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Climate of the Past Discussions

Interactive comment on "The reconstruction of paleo wind directions for the Eifel region (Central Europe) during the period 40.3–12.9 ka BP" *by* S. Dietrich and K. Seelos

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Answer to the interactive referee comments of P. ANTOINE (Referee #1) (Received and published: 9 November 2009)

Thanks a lot for some really constructive comments on our manuscript, these will certainly help to improve it. This referee asks three major questions and adds a few secondary ones, all of which we will now address.

Pierre Antoine has following main questions on our manuscript.

1. His first point concerns the origin of the carbonate silts and how those might be

produced.

In general we do not see a high variability in grain size distribution over the whole section, not even the sediments of MIS 2. Thus we do not see shifts from proximal to more distal sources and vice versa. For our records we use mean grain sizes with high resolution sampling intervals (500 μm). This means that we also measured maximum grain sizes of about 100 μm and more in nearly every sample. A long term transport distance of some hundreds of kilometres for these grain sizes are not known. We suggest that the relatively low content of carbonates in the silt fraction (max. 18 % per sample) is produced by physical weathering in the carbonate belt. The measured grain sizes and shape parameters (elongation and form factor) of the aeolian transported carbonate particles correspond to those of the quartz fraction (Fig. 3a in the revised ms.). The production of quartz particles in silt fraction by physical weathering processes (basically by frost shattering) are already described by Cilek (2001, Quaternary International). Lab experiments show the effects of frost shattering on carbonate rocks produce carbonate granules (Latridou & Ozouf (1982). Secondary aeolian processes such as deflation, saltation and corrasion are able to produce fine grained material like silt. This is in accordance with the generally low content of carbonate in our sequence. Encouraged by the question about the sources and the transport distance of the carbonate particles we used electron microscopy to analyse one thick east wind layer (core De3, 9.773 m depth). Figure 3a (rev. ms.) shows a carbonate particle with a diameter of about 50 μm surrounded by quartz and feldspar minerals of the same size. The qualitative geochemistry analysis in Figure 3b (rev. ms.), measured in the centre of the observed grain, shows the typical calcite pattern. We suggest adding this figures to the ms.

2. Pierre Antoine suggests a more extended discussion of our results, especially with European loess sequences. Different sources of fine material in the ELSA cores should be discussed.

The referee's comment about discussing other European proxy data sets which record changing wind systems over the continent is completely justified. A new study by Antoine et al. (2009, QSR) compares possible centres of loess origin and interpret these results with the migration of the North Atlantic low. This paper had just been accepted when we submitted our ms, thus we could not discuss these results at the time. We will now add this information to our text. In general our east wind layers coincide with coarser sediment (high grain size index, GSI) in the Nussloch P4 loess profile (Upper Rhine Area, Germany). A higher GSI in the Rhine area means proximal aeolian transport. We completely agree with this major finding and suggest the same mechanism for the Eifel region: Coarse carbonate grains are transported from sources in the direct neighbourhood to the Dehner Maar sediment trap. This is why we believe that the carbonate outcrops of the Eifel-North-South-Zone are the most possible source.

3. The referee queries on the used age-depth-model of the sediment core De3 and on the used stratigraphy of the Ngrip ice core.

The 14C-signal in lake sediments is strongly influenced by reworking of organic matter – in this case probably from pedogenesis 48,000 years ago. Calibration of the data gives no "better" ages. The shown uncalibrated 14C ages indicate that the sediment can be settled into MIS 3. This classification is supported by the LST (12,900 yrs BP, 3.5 m depth) and a large piece of wood (45,800 yrs BP, 55.96 m). The fine stratigraphy of our age-depth-model is therefore tuned to the NGrip ice core.

4. Pierre Antoine has difficulties in following our interpretation of a coupling of Heinrich events and the easterly wind layers in our sediment core.

Since there is general blurriness in the used age-depth-model (this is common for all partly tuned time series), it is not possible to decide whether high easterly wind activity corresponds to the 'beginning' or to the 'end' of Heinrich events (HE). Thus, we think that H1, H2 and LGM show a direct coupling to easterly wind systems. We accept the comment that the H3 differ from the younger HE, which is known as an unusual HE (see p. 2165, line 26 ff.).

The referee has following secondary comments:

(P. 2158 / L.16) "the first time period during MIS 3 (40,3–36 ka BP) is controlled by relatively warm climate": this is a very unusual conclusion!, as this part of the record is characterised in ice records by the occurrence of very well marked stadial events such as the one located before GIS8 (between ca. 38 and 40 ka).

