Using Thermal Demagnetization to Date a Diabase Dike, Scottsville Basin, VA

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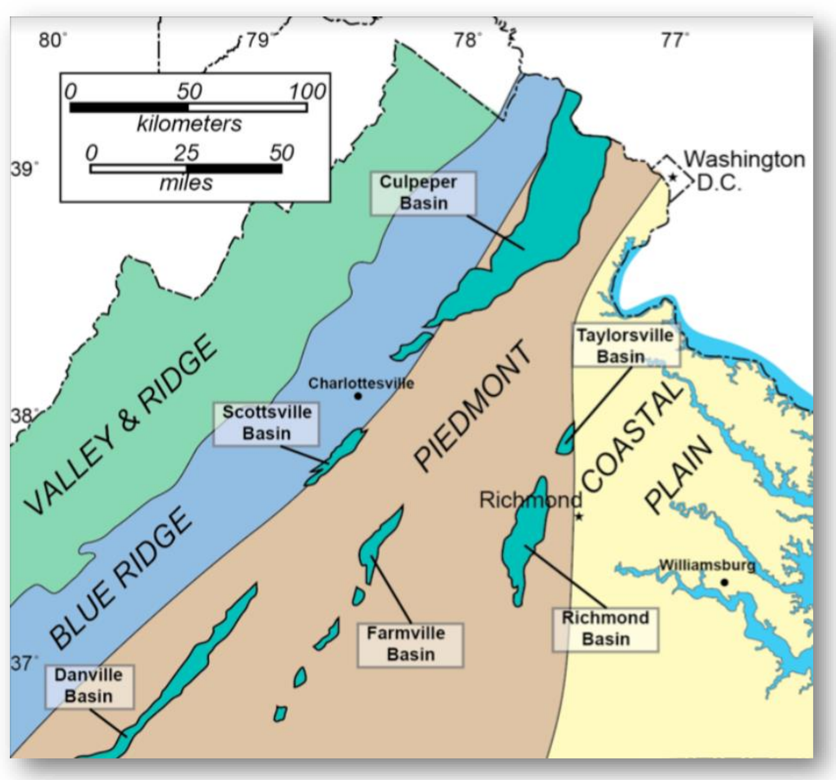
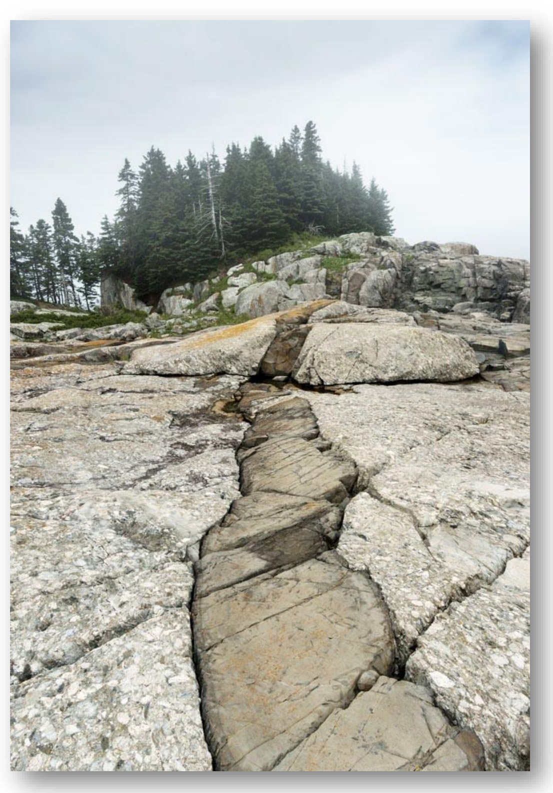
Abstract

