Paleomagnetic data from recent volcanics of Piton de La Fournaise, Réunion Island: constraints on the evolution of the South Atlantic Anomaly

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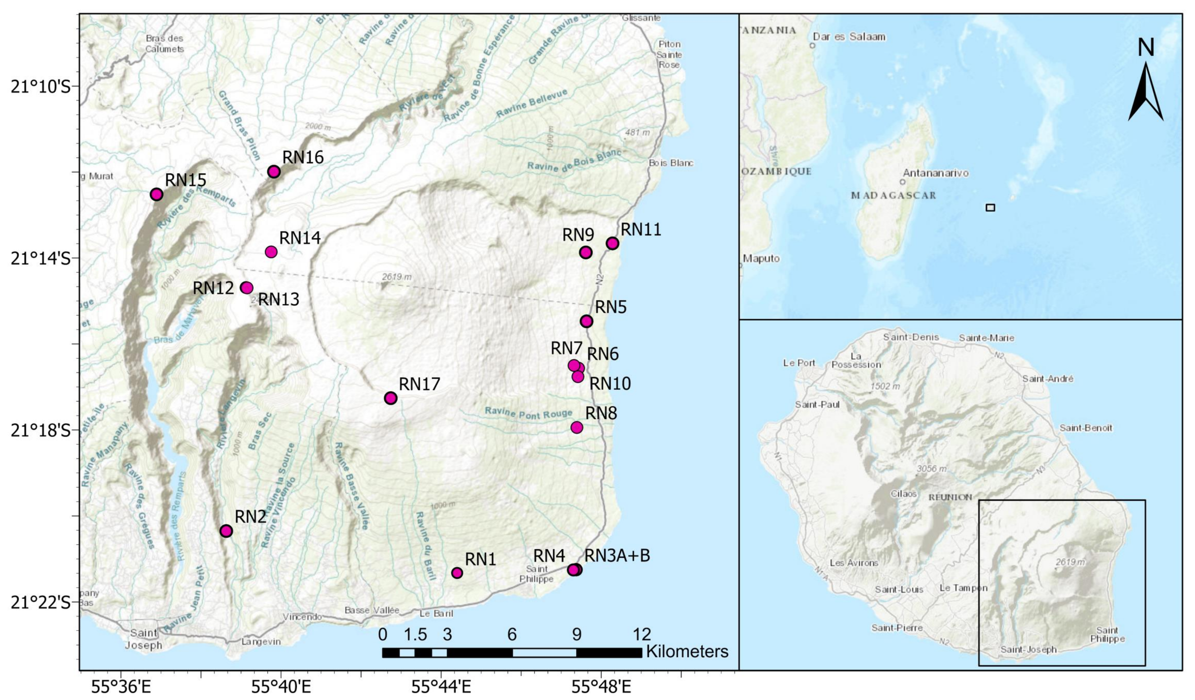
1. Background

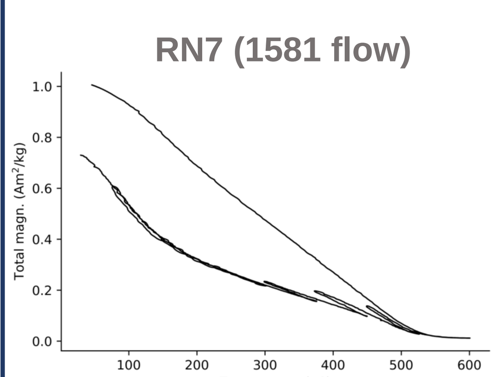
The South Atlantic Anomaly (SAA), located beneath South America, is an ongoing regional minimum of the Earth's magnetic field and it is observed to be expanding and moving westwards. Some geomagnetic field models suggest that the SAA developed underneath the Indian Ocean and moved westwards since, while others propose that the anomaly originated under Southern Africa. Current geomagnetic field models are hampered by a lack of paleomagnetic data from the Southern Hemisphere.

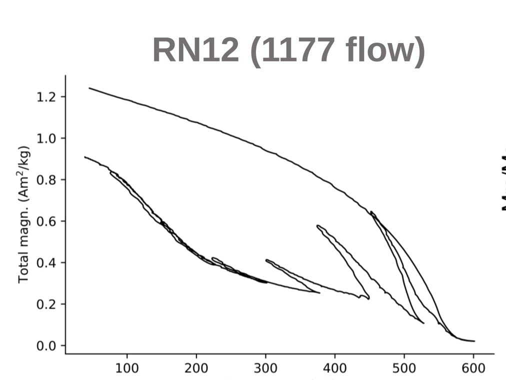
To give more constraints on the evolution of the SAA in the South African region we present preliminary paleomagnetic directions and paleointensity estimates from Réunion Island, located in the Western Indian Ocean. Data from a previous study by Beguin et al. (in prep) revealed the presence of a low intensity field ~1600CE in this area. Unfortunately, there are few datapoints between 1450-1600CE. Here, we improve the data density of Réunion Island by sampling 16 additional lava flows.

