Report Master thesis Anja Dijkhuizen, for Stichting Molengraaff Fonds

Thesis: 'Archean Rocks unraveled: an 'exclusive' first impression on paleomagnetism of deep-drilled rocks of the Onverwacht Suite, Barberton Greenstone Belt (SA)'

Fieldwork: August 2010, University of Cape Town South Africa

Lab-work: September 2010 – February 2011

End of project: September 2011

Supervisor: Prof. Dr. Cor Langereis, Paleomagnetic Laboratory 'Fort Hoofddijk' Utrecht University

Summary of fieldwork and project:
In August 2010 a trip to Cape Town (SA) was set up together with professor Cor Langereis from the paleomagnetic laboratory of the University of Utrecht and professor Maarten de Wit from the University of Cape Town and AEON (Africa Earth Observatory Network). Goal of the fieldwork was to select and collect samples from a deep-drilled core from the Barberton Greenstone Belt (SA) for paleomagnetic research. Research on these 3.5-3.1 billion years old rocks has never been performed on fresh (i.e., directly from the inner Earth instead of from the surface) samples. In 10 days over 400 samples were collected and logged, before they were taken to Utrecht.

At the paleomagnetic laboratory 'Fort Hoofddijk' from the University of Utrecht the rocks were analyzed on their magnetic properties. Main objective of the analyzes was to find the original magnetic signal of the Earth during formation of the studied rocks. With this information we can get a better understanding of the originating of the stable geomagnetic field of the Earth. This magnetic signal is stored in the rocks. However, magnetic overprint can be introduced in the rocks by mechanisms like heating and metamorphism of the rocks. For surface rocks a large overprint can be introduced by lightening as well, this is logically not a problem for the samples from the deep-drilled rocks. The method of stepwise demagnetizing of the rocks (both thermal and by alternating field) was used to break down possible magnetic overprints to end up with the original, primary, signal. The found magnetic overprint signals were compared with known geological events in the history of the studied area known from other paleomagnetic studies on surface rocks of the same area. From a study of Biggin et al. (2011) a suggesting for the primary field was made and aim of this study is to confirm this.
Since this study is the first on deep-drilled rocks of this age a method description on handling these old and fragile rocks was constructed during the whole process.

Results of the study
Rocks with an age of billions of years have a large geological history and must be handled with precision and care during analyzes. When working with magnetic signals, one must be sure to work with demagnetized materials and tools, otherwise a very recent magnetic overprint can be introduced, destroying the original magnetic signals of the rocks.
From this study it is shown that the drilled cores (from which the samples for paleomagnetic research were taken) were sawed in half with a magnetic saw. This has had as an effect that the primary

magnetic signal of the rocks was unable to detect for most of the samples. A lot of time and effort during the project is put into all possible known analyzes to reconstruct the primary and secondary signals from the overprinted samples. For most samples the overprint of the magnetic saw was too strong to still reconstruct the original signals. However, some samples do give a (near) primary signal. These samples all are part of a magmatic intrusion present in the rocks, and rocks around the intrusion. We have found several directions of the signal for rocks present at different levels of the intrusion. However, none of these signals are similar to the signals found by the studies of surface samples of the same rocks. At his stage of my thesis we cannot find a conclusion for this. New work on the same deep-drilled rocks, performed by the group of Biggin, will hopefully give more information on the influence of this intrusion on the magnetic signals.

Conclusion of the research

From the samples from this deep-drilled core it is clear that one mistake can lead to a destruction of very valuable data, especially when working with magnetic signals. If a new project will be started in the future on these Archean rocks, it must be made sure that the rocks are handled with care and precision. However, the good equipment in the paleomagnetic laboratory 'Fort Hoofddijk' and dedication of the researchers have proven that these Archean rocks do hold a (near) primary geomagnetic signal. The results are not as straightforward as hoped beforehand, since the found signals are not similar to earlier results on the same rocks, so more research is needed on these Archean rocks to find more information on the evolution of the stable geomagnetic field as we have on Earth today. This research has shown that a great potential in paleomagnetic research is present in these old rocks, for the first time after measurements on deep-drilled rocks. The constructed method for working with these rocks is suggested for further studies, to minimize errors in the future. Therefore this research has a large impact on paleomagnetic research on Archean rocks and hopefully more research will follow.