Using GIS to Digitize Data Taken from the El Tatio Geyser Field, Chile and to Observe Chemical Concentration Changes from December 2006 to October 2009

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5/5/10

Introduction

The goal of this project is to digitize new and existing data taken from the El Tatio Geyser field in northern Chile, then plot ion concentration changes from data taken in December 2006, June 2009, and October 2009. This project aims to combine old data from The Journal of The Geyser Observation and Study Association (taken in 2003) with new data taken from Megan Franks' doctoral research in 2007. Then with Megan's field data, changes in Iron, Arsenic, and Chlorine will be observed. By doing this, it will georeference Megan's data while putting into perspective where her data was taken with respect to an existing study. To plot these points I will use a map that is spatially referenced and overlay it with a terrain image and then by a scanned map from the Geyser Oberservation and Study Association (GOSA) Transactions book, then plot the locations where Megan took samples. After, concentration changes will be ranked with respect to an ion and its time period and plotted to observe changes.

Data

Imagery was obtained from NASA, Google Earth, and the GOSA Transactions Volume III book. The only image that was georeferenced was that obtained from NASA's GeoCover Landsat satellites. The image from GoogleEarth was not georeferenced because of saving the image without any attributes. The map taken from the GOSA book was scanned in and was not previously georeferenced. Megan's data was taken from a handheld Garmin GPSMAP60 receiver and concentrations were measured with an ICP-mass spectrometer (Arsenic and Iron) and a high-performance liquid chromatograph (Chlorine).

<u>Procedure</u>

To begin, spatial reference from this data was taken from http://zulu.nasa.gov (Figure 1) and uploaded into ArcCatalog. Before it could be loaded into ArcMap, the false northing on the WGS_1984_UTM_Zone_19S had to be changed from 10,000,000 to 0 in order to be recognized by ArcMap (Figure 1).

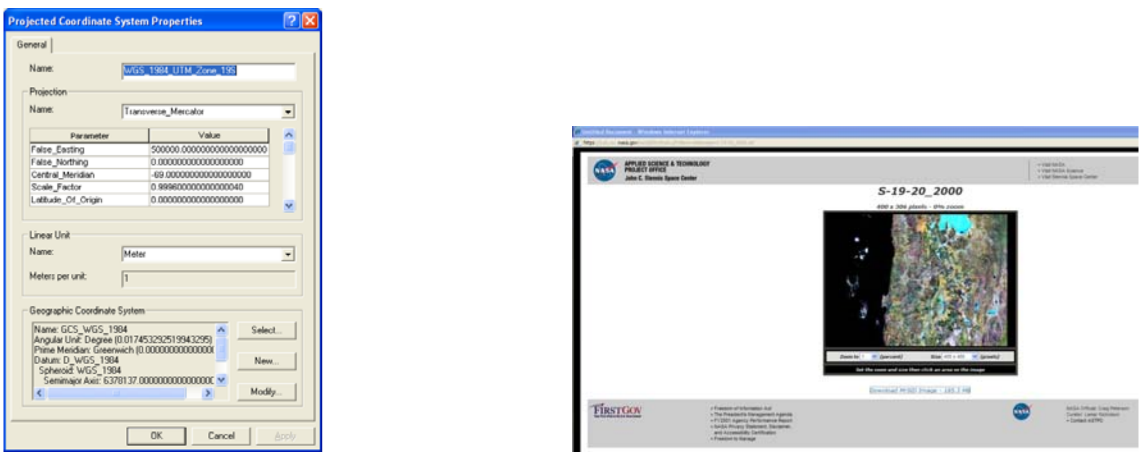


Figure 1: Spatial Image taken from NASA (right) and adjusting the False Northing in ArcCatalog (left)

Then, in GoogleEarth, the Geyser field was located (Figure 2).

Figure 2: El Tatio Geyser Field on GoogleEarth with placemarks

Initially placemarks were placed in order to divide up screenshots for a picture mosaic in Photoshop, but because GoogleEarth is very sensitive to mouse control, it was very difficult to take screenshots from a consistent perspective. After trial and error (and frequent frustration) in Photoshop, I resorted to taking an image capture of the whole geyser field (Figure 3).

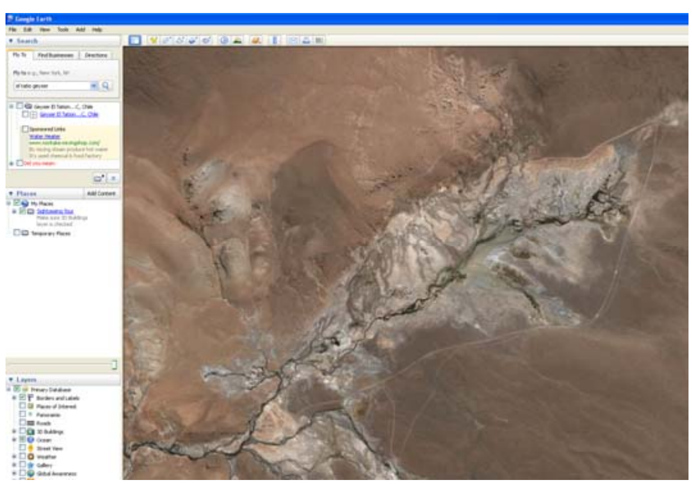


Figure 3: El Tatio Geyser Field

Then, I located the geyser field on the spatial image from NASA (Figure 4) and georeferenced the image from GoogleEarth (Figure 5).

