

# Initial intensification of East Asian winter monsoon at about 2.75 Ma as seen in the Chinese eolian loess-red clay deposit

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The initial intensification of the East Asian winter monsoon (EAWM) at about 2.75 Ma is revealed by the Chinese eolian loess-red clay deposit. The deposit is characterized by a significant increase in the content of coarse-grained particles (silt and sand) and a decrease in the content of fine-grained particles (clay) after 2.75 Ma. This change is interpreted as a result of the intensification of the EAWM, which led to a greater transport of dust from the Asian continent to the East Asian region. The intensification of the EAWM is supported by the fact that the deposit is located in a region that is currently dominated by the EAWM. The intensification of the EAWM at about 2.75 Ma is also consistent with the global climate change that occurred at that time, which was characterized by a significant increase in the intensity of the monsoon system.

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**INDEX TERMS:** 3300. 9320  
**KEYWORDS:** East Asian winter monsoon, loess, red clay, dust, intensification, 2.75 Ma

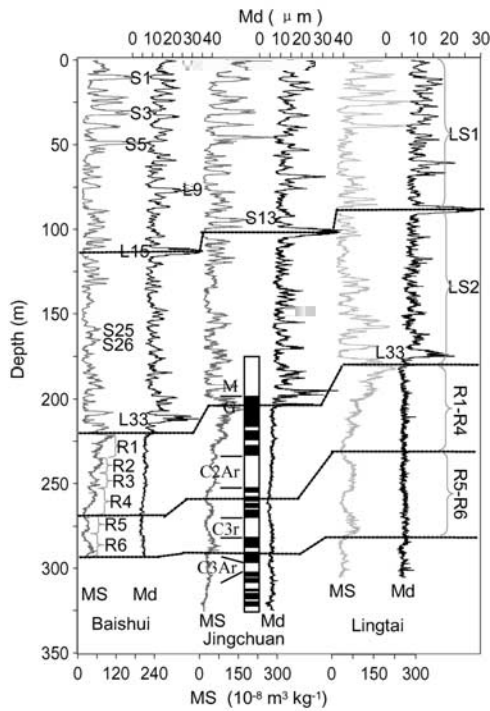
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## 1. Introduction

The East Asian winter monsoon (EAWM) is a major component of the Asian monsoon system. It is characterized by strong northerly winds and frequent dust storms. The EAWM has a significant impact on the climate and environment of East Asia. The intensification of the EAWM at about 2.75 Ma is a key event in the history of the Asian monsoon system. This intensification is supported by the fact that the deposit is located in a region that is currently dominated by the EAWM. The intensification of the EAWM at about 2.75 Ma is also consistent with the global climate change that occurred at that time, which was characterized by a significant increase in the intensity of the monsoon system.

## 2. Material and Method

The study area is located in the Loess Plateau of China. The deposit is a loess-red clay deposit. The deposit is characterized by a significant increase in the content of coarse-grained particles (silt and sand) and a decrease in the content of fine-grained particles (clay) after 2.75 Ma. The deposit is located in a region that is currently dominated by the EAWM. The intensification of the EAWM at about 2.75 Ma is supported by the fact that the deposit is located in a region that is currently dominated by the EAWM. The intensification of the EAWM at about 2.75 Ma is also consistent with the global climate change that occurred at that time, which was characterized by a significant increase in the intensity of the monsoon system.



**Figure 1** Stratigraphic correlation chart showing depth (m) from 0 to 350. The chart displays magnetic susceptibility (MS) and magnetic mineralogy (Md) data for various lithological units. Units include S1-S5, L1-L6, S13, S25-S26, L33, R1-R6, C2Ar, C3r, C3Ar, MS, and Md. Lithological units are labeled as Baishui, MS, Md, and Lingtai. The x-axis at the top shows Md ( $\mu\text{m}$ ) and MS ( $10^{-8} \text{ m}^3 \text{ kg}^{-1}$ ) scales.

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**3. Results**

1. The magnetic susceptibility (MS) and magnetic mineralogy (Md) data show significant variations across the stratigraphic units. The MS values range from approximately 10 to 300  $10^{-8} \text{ m}^3 \text{ kg}^{-1}$ , and the Md values range from approximately 10 to 30  $\mu\text{m}$ . The data indicate a complex magnetic mineralogy, with the presence of both paramagnetic and ferromagnetic minerals. The MS values generally increase with depth, while the Md values show a more variable trend. The data suggest a significant magnetic mineralization event during the deposition of the Baishui and MS units.

**Table 1.** Comparison of MS and Md data for various lithological units.

Unit	MS ( $10^{-8} \text{ m}^3 \text{ kg}^{-1}$ )	Md ( $\mu\text{m}$ )
S1	1.2	2.1
S3	199.0	213.
S5	26.0	370.
L1	21.0	28.0
L3	232.0	3.11
L5	2.12	3.
L7	2.0	2.3
L9	2.0	2.0
L11	2.0	2.0
L13	31.0	6.

