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5/3/2018

Is Groundwater in the Cretaceous Carbonates using joints in the Precambrian Granite as Conduits or Channels for flow at Mason Mountain Wildlife Management Area

Helper, GIS 327G

INTRODUCTION

The Mason Mountain Wildlife Management Area (WMA or MMWMA) “is a state-owned, ~5300 acre former ranch principally dedicated to studying animal husbandry of "super exotic" African ungulates (Oryx, Kudu, Water Buck, etc.) in a Texas Hill Country habitat. Geologically, the WMA is situated near the boundary of the western Llano uplift, where erosion of Cretaceous carbonates of the Edwards Plateau has exposed older Paleozoic and Precambrian rocks of the Llano Uplift beneath.”(M. Helper, 2017) It hasn’t always been like this though. The area was a much wetter place at the end of the last glacial maximum about 18,000 years ago. At the time, the Cretaceous carbonates acted as an unconfined aquifer. They rest on top of the Town Mountain Granite which acted as an aquatard. This granite has joints due to contraction during cooling after it was intruded. These joints have major strike orientations of 040/220 and 160/340. Weathering and erosion re-exposed the granite and caused any water flowing downslope within the aquifer to eventually be expressed at the surface as a natural spring. As the glaciers receded, the climate became increasingly arid, leaving the aquifer empty and evaporate deposits as the only marker of spring water flow.

I hypothesize that this flow used the joints in the granite as conduits, causing a preferred orientation in the direction the deposits face and very near proximity of the deposits to the K-pC contact. In order to test this, I must locate where deposits are on the map, analyze the elevation of the deposits and see if it correlates with the contact between the Cretaceous carbonates and the underlying granite, and compare general orientation of the surface expressions of deposits with the known joint orientations. I also must go into the field and check my locations, and attain pictures as well as samples from the deposits. As this is a first look at the travertine deposits in the area, this is just a general overview with future research potential.

METHODS

Before going into the field to check deposit locations, I needed to first mark on the map where I thought they would be. To do this, I made sure I was working in the proper data frame, the same frame as labs 4 and 5, NAD83 UTM Zone 14N. I then looked for surface expressions of small hills in the hillshade and 50cm resolution DOQQ at the Cretaceous-Precambrian contact that are lighter than the surrounding sediments, indicating a different mineral composition. I then created a new feature class called "Deposits" and marked potential deposits to be field checked at a later date. An example of the process can be seen in figures: 1-4.

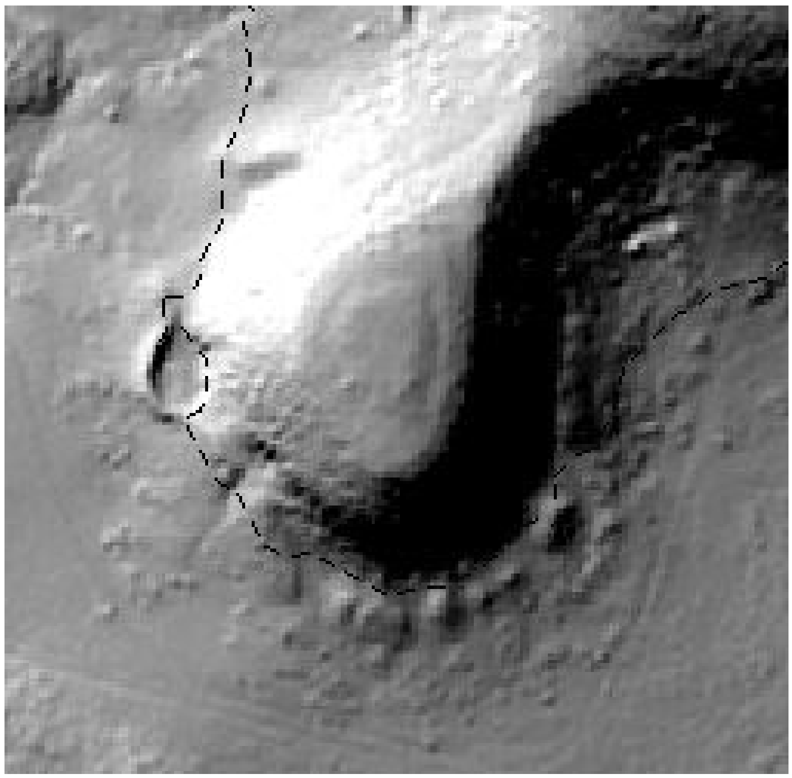

Figure 1: Hillshade of potential evaporite deposits on western most area of interest.

