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Fractionating fresh natural charcoal on a size basis allows distinguishing materials with different characteristics

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Natural charcoal, or natural pyrogenic carbon (PyC), produced by wildfires is widely considered as a continuum of materials formed under different types of combustion. Different components of this continuum show different chemical structure, physical properties and reactivity in soil.
A few published studies showed that size fractions of natural charcoal left on the ground after a fire event have different composition and properties. The aim of this study was to verify if such size-related differences in charcoal occur in two forests that recently experienced wildfires of different severity. One of these forests, is in Tuscany, Central Italy, and underwent a moderate severity fire, the other, is in Victoria, South-East Australia, and underwent an extremely severe fire.

Macroscopic charcoal fragments from both study areas were collected from the ground soon after the wildfire and shared into the following size fractions: <0.5 mm, 0.5-1.0 mm, 1-2 mm, >2.0 mm. These fractions were analysed looking at: morphology (by optical microscopy), elemental and stable isotopic composition, chemical structure (by infrared spectroscopy), lignin and neutral sugar contents, reactivity and resistance to thermal treatment and chemical oxidation, charring temperature formation (by reflectance measurements).

In both sites, the size fractions of charcoal showed significant differences each other, which in some cases were progressive with decreasing size. The finest fraction was the most abundant one, while the coarsest fraction showed highest charring degree and chemical recalcitrance. On the other hand, the different fire conditions (temperature, oxygen availability) and parent material (woody or grassy) accounted for the differences between the same fractions from the two study sites.

In conclusion, we found clear size-related differences between fresh natural charcoal particles, which should be taken into careful account when studying the effect of wildfires, so as to have a better insight into the partly unknown world of pyrogenic C and its biogeochemical cycle.