Characterization of archaeomagnetic Jerks in Europe

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FWF Der Wissenschaftsfonds.

1. Introduction

Abrupt changes in the movement of directional secular variation (SV) of the Earth's magnetic field (EMF) are called archaeomagnetic jerks (AMJ). Gallet et al. (2005)[1] suggested that AMJs correlate with high archaeointensities obtained from French and Syrian pottery. In order to test this hypothesis the much larger European archaeomagnetic data set, direction and intensity, has been investigated.

2. The archaeomagnetic data set

- **Directional** data base[2] updated until 2007[(i.e. 3,4,5,6,7,8,9,10)].
- Five subsets (Fig. 1) for independent SV curves.
- Calculation with RenCurve[11].

- ✕ Western European **intensity** data set[12,13] (Fig. 1) updated[14,15,16,17,18].
- ✕ Classification of Chauvin[12] assigned for all data.
- ✕ SV intensity curve has been calculated for the whole set and a selection with RenCurve.

Figure 1: Map with a compilation of sites with archaeomagnetic data. Boxes indicate areas for which five independent secular variation curves were calculated.

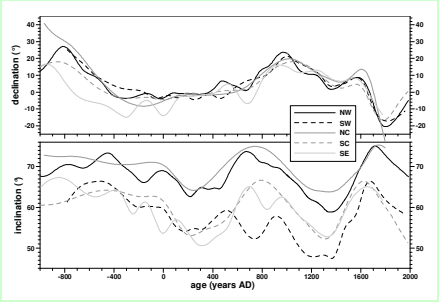

Figure 2: Marginal curves (declination and inclination) at reference sites obtained from Bayesian modelling for five independent archaeomagnetic data sets from Europe (Fig. 1).

3. Characterization of archaeomagnetic jerks

Marginal curves (Fig. 2) show:

- very similar declination
- similar characteristics in inclination
- strong dipolar contribution is seen in inclination
- agreement not so well for times BC

Stereographic projection (Fig. 3) of directional curves show:

- similar SV patterns for all European regions
- cusps or loops where SV slows down
- EMF vector changes direction of movement[(see 16)]

➔ Mathematically an AMJ can be characterised by a minimum in velocity and maximum in curvature of the SV curve (Fig. 4).

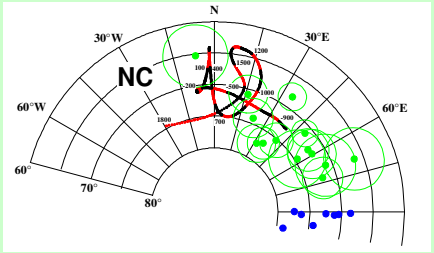

Figure 3: Directional SV curve from region NC in stereographic projection. Archaeomagnetic directions from Rodenkirchen and Glocksin, palaeomagnetic directions from West Eifel excursion.

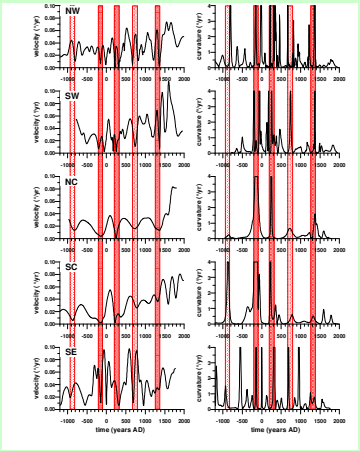

Figure 4: Velocity and curvature calculated from the Bayesian archaeomagnetic SV curves shown in Fig. 2.

3. Contemporaneous archaeomagnetic jerks in Europe?

- Velocity, curvature and marginal curves from region NC are relatively smooth.
- Much more wiggled for the other regions.
- Further investigation on reason is necessary: More scattered data sets or less smoothed curves?
- Five local minima in velocity correspond to five local maxima in curvature (Fig. 4) found in all curves.
- Possible occurrence of AMJs at 920-820 BC, 200-100 BC, 200-320 AD, 680-800 AD, and 1250-1350 AD.
- Compared with Gallet et al.[13] another AMJ is found in the Iron age.

4. Archaeointensity data in Europe

Compared to 1251 archaeodirections from regions NW, SW, NC and SC only 226 archaeointensity determinations exist. Data from region SE have not yet been investigated. Using the weighting proposed by Chauvin[12] a high quality (HQ) data set has been selected (weight >12). These are only 130 data points (Fig. 5).

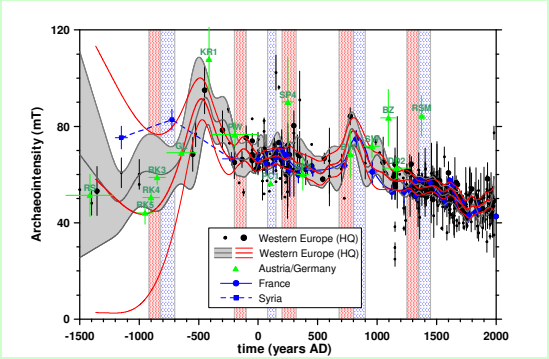

Figure 5: Archaeointensity in Western Europe in comparison with AMJs inferred from Fig. 4

5. Do archaeomagnetic jerks correlate with high intensity?

Gallet et al.[1] suggested a correlation between AMJs, high archaeointensity (Fig. 5, blue curves and data points) and centennial climate change (Fig. 5, blue bars).

- Complete intensity data set is very scattered and gives a wiggled curve.
- Curve from selected data set supports Gallet curve obtained from few data.
- Preliminary new archaeointensities (Fig. 5, green data) support obtained curve.
- Only two strong maxima in intensity are found at 500 BC and 800 AD (4 data)
- Caution is necessary, because there are many temporal gaps.

The sites RK and GL correspond to the AMJ around 800 BC, they do not give high archaeointensities. Interestingly, they have directions (see Fig. 3, D=30-75°, I=~72°) that are close the directions found in several excursions in the WE volcanic field (D=~90°, I=~75°)[19,20].

6. Conclusion

Archaeomagnetic jerks can be characterized by low velocity and strong curvature of the directional SV curve. Five AMJs occur contemporaneous in Europe during the past 3000 a. Evidence for high intensity during AMJ is weak. The SV pattern at 900 BC seems to look similar to the early Brunhes chron excursional field configuration.

Acknowledgements
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