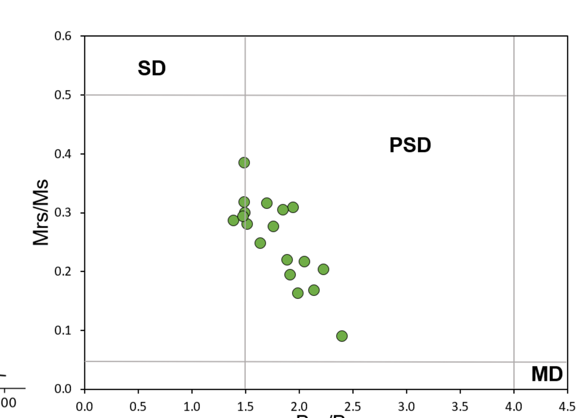


2. Sampling and rock magnetic behavior

Réunion Island was created by two volcanoes, the nowadays extinct Piton des Neiges (3071m) in the north and the still active Piton de la Fournaise (2632m) in the south. Paleomagnetic samples were taken at 18 sites around the flanks of the Piton de la Fournaise. The lava flow ages and UTM locations are known from radiocarbon dates [1] and the size distribution of pioneer trees [2]. Samples for both paleodirections and paleointensities were taken, where possible, spread out over the outcrop.
The rock magnetic behavior of the sites was analyzed using a horizontal translation Curie Balance [3] and hysteresis measurements to assess the magnetic domain state were performed on an Alternating Gradient Magnetometer.







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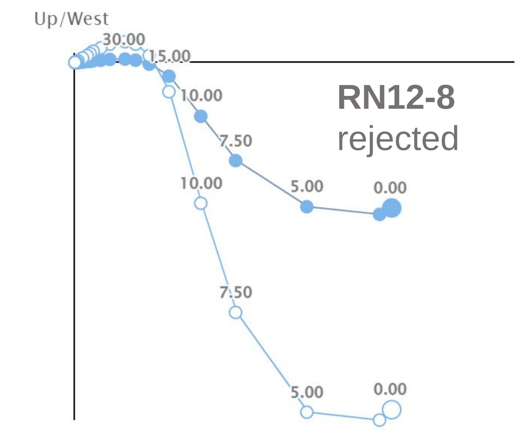
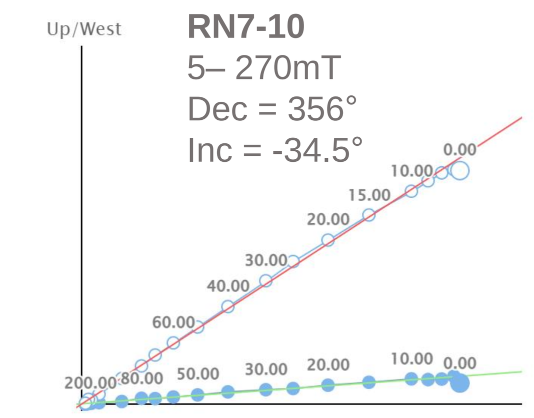
Abstract

