Article

Modification of soil hydroscopic and chemical properties caused by four recent California, USA megafires

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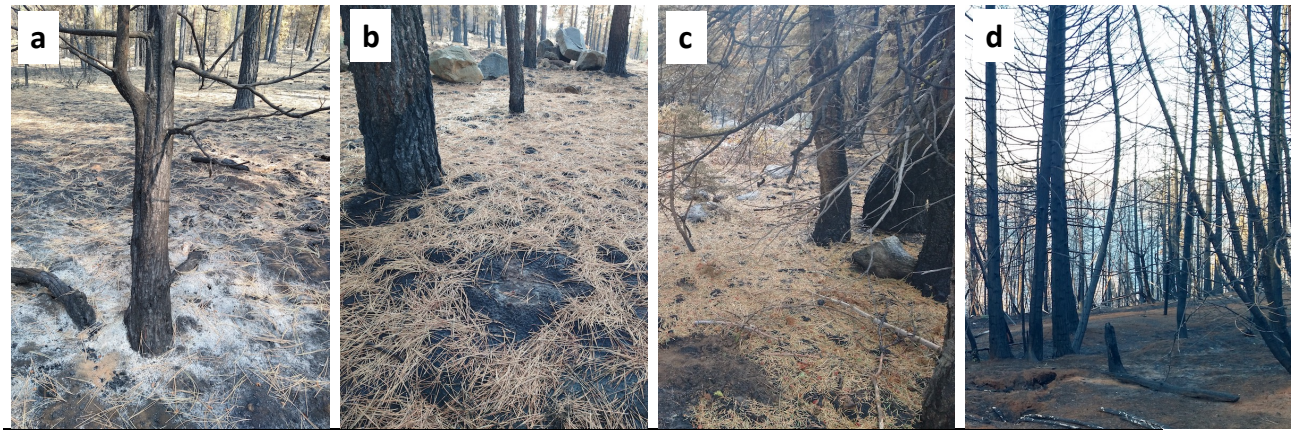


Figure S1. Pictures of the four sites selected for the WDPT tests performed in the field and for sampling of ash and soil samples: **(a)** Dixie fire, **(b)** Beckwourth Complex fires, **(c)** Caldor fire, **(d)** Mosquito fire.