Figure 4: El Tatio Geyser Field located on spatial imagery

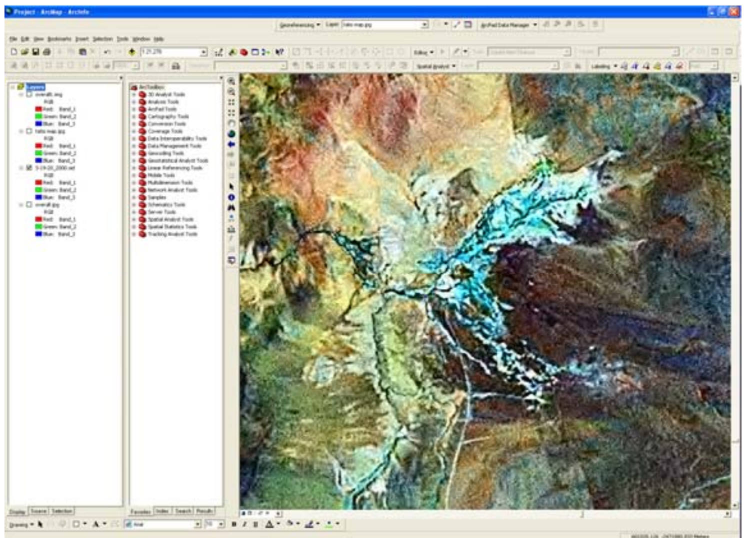
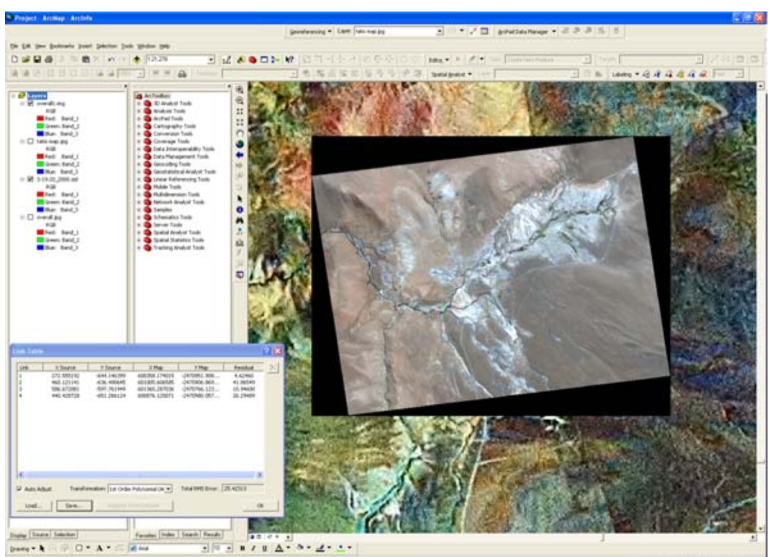


Figure 5: Georeferencing GoogleEarth image to spatial imagery



Then, I scanned in the index map from the GOSA Transactions book (Figure 6) and uploaded it into ArcMap.

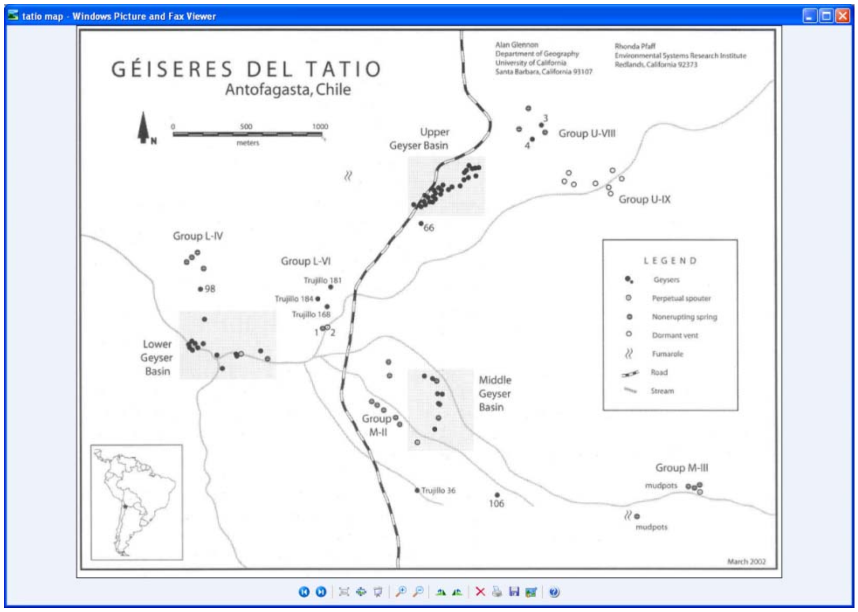


Figure 6: Scanned image of index map

Next, I georeferenced the scanned image to the already georeferenced GoogleEarth image (Figure 7).

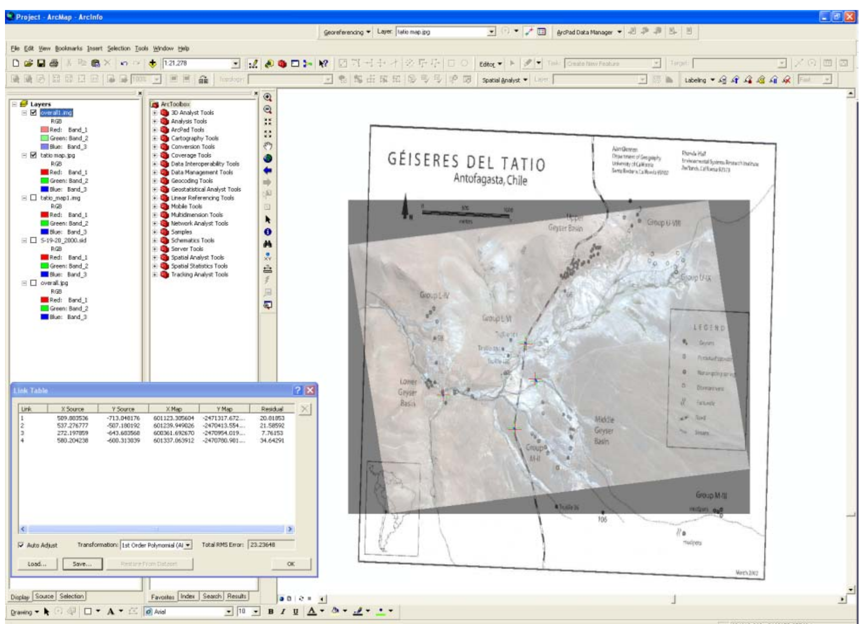


Figure 7: Scanned image being georeferenced to GoogleEarth image

Then I created a geodatabase to store the road, stream, and geyser data from the GOSA transactions and from each year measurements were taken. A feature dataset was created for each of these features called “Geysers” (Figure 8) and projected them on the WGS 1984 UTM Zone 19S coordinate system. Feature classes “Map_Area”, “Roads”, “Streams”, and “Map_Points” were then created (Figure 9).

