Tanami Remanent Magnetization Analysis

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Method

The method for determining remanent magnetization is taken from Dannemiller and Li (2006). This method was one of several that were tested using a synthetic dataset. It performed the best of any of the methods tested.

Dannemiller and Li (2006) determined magnetization direction from TMI data by looking at the correlation between the first vertical derivative and the analytic signal using different sets of RTP parameters. These two filtered products should correlate best when the correct RTP parameters are used. The analytic signal does not change very much using the different parameters but the first vertical derivative can change dramatically. Care has to be taken because if data is collected too close to a source, the analytic signal will contain peaks over both the edges and the centers of bodies. To prevent this, the data were upward continued by 120 m.

The method for determining magnetization direction is straightforward for a single anomaly. However, it is difficult to apply to large gridded datasets. We developed methods to locate anomalies on which this method was likely to work, extract those anomalies and calculate the total magnetization vector. We know the ambient field vector so the difference between the total magnetization vector and the ambient field vector provides some indication of the amount of remanent magnetization. We cannot directly calculate the magnitude of the remanent magnetization or the direction of the remanent magnetization.

For this work, we ran reduction to the pole at inclinations from -90 to -30 in 10 degree increments, -25, +25 and +30 to +90 in 10 degree increments. The declination range we used was -180 to +180 in 15 degree increments. Then the analytic signal and first vertical derivatives were calculated for all sets of parameters.

The anomalies were then extracted using the analytic signal of the TMI so that anomaly locations were the same for all parameters. This is valid because the analytic signal does not change significantly with the different parameters used. Correlation between the first vertical derivative and analytic signal was then determined on each of the segments for all sets of parameters and the set of parameters with the highest correlation was kept. The angular difference between the determined total magnetization direction and the ambient field direction were calculated as was the difference in inclination and declination separately.

The only major problem with this method is if the magnetization vector is close to horizontal. The problems that affect the reduction to the pole correction with an ambient field near the magnetic equator also cause problems

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with a horizontal magnetization vector. This is why magnetization directions with inclination between -25 and +25 were not used.

Results

Figure 1 shows the angular difference between the ambient field and the magnetization direction for the Tanami grid. Direen et al (2008) showed that several areas in the Tanami grid contain rocks with known remanent magnetization. However, they did not use oriented samples for their analysis so the orientations that they provide in their paper are not particularly useful. Figure 2 shows the results for the Callie area. The results show that the magnetization direction is significantly different than the ambient field direction but not drastically so. Figure 3 shows the results for the North Arunta grid. Overall, this grid shows less remanent magnetization.

Conclusions

The prevalence of remanent magnetization in this area suggests that just looking at remanent units may not help very much with exploration. It may not narrow the areas down enough. However, since the orientation of the total magnetization is extracted, it is possible to pull out units that have a similar magnetization direction to the units in the Callie area.

References

Dannemiller, N. and Li, Y., 2006, A new method for determination of magnetization direction. Geophysics, v.71, pp. 69-73.

Direen, N., Pfeiffer, K. and Schmidt, P., 2008, Strong remanent magnetization in pyrrhotite: A structurally controlled example from the Paleoproterozoic Tanami orogenic gold province, northern Australia. Precambrian Research, v. 165, pp. 96-106.