We completely accept the opinion of the referee about a "relative warm climate" regarding the time slice 40–36 ka BP. We have changed the text as follows and, analogue to this, the results concerning the content of organic and dust (Fig. 3): "The first unit covers the periods of the ending GIS9, H4, and GIS8. With the exception of H4 (40–38 ka BP) the content of organics in our record is relatively high. With the end of GIS8 (38–36.5 ka) the content of organics decrease and the content of dust increases rapidly." Thus, our record follows the variation of fast phase transitions of interstadials to stadials as observed in ice core records.

(P. 2158 / L.24) please cite Hatté et al., 1998 at that place.

We agree with this comment and will add this reference.

(P. 2161 / L.16) What is the distance of the nearest carbonate source to the west?

We will add following lines to our ms. "The nearest carbonate source to the West of Dehner Maar are cretaceous units near Liège or Aachen, which lie over 60 km to the NW. The nearest lime stone units, which are fluvialey influenced are Triassic outcrops in the Meuse valley (130 km to the west).

(P. 2161 / L.24-25) What is the process at the origin of the reworking of the fine particles from the Triassic sandstone (Buntsandstein)?

We definitely detected reddish fine silt and clay in the core De3. Nevertheless, it is only an assumption that the origin of these particles is really Buntsandstein, which outcrops are not far away from the location of the Dehner dry maar. Since the reddish fine sediment is not the focus of our study we will delete this part of the sentence to avoid confusion.

(P.2160 / L.20; P. 2161 / L.24-25) The conclusion concerning "an increase in eastern winds during the H events" is not really clear from this paper (see comments about Fig. 3).

We give a detailed answer to this comment in response to main question #4.

Comments on the figures: Pierre Antoine suggests improvements to our illustrations and mentioned that all images should be enlarged, which we will do.

Fig. 1: This fig. should be replaced by a "real geological map" showing the main geological formations and the accurate outcropping area of the carbonate (Kalkmulde). It must be also enlarged to a larger area including the loess cover and other possible carbonate sources.

We will simplify the map with highlighted signatures for carbonate/limestone units and loess depositions.

Fig. 2: Enlarge / presently not informative

We have edited the figure. New figure 2 replaces the old Fig 2b, showing a new calibration study of artificial samples, focusing on low concentration of the carbonate silt fraction. The level reproduction is quite high for low concentration (up to 10%) of carbonates. Furthermore we have added a new figure 3 to the ms, showing electron micrographs of aeolian transported quartz and carbonate particles in silt size fraction. The old figure 2a is moved to a new figure 4.

Fig. 3: (idem: enlarge) + Contrary to what is announced in the caption "common process between . . .", the proposed correlation between the East-wind record from the Maar and the N Grip dust index is not so clear. Indeed, H1 is characterised by high East wind values whereas H2 and H2 (H3?) exhibit markedly lower values . . .

(New fig. 5) Our data show that we have high contents of east wind sediments during

H1 and H2. The coupling of east wind sediments and the events H1 and H2 is also dicussed in our answer to the comments of referee #2. The exact timing and duration is still under scientific discussion, but when we compare our results for the time period of H3 with those of Antoine et al. (2009) we see once again the same pattern. This means that high content of east wind sediment corresponds to a high GSI at Nussloch for the time 32–30.5 ky BP (declared as the first phase of H3 in Antoine et al., 2009). The period 30.5–29 ka BP is marked in our figure as the most probable time for H3 after Wang (2001, Science). This period is characterized by low contents of east wind sediment and coincides with a lower GSI at Nussloch, too.

Fig. 4: Compared to the loess record that exhibits $\pm$ 15–20 % of carbonates during the same period (22-24 ka), the percentage of carbonate is extremely low in the DML sequence: how can you explain this strong discrepancy?

(New fig. 6) The lower limit of our measurement is 20 μm for all particles. The content of very fine carbonate is not detected by RADIUS with an original 20x magnification. Therefore, it is not possible for us to estimate the real content of fine carbonates in our sediments. Another reason could be the solution process of fine grained carbonate, which is intensified by cold water.