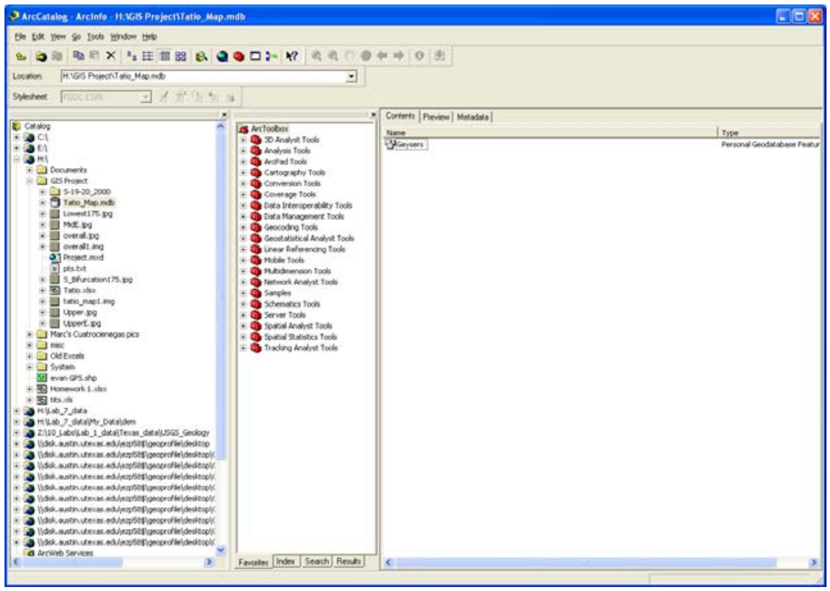


Figure 8: Creating "Geysers" feature dataset

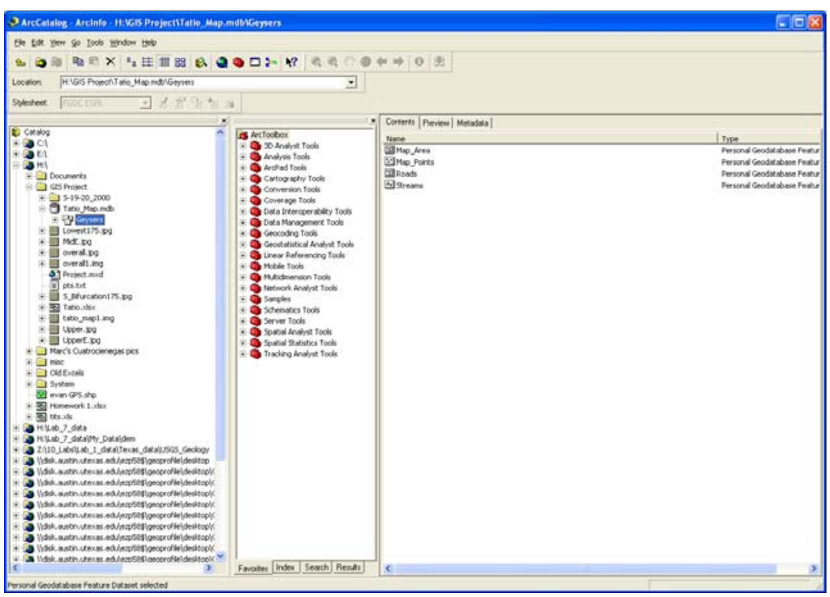


Figure 9: Creating feature classes

The only feature class that a domain was added to was the “Map_Points” dataset. Because all of these points will be for geyser data, the codes I created for the point data were: Perpetual Spouter, Nonerupting Spring, Dormant Vent, and MAF sample (representing samples taken by Megan A. Franks) (Figure 10).

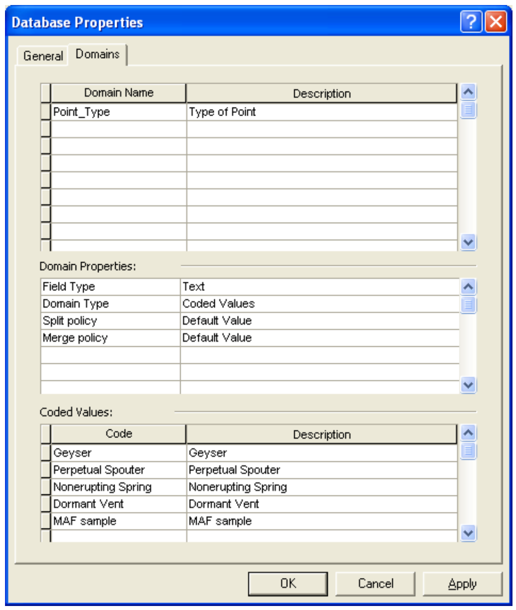


Figure 10: Creating codes within the domain for geyser description

Then I digitized the map using the features created in the geodata base and correlated them with data on the GoogleEarth image and the GOSA map (Figure 11-13).

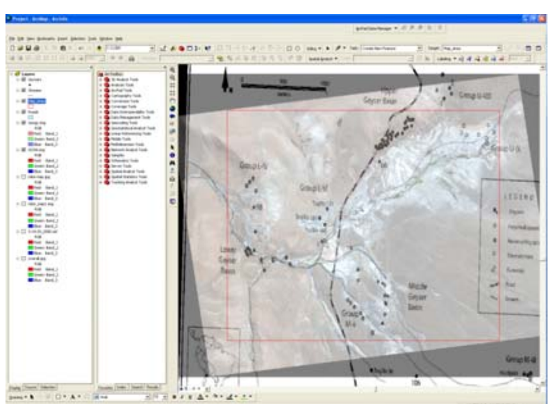


Figure 11: Digitizing features (Map Area)

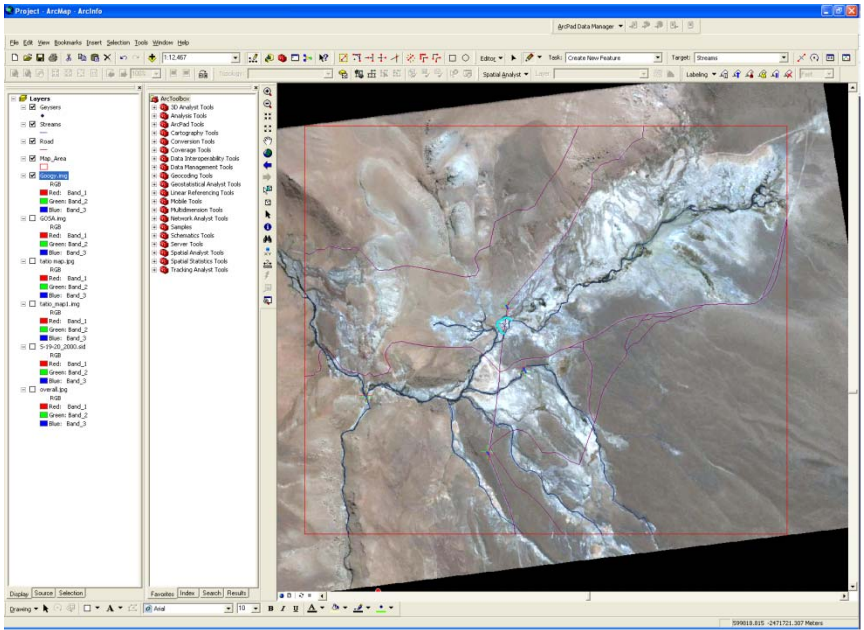


Figure 12: Digitizing features (Roads & Streams)