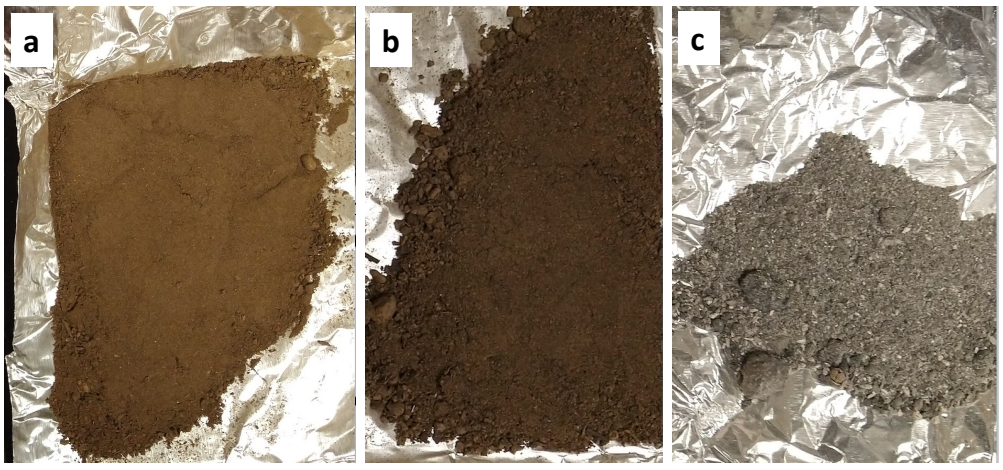
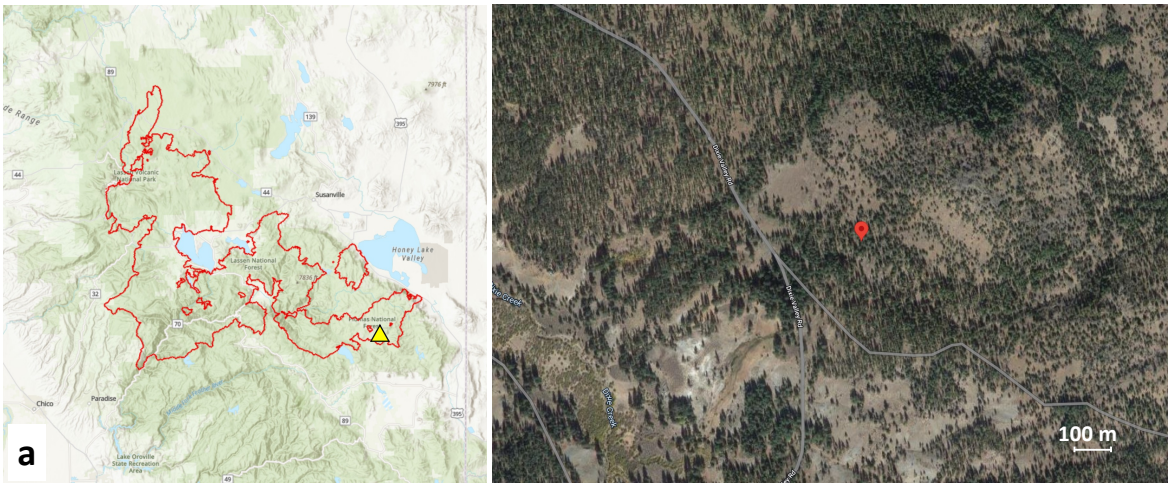
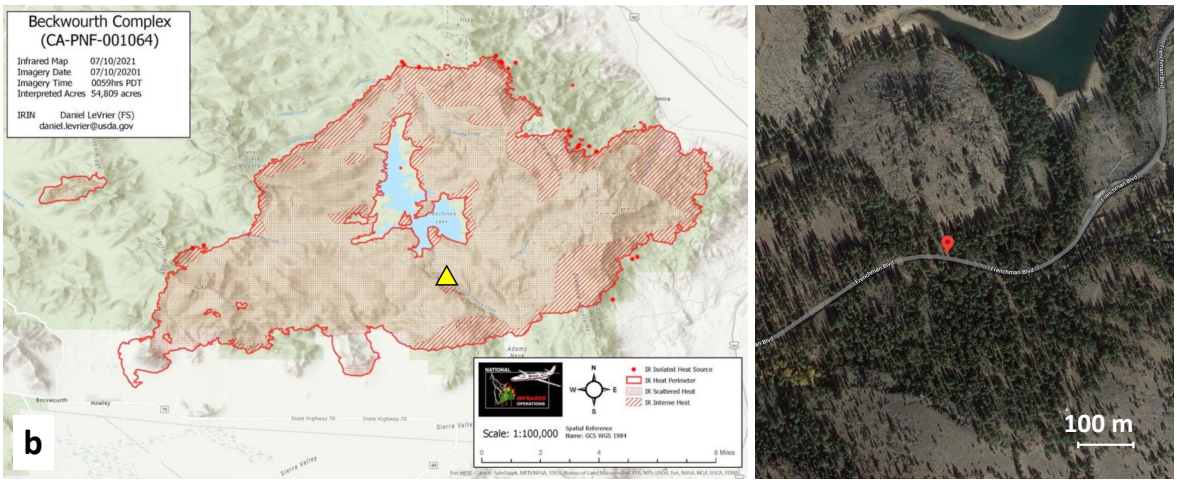
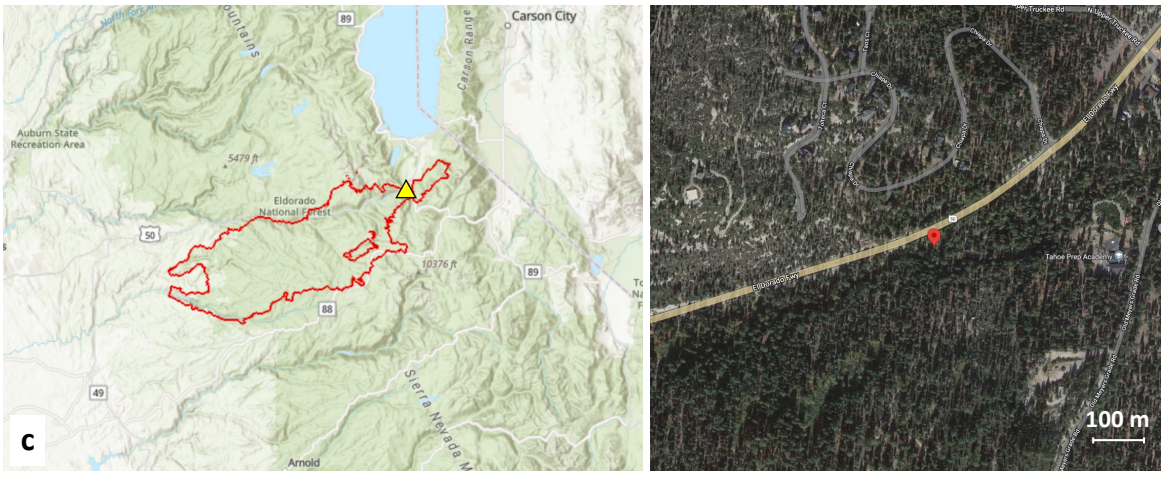


Figure S2. Three types of the collected samples: **(a)** ash, **(b)** burned soil, **(c)** unburned (or control) soil. The samples on these pictures were collected right after the Dixie fire.


