

Evaluating the anomalous palaeomagnetic field behaviour in the Ediacaran with new palaeointensity data from Laurentia and Baltica

Thallner D.¹, Biggin A.¹, Hill M.¹, Halls H.², McCausland P.J.A.³, Shcherbakova V.⁴, Shcherbakov V.⁴, Bakhmutov V.⁵

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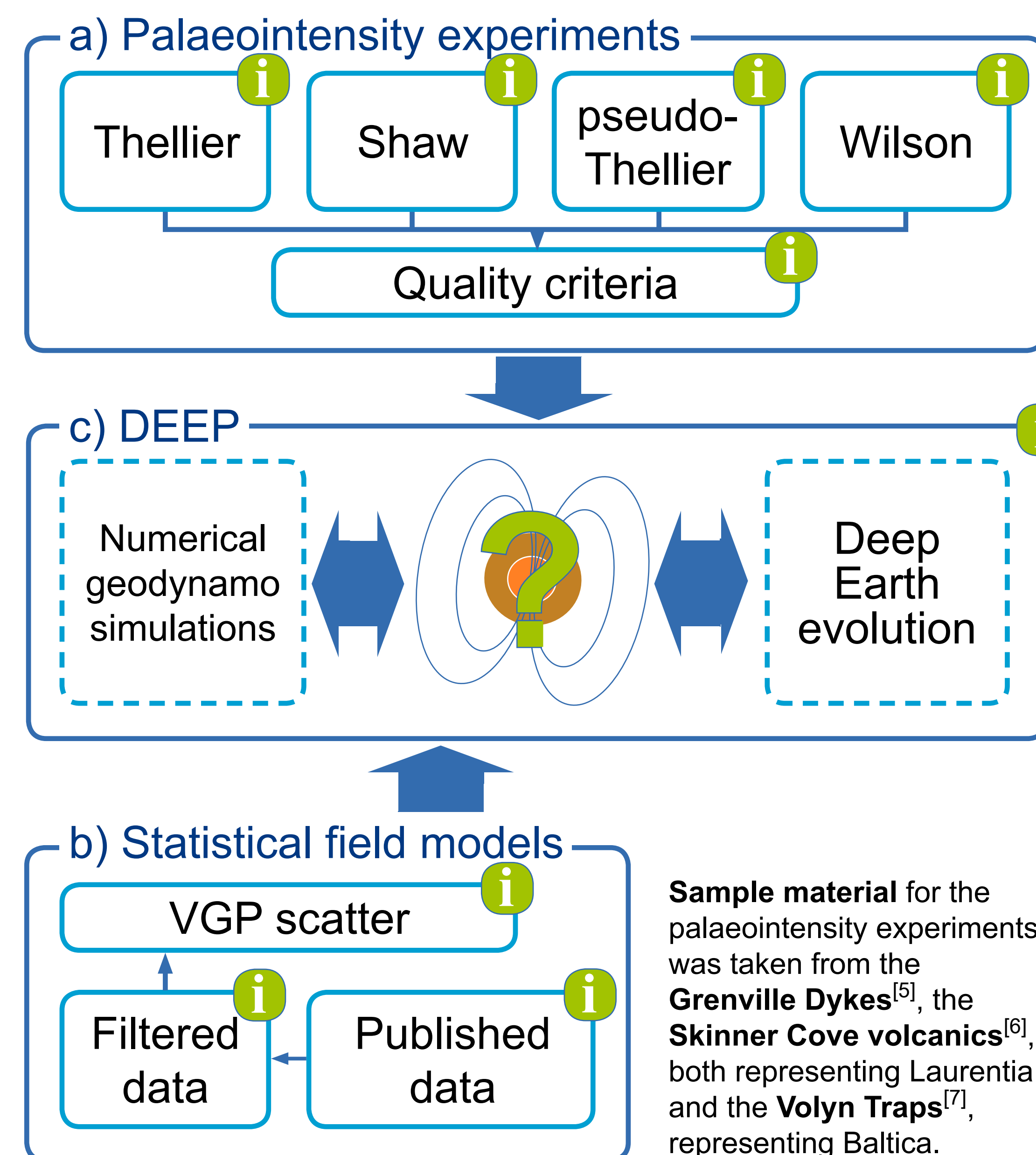