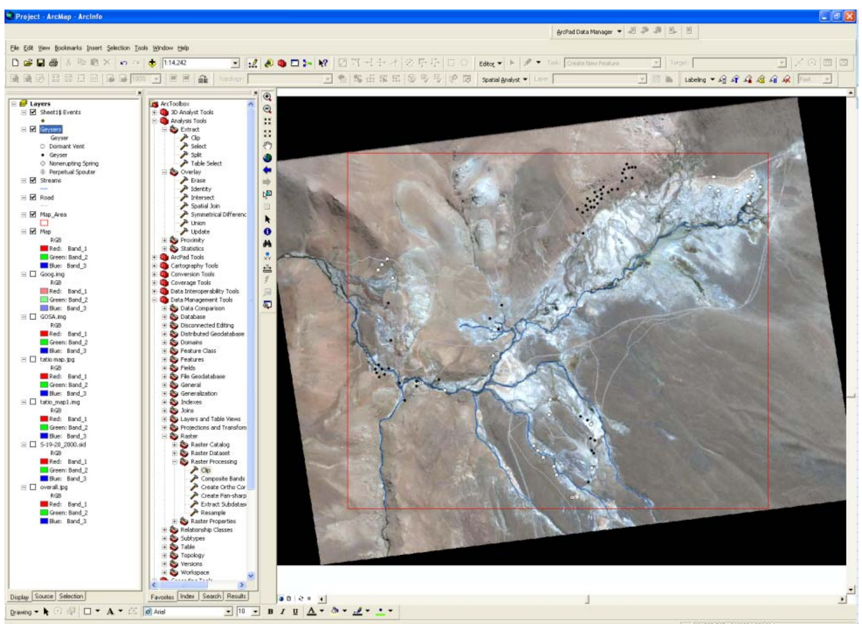


Figure 13: Digitizing features (Geysers)

Then, I used the GPS measurements on the provided spreadsheets and plotted the 3 geysers Megan observed onto the digitized map (Figure 14-15).

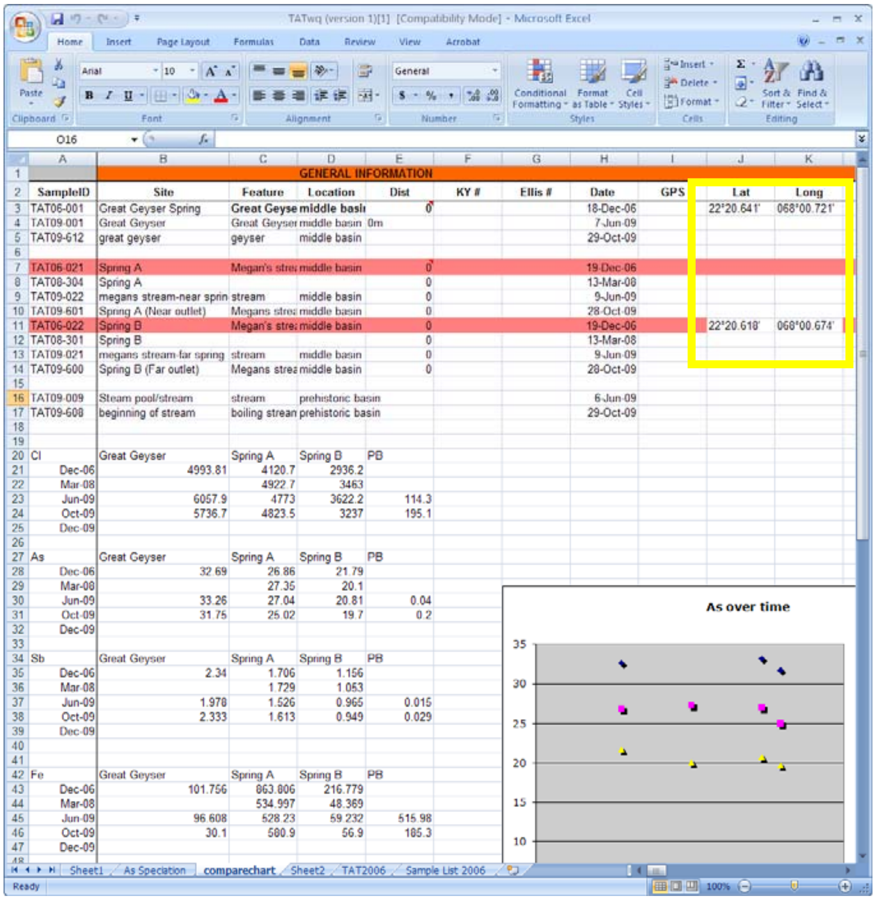


Figure 14: GPS Data

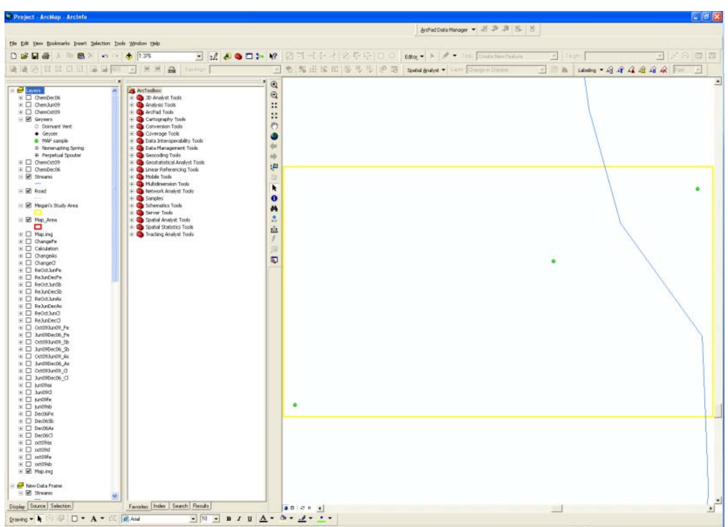
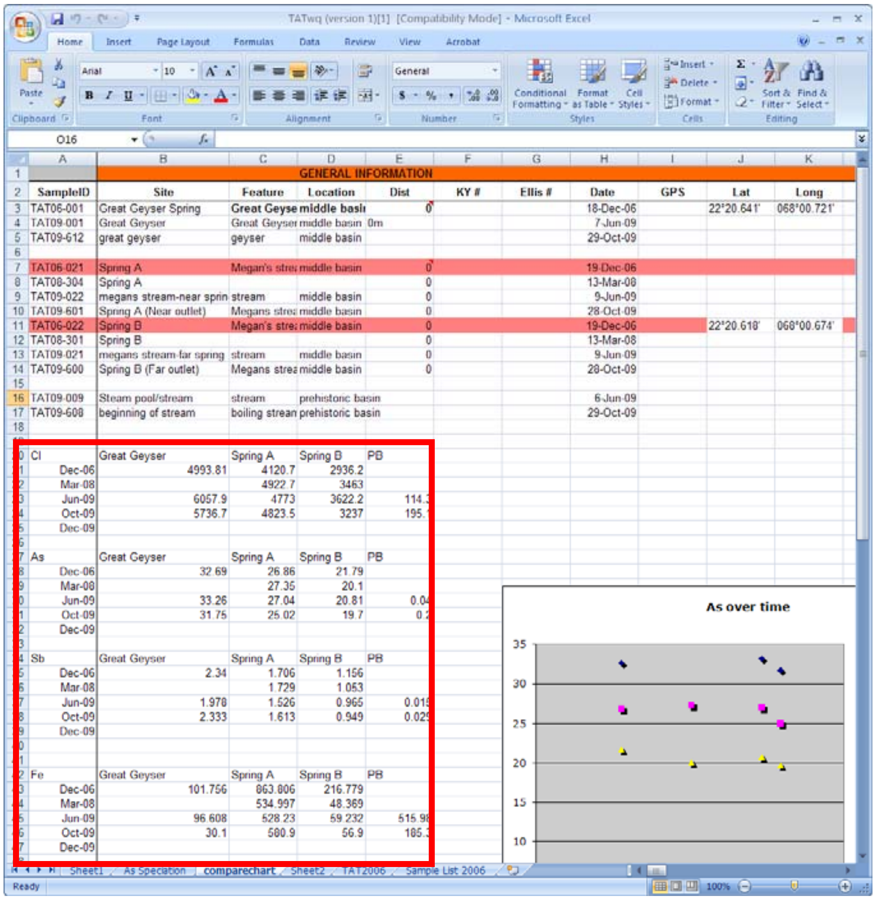


