Wed. Apr. 25, 2018

- GIS DEMO

- Reading:
  - Ch. 14 -- Comparing Image Types (Death Valley)
    - Treat as review of techniques already studied

GIS: Geographic Information Systems

- Way to organize data obtained by remote sensing (and other) observations
- Types of data:
  - Raster Files
    - Images
    - Digital Elevation Maps
  - Vector Files
    - Political Boundaries
    - Land Use Groups
    - Geological Unit Boundaries
  - Data bases
    - Population
    - Information about data sources (which image went into mosaic?)
    - (at some level the whole data set can be considered a data base)
- ArcGIS and associated programs from ESRI
- Variety of other lesser used GIS systems
  - QGIS (Quantum GIS) is anOpen Source GIS system (running on Linux, MacOS, and Windows) used for Io demonstration

Raster vs. Vector Data

- Raster data:
  - An matrix of cells, each of which contains some value
    - Good for:
      - Intensity in an image
      - Radar reflectivity vs. position
      - Height vs. position
  - There is some implicit relationship between row and column index (i, j) and position in space (x, y)
    - If there is a constant scale the relationship is simple and linear

- Vector data:
  - A list of (x, y) coordinates, and often some value specified at that coordinate
    - Good for:
      - Plotting lines in space (roads, rivers, borders, contours, etc)
      - Heights of discrete locations such as mountain peaks
      - Locations of discrete features

Coordinates

- “Geographic” vs. Projected
  - “Geographic” coordinates usually mean (longitude, latitude)
  - Projected coordinates are (x,y) values on some “map”
    The relationship between (x,y) and (long., lat) depends on the type of “projection”
- Datums: Set of assumptions about the shape of the Earth and the location of the reference points which go into determining the coordinates of a given spot on the surface:
  - Would be simple if the earth were a sphere of perfectly known size, but it is not.
  - The same location can have different coordinates in different “datums”.
- Coordinate Reference System (CRS): Choice of datum, geographic vs projects values, etc., which are inherent in the location information given with a vector or raster data set.
- On-the-fly projection: The ability of a GIS system to simultaneously display multiple data sets that have different CRS's, without you first having to “reproject” them to a common CRS.

Datums

- Datums: Set of assumptions about the shape of the Earth and the location of the reference ponits which go into determining the coordinates of a given spot on the surface:
  - All this would be simple if the earth were a sphere of perfectly known size, but it isn't.
  - Some of the assumptions:
    - Location of the "prime" meridian (i.e. Greenwich, Paris, etc.)
    - Equatorial and Polar Diameter or Equatorial + Flattening (or some other combination)
    - Non-ellipsoidal terms (usually ignored)
    - Planetographic vs. Planetocentric Latitude
      (not really part of "Datum" choice, but explanation fits here)

  - NAD27 = North American Datum of 1927 (Used on most printed USGS maps)
  - NAD83 = North American Datum of 1983
  - WGS84 = Wold Geographic System of 1984 (common default for GPS devices -- but they can be switched to use others)

  - Differences between NAD27 and WGS84 "UTM" coordinates are 100's of meters near Laramie -- can be km in places
  - Latitude and Longitude values for a given spot also change with datum -- although typically not as much
  - Changes with time: NAD83 fixed to North American Plate -- WGS84 is a "world average"

Map Projections

- If region covered is large enough, you must consider the curvature of the Earth

- Impossible to display curved surface on flat paper (or computer screen) without some distortion.

