# CONSERVATION, SCANNING AND DIGITIZATION OF HISTORICAL GEOMAGNETIC DATA ARCHIVES FROM BRAZIL

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# PRELIMINARY RESULTS OF THE LATITUDINAL AND TIME DEPENDENCE OF PALEOSECULAR VARIATION DISPERSION PARAMETER DURING THE KIAMAN SUPERCHRON (318-262 Ma): AN INTER-HEMISPHERIC APPROACH

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## Abstract

One of the most fundamental questions about geomagnetic polarity reversals is that of stability. It has been suggested that the observed latitudinal dependence for the angular dispersion of paleosecular variation (PSV) and the inferred relationship with the mean geomagnetic reversal rate could be used as a good first-order tool for assessing the stability of geomagnetic field.

Geomagnetic 'superchrons' – with single geomagnetic polarity period for ~ $10^7$ years – are so long they clearly do not represent an ordinary polarity change, but imply a fundamental transition in the dynamo processes. Studies on the PSV behavior throughout these lengthy geomagnetic intervals do represent an outstanding opportunity for providing useful constraints for understanding reversal processes and the geodynamic evolution.

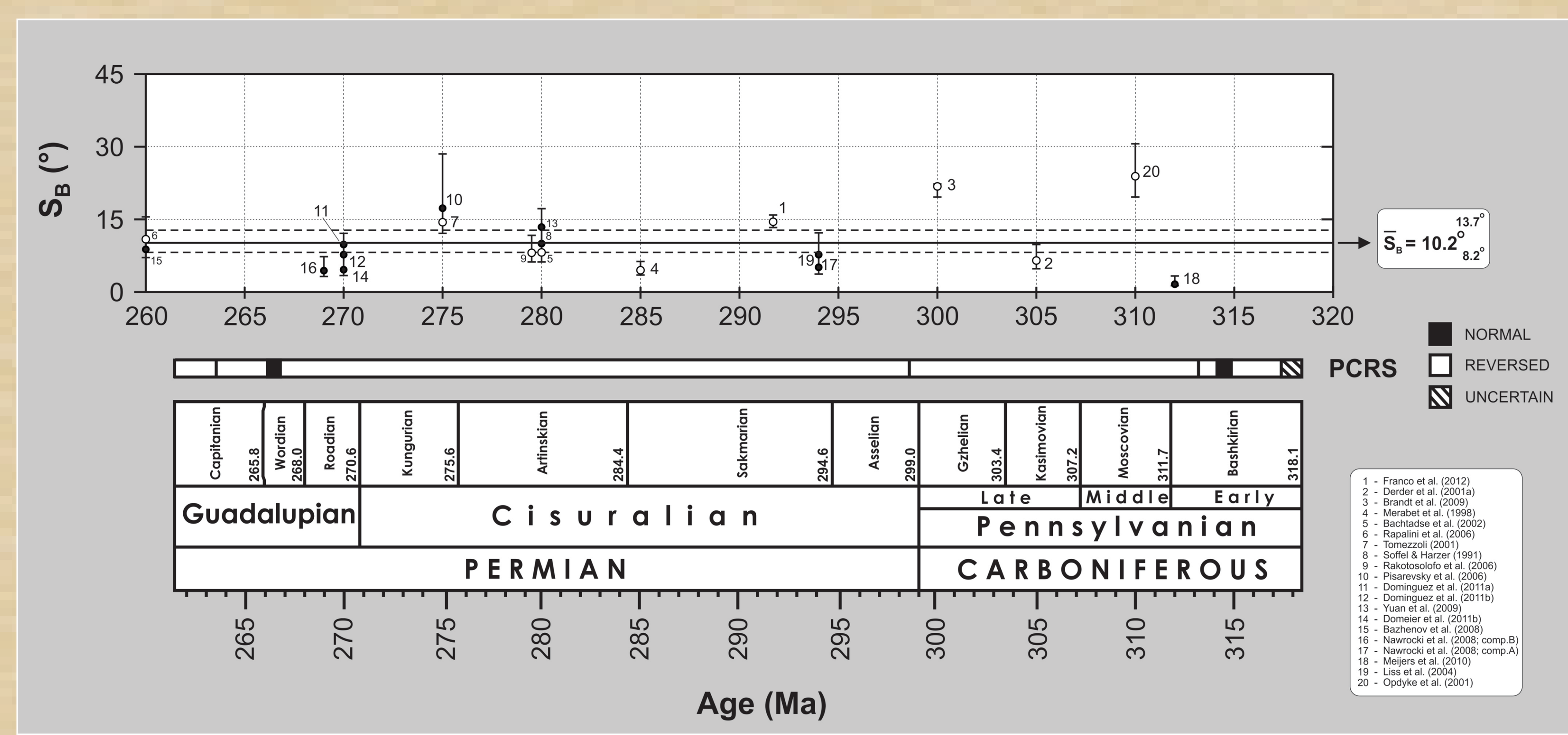
In this work, we present our preliminary results from an inter-hemispheric evaluation of the latitudinal and time dependence of the PSV stability through evaluation of scattering pattern of VGP datasets (estimation of dispersion parameter corresponding paleolatitude ($S_B$-λ)) calculated from pre-selected paleomagnetic datasets for the ~318-262 Myr Permo-Carboniferous Reversed Superchron (PCRS).