The purpose of this project was to determine the age of a diabase dike intrusion in Virginia using paleomagnetism. Previous attempts to date this intrusion using alternating field demagnetization were unsuccessful. Ten samples of this intrusion were run through thermal demagnetization to measure the orientation of the dike's primary magnetization. The specimens were put through a series of heating steps in a paleomagnetic oven. After each heating step, data was collected for the samples' magnetic orientation and magnetic susceptibility. Results indicated the magnetic susceptibility gradually decreased as the experiment progressed, signifying a lack of magnetic mineral growth during heating. The data suggested that this dike had a consistent, reproducible magnetic signal. A reasonable age of emplacement of approximately 160 Ma was also identified. This experiment shows that thermal demagnetization was a great technique for identifying a rock sample's magnetic signal. While this technique may not work on all specimens, it is still a useful tool and should be utilized on similar samples. Future projects should analyze dike samples from many different locations in Virginia to determine if the results presented here are an accurate estimation of the age of this rock sample.





Figures 1 and 2. Figure 1 (left) is a map of the Virginia Piedmont and surrounding area, including the Scottsville Basin. Figure 2 (right) is an example of a diabase dike intrusion from Maine. This image shows the contact between the dike and the metaconglomerate rock surrounding it.

Introduction

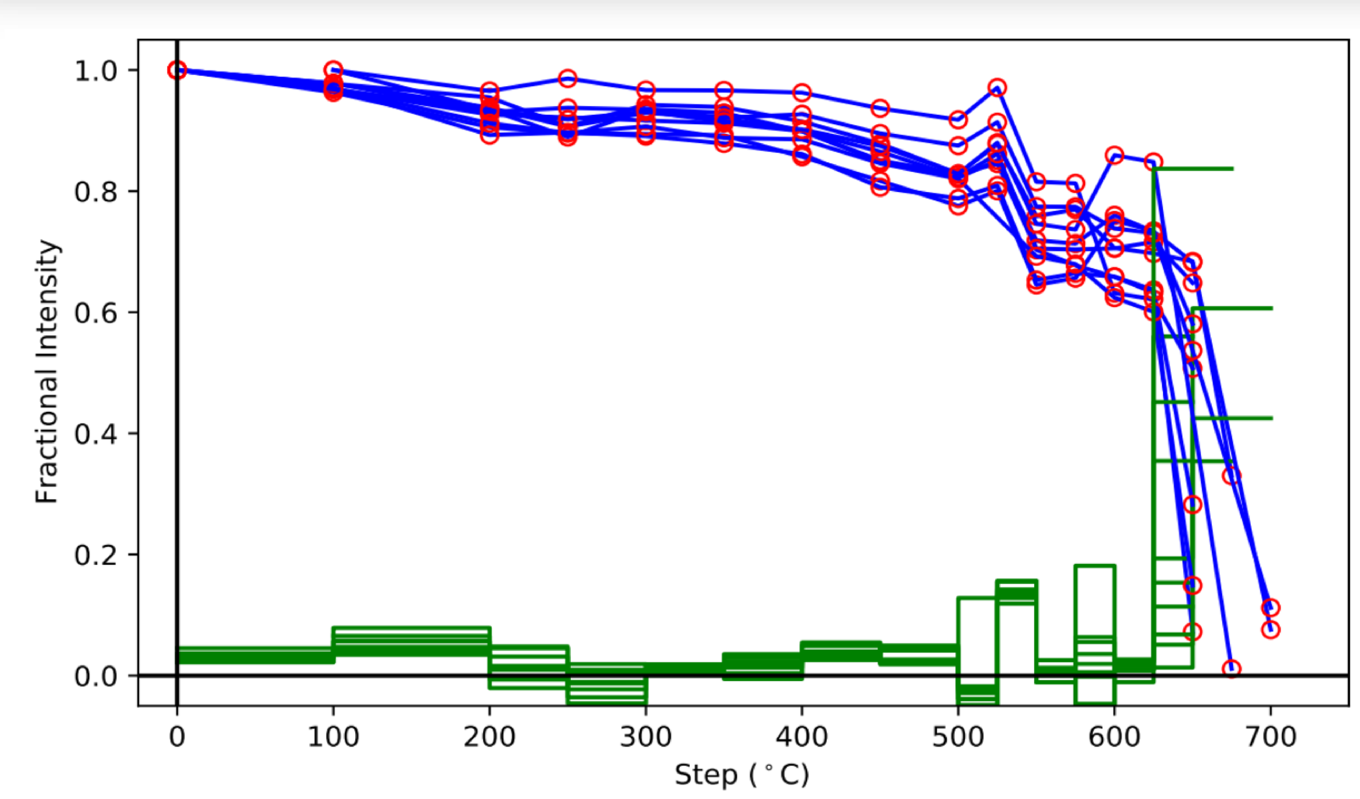
This project analyzes a set of core samples from a diabase dike intrusion in the Scottsville Basin. Diabase dikes are dark-colored, fine-grained intrusive igneous rocks (Figure 2). The Scottsville Basin is in the western Virginia Piedmont (Figure 1). Our plan was to use paleomagnetism to determine the age of this intrusion. Paleomagnetism is the record of Earth's magnetic field. When an igneous rock cools it can preserve the orientation of that magnetic field in the rocks' magnetic minerals. This can tell us both the direction and intensity of Earth's magnetic field at the time of formation. The goal of this experiment is to use a thermal demagnetization experiment to constrain an age of emplacement for this intrusion.