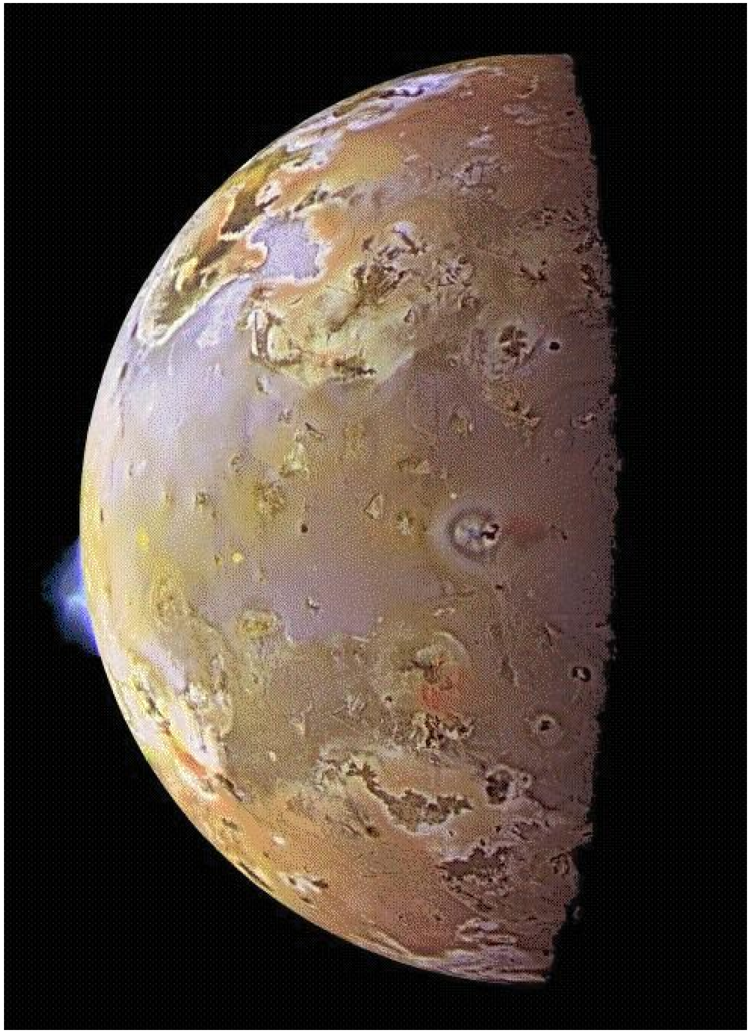
- Standard map "projections" define the distortion
  - Can be geometric "projection" or more complicated math formulae
    - "Project" sphere (or ellipsoid) onto a (rolled up) plane (then if necessary unroll plane)
  - Different projections have different advantages/disadvantages
    - Mercator good for navigation because azimuth (compass) directions correct
    - Mercator bad for estimating size of regions – exaggerates high latitudes

  - All can be reduced to a pair of formula for converting (latitude, longitude,) = (λ,ϕ) into (x, y)

  - Notation: Lines of latitude = "parallels", Lines of longitude = "meridians"

- John P. Snyder, 1987 "Map Projections – A Working Manual"
  - USGS Professional Paper 1395, available on USGS web site