a
Susanville
Honey Lake Valley
Chico
Paradise
100 m


Beckwourth Complex
(CA-PNF-001064)
Infrared Map 07/10/2021
Imagery Date 07/10/20201
Imagery Time 0059hrs PDT
Interpreted Acres 54,809 acres
IRIN Daniel LeVrier (FS)
daniel.levrier@usda.gov
IR Isolated Heat Source
IR Heat Perimeter
IR Scattered Heat
IR Intense Heat
Scale: 1:100,000
b
100 m


Carson City
Auburn State Recreation Area
5479 ft
Eldorado National Forest
10376 ft
Arnold
c
100 m

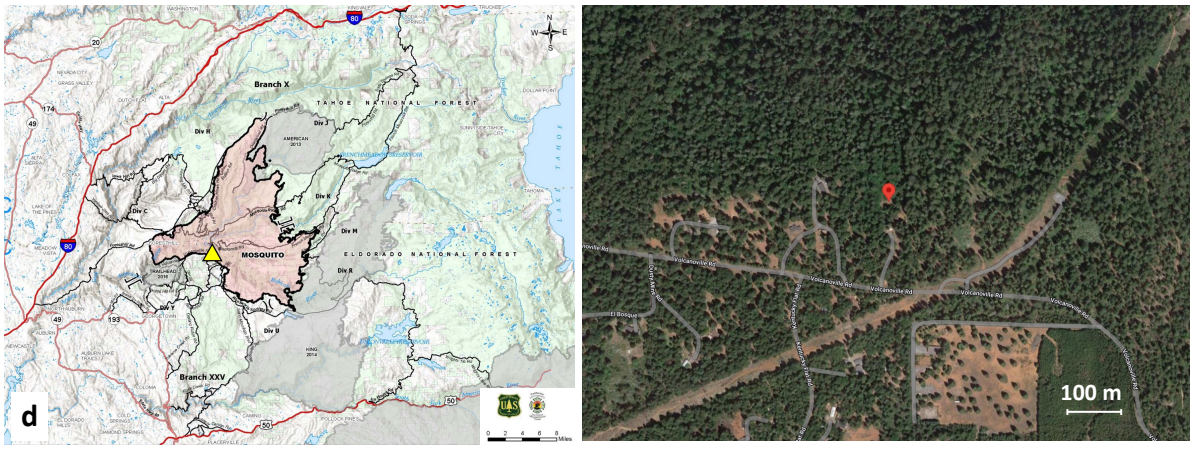


Figure S3. Maps and sampling sites: **(a)** Dixie fire, **(b)** Beckwourth Complex fires, **(c)** Caldor fire, **(d)** Mosquito fire (maps adopted from Google Maps web and U.S. Forest Service).

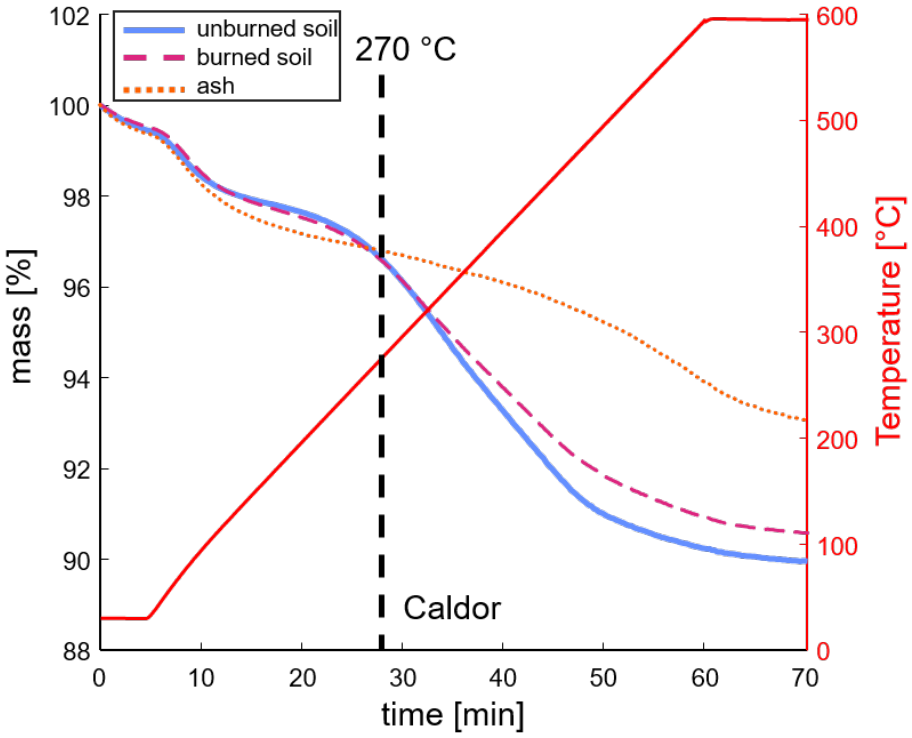


Figure S4. Thermogram (mass loss, left y-axis) of averaged triplicates for ash (orange dotted line), control soil (blue solid line) and burned soil (magenta dashed line) of the Caldor fire with temperature program indicated by red solid line (right y-axis). The ash revealed the lowest mass loss (~7 w-%), whereas control and burned soil showed very similar maximum mass loss at around 9-10 w-% with slightly higher evaporation for the control soil.

