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Rock barbeque: Recent landslide-triggered fires in shale and coal on west Greenland, and the implications for fire as a geological agent

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Natural rock fires are known from a range of geological settings commonly associated with coal seams or shallow peat layers. They differ from normal fires by their subsurface nature and that rocks and sediments, not surface vegetation, is combusted. The importance of rock fires in the geological record is virtually unknown, as they result in less ash production and distribution, and that few diagnostic traces are left behind in the combusted rocks. In order to investigate the consequences of rock fires, we have studied two localities in the Nuussuaq peninsula of west Greenland where recent landslides have triggered fires in coal and shale host rocks. One of the sites burnt for several years in the 1930's, whereas the second locality (coal) was likely active in historic times. The Vaigat in western Greenland is prone to large landslides due to instabilities in Late Cretaceous sediments overlain by a thick sequence of volcanic rocks and steep slopes that rise about 2 km above sea level. Where coal beds are combusted, the host sandstones are baked into red and oxidized brick-like sandstone. Evidence for melting of coal beds (producing paralava) is abundant. In contrast, fires associated with landslides affecting marine shale is characterized by oxidized shale, sharp reaction fronts and abundant gas emanation structures (vents) with mineralization of alumina salts, ammonium salts and sulfates. Cordierite and cristobalite have been identified in both settings, emphasizing high temperature metamorphism. We suggest that the occurrence of these minerals, together with the pervasive oxidation of the shale, can be used as tracers for fires in other geological settings. The rock fires were ignited either as a consequence of heat release from pyrite oxidation followed by self-ignition of the organic components, or by frictional heating during sliding. We have constructed a numerical model using the SAGE hydrodynamic code in order to evaluate the frictional heating scenario. Cell-averaged rock temperatures of 80-90 C are achieved in low-resolution calculations, suggesting that temperatures sufficient to initiate combustion could be reached on finer scales.