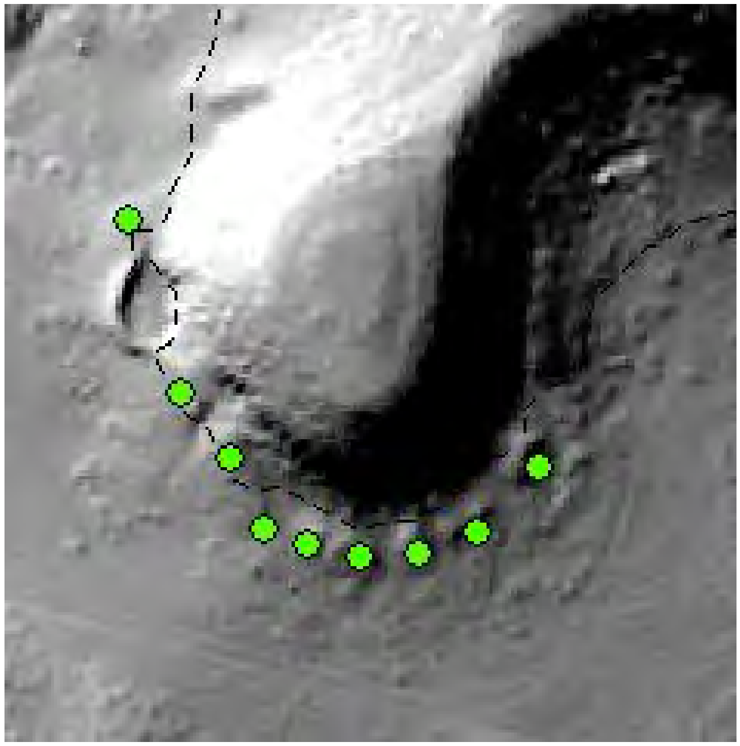

Figure 2: Potential deposits marked on hillshade of western most area of interest.

Figure 3: DOQQ of potential evaporite deposits on western most area of interest.

Figure 4: Potential deposits marked on DOQQ file of western most area of interest.

Once I marked all the potential deposits, I uploaded and appended the feature class to the previously made map on Arc Online for the Mason Mountain labs and project from earlier this semester. All of the red dots are area to be checked in the field. (figure 5)

Figure 5: ArcOnline map with the potential deposits feature class added.

Next, I downloaded the map to my phone and went out to the MMWMA to check my marks on the map (figures 6-9) and upload photos of what I found (figures 10 & 11).

Figure 6: My vehicle near the western most deposits. Proof I was there.

Figure 7: My vehicle near deposits by the entrance to the turkey pasture

Figure 8: a photo of me posting a photo to the map on my phone. Proof I was there.

Figure 9: A photo of me, super stoked to be out there recording data.