1. Introduction

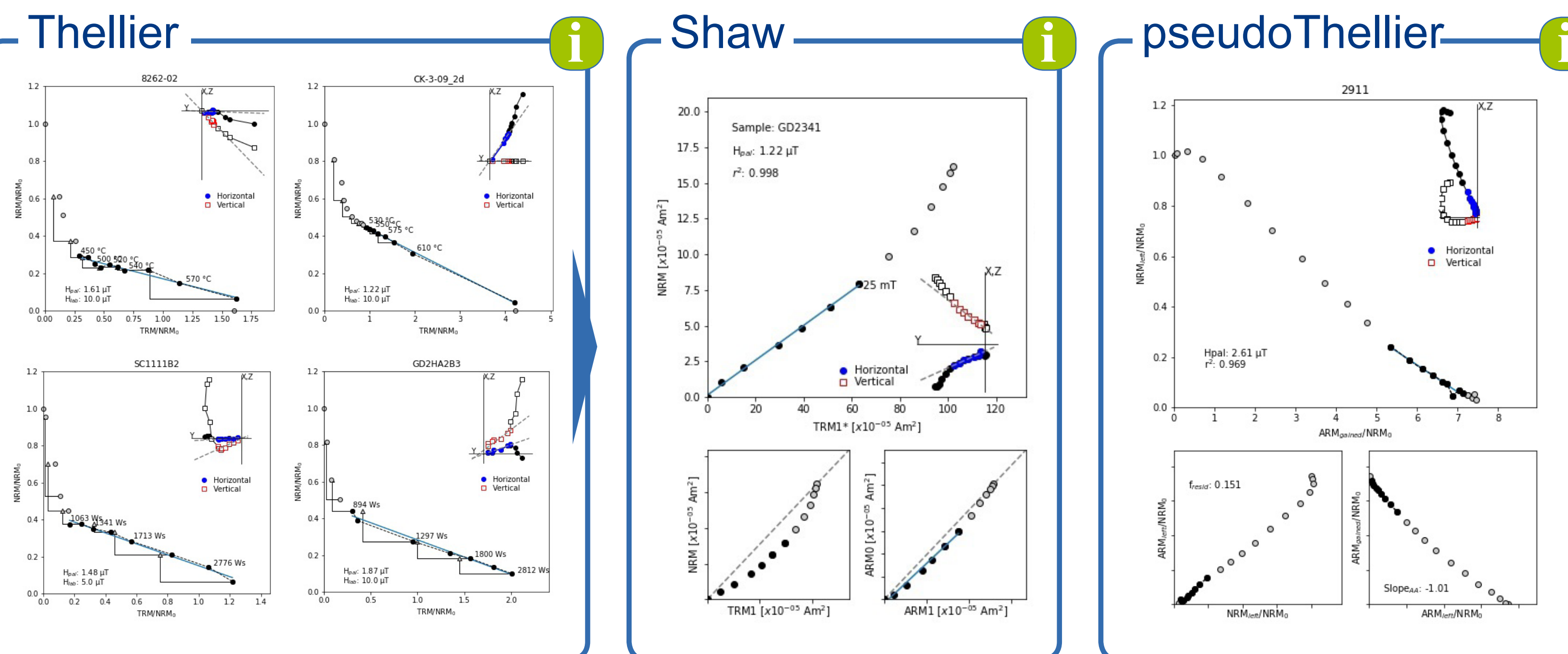
Palaeomagnetic investigations of the geomagnetic field directions in the **Ediacaran period (635-541 Ma)** suggest an **anomalous behaviour** of the field, leading to interpretations ranging from an equatorial dipole configuration^[1] or rapidly reversing field^[2] to inertial interchange true polar wander^[3]. To date, no definitive explanation for the field behaviour has been accepted. In addition, a recent palaeointensity study revealed that the **time-averaged field strength** was also **unusually weak**^[4], inferring that the onset of inner core nucleation was in the Ediacaran. But what about the field itself?

Can we use the existing field data together with new palaeointensity data to characterise the geomagnetic field and explain its anomalous behaviour in the Ediacaran?