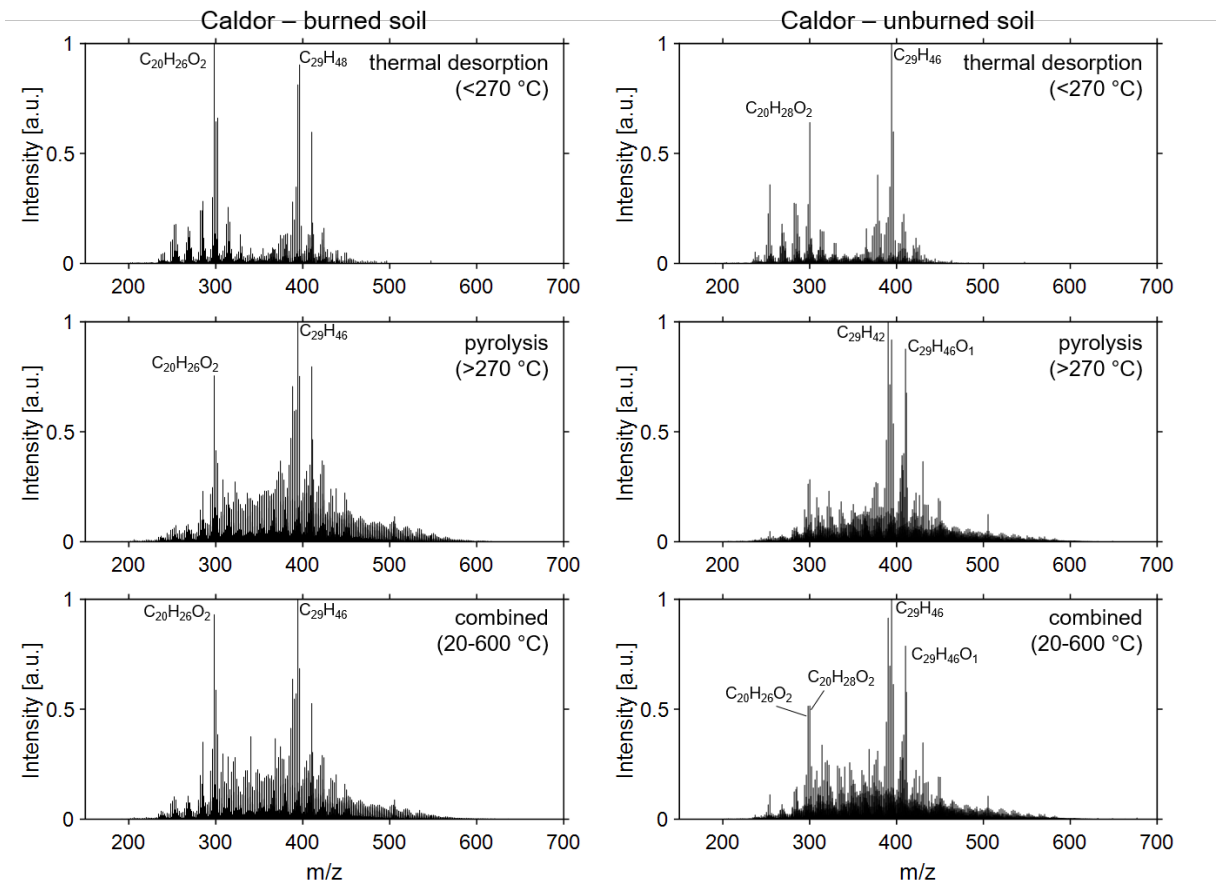


Figure S5. Normalized average mass spectra of assigned elemental compositions for Caldor burned soil (left) and control soil (right) separated into thermal desorption (20–270 °C, top), pyrolysis phase (270–600 °C, middle) as well as an average over the whole temperature range (20–600 °C, bottom).

