available DEM
- Input ground control points, if available
- Output
  - Refined interior & exterior orientation



Ortho Mapping

Compute Fiducials,
Run Aerial Triangulation
& Block Adjustment

Publishing (Workflow step 6)

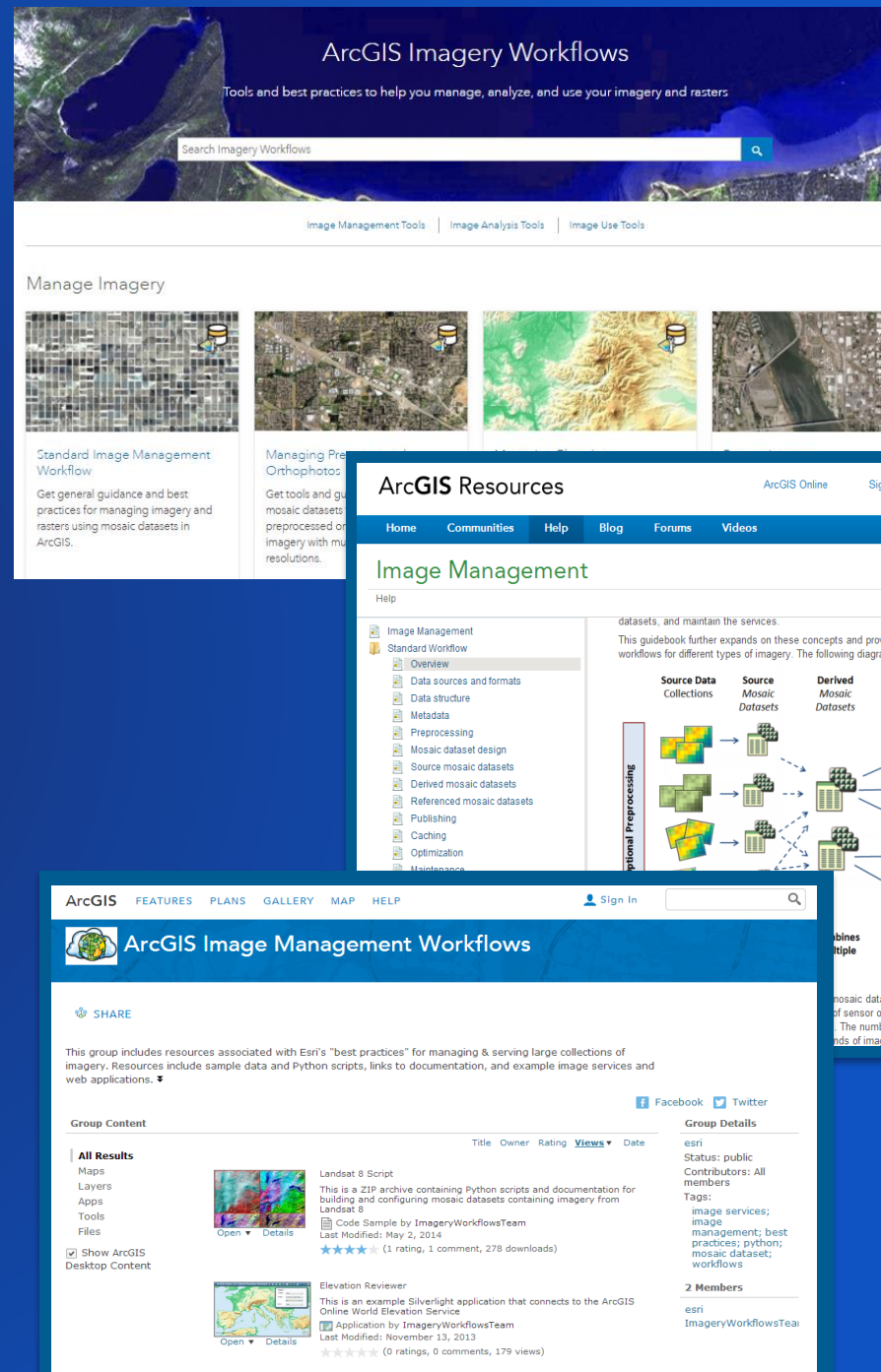
- As Image Services
  - Highest Image Quality (No data loss)
  - Provide Metadata
  - Access to All Overlapping data
  - Clip to Footprints

- As Raster Tile Cache
  - Generate in ArcGIS Pro or Server
  - Publish through Server or to ArcGIS Online
  - Provides Static Backdrop

Imagery Workflows

Best Practice Workflows for Image Management, Analysis, & Use

- **Landing page**
  - http://esriurl.com/ImageryWorkflows
- **ArcGIS Online Group**
  - **Downloadable scripts & sample data**



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