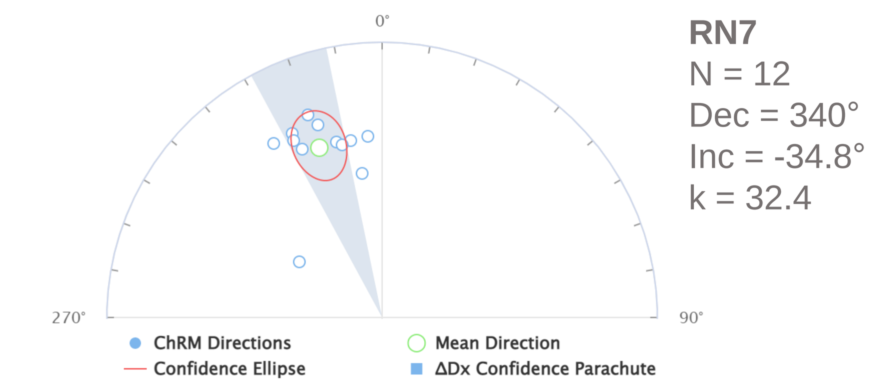
3. Paleodirections

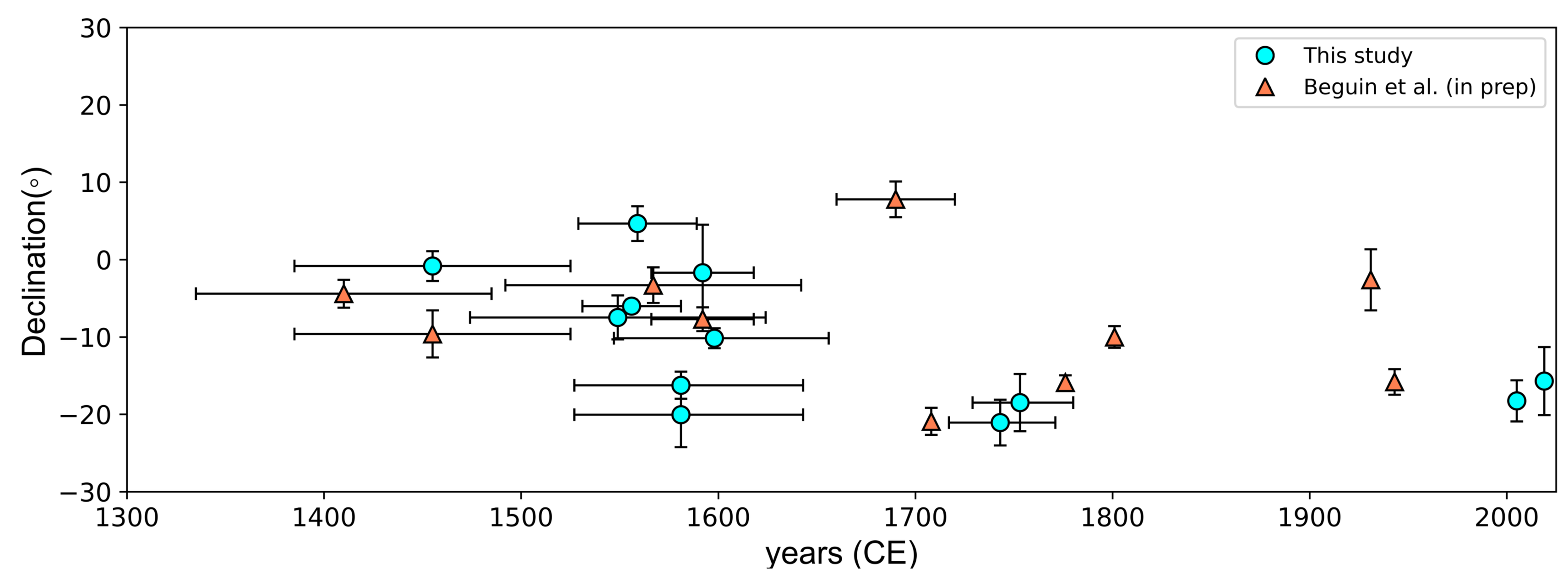
Paleomagnetic directions were obtained with both thermal and alternating field (AF) demagnetization experiments. Four samples per site were thermally demagnetized and eight samples per site were demagnetized by increasing alternating fields.