Figure 15: Plotted Study sites (without imagery background)

Then I created feature classes based on the ions and year examined (Figure 17).



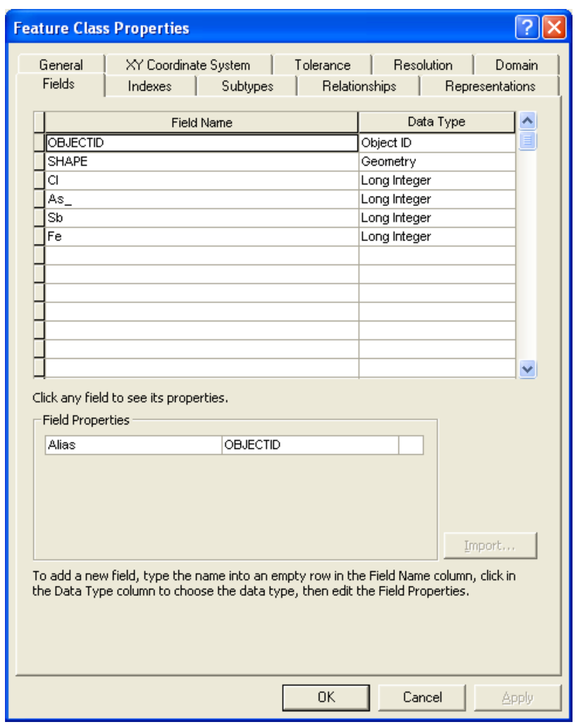


Figure 16: Chemical data sorted by year and geyser (top) and making feature classes based on them (bottom)

Then, I plotted the points based on the year they were taken and entered their chemical data based on the site they were taken at. Values are in ppm or mg/L. The Great Geyser is located the farthest west, Spring A in the middle, and Spring B is the farthest East. (Figure 17)

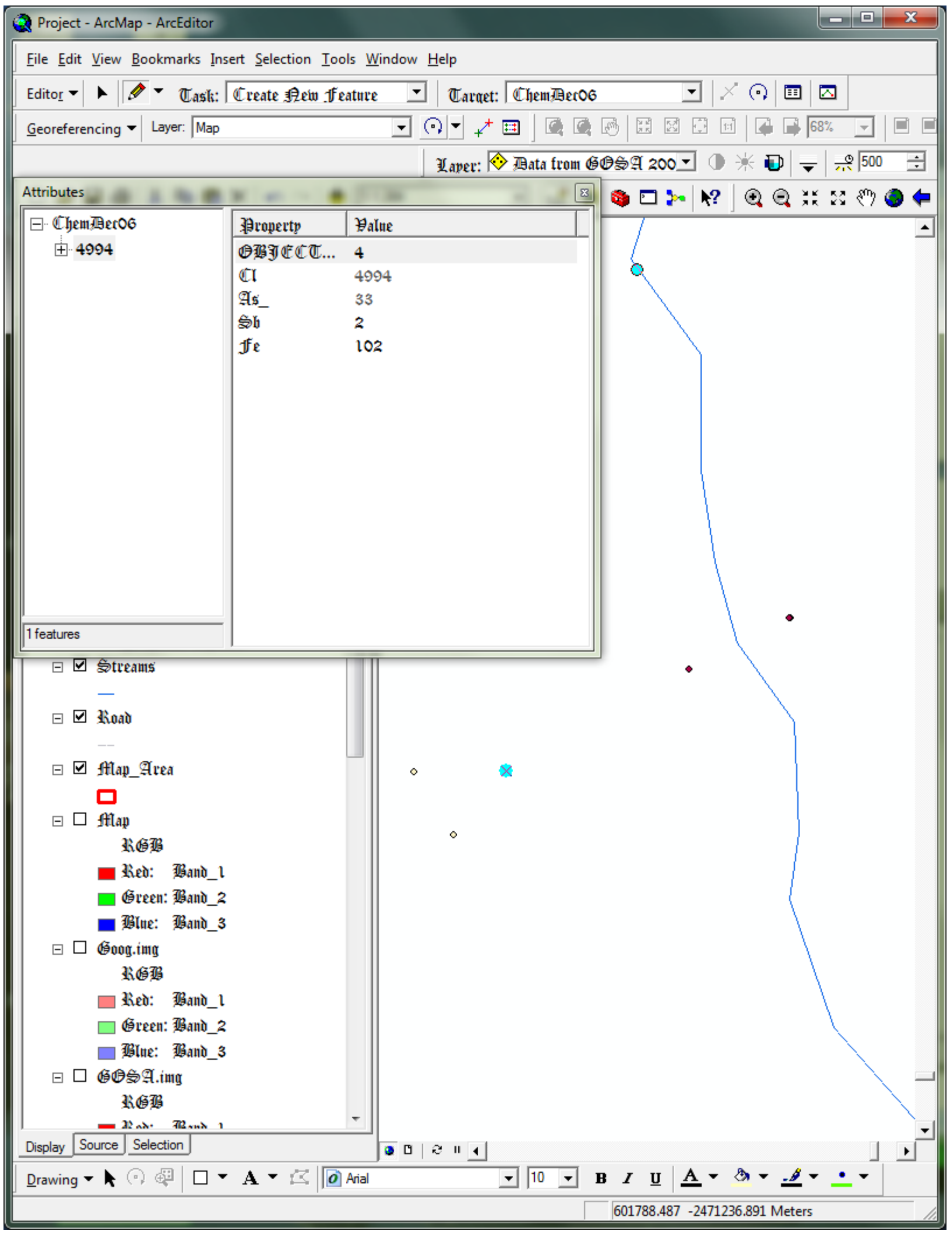


Figure 17: Entering Chemical data for Dec2006 at the Great Geyser site

After all of the data was entered for each respective year and site, I chose to spline the data for each ion because of its apparent smoothness (Figure 19).