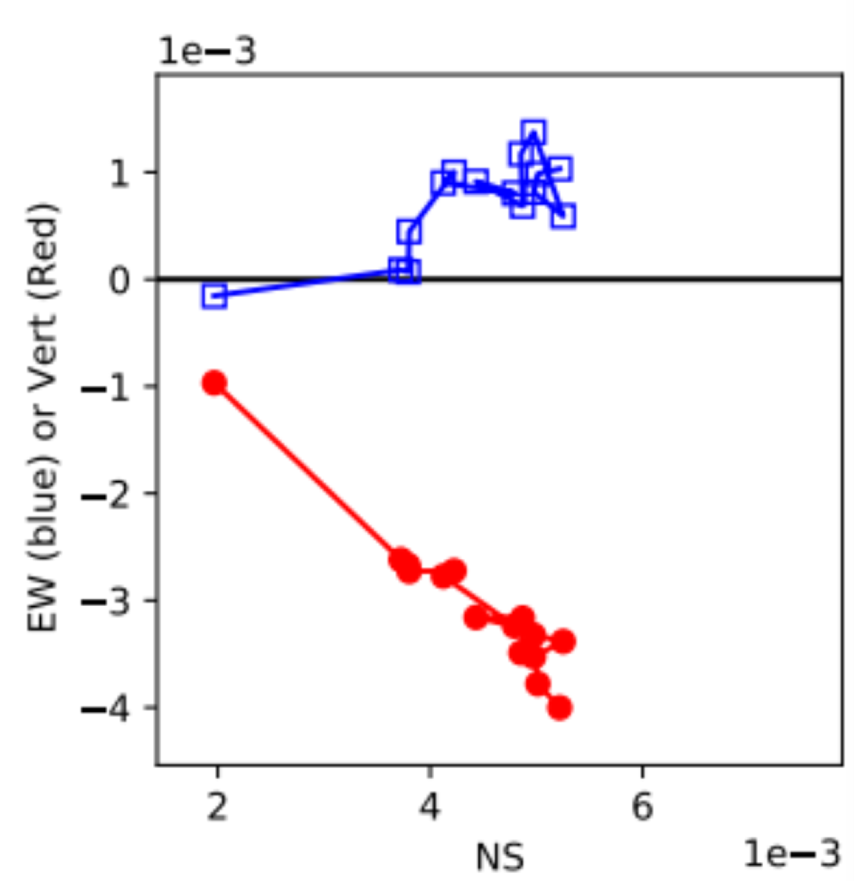
Methodology

First, 10 core samples from the Scottsville basin dike were obtained to conduct this experiment. The first step was to place the fresh cores one by one into the spinner magnetometer to measure the orientation and magnitude of magnetization for the cores after no heating. Next, we used the magnetic susceptibility bridge to measure each of the core's magnetic susceptibility. Then the cores were taken to a thermal oven to remove the magnetization. For their first heating, the cores were heated to 100°C. This process of heating, spinner magnetometer, and magnetic susceptibility was repeated over 16 steps to 700°C. Next, all the data was placed into magnetic susceptibility magnitude graphs, core orientation stereonet charts, fractional intensity charts, and vector component graphs. Finally, the data, graphs and charts were analyzed.

