GSA DATA REPOSITORY 2014312

SUPPLEMENTAL INFORMATION FOR:

Latest Permian chars may derive from wildfires, not coal combustion

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CONTENT INCLUDES

SAMPLING METHODS

368 charcoal and coal samples have been collected for this and previous studies from 2008 to 2013. Reflected-light photomicrographs were subsequently re-examined and compiled for this study.

Late Permian Russian coal samples

Thirteen Late Permian coal seams (numbered 68 to 94) as well as short *in situ* coal pillars from seams 78, 88, 91, were sampled from the Kuznetsk Basin, Russia from two open cast coal mines. Mine information has been removed at mine owners' request. Seams 68-73 are from the Gramoteinskaya Formation and 78 to 94 from the Tailuganskaya Formation, both Formations are Late Permian (thought to be Changhsingian) in age. Detailed petrographic analysis was undertaken on crushed coals and short *in situ* coal pillars as part of VH unpublished Ph.D. thesis. Field and sampling methods are given in Hudspith et al. (2012). Vesicular char images (this paper) derive from *in situ* coal pillars from seams 78, 88, 91. These coal pillars contain high mean inertinite (fossil charcoal) contents from 27.6 vol.% (78) to 48 vol.% (88) (mineral-matter-free basis).

Experimentally charred modern woods

Experimental charcoals of white spruce (*P. glauca*), trembling aspen (*P. tremuloides*) and paper birch (*B. papyrifera*) were analyzed using reflected-light microscopy to ascertain if wood or bark charcoal was capable of producing comparable morphologies to vesicular chars seen in Grasby et al. (2011). 10mm^3 pieces of wood (with bark intact) were wrapped in foil, placed in steel tubes to

exclude oxygen and charred in a muffle furnace for 1 and 5h durations. Resulting charcoals were embedded in polyester resin and polished.

Vesicular chars produced in wildfires in various ecosystems

Site	Age of vesicular chars studied	Ecosystem	Vesicular char sampling methods	Comments
Screaming Lynx Lake (66° 04′N, 145° 24′W), Yukon Flats, Interior Alaska, USA	551 cal yr BP (Fig. 1F) and 1122 cal yr BP (Fig. 1 E) (age model given in Kelly et al., 2013)	Lake sediment record from the Alaskan boreal forest	All charcoal particles (>180μm) were manually subsampled from sediments containing previously identified charcoal peaks. Detailed methods are given in Kelly et al. (2013).	Vesicular chars (Fig. 1 E,F) pre-date industrialization, are >60μm in size and not spherical (Rose, 2008) and therefore unlikely to be fly ash from modern coal combustion.
Noatak National Preserve, western Brooks Range, Alaska, USA	Modern wildfire (July-September 2010)	Tussock tundra	Charcoals were manually sub sampled from soil monoliths from four burned areas	Vesicular chars (Fig. 1 G,H) are >60μm in size and not spherical (Rose, 2008) and therefore unlikely to be fly ash from modern coal combustion.
All Saints Bog, Offaly County, Ireland (53° 7′N, 7° 56′W).	Modern wildfire (July 2013).	Raised bog and bog woodland that is actively being cut and drained	Charcoals and vesicular char were manually sampled from selected $1m^2$ areas, from 17 sites across the charred peat surface.	The vesicular char samples are unlikely to have been contaminated by modern fly ash as active peat cutting has removed modern peat from the bog surface. The top surface has been 14C dated to 1300 AD (New, 2014, unpublished masters thesis). No Spheroidal Carbonaceous Particles (SCPs = modern fly ash), were observed in the entirety of a 2m core sampled from this peat bog. Vesicular chars (Fig. 1 I, J) are >60μm in size and not spherical (Rose, 2008) and therefore unlikely to be fly ash from modern coal combustion.

REFERENCES CITED

Hudspith, V., Scott, A.C., Collinson, M.E., Pronina, N., and Beeley, T., 2012, Evaluating the extent to which wildfire history can be interpreted from inertinite distribution in coal pillars: an example from the Late Permian, Kuznetsk Basin, Russia: International Journal of Coal Geology, v. 89, p. 13-25.