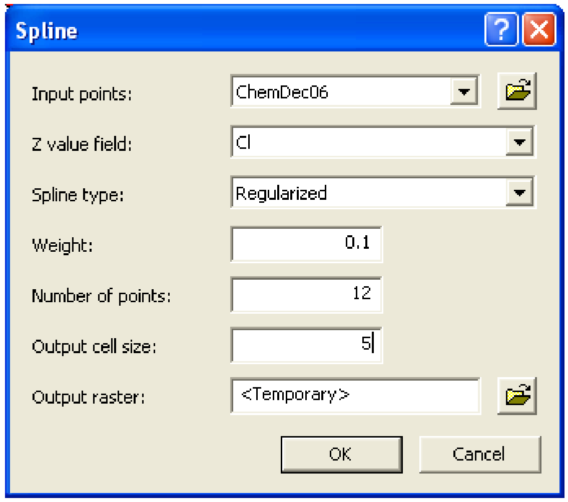


Figure 18: Splining Chlorine data from Dec2006

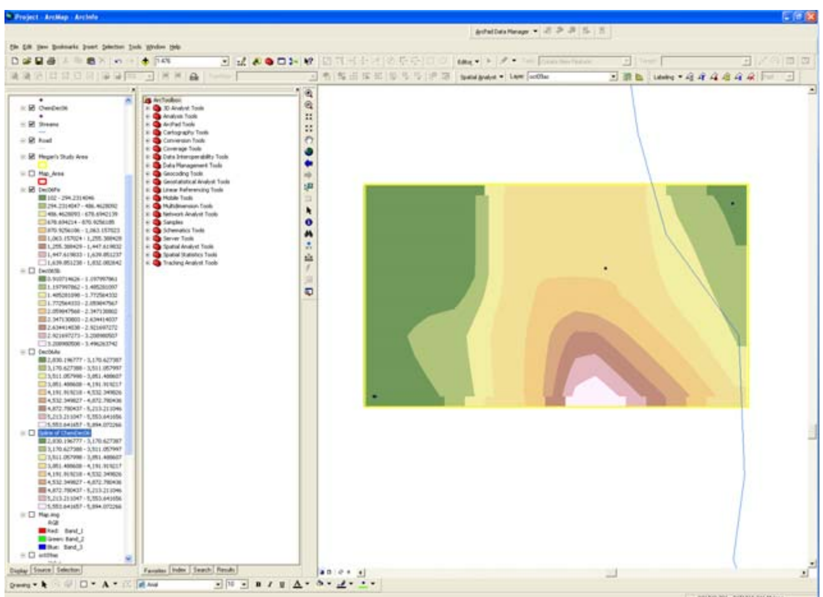


Figure 19: Spline of Chemical data

Then, what turned out to be a crucial part, I classified each ion so that it had about 10 distinctive ranges of ion concentration (Figure 20). After, in raster calculator, I subtracted December 2006 ion concentrations from June 2009 ion concentrations, and later subtracted June 2009 ion concentrations from October 2009 ion concentrations in order to have long and short term concentration changes (Figure 21).