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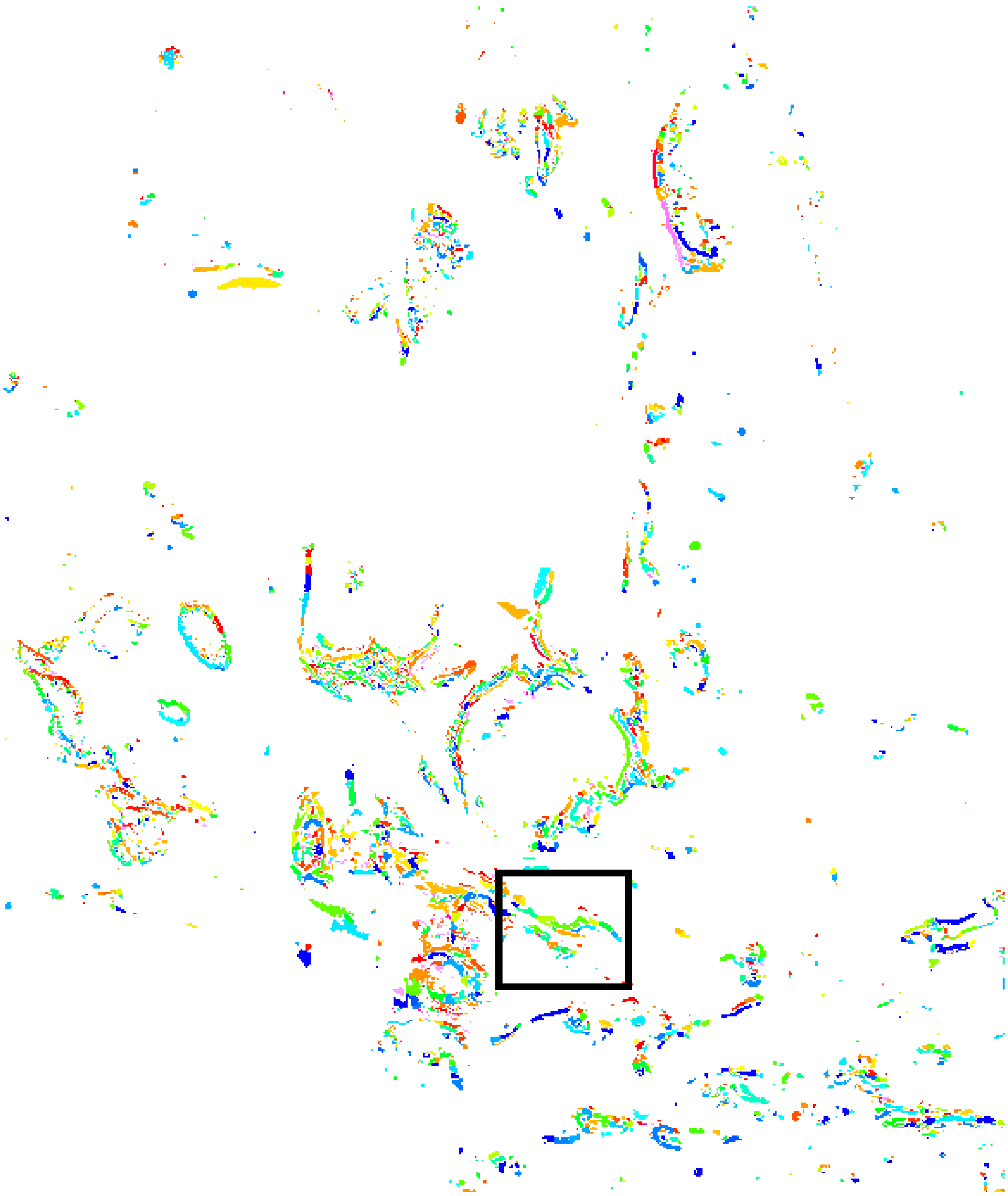

Figure 1. Angular difference between magnetization direction and ambient field directions for the Tanami grid. There are a lot of areas that show remanent magnetization in this area. The Callie area is shown in the black box and a detailed image is in the following figure.

