

Chemical composition of low-temperature biomass ash

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The aim of the study of chemical composition of biomass ash is to evaluate its possible influence on composition of ash obtained during co-combustion of biomass and coal. Modification of composition of fly ash by biomass co-combustion with coal often reduce possibility of its utilization. Environmental impact of biomass combustion is poorly studied. There is a common opinion that biomass ash does not contain toxic metals like in the case of coal ash. The study is based on eight samples of biomass used in power plants in southern Poland.

Biomass was ashed at 475°C and the yield of ash was from 0.5wt% (sawdust) to 10.8 wt% (olive kernel). Ash is usually rich in Ca (highest content ca. 16wt% in sawdust ash; content above 10wt% in three other samples; and the lowest ca. 1.9wt% in bran biomass ash), K (six samples with content above 10wt%, the lowest value for beechwood biomass), and P (two samples with content above 5wt% and the lowest content ca 0.5wt%).

Content of trace elements in studied samples of ash is often higher comparing with typical coal ash, e.g. Mn from 321 to >10 000 ppm; Ag from 0.02 to 5.3 ppm; Cd from 0.13 to 71.3 ppm; Cr from 3.8 to 988 ppm; Cu from 18 to 588 ppm; Mo from 2 to 14.7 ppm; Zn 106 to 1923 ppm and Hg from <5 to 35 ppb.

Ash is usually enriched in metals comparing with biomass samples. Highest enrichment (measured as ratio of content of element in ash/content of element in biomass) is observed for sawdust ash (e.g. Mo – 150; Cu – 193; Zn – 196; Ag – 143; Ni – 91; Co – 287; Mn – 156, Fe – 270; Cd – 230; Bi – 250; Cr – 177; Ba – 198; B – 464).

Obtained results indicate that both the composition of low temperature biomass ash and degree of enrichment in selected elements during ashing varies within broad range. Systematic study is necessary to predict the influence of biomass co-combustion on properties of ash and possible environmental impact.

Evidence for habitable environments deep in the Martian crust

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Observations

Using infrared reflectance spectroscopy and high-resolution imaging, we have detected the presence of Fe/Ca-carbonates and Fe/Mg-rich phyllosilicates on Mars within rocks exhumed from deep in the subsurface by meteor impact [1]. The carbonates occur within layers or bands that are interbedded with or injected into layered and foliated chlorite, chlorite-smectite-, pumpellyite-, and possibly serpentine-bearing bedrock (Figure 1). This category of deposit is fundamentally different from previous detections of clay minerals [2-3] and carbonates [4-5] on Mars because in this case: a) carbonates and putative hydrothermal phyllosilicates occur together, b) the materials reflect a subsurface environment, rather than surface materials, and c) the minerals occur within rocks that have metamorphic and hydrothermal textures.

Implications

The carbonate- and clay-bearing rocks observed within Leighton Crater were excavated from ~6 km depth. These rocks may represent some of the most ancient sedimentary rocks on Mars (also in the Solar System) that were subsequently buried and metamorphosed. Alternatively, they may be evidence for deep-seated hydrothermal activity in a habitable subsurface environment.



Figure 1: A HiRISE image of the central peak of Leighton Crater, Mars, where carbonates are detected within light-toned rocks that occur within exhumed, phyllosilicate-rich bedrock. Arrows point to a fault that offsets carbonates.

- [1] Michalski & Niles (2010) *Nature Geo.* **3**, 751–755.
[2] Bibring *et al.* (2006) *Science* **312**, 400–404. [3] Murchie *et al.* (2009) *J. Geophys. Res.* **114**, 1–30. [4] Ehlmann *et al.* (2008) *Science* **322**, 1828–1832. [5] Morris *et al.* (2010) *Science* **329**, 421–424.