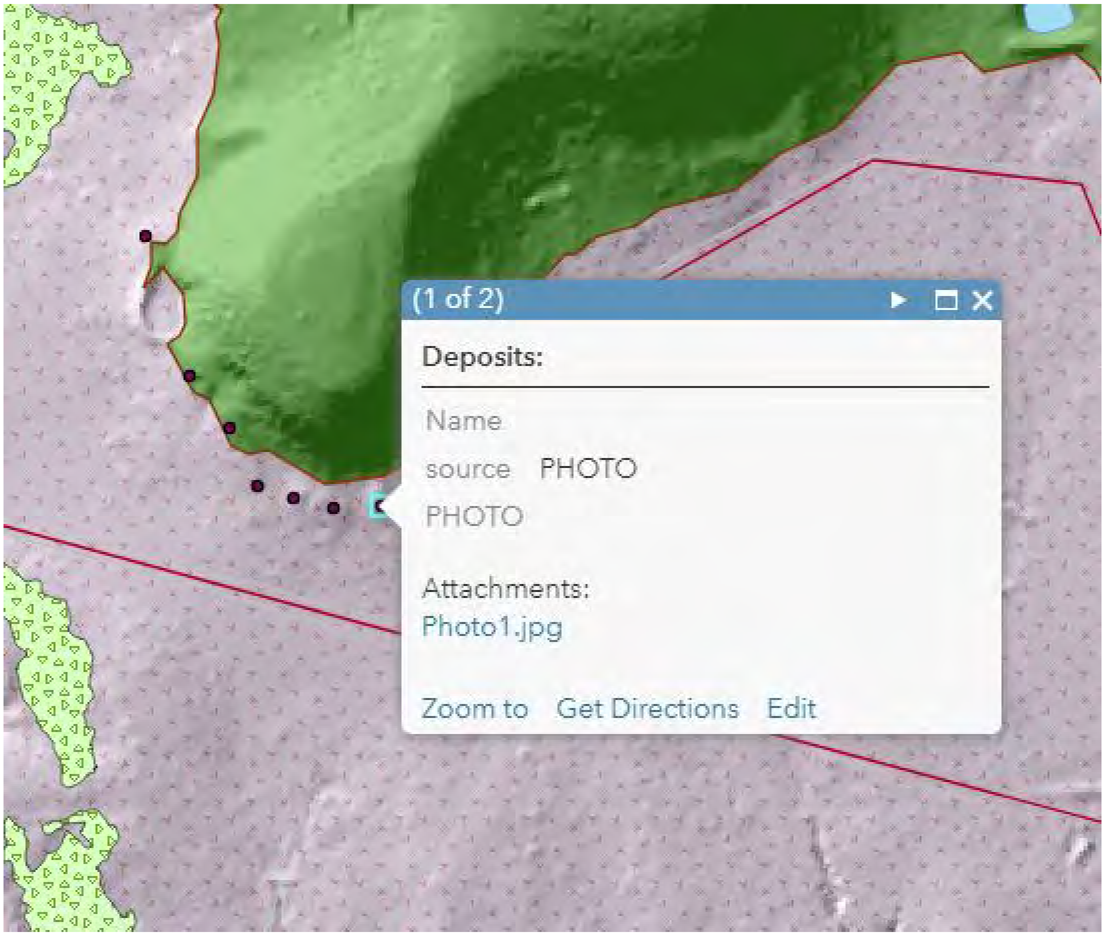

Figure 10: Photo uploaded to a deposit on the western most area of interest.

Figure 11: photo of previously mentioned deposit.

There were a few potential deposits that I got wrong and could then ignore on the map (fig 12 &13).

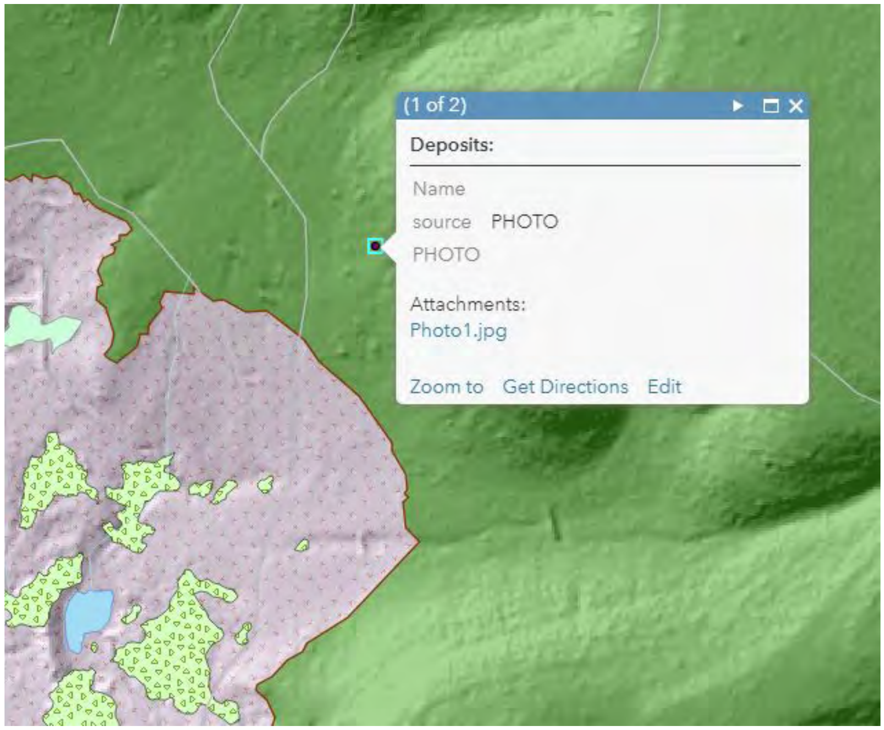

Figure 12: incorrectly marked potential deposit that can be ignored in the dataset.

Figure 13: Photo of erroneous evaporite deposit.

I then synced the pictures to ArcOnline when I returned to Austin. With data to back up my potential evaporate deposits as actual deposits, I can move forward with the project. Continuing to work in the NAD83 UTM Zone 14N, I created a contour raster to constrain elevation differences between deposits (fig 14) and an aspect raster to find the direction the springs face (fig 15) using the Contour with Barriers tool and the Aspect tool respectively in the Spatial Analyst Tools toolbox. These analyses can be used in conjunction with known elevation data of the contact and given rose diagram (fig16) to determine the strength of the correlation between joint orientations and where evaporate deposits are located.