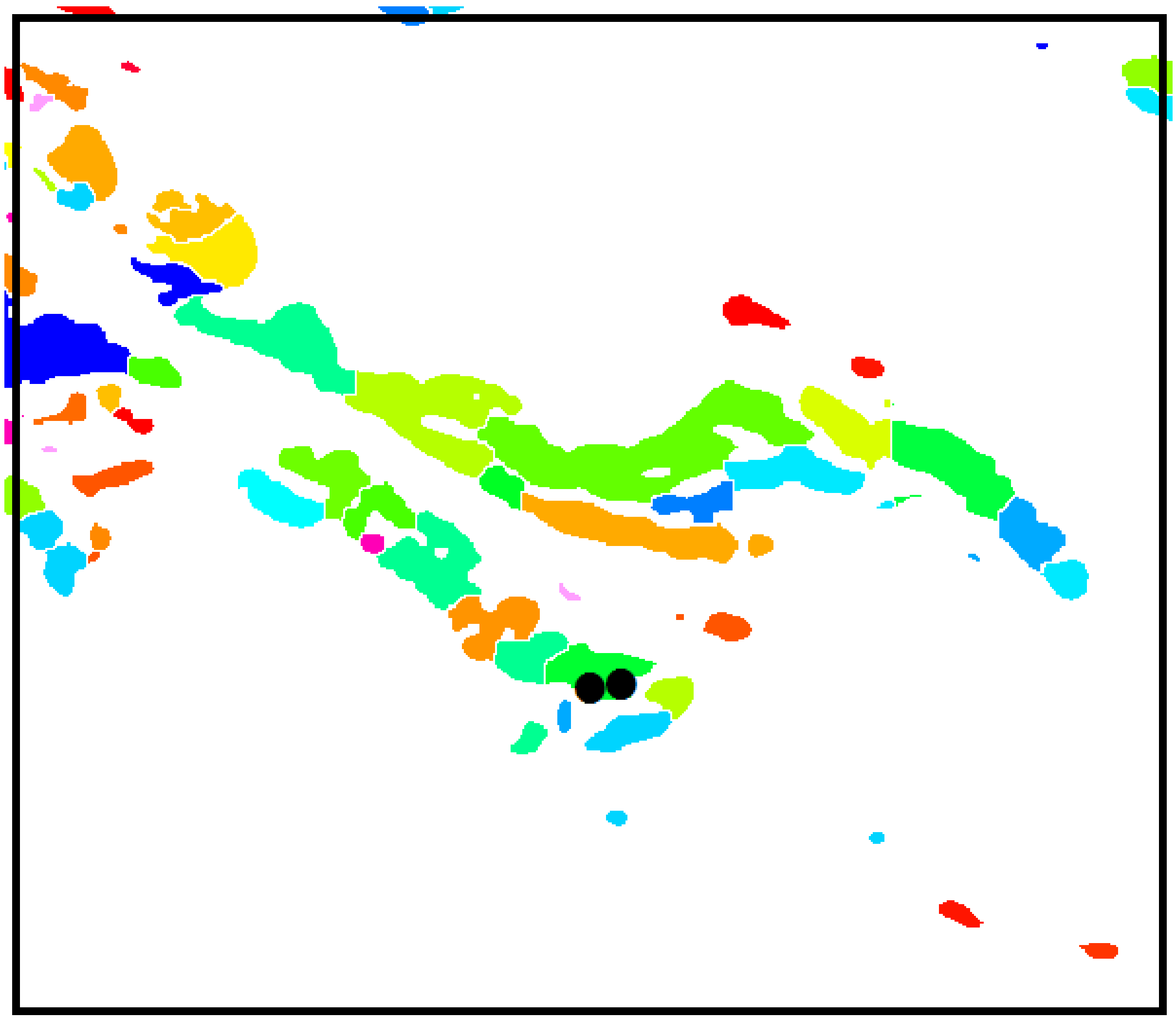

Figure 2. The angular difference between magnetization direction and ambient field directions for the Callie area. The location for the Callie deposit is shown by the black dots. These were obtained from the Australian Mines Atlas. Most of the rocks in this area do not show a big angular difference in the magnetic field vectors. According to Direen et al there is only one strongly remanent unit in the Callie area. That may be the unit that is colored orange to the northwest of the Callie mine. It should be noted that these are just difference between orientation and not magnitude. It may well be that the Callie rocks have very strong remanent magnetization but that the orientation is not that different than the ambient field.