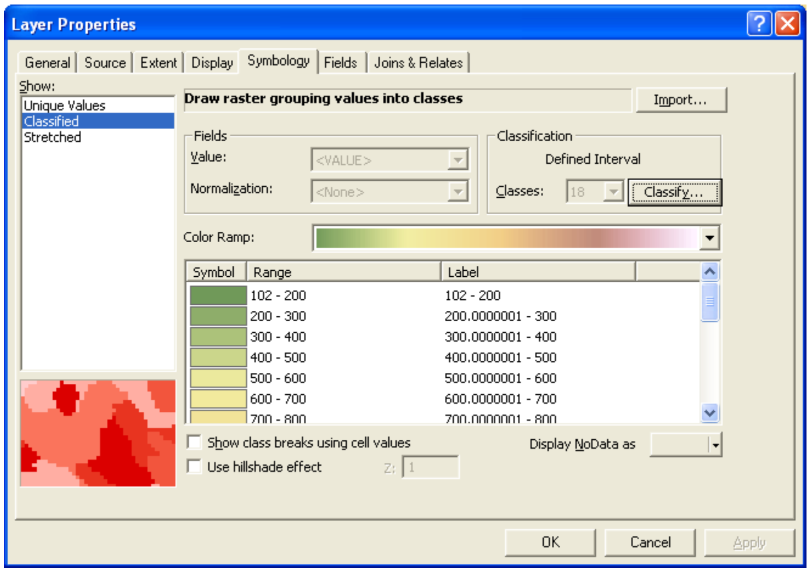


Figure 20: Classifying Ion Concentration levels to have about 10 distinct ranges

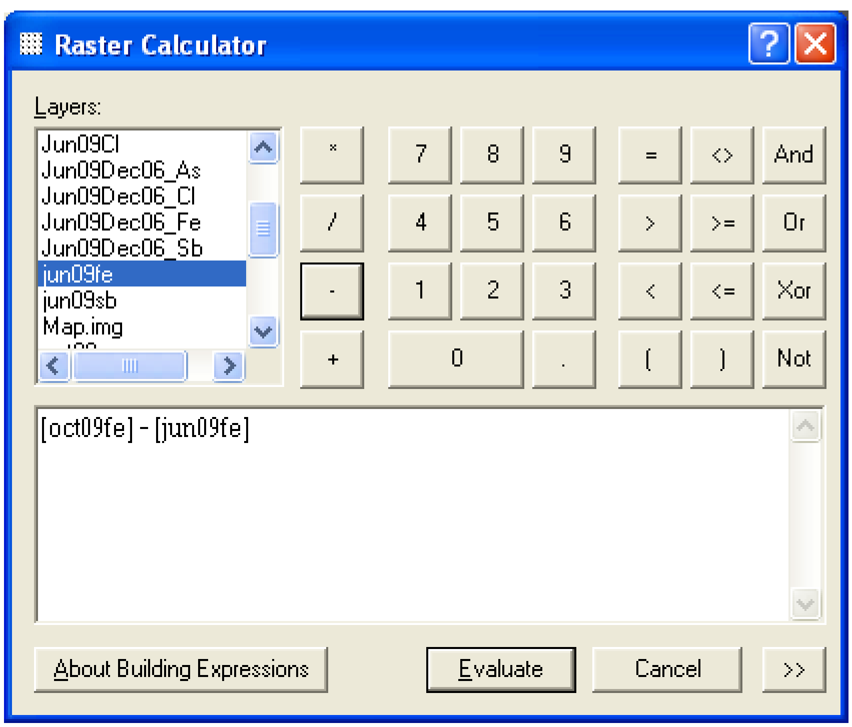


Figure 21: Subtracting June 2009's Iron concentration from October 2009's Iron concentration

Then based on the range of the change in concentration and the classified intervals, a rank was given (large increases in concentration=higher rank, large decreases in concentration=lower rank) (Figure 22). Also, I kept the ranges and ranks consistent between ions.

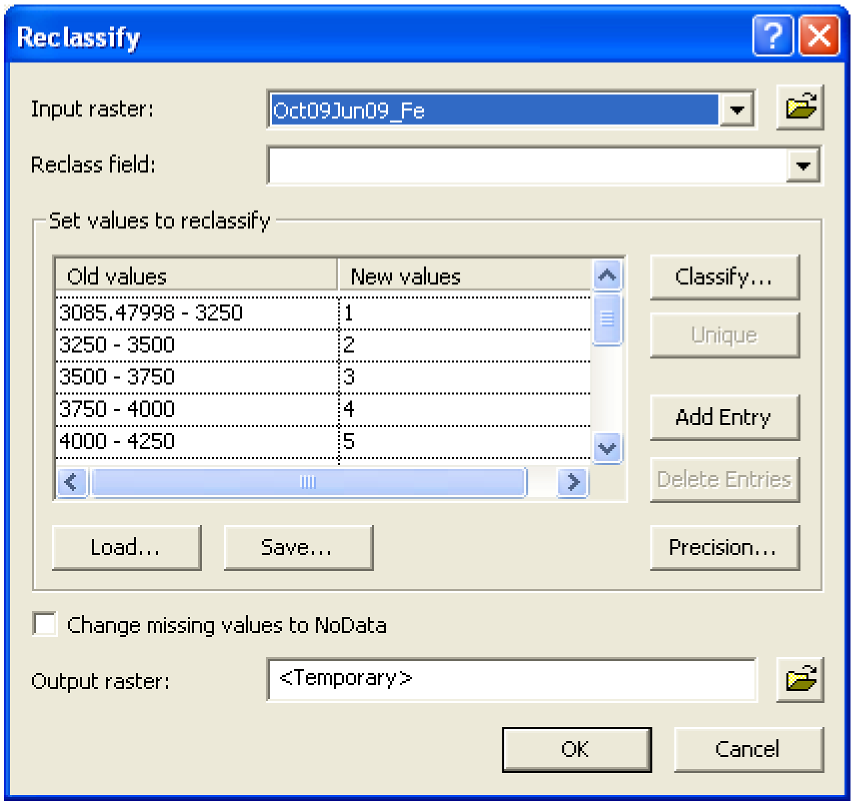


Figure 22: Ranking concentration changes

Then I added all of the newly reclassified concentration changes for each ion from December 2006-June 2009 to June2009-October 2009 in the raster calculator and observed the changes (Figure 23-24).