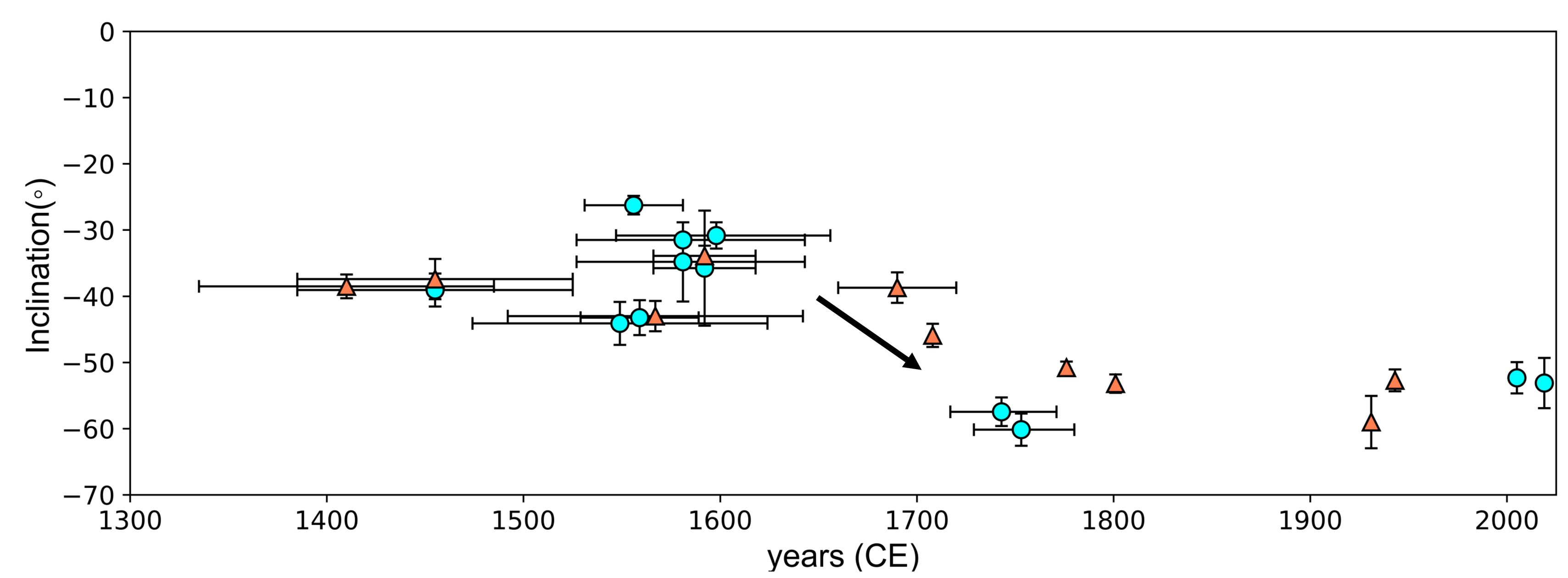
Some sites were magnetically so strong they exceeded the measurement range of the cryogenic magnetometer, and the results from AF demagnetization experiments could not be interpreted. These sites (RN12, 13, 15, 16) are excluded from further interpretations. Of the 14 accepted sites, three sites have a precision parameter k<100.

