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Dust-flux estimates for the last glacial–interglacial cycle in southern South America based on loess deposits

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Dr. Gabriela Torre, from Argentina, visited the Universidade de São Paulo, Brazil, as a PAGES-IAI International Mobility Research Fellow (October–December 2023) to determine the age of eolian records through Optically Stimulated Luminescence (OSL). The new ages enabled determination of the chronological framework of dust deposition in southern South America, together with dust fluxes in the region. This project aims to expand understanding of the dynamics of atmospheric dust, and its influence on past climatic variabilities.

Past climatic fluctuations recorded in ice cores indicate great variability in past fluxes of atmospheric dust, emphasizing their key role in changes in the global climate system. Atmospheric dust is an important component of the climate system, affecting and responding to climate changes through a series of complex feedbacks involving nutrient cycling, albedo, radiative forcing, and cloud formation (Bullard et al. 2016). However, the role of dust in climate forcing remains poorly understood, and represents one of the largest uncertainties in climate-model simulations (Adebiyi and Kok 2020; Heavens et al. 2012). Atmospheric dust generated on the continents is a fairly unknown variable of the climate system, and loess sequences are the main records of continental dust deposition. In this sense, the loess-paleosol sequences from Argentina are the most extensive paleorecord of eolian material in the Southern Hemisphere.

The fellowship investigated the dust cycle recorded in loess-paleosols through the determination of dust accumulation rates for the past glacial–interglacial periods. The comparison between dust fluxes at the continental loess deposits with those recorded at more distal regions (south Atlantic Ocean and Antarctic Plateau) will allow us to improve our knowledge related to the dynamics of dust during the last glacial–interglacial cycle. We applied OSL techniques in two loess-paleosol sequences, located in elevated regions, to increase the spatial resolution of previous studies in dust archives (Torre et al. 2022), and to enhance the spatial resolution of paleoclimatic studies in the continental region of southern South America.

Research activities

1) Sample selection: A total of 20 samples were collected for OSL determinations from two loess-paleosol sections exposed in relatively elevated regions – Las Carreras section at ~2290 m asl and Majada de Santiago section at 1600 m asl (Fig. 1). These sections were sampled vertically every 20 cm for the uppermost 2 m by embedding PVC pipes 1.5" in diameter.

2) Equivalent dose determination: All sample preparation was performed in a lab room with red/orange light conditions. Samples were open and sieved to separate fine sand from silt-size particles. Then, samples were treated with HCl and H_2O_2 hydrogen peroxide to eliminate carbonates and organic matter. Thereafter, quartz grains were isolated through heavy liquid separation methods. The concentrates were subjected to HF attack for 40 minutes. This procedure removes remanent feldspar grains and the outer ring of quartz grains.

3) Dose rate determination: Dose-rate calculation was performed through the determination of ^{238}U, ^{232}Th and K concentrations. For this purpose, samples were dried and stored in plastic containers previously sealed for more than 20 days. Dose rate was determined through high-resolution gamma-ray spectrometry with a high-purity germanium detector and corrected for moisture content (water weight/dry sample weight) of each sample. Also, dose rate was corrected for the cosmic rays dose rate, which is estimated as a function of depth, altitude and latitude of each sample.

Outcomes

Infrared stimulation tests showed a significant contamination of feldspar in the quartz concentrate samples even after several HF attacks. Due to reduced sample size, and difficulty in obtaining pure quartz aliquots, luminescence dating had to be applied in silt-sized polymineral aliquots. Toward the end the fellowship, the 4-11 µm fraction was isolated through settling in distilled water, followed by acid attacks. Equivalent doses of the silt fraction were measured in December 2023 and January 2024.

Once the measurements of dose rate and equivalent doses for each sample are ready, we will be able to calculate the age of deposition of each level (i.e. age(yr)= equivalent dose(Gy)/dose rate (Gy yr^{-1})). These ages will provide a chronological framework of the different geochemical and physical parameters already determined for the loess samples. Also, these ages will allow the correlation of loess sections with other paleoclimatic records of the Southern Hemisphere, improving the spatial resolution of paleoclimatic studies. Moreover, the detailed chronology will allow the determination of the mass-accumulation rates of eolian sediments. This proxy will be a valuable contribution to the modeling community working on the past glacial cycle, and will also allow us to compare dust fluxes between different dust records, which surely will improve the understanding of past dust variability.

AFFILIATIONS

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REFERENCES

Adebiyi AA, Kok JF (2020) Sci Adv 6: eaaz9507

Bullard JE et al. (2016) Rev Geophys 54(2): 447-485

Heavens NG et al. (2012) J Adv Mod Earth Syst 4(4): M11002

Torre G et al. (2022) Earth-Sci Rev 232: 104143

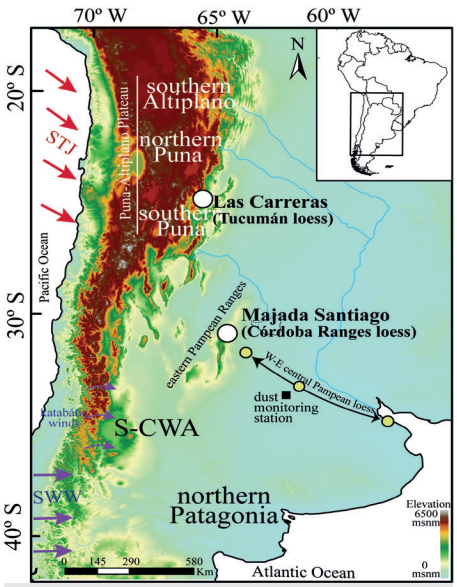

Figure 1: Map showing the location of the two loess sections studied in this work (white circles): Tucumán section and Córdoba section. The yellow circles indicate previously studied loess sections within the Pampean Plain.