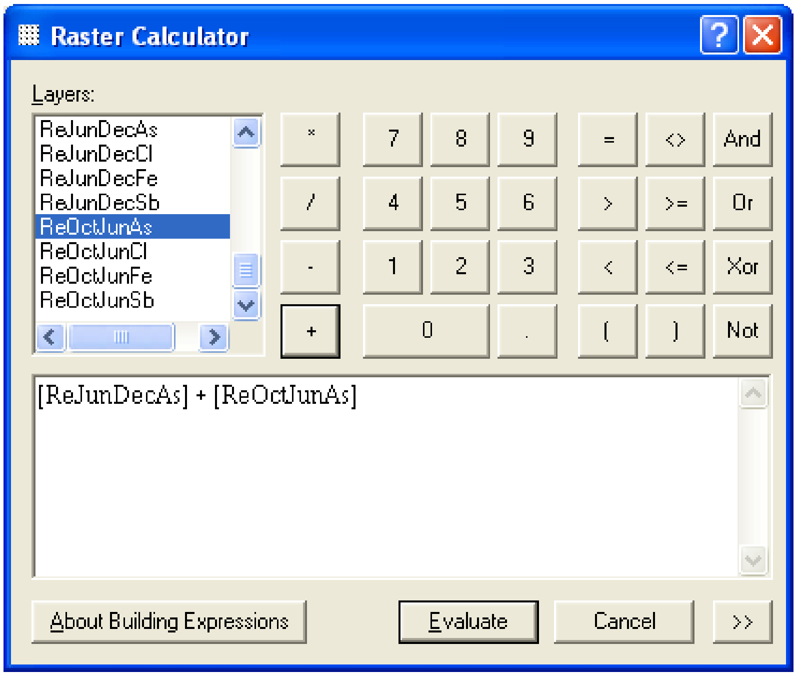


Figure 23: Adding ranked ion concentration changes from 2 time periods

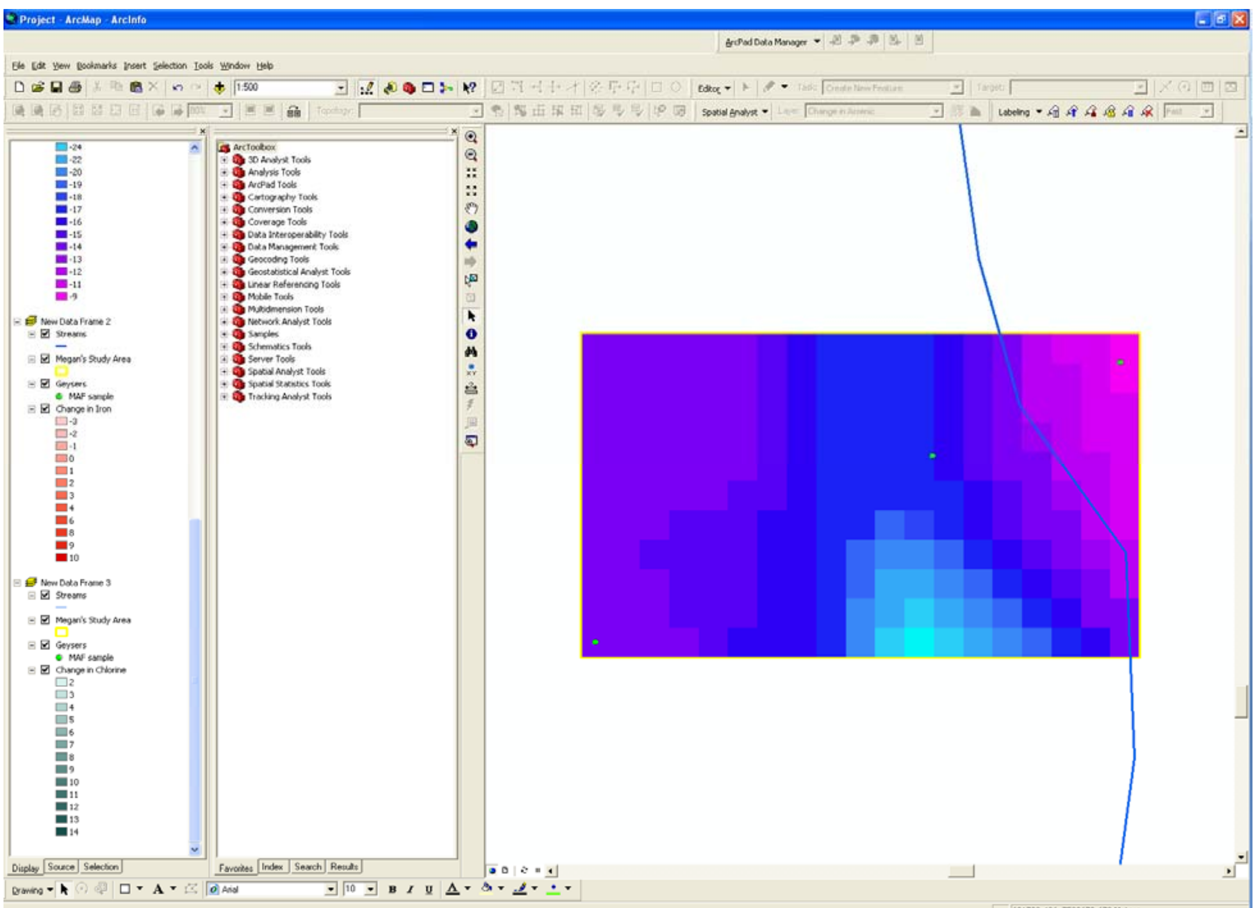


Figure 24: Ranked changes in Arsenic

After I calculated the changes for the 3 ions, I placed them on a map together with the digitized map and an overall map of South America (Figure 25).

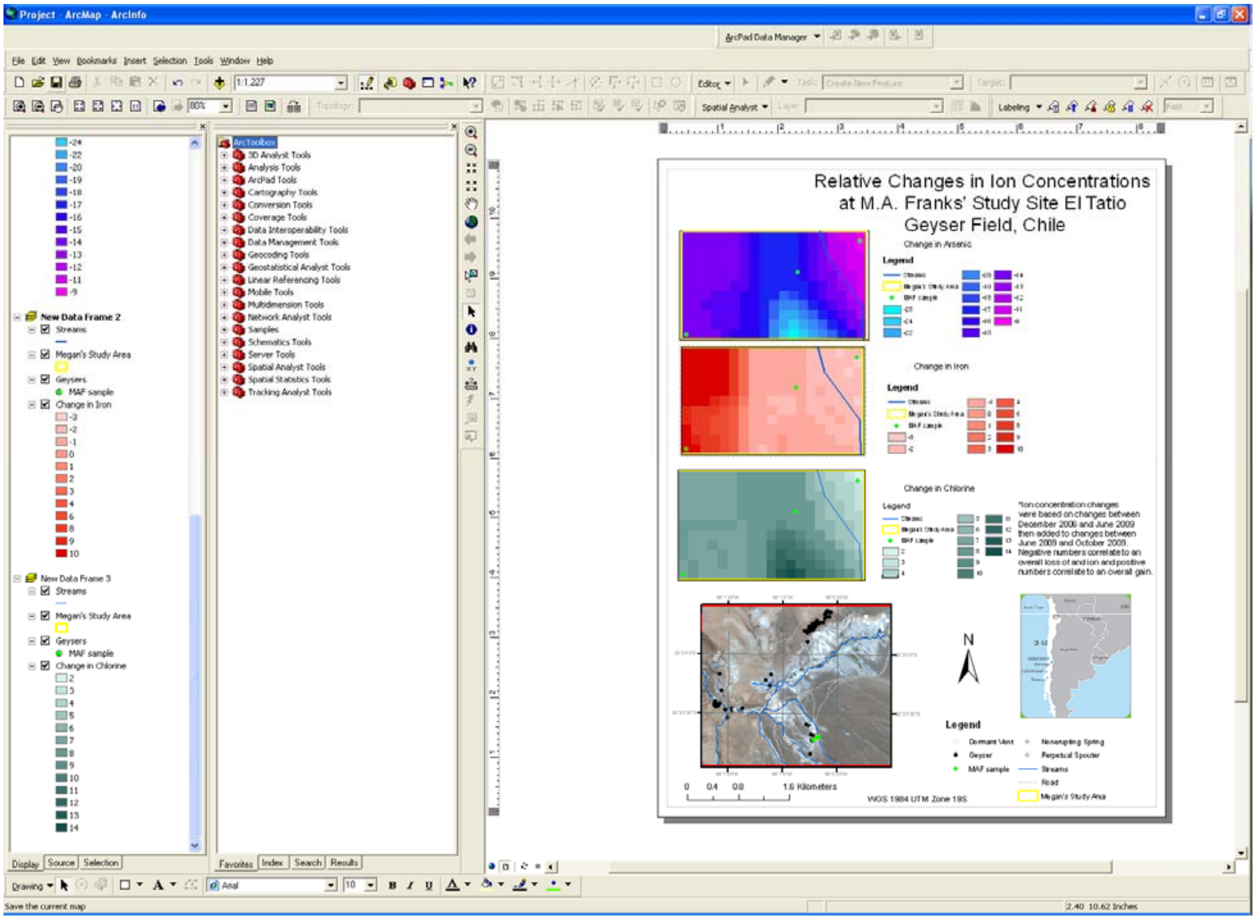


Figure 25: Final Map

Error

To improve this project I would like to have more data points and dates where samples were taken. This would allow ArcMap to make more accurate predictions and lead to a more comprehensive study of the hydrogeochemistry of the region.