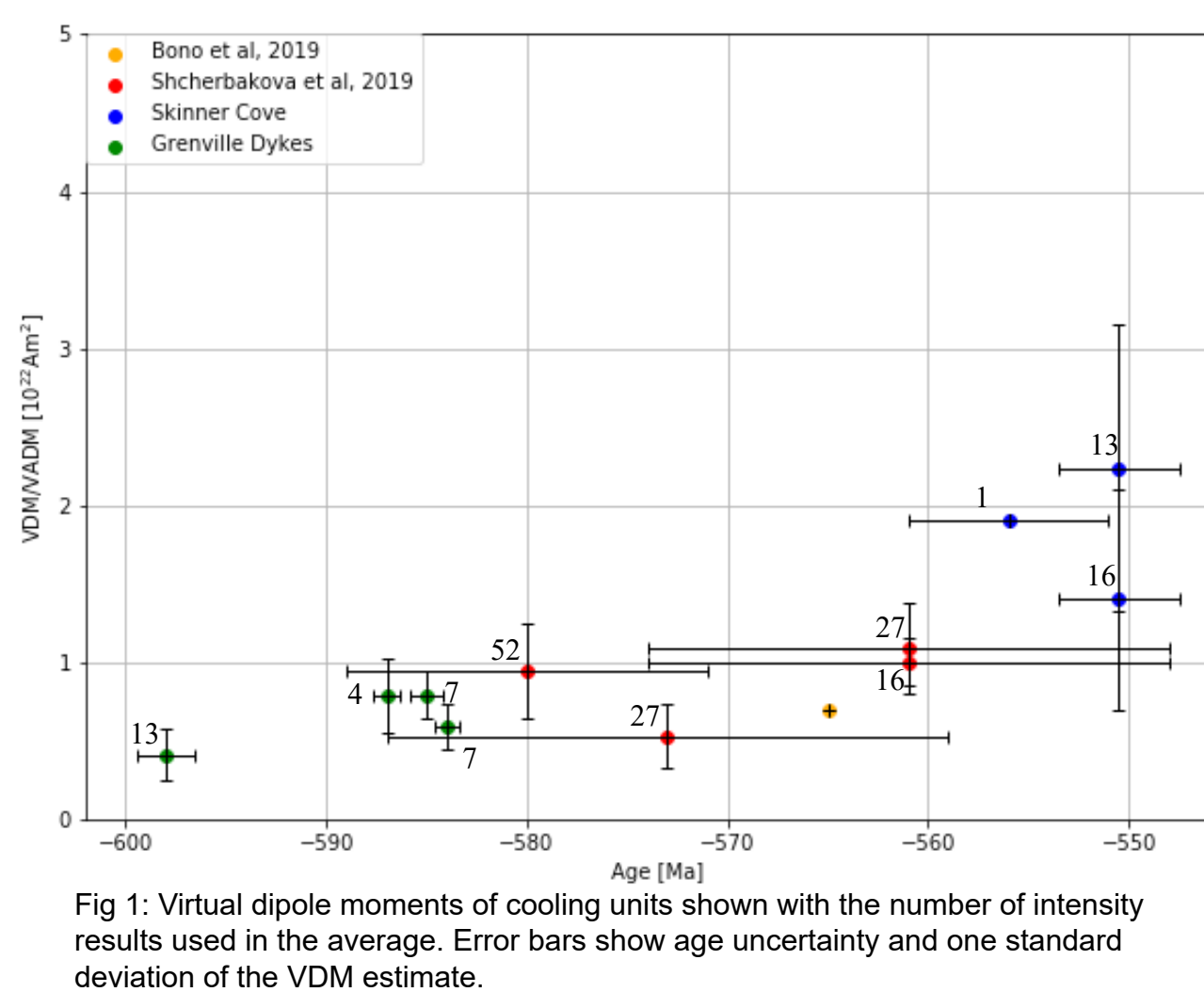
2. Workflow



3. Results



Virtual dipole moment



All **palaeointensity** experiments result in **extremely low** values for the Ediacaran field strength. The new whole-rock intensities from fast-cooled units are in good agreement with the time-averaged single-crystal results^[4].

The resulting data points suggest that the **geomagnetic field** might have been **extremely weak** throughout the the last 50 Ma of the Ediacaran and the **strength of the field starts to increase around 560 Ma**.

As suggested before^[4,7], the complete absence of high palaeointensity results **infers a transitional field** and possibly high reversal frequencies over prolonged periods of time in the Ediacaran.

VGP dispersion

Palaeosecular variation of filtered directional studies, computed as between-site scatter of angular deviations of virtual geomagnetic poles and averaged in 10° latitude bins, result in **VGP scatter values similar to those seen in the last 10 Ma**.

This **contradicts expectations from palaeointensity** values and recently published high scatter estimates at low latitudes^[4]. The approach used to obtain scatter statistics has been applied on Precambrian datasets before^[8], but it does not seem to be appropriate for the Ediacaran data and the VGP scatter statistics here have to be viewed sceptically.

