

Automated image analysis of pyrogenic products from Lake Lucerne sediments and glacier Colle Gnifetti (Switzerland).

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Automated counting of charcoal particles has been applied to sediment cores from Lake Lucerne (4WS00-1P and 4WS05-S1) and to an Alpine ice core from the glacier Colle Gnifetti (CG03). This study provides 1) high-resolution records of pyrogenic products in natural archives, 2) new proxy for reconstructing the variations of mineral dust deposition on continental areas, 3) a reproducible technique for detecting chronologic markers (e.g. Holocene/Anthropocene transition in Lake Lucerne sediments, Saharan dust horizons in Colle Gnifetti ice core).

Lake Lucerne (47°N, 8°E; 437 m asl.) sediments have been chemically treated (NO₃, H₂O₂) to remove the labile organic matter, and sieved at 38 µm. The size-fraction >38 µm has been scanned by an automated incident light microscope (pixel resolution of 1.4 µm) (Figure 1). The size-fraction <38 µm has been scanned by an automated transmitted light microscope (pixel resolution of 0.16 µm) (Figure 2). Charcoals (i.e. dark particles) were isolated by thresholding the gray-level of the binary images (Figures 1 and 2) (Thevenon *et al.*, 2003). Results were expressed as the charcoal area per weight of dry sediment (mm² g⁻¹) and charcoal flux (mm² cm⁻² y⁻¹).

Peaks of charcoal are synchronous with the major (pre)historic human cultural changes: Neolithic lake dwelling and development of agriculture, Bronze and Iron metallurgy, Middle Ages deforestation, and Modern industrialisation. During the nineteenth-century, the development of the steamboat traffic on Lake Lucerne and the associated high temperature wood burning and fossil-fuel combustion (wood from AD 1838, coal from AD 1862, and oil from AD 1931), produced specific carbonaceous fly-ash particles, as evidenced by the automated morphological analysis and scanning electron microscopy observation (Figure 1), that can be used to date the recent sediments.

The automated particle analysis of digital images has been applied to an ice core from the high-alpine glacier Colle Gnifetti, located in the Monte Rosa massif (45°N, 7°E; 4450 m asl.). In addition to the quantification of the black aerosols with the method describe above and with an elemental analyzer (µg of black carbon kg⁻¹ of ice), images have been acquired under polarized light in order to study the bright particles, i.e. the mineral fraction (Figure 2).

This project has been funded by the host institutions (ETH Zurich and PSI Villigen) and a postdoctoral grant from the French Ministry of Foreign Affairs (Lavoisier).

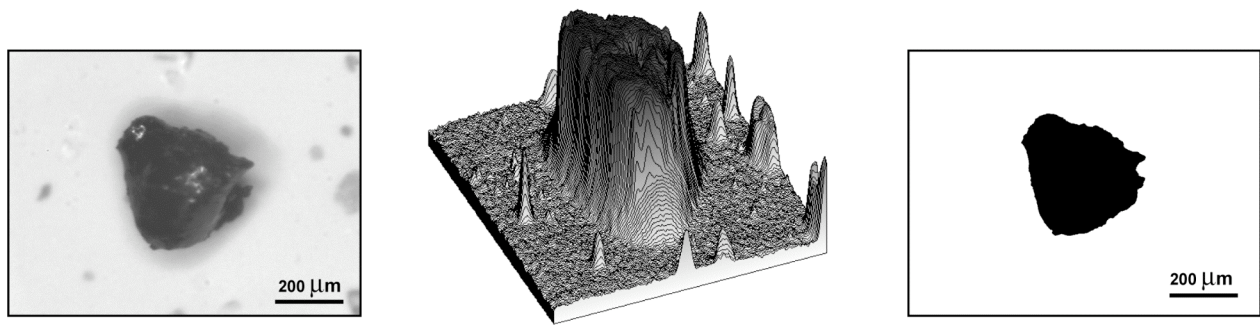


Figure 1. Carbon particle from the fossil-fuel combustion. Macro-charcoal ($> 38 \mu\text{m}$) analysis through incident light microscope from Lake Lucerne sediment sample (core 4WS05-S1; 15 cm, AD 1890).

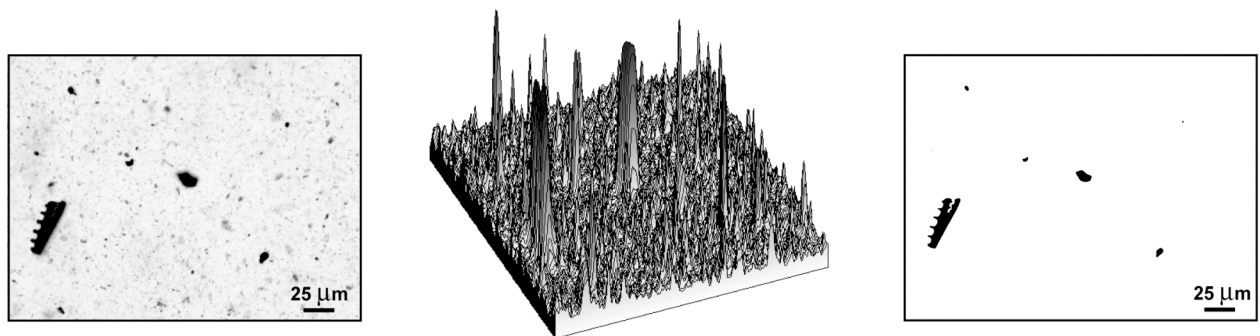


Figure 2. Carbon particles from biomass burning. Micro-charcoal ($< 38 \mu\text{m}$) analysis through transmitted light microscope from Lake Lucerne sediment sample (core 4WS00-1P; 223 cm, 2675 cal. yr BP).

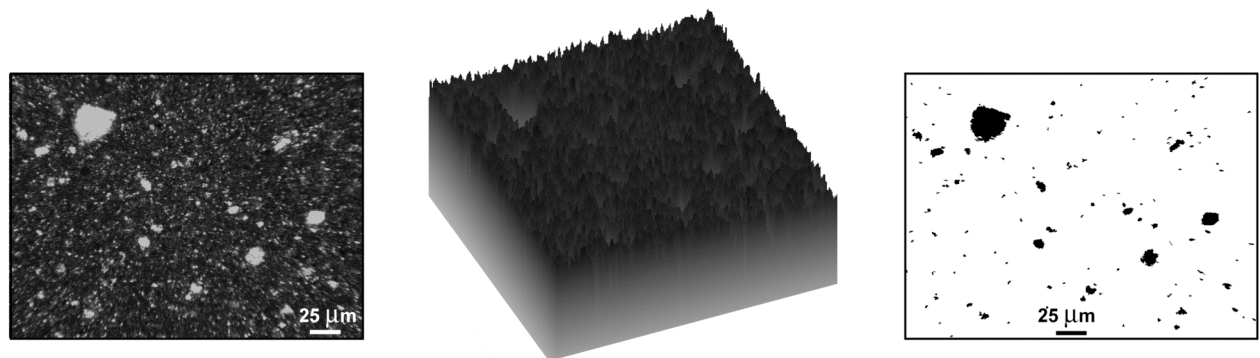


Figure 3. Analysis of mineral particles from the Colle Gnifetti ice core (CG03; 23.33 m) through a transmitted light microscope under polarized light.

REFERENCE

Thevenon F., Williamson D., Vincens A., Taieb M., Merdaci O., Decobert M. and Buchet G. (2003): A Late Holocene charcoal record from Lake Masoko, SW Tanzania: climatic and anthropologic implications. *The Holocene* 13(5): 785-792.