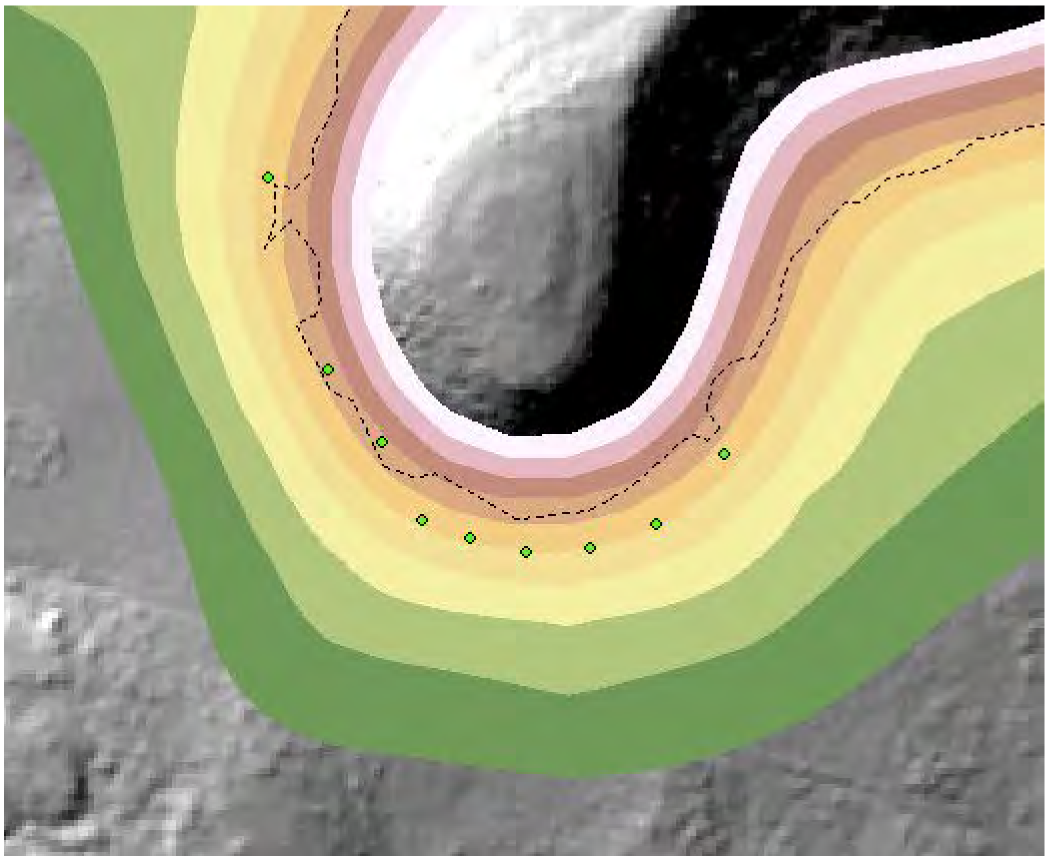

Figure 14: contouring raster of western most area of interest. each color represents about 6.5 feet of elevation change. The green dots are deposits, and the dotted black line is the K-pC contact.

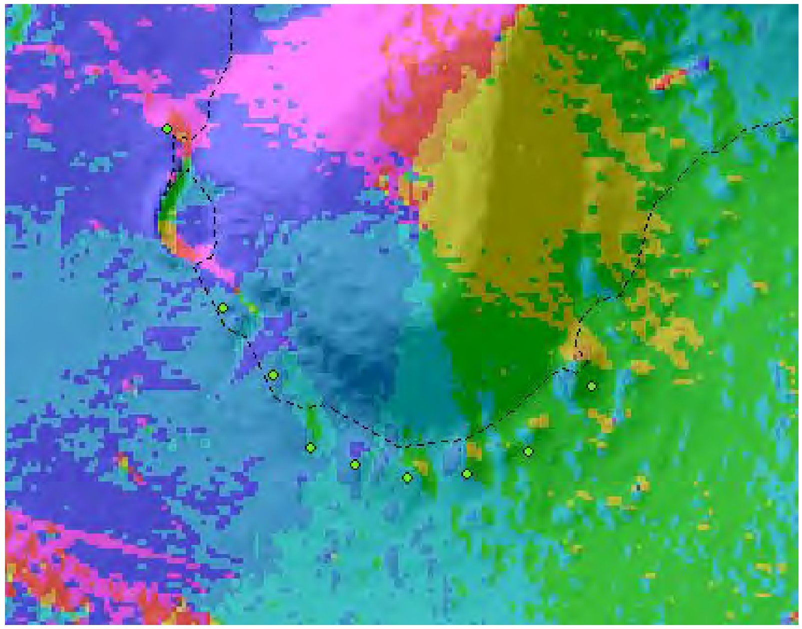

Figure 15: Aspect raster of western most area of interest. Colors equate to direction of slope. Red - N, Orange - NE, Yellow - E, Green - SE, Light Blue - S, Med Blue - SW, Dark Blue - W, Pink - NW.

