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# Magnetic Properties and Size of Microscopic Pollutant Particles in the Urban Area of Coimbra

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Pollutant particles of small size are produced and resuspended every day as a result of traffic. These particles, identified as particulate matter ($PM_{10}$, $PM_{2.5}$), can affect human health when inhaled, mostly the respiratory and cardiopulmonary systems. Some of these particles are ferromagnetic (*s.l.*) and their magnetic properties indicate their sources, composition and size. Coimbra is an inland city situated in the center of Portugal at a distance of 40 km from the coast. Coimbra has a total area of 320 $km^2$ and a population of about 168.000. Motor vehicle traffic is the main source of air pollutant in the city. The main goal of this research is to assess pollution levels in the urban area of Coimbra using the magnetic properties of microscopic pollutant particles on *Nerium oleander* leaves.

Leaves were collected in a maximum of 52 sample sites from March 2004 till March 2005 and were used to determine the amount of ferromagnetic particles attached to their surface. A total of 553 samples leaves were obtained and their magnetic properties determined namely isothermal remanent magnetization (IRM) values, $S_{ratios}$ ($S_{-100}$ e $S_{-300}$) and AF demagnetization curves. Pollutant matter on the surface of selected leaves was investigated using standard SEM techniques.

The variation of IRM values (Fig. 1, Table 1) allows the identification of the most polluted urban areas (red and orange circles in Fig. 1). $S_{-300}$ values (Table 1) are close to 1 indicating the presence of ferrimagnetic pollutant particles. The AF demagnetization curves, when compared to well-known curves [1], suggest that ferrimagnetic particle size is in the range of 1 to 9 μm (Fig. 2). Besides, SEM studies revealed that airborne particles, accumulated on the surface *of Nerium oleander* leaves, present different shape and size, most of them with less than 10 μm in diameter (Fig. 3).

The main conclusions achieved by this research can be summarized as follows: IRM values of *Nerium oleander* leaves are controlled by their proximity to major roads, roundabouts, traffic lights and uphill roads; as derived from $S_{ratios,}$ the ferromagnetic particles have the same source; identified particles are mostly $PM_{10}$ and some $PM_{2.5}$ as indicated by both the AF demagnetization curves and the SEM analysis.

References

[1] D.J. Dunlop and Ö. Özdemir, Rock Magnetism. Fundamentals and Frontiers. Cambridge University Press, Cambridge, 1997.

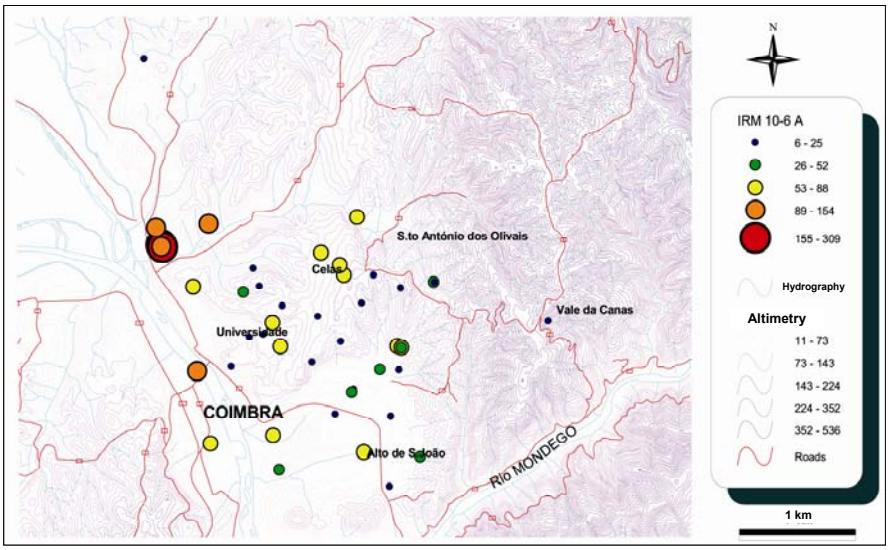


Fig.1. One tesla Isothermal Remanent Magnetization ($IRM_{1T}$) values measured in the *Nerium oleander* leaves sampled on 24 March 2005.

TABLE 1. IRM and $S_{ratios}$ mean values determined for the *Nerium oleander* samples collected from March 2004 till March 2005.

| Date | 7.3.04 | 14.3.04 | 4.4.04 | 1.5.04 | 29.5.04 | 3.7.04 | 16.8.04 | 26.9.04 | 25.11.04 | 23.12.04 | 23.1.05 | 26.2.05 | 24.3.05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **N** | 18 | 23 | 21 | 30 | 49 | 54 | 52 | 52 | 48 | 50 | 52 | 52 | 52 |
| **IRM** $Am^{-1}kg^{-1}$ | 22.57 | 18.89 | 20.70 | 15.08 | 10.40 | 13.31 | 10.68 | 16.05 | 12.60 | 13.40 | 19.31 | 17.37 | 12.97 |
| **$S_{-100}$*** | 0.64 | 0.65 | 0.64 | 0.56 | 0.59 | 0.54 | 0.54 | 0.63 | 0.67 | 0.64 | 0.60 | 0.62 | 0.60 |
| **$S_{-300}$*** | 0.96 | 0.95 | 0.96 | 0.89 | 0.97 | 0.94 | 0.93 | 0.96 | 0.99 | 0.96 | 0.96 | 0.97 | 0.96 |

*$S_{-100}=IRM_{-100}(mT)/IRM_{1T}$
** $S_{-300}=IRM_{-300}(mT)/IRM_{1T}$

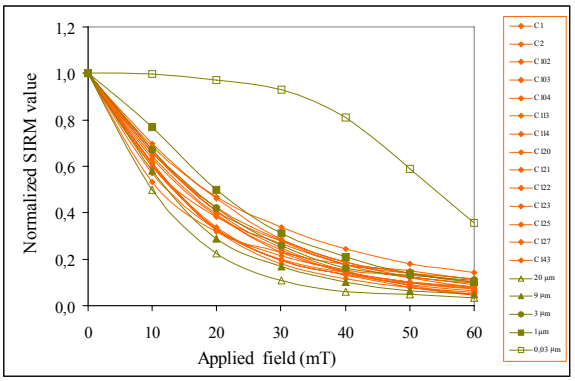


Fig. 2. Alternating Magnetic Field demagnetization curves.
C1 – C143 curves: *Nerium oleander* samples.
0.03 – 20 μm curves: Dunlop and Özdemir (1997) curves for magnetite

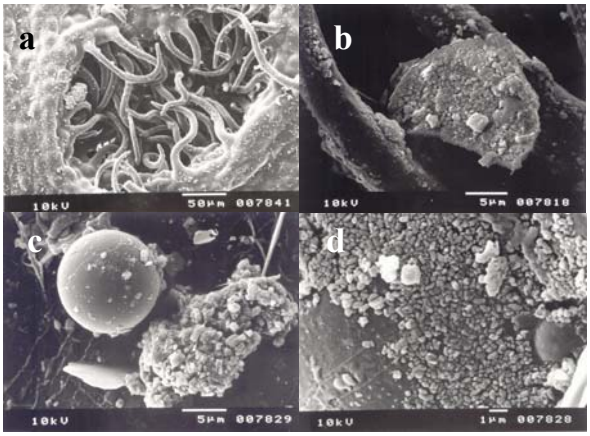


Fig. 3. Photomicrographs of dust particles on the surface of leaves from roadside *Nerium oleander* plants. Particles dimension varies between 22.5μm (b) and 0.1μm (d).

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