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Oxidation and carbonisation of coals: a case study of coal fire affected coals from the Wuda coalfield, Inner Mongolia, China

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At the coalfield of Wuda (Inner Mongolia, PR China) extensive underground coal fires cause widespread thermal and oxidative effects in coal seams. Within phase B of the Coal Fire Research Project of the Sino-German Initiative, methods for innovative fire-extinguishing technologies were investigated in multifaceted research approaches. Extensive investigations of oxidative and thermally affected coal seams in coal fire zone 18 were conducted in 2008 prior to application of new fire-extinguishing methods. We present results from the outcrop of coal seam No. 4 in the fire zone 18.

The coal of seam No. 4 is of Early Permian age and belongs stratigraphically to the Shanxi Formation. The unaffected coal displays a high volatile bituminous A rank with a background value of random vitrinite reflectance ranging from 0.90 to 0.96 % Rr. Coal channel samples were coallected at actively extracted coal faces along multiple profiles with surface temperatures ranging from about 50° to 600°C.
Microscopic examinations revealed a variety of products of coal exposure to the fire. Within coal samples, a marked rise in vitrinite reflectance from background values to 5.55% Rr (6.00 % Rmax) is encountered. In addition, a number of coal samples showed suppressed vitrinite reflectances ranging between 0.82 to 0.88% Rr. Further, seemingly heat unaffected coal samples display intensive development of oxidations rims at coal grain edges and cracks as well as shrinkage cracks and formation of iron oxides/hydroxides. Instead, thermally affected coal samples with higher coalification grade are further characterised by development of macropores (devolatilisation pores) in vitrinitic streaks, transformation of liptinite to meta-liptinite and micrinite as well as by natural coke particles of mostly porous nature and fine to coarse grained anisotropic mosaic.

Coal petrographic investigations confirmed a hypothesis that both, oxidations as well as low temperature carbonisation govern the thermal regime in the coal fire zone 18. The occurrence of various thermal alteration products indicates temperatures in the range of 500-700°C.