## Highlights

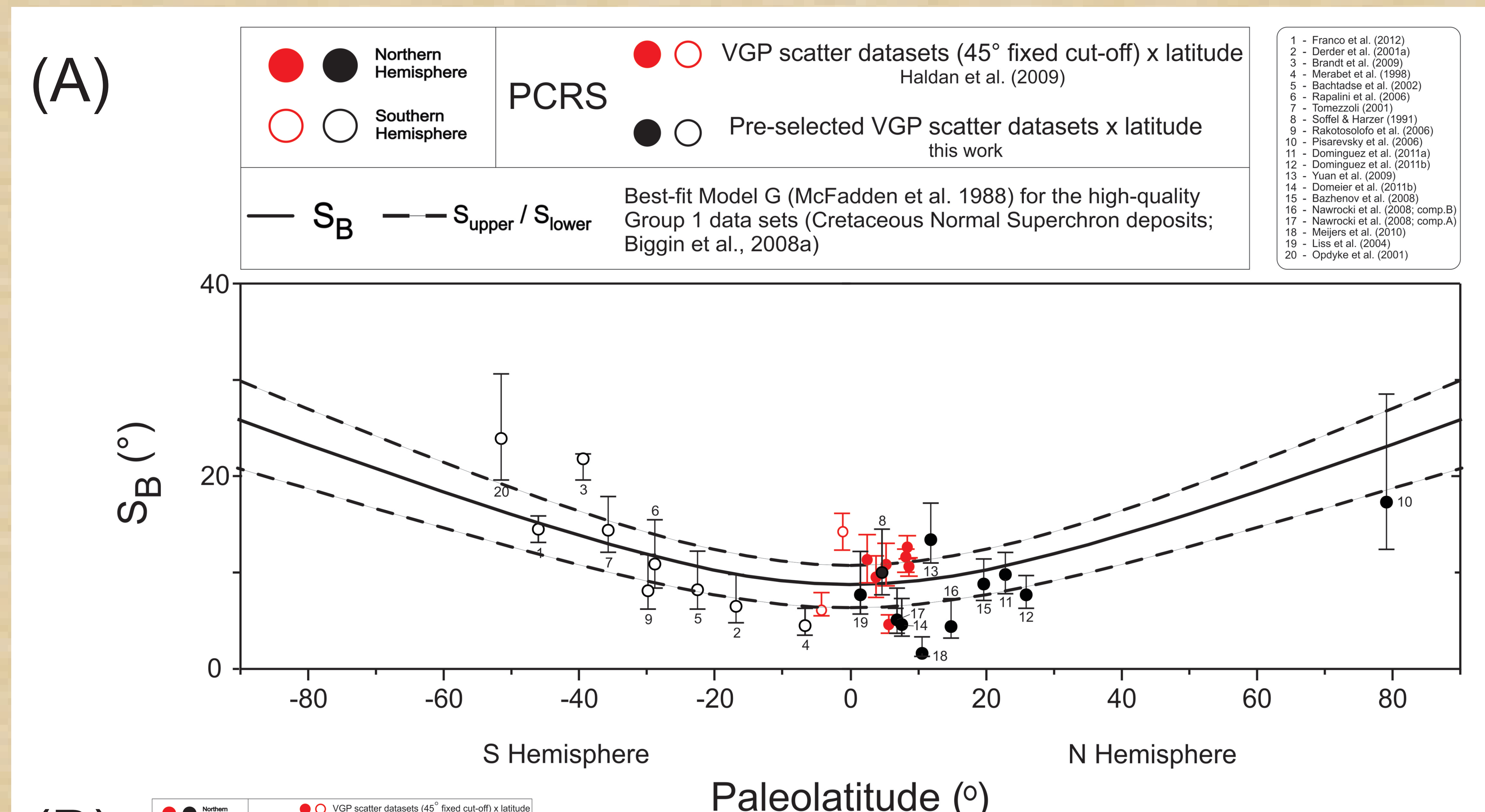
It is well-accepted that a very complex interplay, still far to be fully elucidate, rule over the geodynamic processes between Earth's core, mantle and crust (Eide & Torsvik, 1996). Surely, one of the most fascinating, enigmatic and longest standing set of problems in Earth Sciences, still far to be fully understood, are those related to how the self-sustained geodynamo is kept against ohmic decay along the Earth's evolution (Kuang & Bloxham, 1997; Jackson et al., 2000; Christensen & Tilgner 2004).