Results

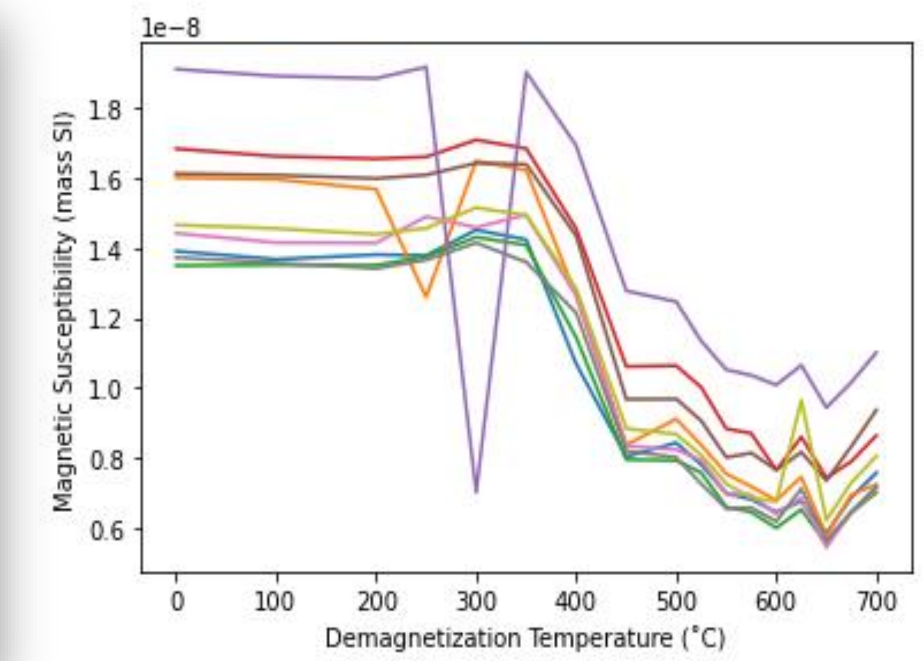
The Magnetic susceptibility of the cores decreased on average from a value of between 1.9 and 1.3 to a value between 1.0 and 0.5 (Figure 5). The Fractional Intensity of the cores decreased from 1.0 to between 0.2 and 0 (Figure 3). The cores' average inclination was 355.3° with an average declination of 41.5 (Figure 4).





Figures 3 and 4. Figure 3 (top left) is a graph of fractional intensity on the y axis versus temperature in degrees Celsius on the x axis. Fractional intensity is the fraction of magnitude of magnetism left in a rock or core. Figure 4 (bottom left) is a vector component graph. The y axis plots east to west orientation (red dots) or vertical orientation (blue dots), the x axis plots North to south orientation. The orientations plotted are the directional components of the magnetic susceptibility of the cores.