Kelly, R., Chipman, M.L., Higuera, P.E., Stefanova, I., Brubaker, L.B., and Hu, F.S., 2013, Recent burning of boreal forests exceeds fire regime limits of the past 10,000 years: PNAS, v. 110, p. 13055-13060.

Rose, N.L., 2008, Quality control in the analysis of lake sediments for spheroidal carbonaceous particles: Limnology and Oceanography: Methods, v. 6, p. 172-179.

Figure DR1 Photomicrographs illustrating the morphological variation observed in vesicular chars **(A, B, E-H)**, secretinite (**C, D;** ICCP, 2001) and semifusinite **(I, J;** ICCP, 2001**)** from Late Permian coals, Kuznetsk Basin, Russia. To be directly compared with coal combustion chars in Fig. 2 Grasby et al. (2011). Photographs are taken using reflected-light microscopy with immersion oil. 50µm scale bar in **'A'** is the same for all images.

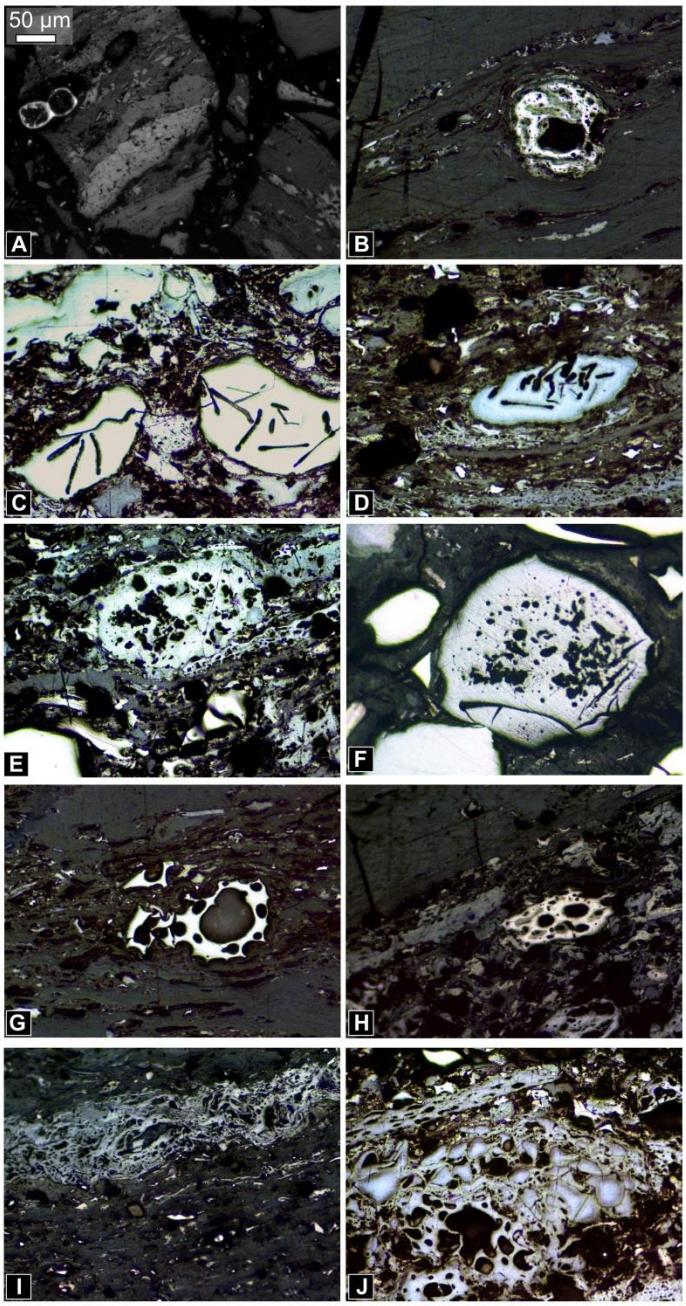
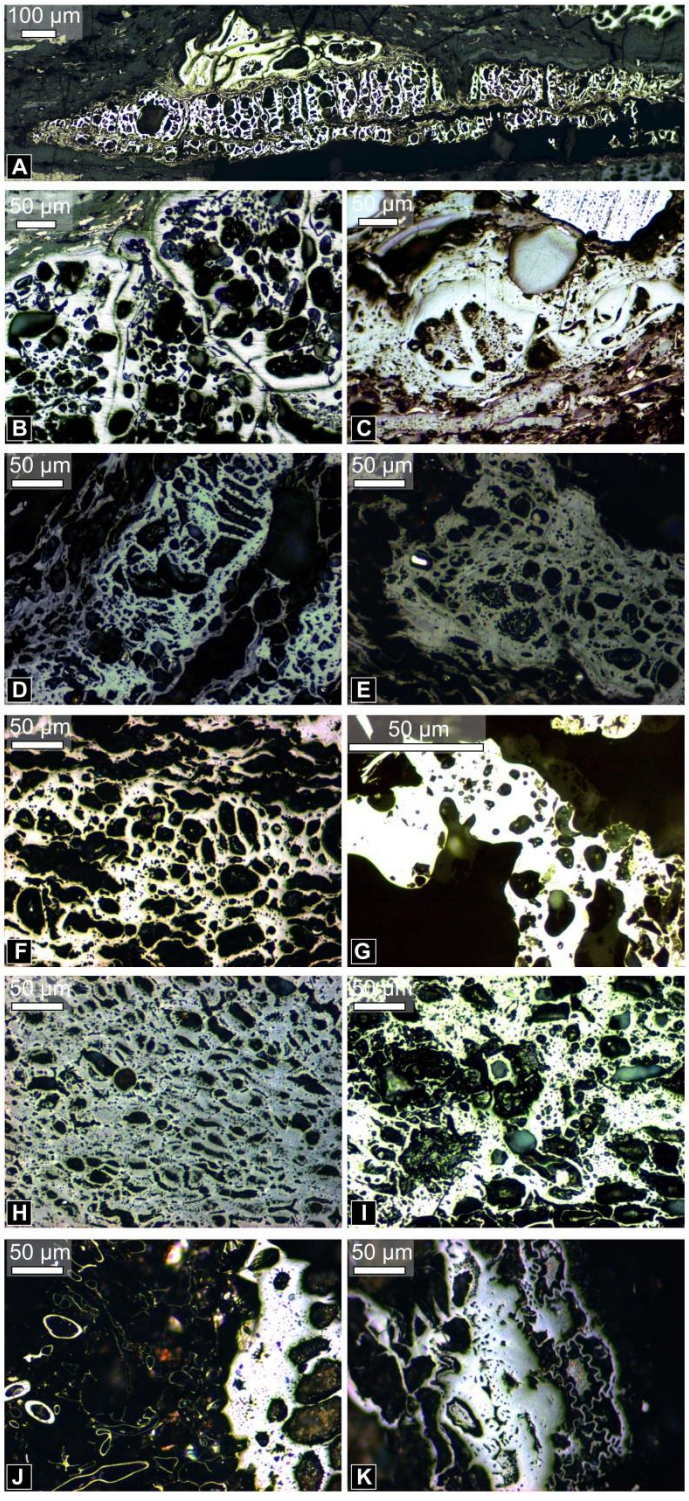


Figure DR2 Photomicrographs of modern and ancient charred degraded plant material showing variable vesicle distribution. **A** montage of 8 images from coal seam 91, Kuznetsk Basin, Russia. Cluster of vesicular char attached to charred bark. **B-C** Irregularly distributed vesicles in degraded inertinite from Permian Russian coal. **D-G** Experimentally produced bark charcoals, trembling aspen 400°C for 5h **(D**), paper birch 400°C for 1h **(E),** 600°C for 1h **(F),** white spruce 700°C for 1h **(G). I** Holocene boreal forest vesicular char. **H-K** Vesicles in extremely degraded plant material of varying reflectance, All Saints bog, Ireland. Photographs are taken using reflected-light microscopy with immersion oil.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