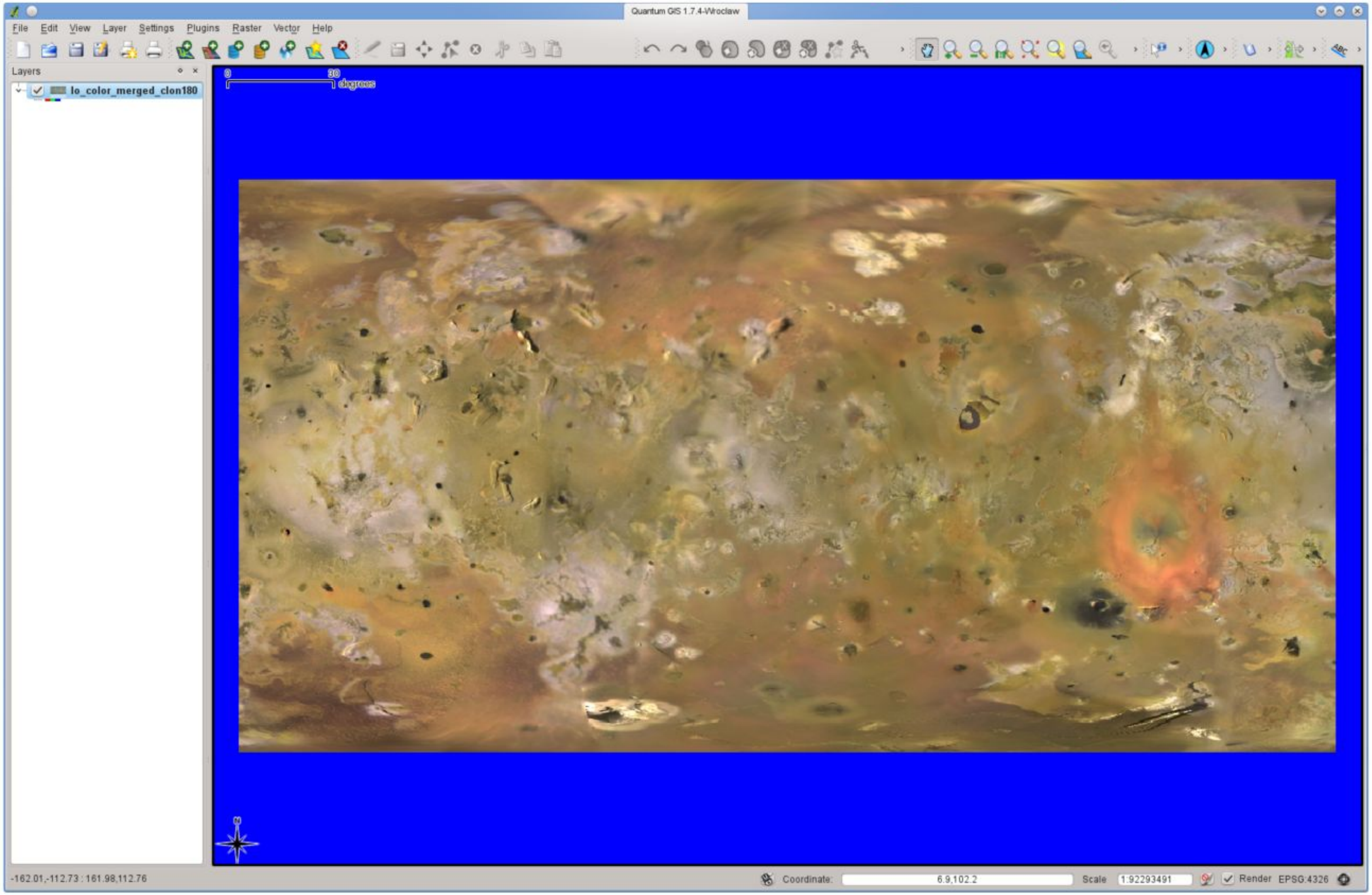
Io: Innermost of 4 large Galilean Satellites of Jupiter



- Most volcanically active body in the solar system
- Heated by tidal flexing caused by its slightly eccentric orbit around Jupiter
  - Massive Jupiter causes massive tides
    - They would just cause a fixed distortion of Io if orbit were circular
    - It keeps one face towards Jupiter (like our Moon toward Earth)
  - Eccentric orbit causes tides to get larger and smaller, and to shift position slightly
  - Presence of other moons keeps the orbit eccentric
- Heat flow from Io is 1-- 2 W/m^2 , similar to highest heat flow areas (Yellowstone) on Earth
- Very high rates of volcanism
  - See unusual processes like flood basalts, perhaps ultramafic volcanism
- The only volatiles left are S, SO_2 related compounds (H_2O and CO_2 have been lost)
- Tidal heating important (but harder to study) elsewhere in the solar system
  - Europa (subsurface ocean)
  - Enceladus (moon of Saturn with water jets from south pole)
  - Perhaps even early earth when shortly after moon formed from giant impact and was closer