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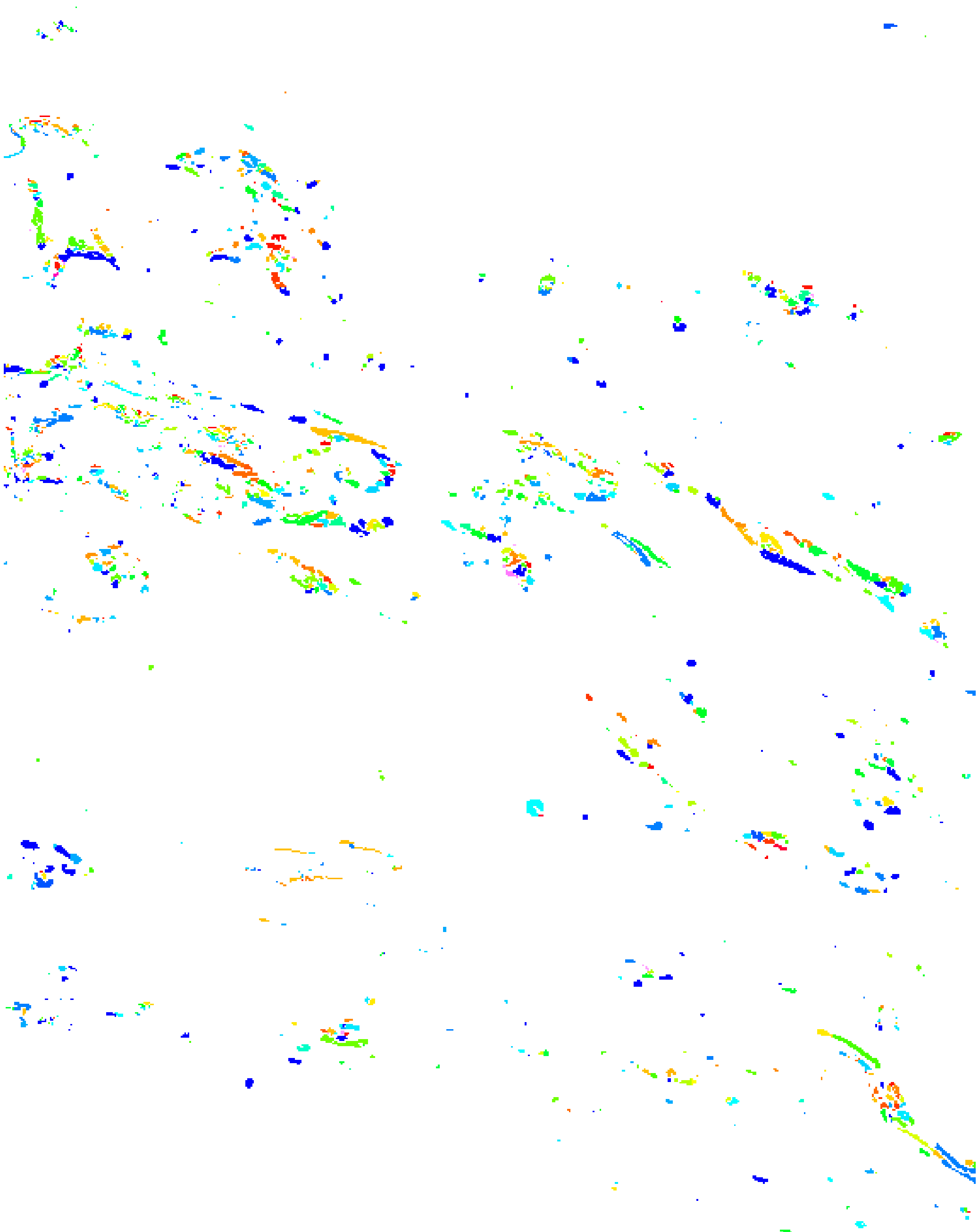

Figure 3. Angular difference between magnetization direction and ambient field directions for the North Arunta grid. Overall, there is less remanent magnetization in this grid.

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