The data in Table 1 show that the MS and Md values are generally higher in the S1, S3, and S5 units compared to the L1-L13 units. This suggests a higher degree of magnetic mineralization in the S1, S3, and S5 units. The data also indicate that the MS and Md values are relatively stable in the L1-L13 units, suggesting a consistent magnetic mineralogy during the deposition of these units.

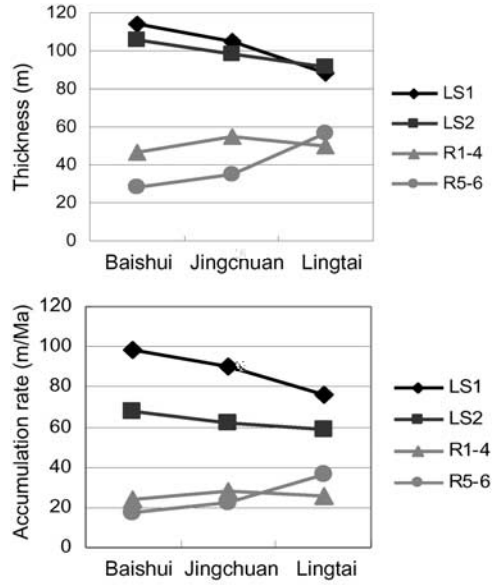
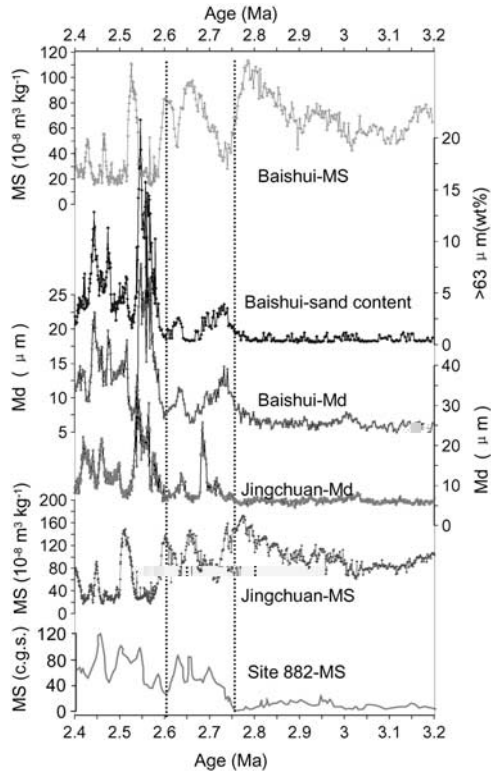


Figure 3. Thickness and accumulation rate of loess profiles LS1, LS2, R1-4, and R5-6 at Baishui, Jingchuan, and Lingtai. The thickness and accumulation rate were calculated from the stratigraphic data and the radiocarbon dates. The error bars represent the 1σ uncertainty.

Figure 2. Magnetic susceptibility (MS) and median diameter (Md) versus Age (Ma) for Baishui, Jingchuan, and Site 882. The top panel shows MS ( $10^{-8} \text{ m}^3 \text{ kg}^{-1}$ ) and  $>63 \mu\text{m}$  (wt%) for Baishui-MS. The second panel shows Md ( $\mu\text{m}$ ) for Baishui-sand content and Baishui-Md. The third panel shows MS ( $10^{-8} \text{ m}^3 \text{ kg}^{-1}$ ) and Md ( $\mu\text{m}$ ) for Jingchuan-Md and Jingchuan-MS. The bottom panel shows MS (c.g.s.) for Site 882-MS. Vertical dashed lines indicate specific ages.

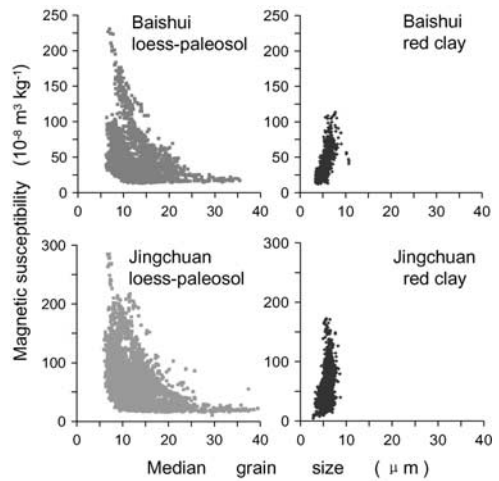


Figure 4. Magnetic susceptibility versus median grain size for Baishui and Jingchuan. The data points represent individual samples from the loess-paleosol and red clay sequences.

#### 4. Discussion and Conclusions

The results of this study indicate that the Baishui and Jingchuan loess sequences are well-developed and show clear evidence of pedogenesis. The magnetic susceptibility and median grain size data suggest that the loess sequences are composed of alternating layers of loess and paleosol. The accumulation rates of the loess profiles are relatively low, indicating a slow rate of loess deposition.

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