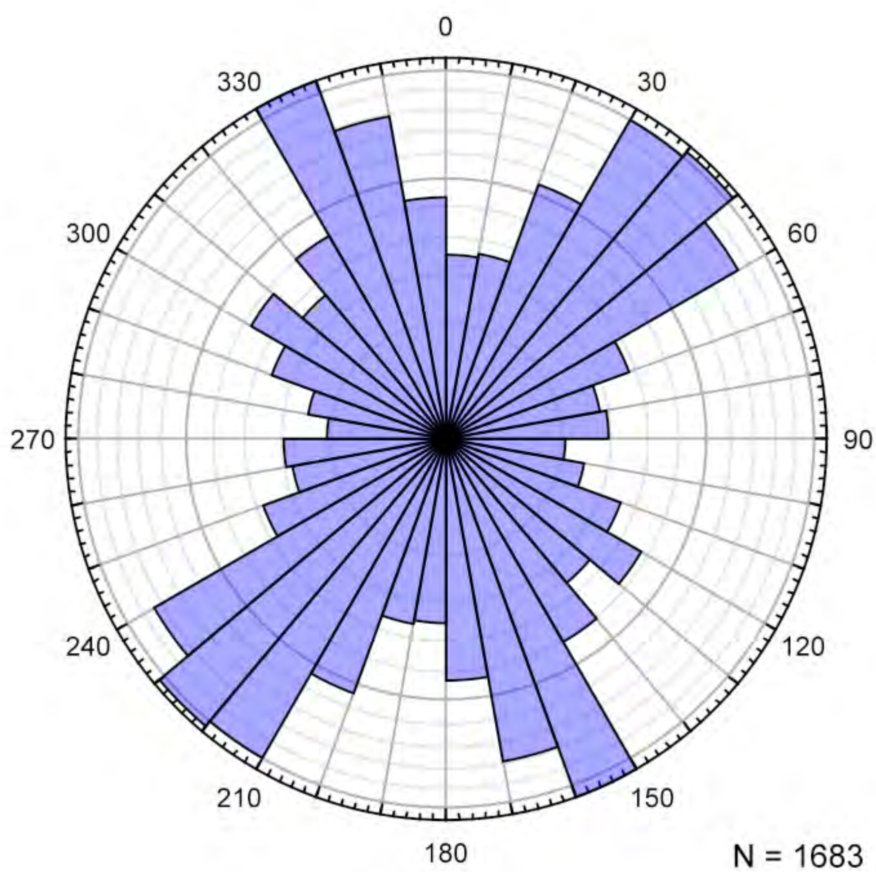

Figure 16: Rose Diagram of strike orientation of 1683 joints (M. Helper, 2017)

ANALYSIS

Most of the marked deposits I was able to check were correct, except for 2 small dense patches of vegetation. I was not fortunate enough to check every single potential deposit, only what I could reach within the Turkey Pasture. The vast majority of deposits were within +-10ft of the contact, which is consistent with the proximity requirement in the initial hypothesis. Additionally 21 of 35 or 60% of deposits in the Turkey pasture solidly dip southwest between 202.5 and 247.5 degrees, which encompasses the major strike orientation of the joints. 6 or ~17% dip south between 157.5 and 202.5 degrees, usually very near the border with southwest. 2 or ~6% dip west between 247.5 and 292.5 degrees and also very near the border with SW. this is significant because the points are placed by hand and not necessarily directly on top of the highest or most dominant portion of the deposit. This means between 60% and 83% of the deposits are consistent with the initial hypothesis and that is just in the turkey pasture. If you include all the marked sites on the south slope, the percentages jump to 64.5% and 85.5% respectively. This is not statistically significant with a p value of < 0.05, however I believe that it still shows significant correlation that can be fleshed out in further research ventures.

CONCLUSION

In conclusion, I believe there is good correlation in the data to support the hypothesis, however correlation doesn't equal causation, and thus I concede that there is insufficient data to make a definitive conclusion one way or another on the hypothesis. More research must be conducted before it can be determined, without a doubt, whether or not groundwater flow was using joints as conduits for flow.