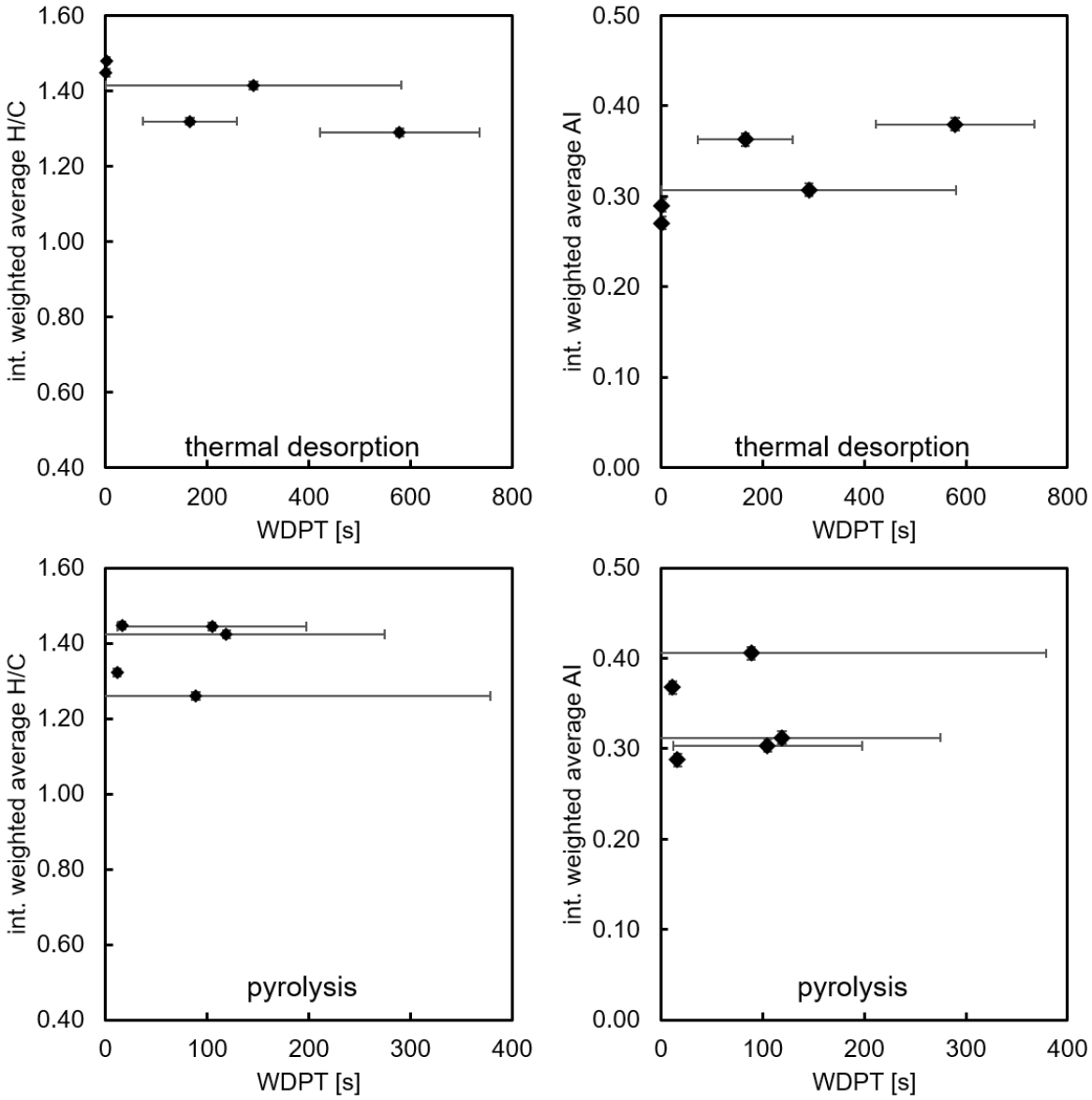


Figure S6. Water drop penetration times (WDPT) [s] versus intensity weighted average hydrogen-to-carbon ratio (H/C) and aromaticity index (AI) for the thermal desorption (20–270 °C, top) and pyrolysis (270–600 °C, bottom) phase for five soil samples (Caldor, Beckwourth, Dixie). No trend is apparent from the evolved gas mixture during pyrolysis, whereas a slight correlation might be given for the constituents released during thermal desorption. Error bars indicate standard deviation.