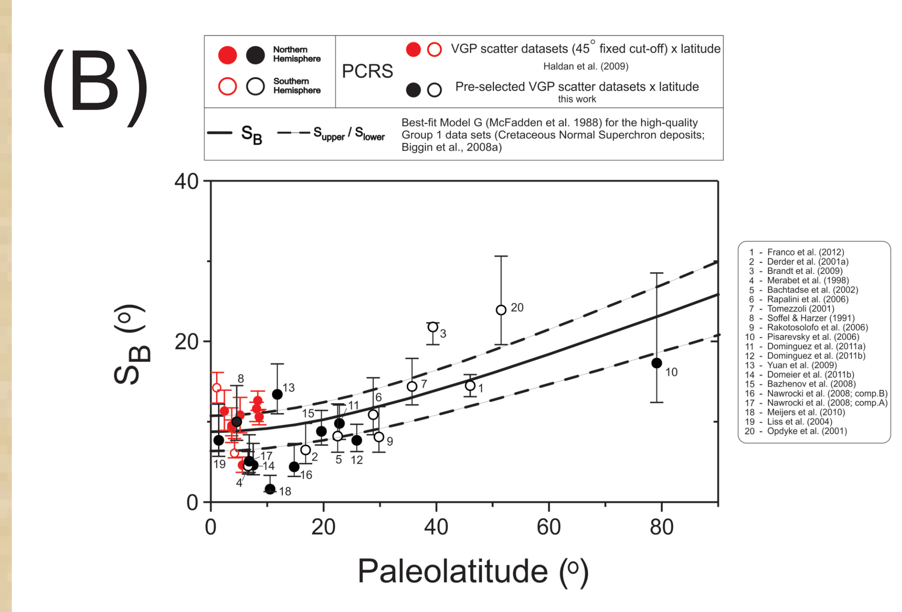
In such context, important advances have been achieved by numerical geodynamo modelling efforts in the last decades, providing important insights about the Earth's deep interior and surface processes, as well as its relationship with the geodynamo's phenomenology and generation mechanisms. Some illustrative debates are those related to the role of outer core dynamics and core–mantle coupling on the triggering of excursions and reversals processes, its timescales and frequencies, as well as on the field strength along geological eras (Loper & McCartney, 1986; Larson and Olson, 1991; Glatzmaier et al., 1999; Tarduno et al., 2001; Biggin & Thomas, 2003; Tauxe, 2006). Notwithstanding, several issues remain unsolved due to a set of factors – ranging from distinctive modeling approaches (e.g. definitions of boundary conditions, dimensionless parameters, sources of energy) to computational threshold for modelling on a realistic parameter regime (Yokoyama & Yamazaki, 2000; Dormy & Le Mouël, 2008; Kageyama et al., 2008) – which prevents a full understanding of the dynamics of the EMF and the geodynamo.