References

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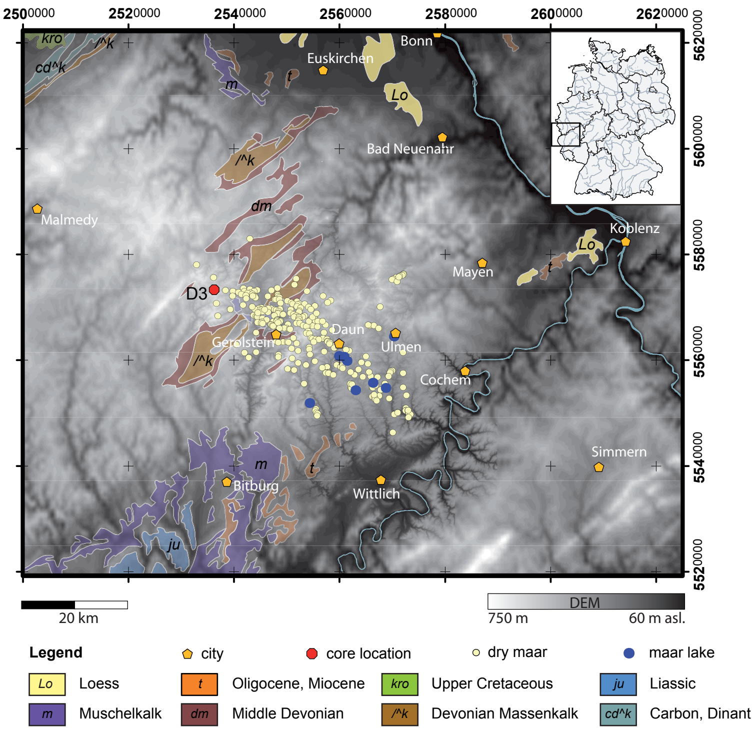

Fig. 1.

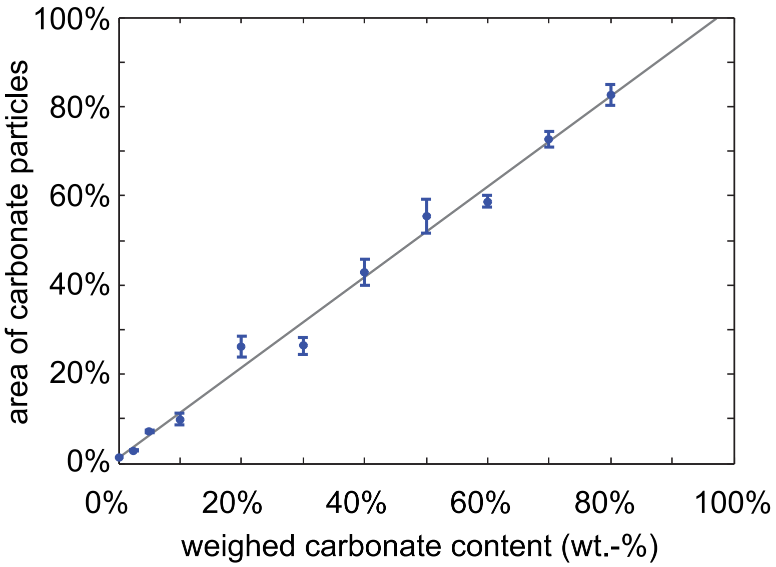
100%
80%
60%
40%
20%
0%
area of carbonate particles
0%
20%
40%
60%
80%
100%
weighed carbonate content (wt.-%)

Fig. 2.

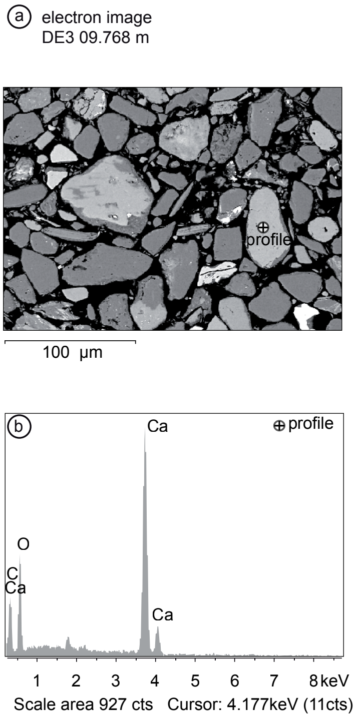
a
electron image
DE3 09.768 m
profile
100 µm
b
Ca
profile
O
C
Ca
Ca
1 2 3 4 5 6 7 8 keV
Scale area 927 cts Cursor: 4.177keV (11cts)

Fig. 3.