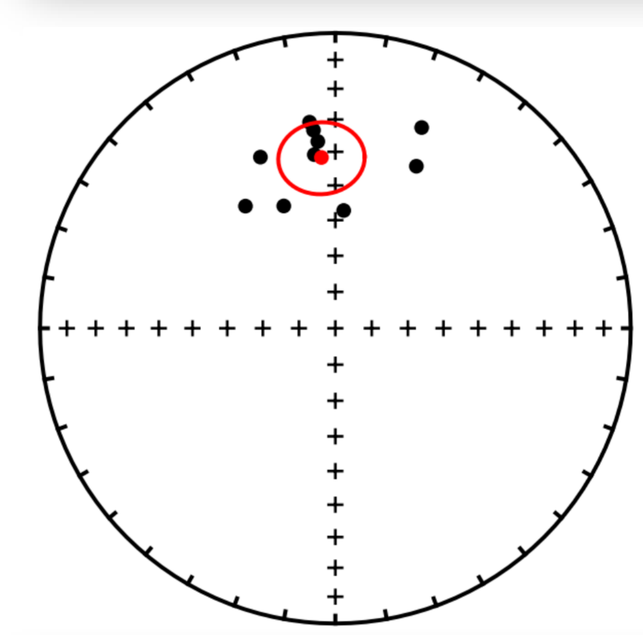
Figure 5. Graph of the magnetic susceptibility of each core sample as a function of heating step. Magnetic susceptibility is the amount of magnetization experienced by a rock when it is subjected to an applied magnetic field.

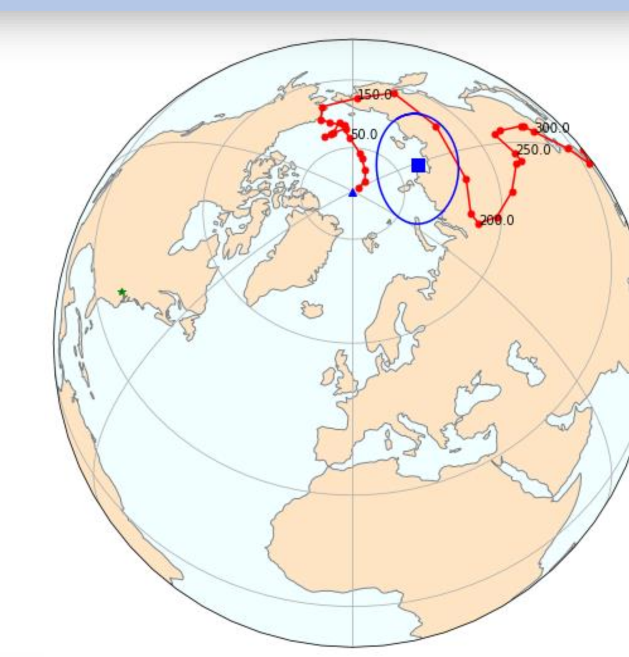


Discussion and Conclusion

Magnetic susceptibility and fractional intensity decreased over the 16 steps of heating. This meant that the demagnetization experiment was successful in erasing the magnetization in the cores created by weathering. After removing the magnetization associated with weathering, we successfully isolated the original orientation of the magmatic dike's magnetic field. We used the inclination and declination values to create a zone of possible pole locations. We combined this with a map of known locations of the north pole throughout the earth's history. The zone of possible pole locations overlapped with the map of known north pole locations at 160 Ma. From the results of this experiment, we can conclude that this sample from the Scottsville Basin was originally deposited approximately 160 Ma. In figure 5 the magnetic susceptibility increases at the very end of the heating process. This indicates that new crystals began to form within the cores adding magnetic susceptibility. Further clarity on this age of emplacement would be provided by analyzing dike intrusions in different locations in Virginia. The analysis of more cores can reduce the zone of possible pole locations and move the average closer to the actual location of the pole.

Figures 6 and 7. Figure 6 (left). Stereonet plot of the orientations of all the cores as black dots using their inclination and declination. The red dot is the average inclination and declination of all of the cores. The red circle is the 95% confidence interval. Figure 7 (right) Map of the known locations of the north pole throughout the Phanerozoic (Torsvik et al., 2012). The blue dot marks the pole location and 95% confidence interval calcuated from our data.





Acknowledgements

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