- Recently Williams et al. (2012) have released a nw global geological

Williams et al. Io Geological Map



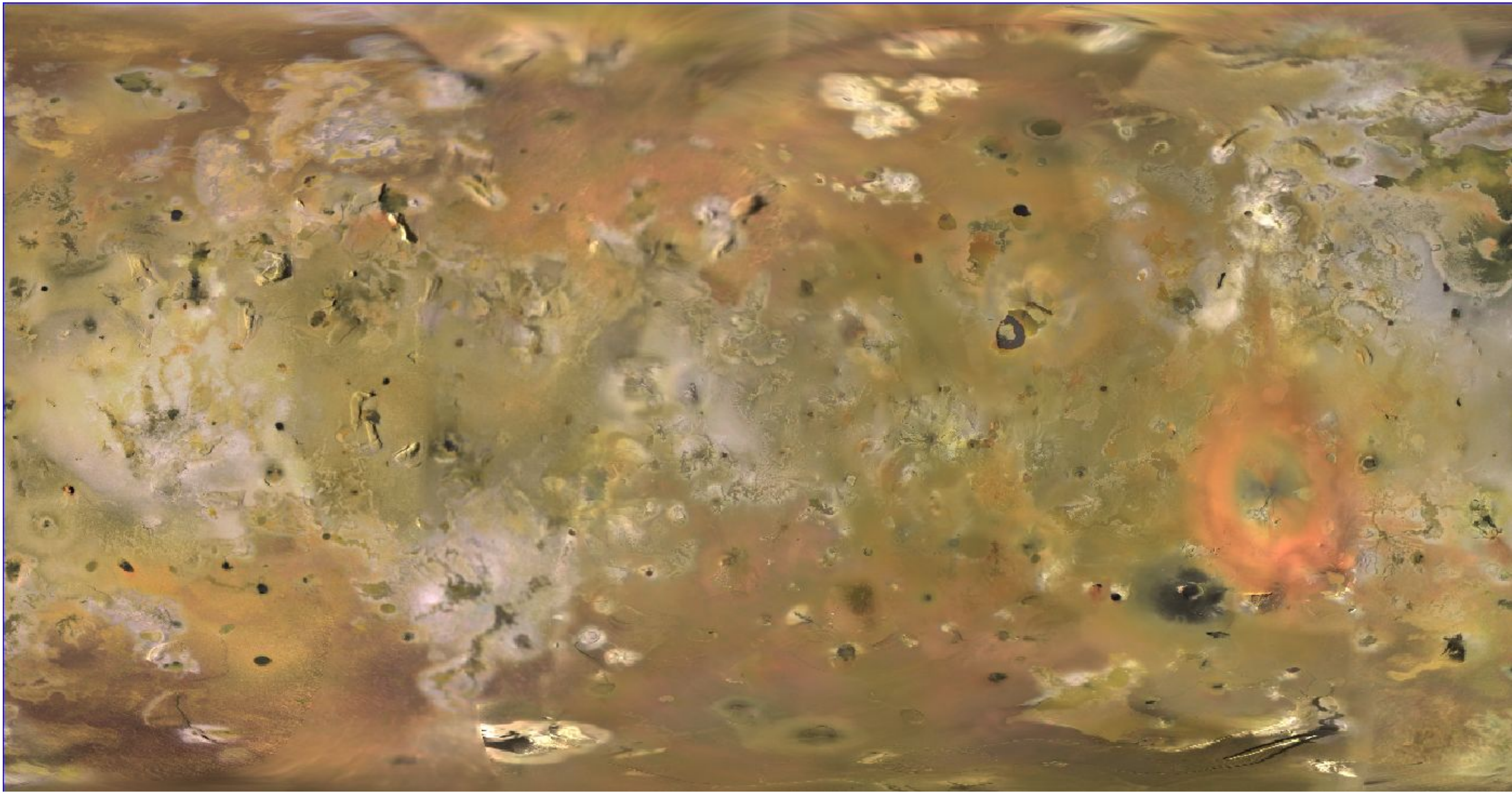
•Data from both Voyager (1979) and Galileo (1995-2003) spacecraft

•Color produced from low-resolution images then added to the highest resolution monochrome images

Williams et al. Io Geological Map

- I gave a live demonstration using the QGIS (Quantum GIS) software and the recent Williams et al. geological map of Io. The following show some screen shots from that demonstration. monochrome images