CITATIONS

Lab 4: Digitizing in ArcMap I, Mark Helper, 9-24-17

Lab 5: Digitizing in ArcMap II, Mark Helper, 9-26-17

Rose Diagram of Joint Data, n. 1683, Mark Helper, 2017

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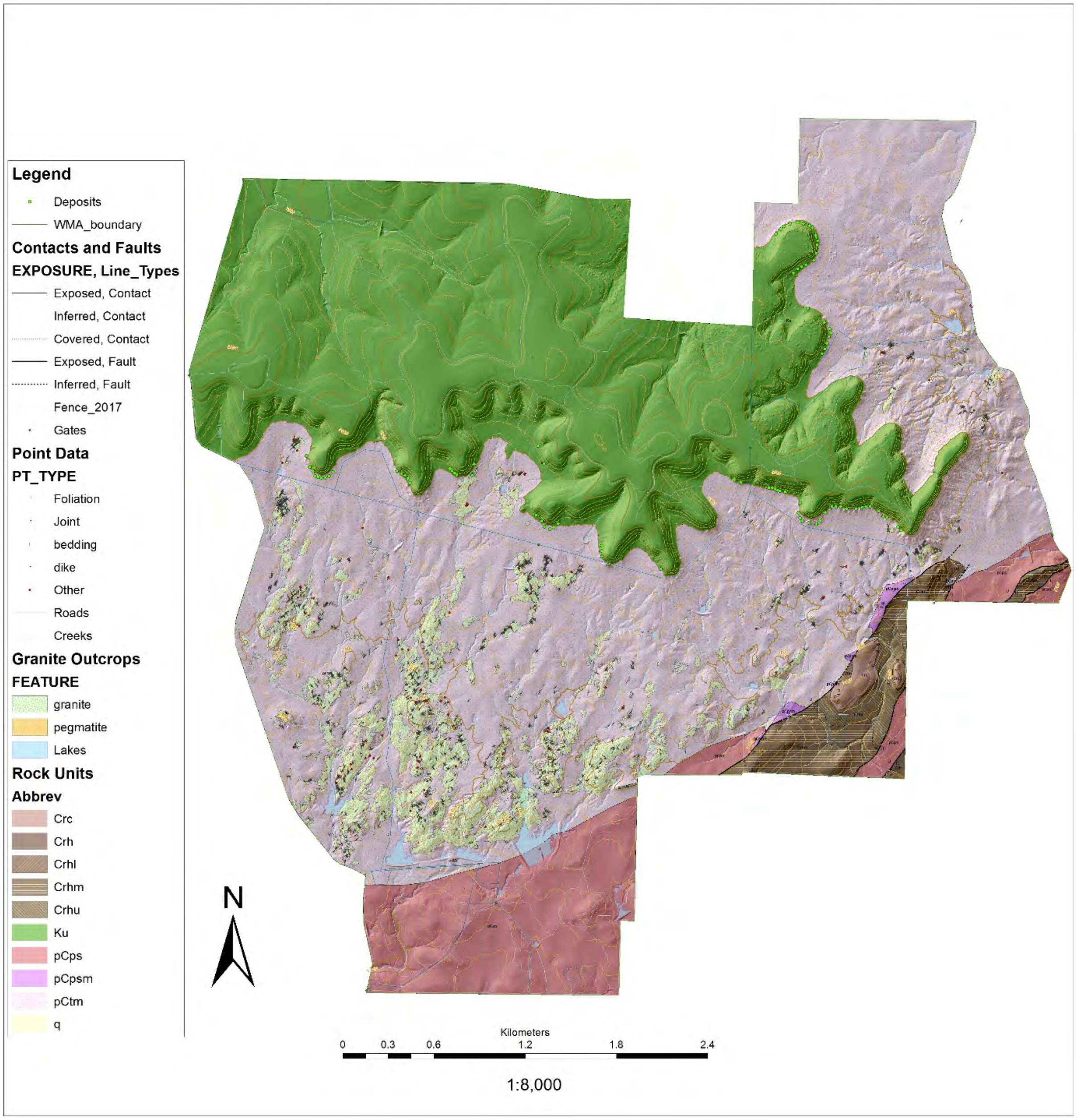
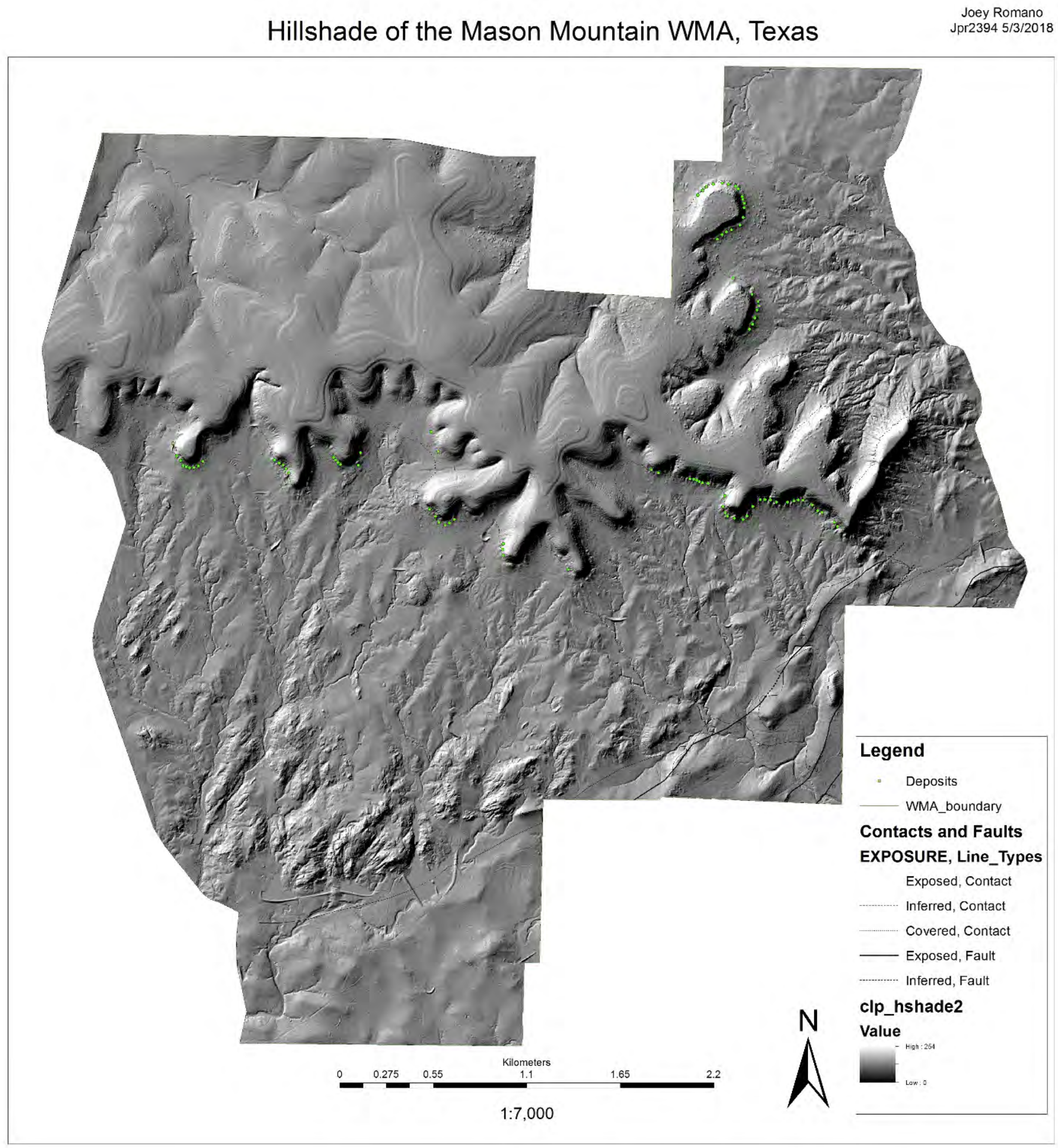
Geological Map of the Mason Mountain WMA, Texas