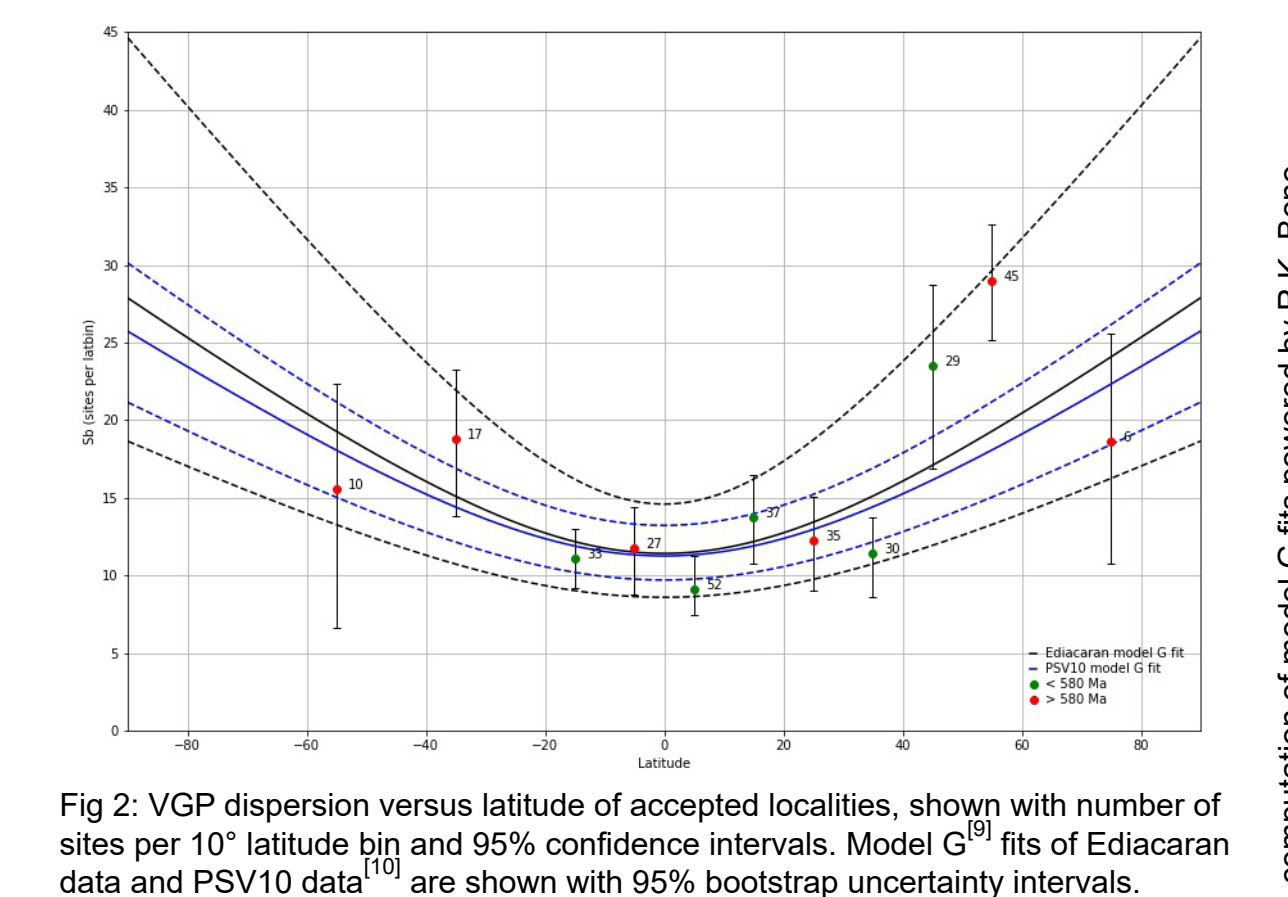


Fig 2: VGP dispersion versus latitude of accepted localities, shown with number of sites per 10° latitude bin and 95% confidence intervals. Model C¹¹ fits of Ediacaran data and PSV10 data^[10] are shown with 95% bootstrap uncertainty intervals.

4. Discussion

Laboratory alteration and MD effects could lead to an underestimation of palaeointensity. However, as the **good agreement** between the **time averaged intensities** and the **extremely weak** over long

While it does not rule out a **palaeosecular variation** analytical artefact, introduced

- **low number of directions**: the large 95% confidence intervals for the interpretations and a large scatter
- **low data quality**: high within-site scatter and the resulting between-site scatter
- **usage of magnetic latitudes**: since the field is behaving differently from the palaeogeographic record and lead to a different

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5. Conclusion

The **geomagnetic field** in the Ediacaran shows **ultra-low** values over prolonged time periods. The **addition of palaeointensity data** and the **statistical analysis of published directions** has lead to **progress**, but the **anomalous behaviour** of the field **remains a mystery**.

6. Future Work

- **further palaeointensity studies** - especially in the time period between 600 and 700 Ma - would be needed to constrain the distribution of the ultra-low palaeointensity period.
- **estimates of reversal frequencies** in the Ediacaran would be an extremely valuable addition to the known properties of the field.
- a better approach to **evaluate palaeosecular variation** is needed to be able to understand the anomalous field behaviour.
- the new data can be used as additional **constraints for numerical geodynamo simulations**. These could give further **insight** into deep Earth evolution at this unique time.