USGS Voyager + Galileo Mosaic



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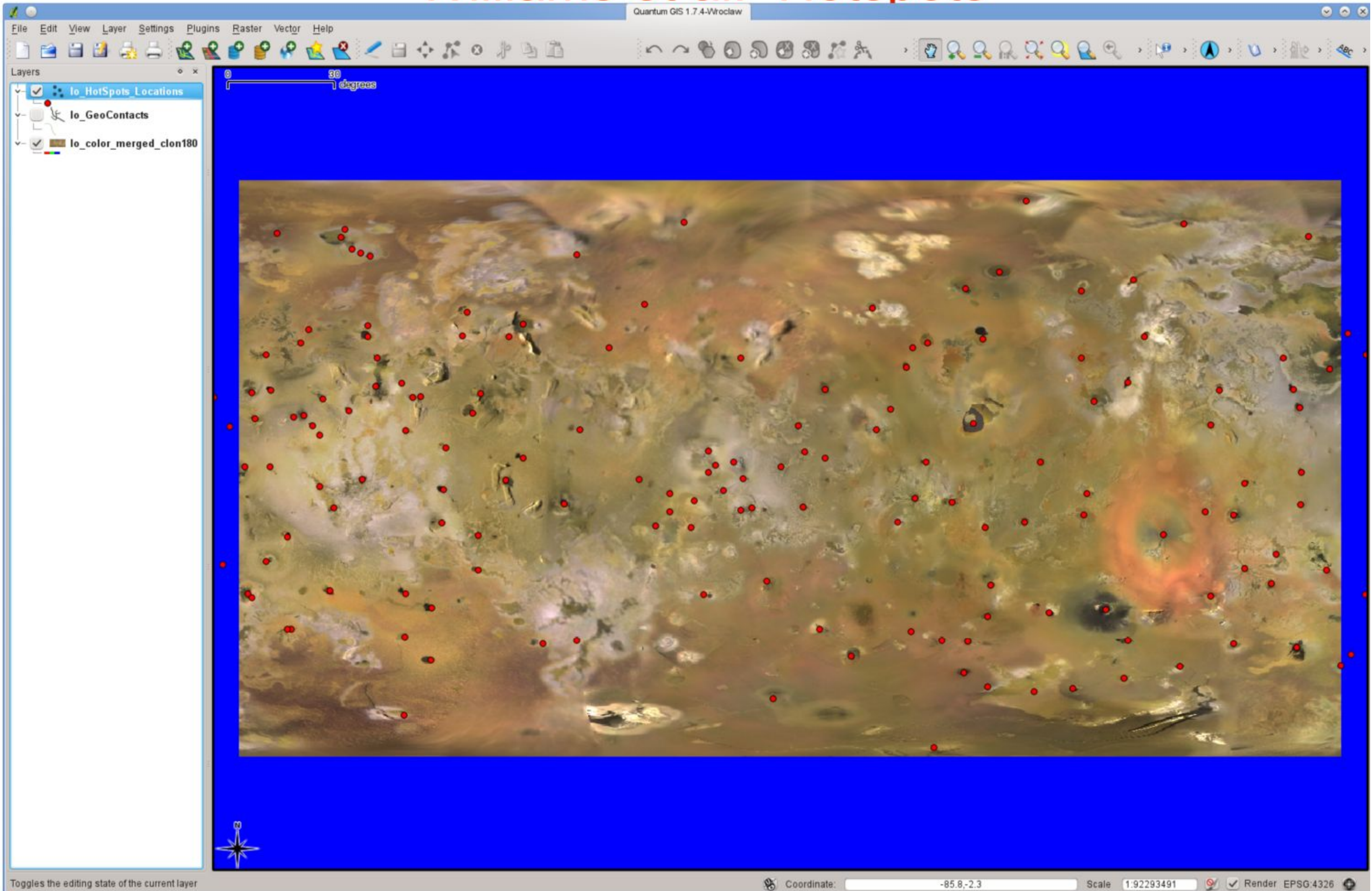
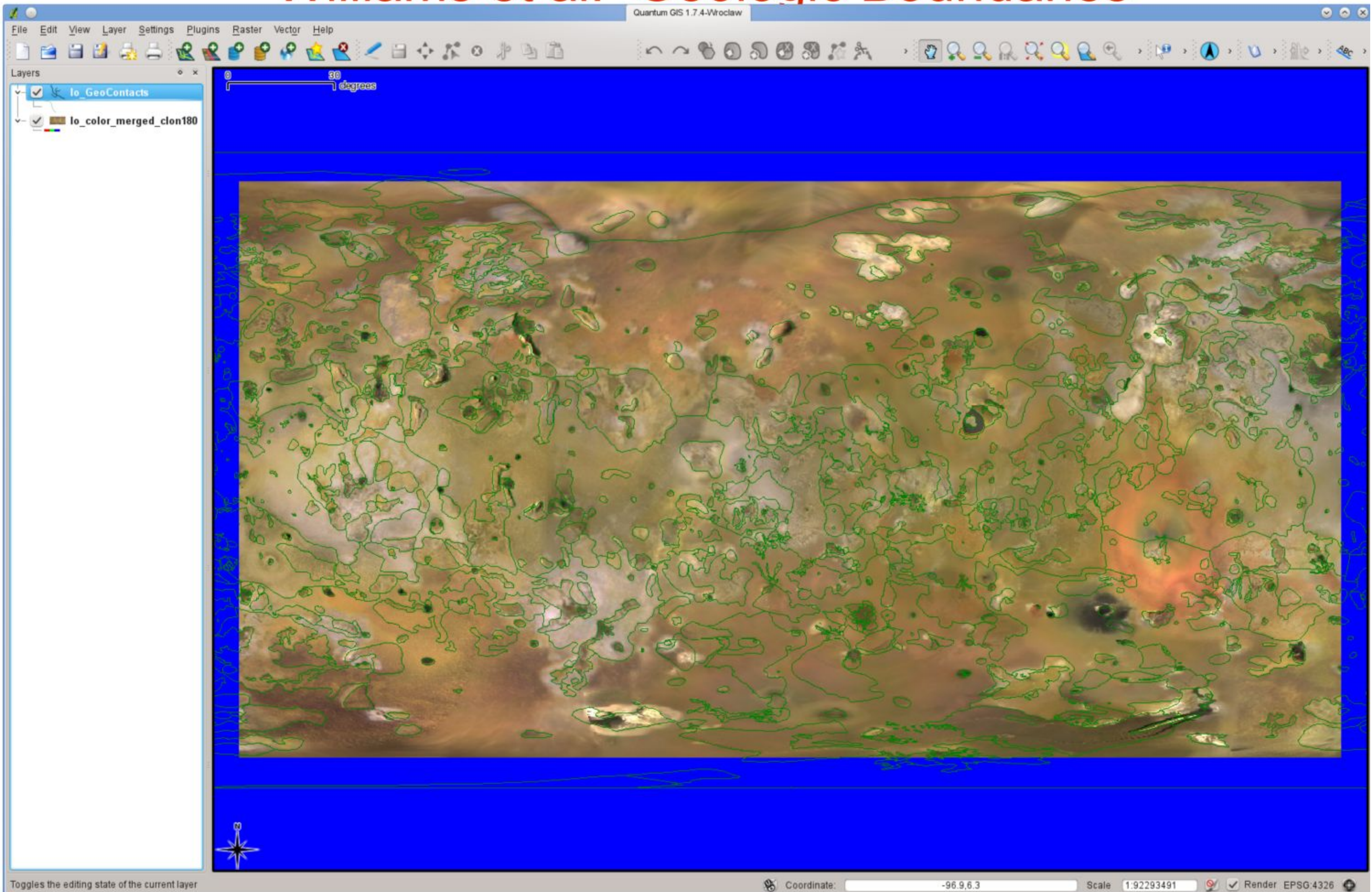
Williams et al. Hotspots