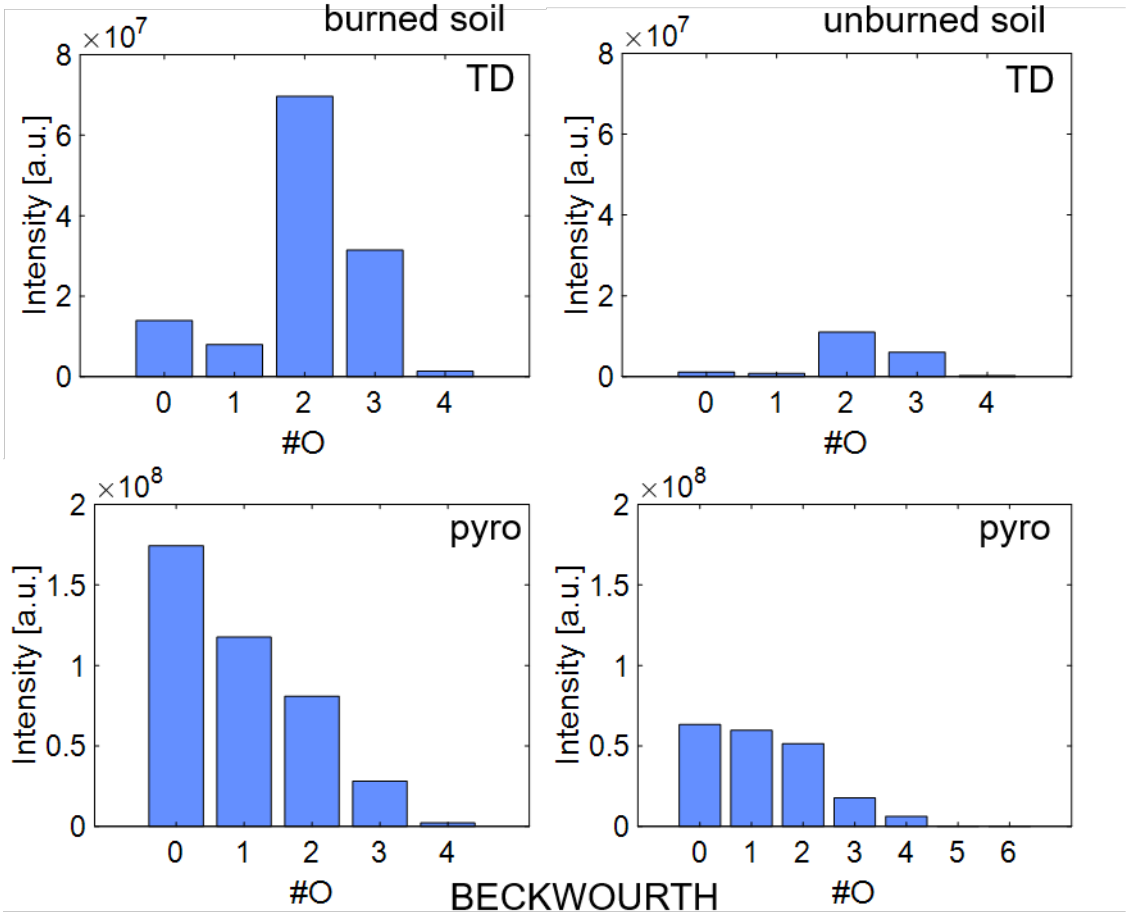


Figure S7. Oxygen number distribution (sum of intensity of every compound with the respective number of oxygen) of burned soil (left) and control soil (right) from Beckwourth fire divided into thermal desorption (TD, 20–270 °C, top) and pyrolysis phase (pyro, 270–600 °C bottom). Absolute intensities have been normalized by the deployed sample weight.