Hillshade of the Mason Mountain WMA, Texas
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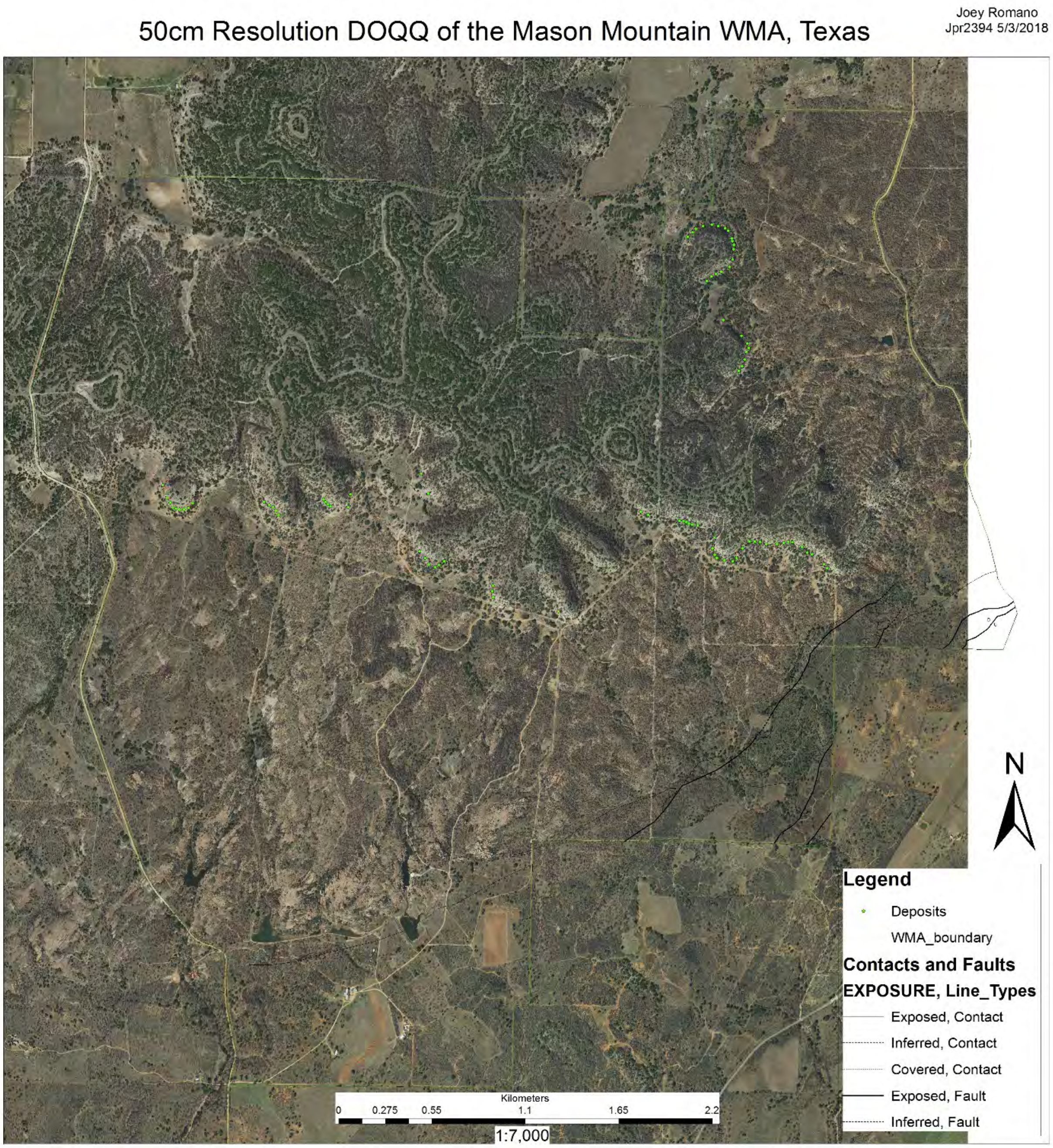
Legend
Deposits
WMA_boundary
Contacts and Faults
EXPOSURE, Line_Types
Exposed, Contact
Inferred, Contact
Covered, Contact
Exposed, Fault
Inferred, Fault
clp_hshade2
Value
High : 254
Low : 0
N
Kilometers
0 0.275 0.55 1.1 1.65 2.2
1:7,000