Most of experimental database which support the modelling efforts traditionally come from paleomagnetic research. Since the decade of 1950, substantial information has been provided related to the behavior of geomagnetic polarity and paleosecular variation (PSV) through geological time. It has been discussed that PSV may reflect the evolution of the core-mantle boundary (CMB) conditions and hence it could be of great importance in providing constraints to geodynamo numerical models (Heller et al., 2002; Haldan et al., 2009). For instance, geodynamo models based on different thermal conditions to the CMB (e.g., Glatzmaier et al., 1999; Coe & Glatzmaier, 2006) have indicated distinctive patterns of latitudinal dependence of PSV with latitude (Tauxe, 2008), and some studies (e.g., McFadden et al., 1988; 1991; Hulot & Gallet, 1996; Johnson et al., 2008; Biggin et al., 2008b) have pointed out for a possible relationship between virtual geomagnetic pole (VGP) scatter curves and the geomagnetic reversal rate for a given geological period.




Results of VGP dispersion parameter ($S_B$) vs. time for the period related to Permo-Carboniferous Reversed Superchron (PCRS)




Evaluation of the latitudinal dependence of the palaeosecular variation (PSV) by comparison of the best-fit Model G (McFadden et al. 1988) – within a 95 per cent confidence limit for the high-quality Group 1 data sets, Cretaceous Normal Superchron deposits, and after using the cut-off angle using the method proposed by Vandamme (1994)–and that were presented by Biggin et al. (2008a) compared with low (palaeo)latitude Permian data sets related to the Dôme de Barrot and Lodève basins (Haldan et al. 2009 – red symbols). Open and dark circles are, respectively, the results from the northern and southern hemispheres) and the observed scattering patterns of the pre-selected VGP data sets by this work. (A) Inter-hemispheric; and (B) superimposed datasets.

## Discussion

The debate about superchrons in the literature – for instance, about its onset, relationship between reversal frequency and field strength, secular variation behavior, theoretical and numerical modelling – is highly contendious. As recently summarized by Kruiver et al. (2002), different, and even contraditory, model concepts arises from phenomenological geodynamo modelling, aiming to explain the origin of superchrons.

Noteworthly, it is important to highlight some demonstrative points about of the still limited knowledge on how superchrons had occurred: (i) As discussed by Kruiver et al. (2002), paleomagnetic observations have not been able to unequivocally discard either the 'high-' or 'low-energy state' models; (ii) besides the discussion on 'low-' and 'high-energy state' models, it is also advocated that there is no simple relationship between superchrons (e.g. Prévot et al., 1990; Thomas et al., 1998, 2000), and even any correlation between reversal processes and the EMF's strength had been suggested (Biggin & Thomas, 2003; Garcia et al., 2006); (iii) basically, the most of the phenomenological models were, up to now, formulated for the ~ 118-83 Myr Cretaceous Normal Superchron (CNS); (iv) different tectonic and geodynamic conditions were related to the KRS and CNS periods – the KRS corresponds to a continental assemblage episode (during the amalgamation of Pangea), whereas the CNS post-dates a prolonged period of supercontinental mantle insulation followed by continental break-up (Eide & Torsvik, 1996); (v) it cannot be ruled out that these models - which were designed aiming to explain the CNS - could not be compatible to the KRS – and, in such scenario, the geodynamo's state might be substantially different between both superchrons.

These preliminary results, based on calculations of VGP dispersion parameters from a pre-selected paleomagnetic data sets, are remarkably consistent with the S-λ behavior for the CNS best-fit Model G - which can be particularly verified for the Southern Hemisphere results -, and are in a good agreement with some studies (e.g., Tarduno et al., 2002; Haldan et al., 2009) which indicate that the (paleo)secular variation may tend to be lower during superchrons than for periods of higher reversing rates (e.g., the 0-5 Myr Jurassic period; Johnson et al., 2008).

Our goal for the upcoming advances on this research is to improve such paleomagnetic database and to provide a best fit for S-λ related to the PCRS.

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