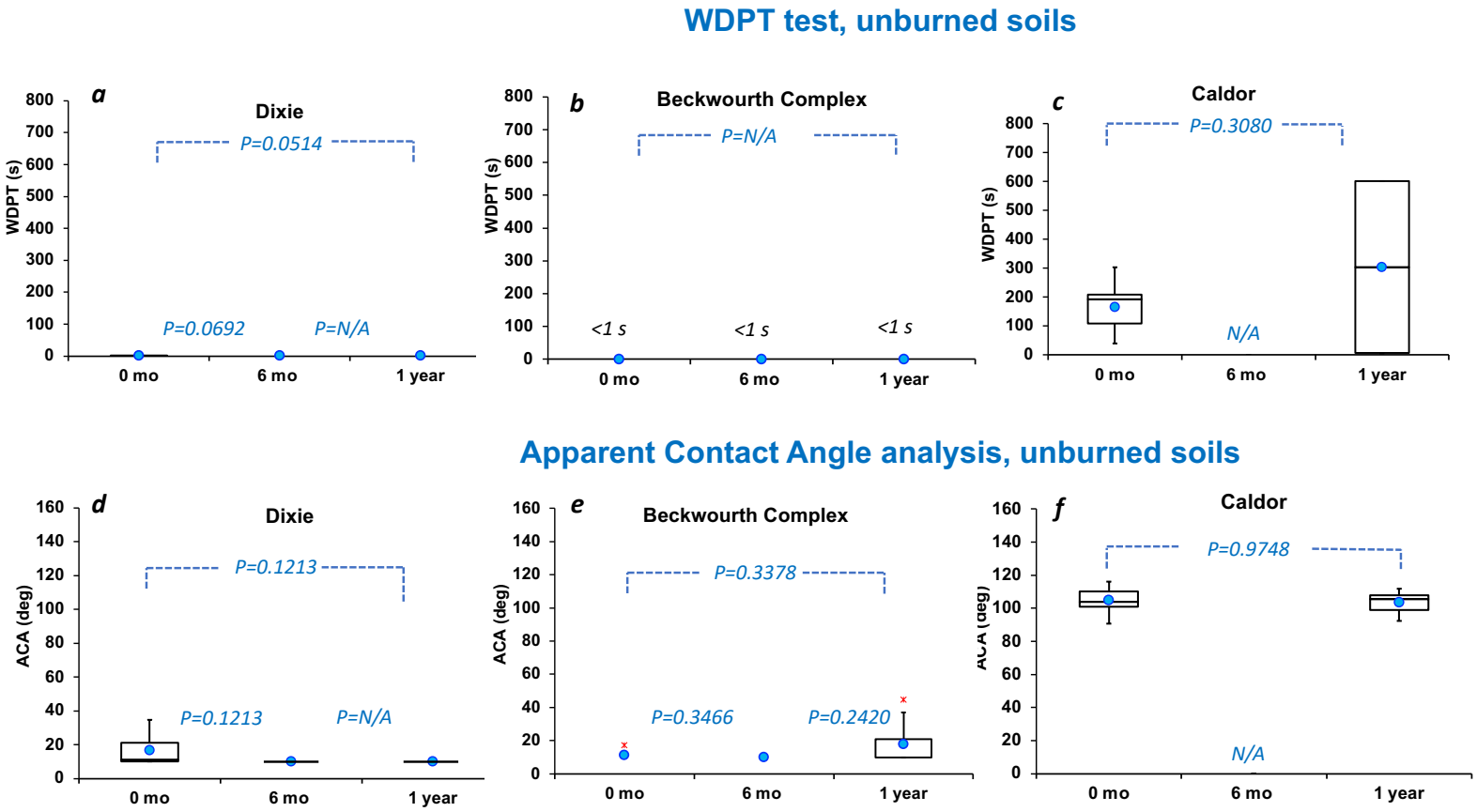


Figure S8. Results of WDPT and ACA measurements for burned soil samples: 0 month (2 weeks), 6 months, and 1 year after the fires containment.; *P*-values were calculated using unpaired *t*-test (N=5-15, α=0.05).

Table S1. Intensity weighted average sum parameter for the results of the TG APPI FT-ICR MS experiments. pyro – pyrolysis phase 270–600 °C, TD – thermodesorption phase 20–270 °C, DBE – double-bond-equivalents, AI – aromaticity index.

Fire name	sample	phase	number	DBE	AI	H/C	O/C
Beckwourth	ash	pyro	23	11.95	0.53	1.02	0.13
Beckwourth	ash	TD	11	8.27	0.37	1.29	0.13
Beckwourth	control	pyro	454	8.54	0.37	1.32	0.09
Beckwourth	control	TD	86	6.90	0.29	1.45	0.11
Beckwourth	burned	pyro	646	9.20	0.41	1.26	0.08
Beckwourth	burned	TD	231	7.56	0.31	1.41	0.11
Caldor	ash	pyro	101	6.26	0.28	1.49	0.09
Caldor	ash	TD	135	7.54	0.37	1.34	0.09
Caldor	control	pyro	1155	7.50	0.30	1.44	0.09
Caldor	control	TD	3819	10.44	0.36	1.32	0.07
Caldor	burned	pyro	1148	7.76	0.31	1.42	0.09
Caldor	burned	TD	3476	10.76	0.38	1.29	0.07
Dixie	control	pyro	274	7.09	0.29	1.45	0.10
Dixie	control	TD	290	6.69	0.27	1.48	0.10

Table S2. Compound class distribution with absolute intensities normalized to the sample mass. Herein, CHO refers to all compounds solely containing oxygen as heteroatom, likewise for the other heteroatom combinations. pyro – pyrolysis phase 270–600 °C, TD – thermodesorption phase 20–270 °C.

Fire name	sample	phase	CH	CHO	CHNO	CHOS	CHN	CHNS
Beckwourth	ash	pyro	5.40E+06	5.55E+06	0	0	0	0
Beckwourth	ash	TD	1.03E+05	3.67E+06	0	0	0	0
Beckwourth	unburned	pyro	6.33E+07	1.35E+08	0	0	5.52E+04	0
Beckwourth	unburned	TD	1.11E+06	1.80E+07	0	0	0	0
Beckwourth	burned	pyro	1.74E+08	2.29E+08	7.56E+04	1.68E+05	3.16E+06	0
Beckwourth	burned	TD	1.40E+07	1.10E+08	0	2.92E+04	0	0
Caldor	ash	pyro	1.75E+08	2.60E+08	0	0	0	0
Caldor	ash	TD	1.48E+09	8.25E+08	0	0	3.28E+05	0
Caldor	unburned	pyro	1.59E+08	3.91E+08	3.80E+06	0	0	6.05E+05
Caldor	unburned	TD	8.29E+08	6.27E+09	2.42E+08	1.24E+06	2.81E+08	4.85E+06
Caldor	burned	pyro	2.93E+08	7.26E+08	2.80E+06	0	0	6.49E+05
Caldor	burned	TD	1.08E+09	5.61E+09	2.16E+08	2.44E+05	3.24E+08	5.11E+06
Dixie	unburned	pyro	1.99E+06	1.03E+08	0	0	0	0
Dixie	unburned	TD	3.38E+06	2.12E+08	0	0	0	0