50cm Resolution DOQQ of the Mason Mountain WMA, Texas
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N
Legend
Deposits
WMA_boundary
Contacts and Faults
EXPOSURE, Line_Types
Exposed, Contact
Inferred, Contact
Covered, Contact
Exposed, Fault
Inferred, Fault
Kilometers
0
0.275
0.55
1.1
1.65
2.2
1:7,000

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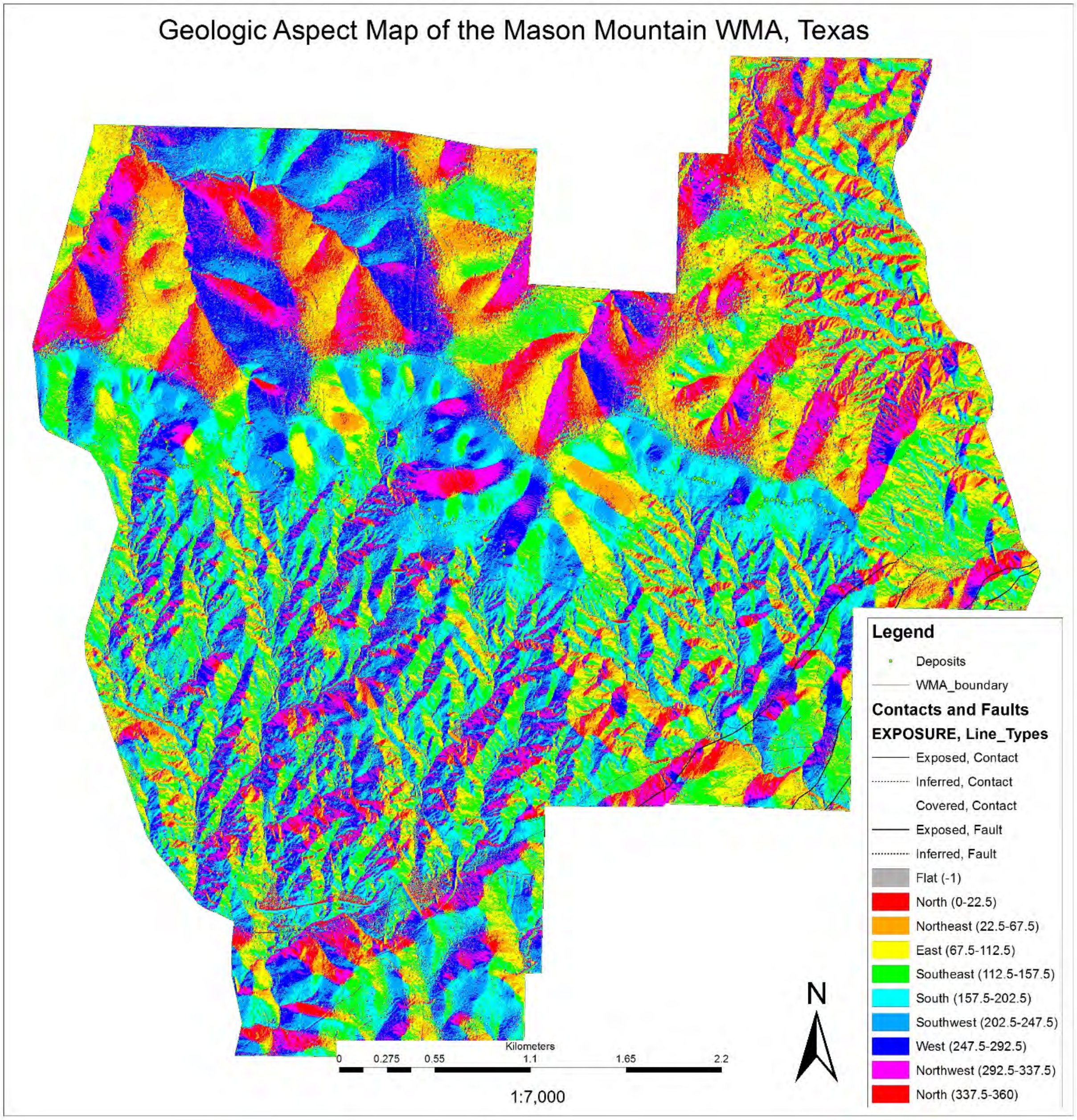

Contour Map with Barriers in ft of the Turkey Pasture, Mason Mountain WMA

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