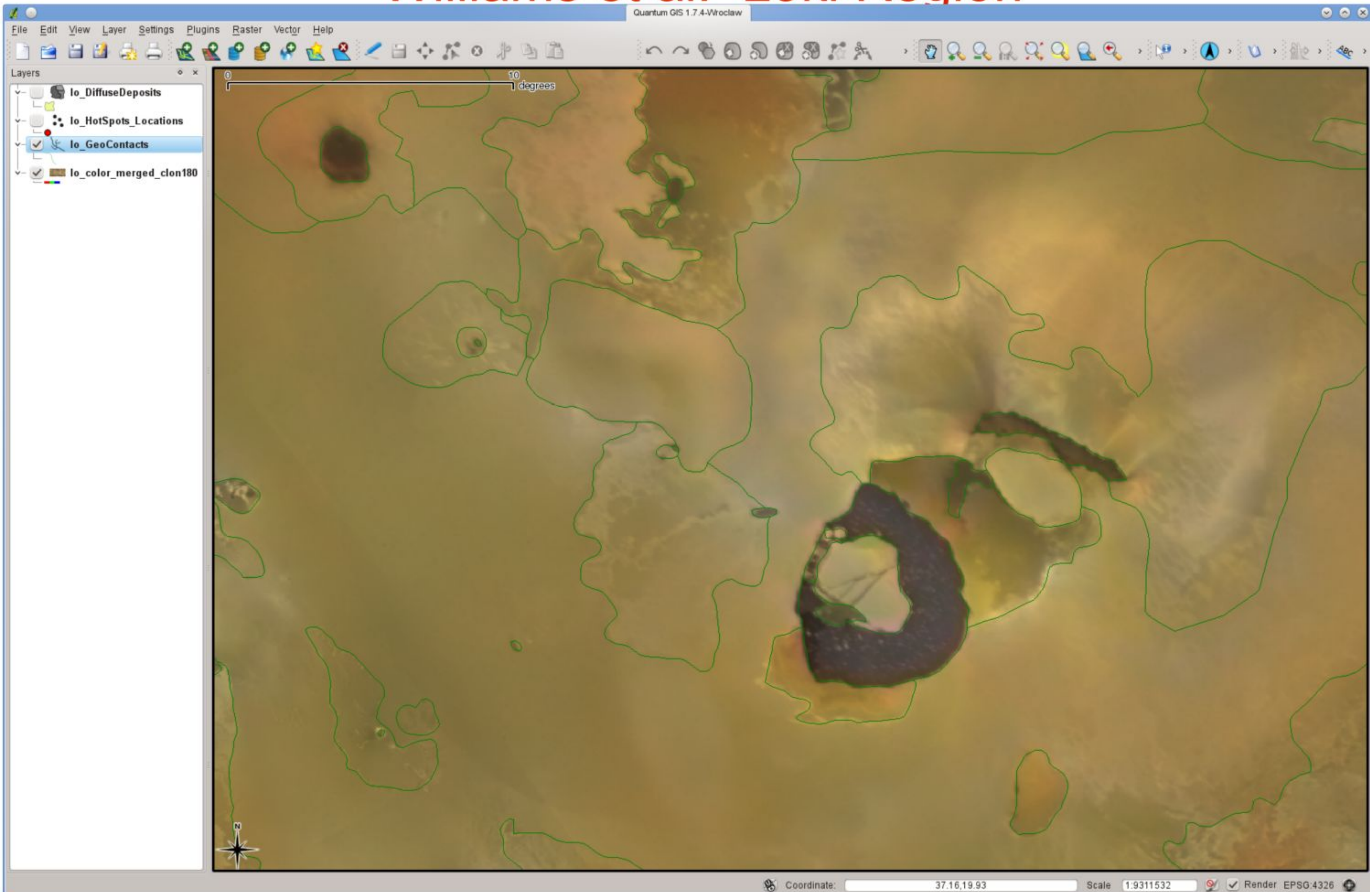
•Hotspots (from other's work)

Williams et al. Geologic Boundaries



- Boundaries

Williams et al. Loki Region



- Loki Region