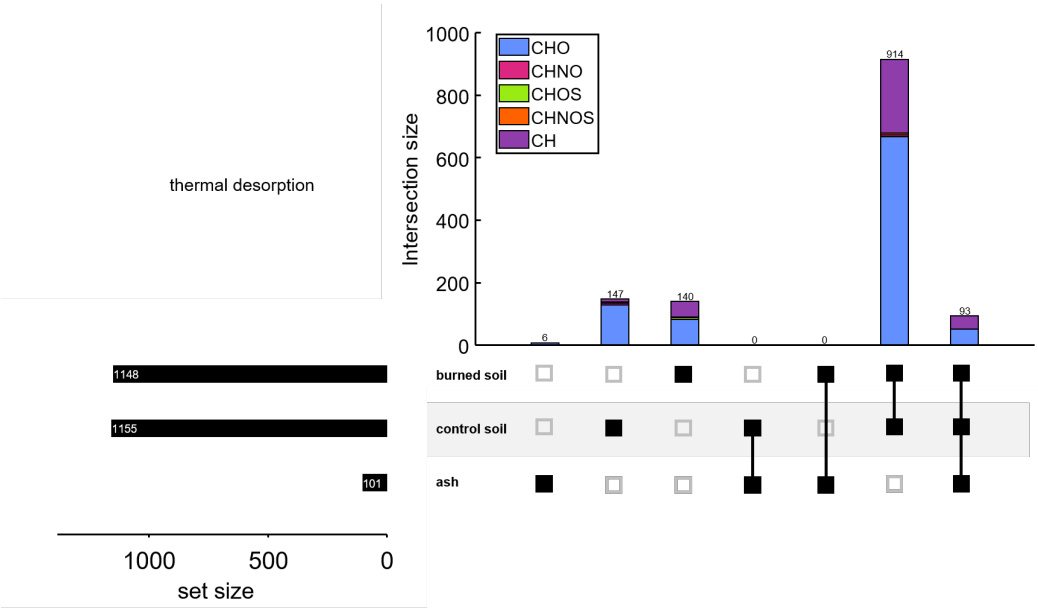


Figure S9. Upset plot of the averaged thermal desorption phase (20–270 °C) from all three Caldor fire soil samples (control pre-fire soil, burned post-fire soil, and ash). The compound class distribution for the respective interest is indicated by a color coded-stacked bar plot.

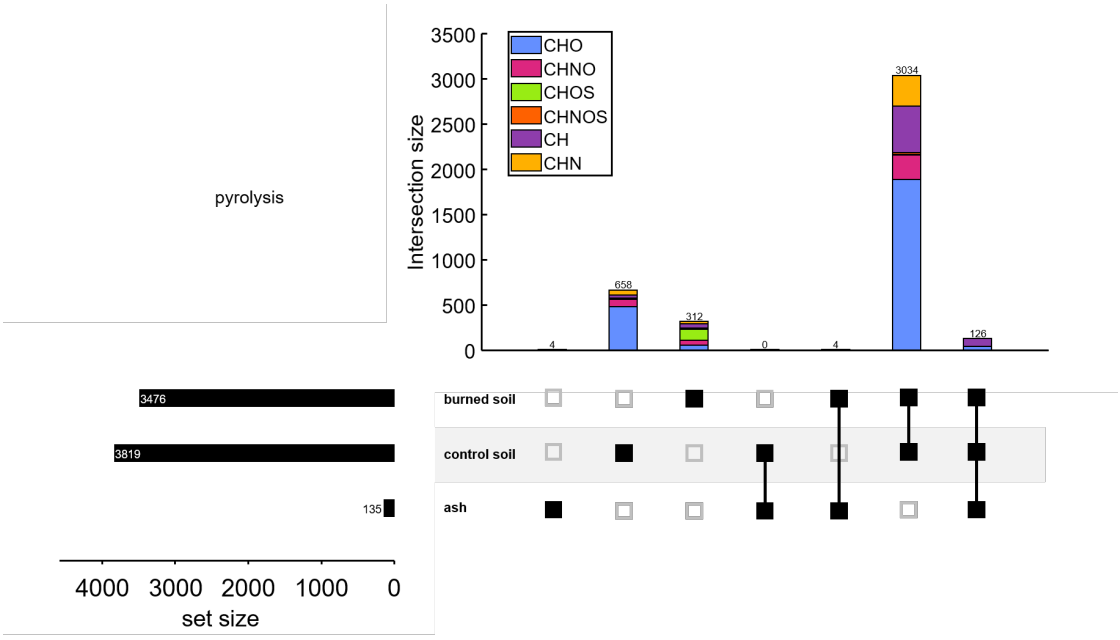


Figure S10. Upset plot of the averaged pyrolysis phase (270–600 °C) from all three Caldor fire soil samples (control pre-fire soil, burned post-fire soil, and ash). The compound class distribution for the respective interest is indicated by a color coded-stacked bar plot.