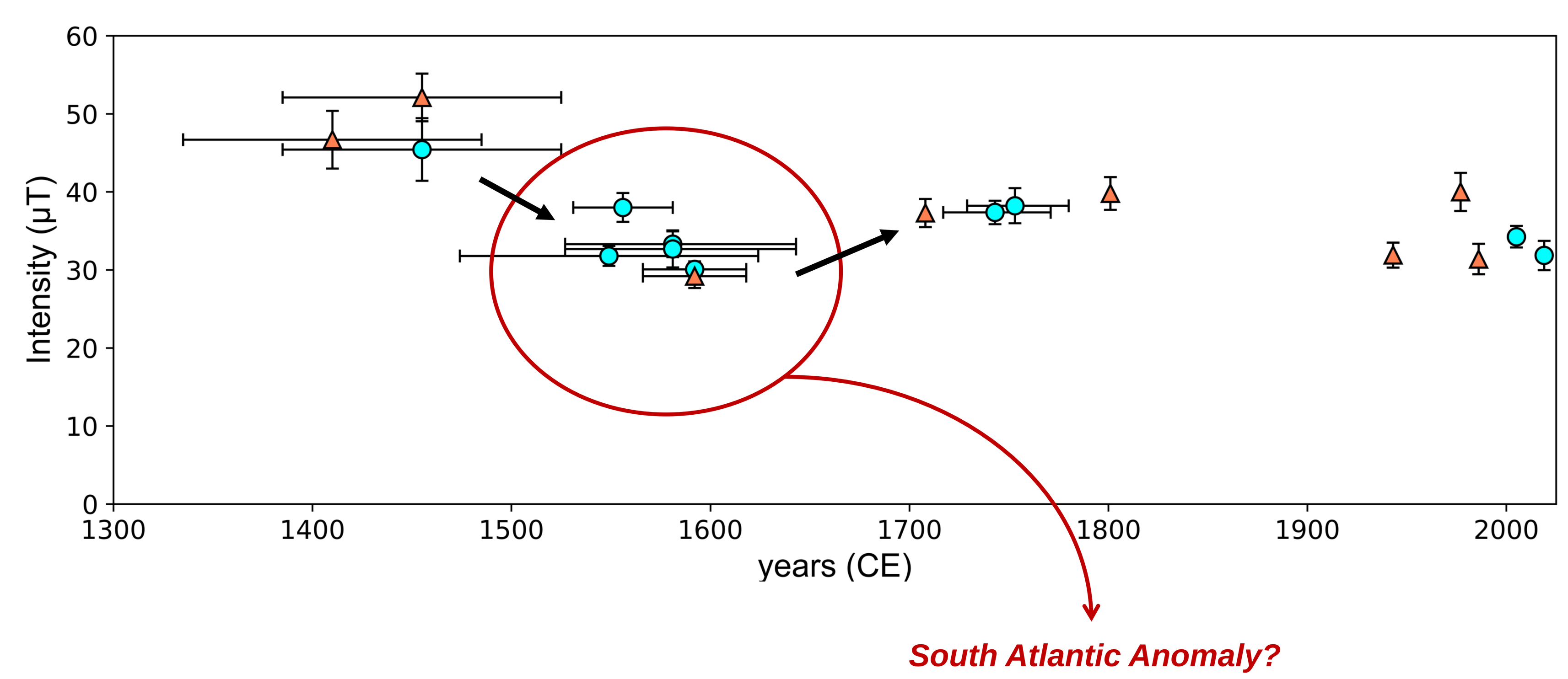








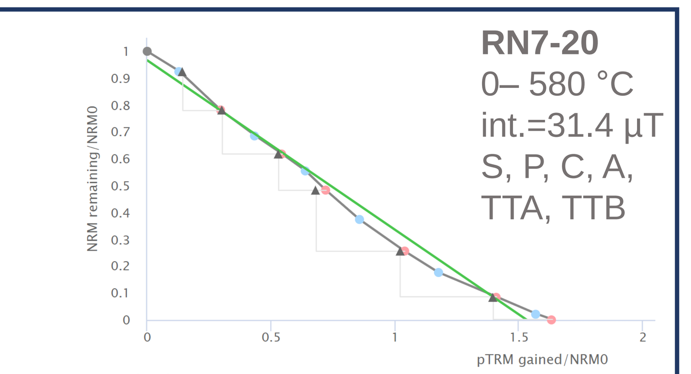


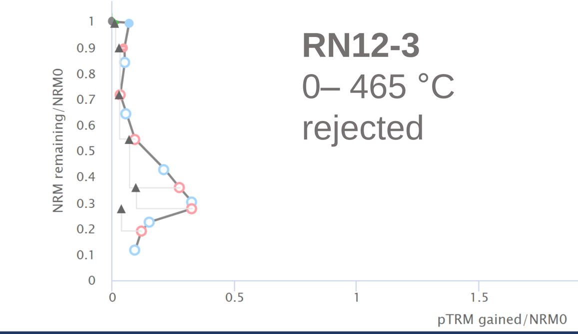


4. Paleointensities

The paleointensity was derived using the IZZI-Thellier technique. Between eight to five specimens per site, in total 139 specimens, were heated in several steps whereby the natural remanent magnetization (NRM) was progressively replaced by a partial thermal remanent magnetization (pTRM) under a 50µT laboratory field.

93 specimens passed at least one or more out of the six applied selection criteria, which is a success rate of 67%. From the 18 measured sites, 10 gave a successful result. Of the other eight sites the standard deviation divided by the mean exceeded 20%, or the paleointensity obtained was an impossible 600µT from the samples which might have been hit by lightning.





5. Do we see the South Atlantic Anomaly?

Data from archeological materials in Southern Africa [5] suggest the SAA has influenced this region. There are rapid changes in directions observed from 1225-1550CE and the lowest paleointensities in Southern Africa are found at ca. 1370CE, followed by an increase in field strength. If the SAA formed underneath the Indian Ocean and moved westwards since this should be visible at Réunion Island before 1370CE. Our paleomagnetic data from Réunion Island also show drastic changes in both direction and intensity, but around 200 years later.

The declination values scatter, but both inclination and declination values seem to become more negative after 1700CE. For intensity, our additional paleomagnetic data supports the data from Beguin et al. (in prep) and shows a gradual decrease between 1450-1600CE, the minimum is reached at 1600CE. There are multiple scenarios to explain the observations: 1) The SAA migrated from the Indian Ocean westwards and passed Réunion in 1600CE (how does this fit with the Southern Africa data). 2) The SAA migrated from Indian Ocean prior to 1300CE and moved slightly eastward at 1600CE. 3) The SAA formed under Southern Africa, at 1600CE influencing the field around Réunion Island.

Outlook

- Make a new paleosecular variation curve for Réunion Island
- Create a geomagnetic field model to observe the evolution of the South Atlantic Anomaly in global context
- **But first**: obtain paleomagnetic data from volcanic areas east of Réunion: the Pacific and Indonesia

References
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