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Why coal fire "Hot spots" cannot be located using Remote Sensing or Infrared Mapping - Experiences from fieldwork in India and China

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What is a “Hot Spot”
In geosciences a hot spot is a hot magmatic area called mantle plume at the Earth’s core-mantle boundary. J. Tuzo Wilson postulated in 1963 that volcanic chains like the Hawaiian Islands result from the slow movement of a tectonic plate across such a fixed hot spot deep beneath the surface of the planet WILSON. J.T. (1963).
In the first reports of the Sino-German Coal Fire Project 2004 and 2005 DMT geologists in-troduced the term “Hot Spot” into the technical terminology of Coal Fire Research. The centre or the “Hot Spot” of the coal fire is concealed from the observer and its underground location cannot be determined by any simple means from the Earth’s surface.
The centre of a fire (the “Hot Spot”) is the hottest point (Gielisch & Goerlich, 2002), with the temperature decreasing generally with distance from the hot spot. So the “Hot Spot” of a coal fire was defined as the burning centre of the coal fire, the hottest place in the burning coal seam. Due to the character of coal fires 95% of these “Hot Spots” are located more or less deep under the surface.
Thermal surface anomalies result from these “Hot Spots”. But due to the ways of transporta-tion of heat in and from the underground the location of the “Hot Spot” and the thermal sur-face anomaly are completely different. Only if the coal fire occurs directly at the surface the “Hot Spot” and the surface anomaly occur at the same location.
Remote Sensing
Remote sensing in coal fire fighting operations is the observation of a coal fire area using thermal satellite images. Using these images it is possible to find fires or thermal anomalies in the areas of active coal fires and endangered areas where coal deposits could catch fire. These thermal anomalies could be camp fires, burning forests, coal fires or any other natural and artificial fires or heating. To verify that the observed anomaly is a coal fire or not, ground checks are absolutely necessary. In all cases the images show the thermal status quo at the surface only, but do not reveal the character of the coal fire in the underground.
Infrared Investigations
The infrared exploration is a pre-condition for locating and defining fire zones. The recognition of even the small-est of fires provides information for preparation of the area for a geological survey and subsequent geophysical exploration. The knowledge of the areal extent of the thermal anomalies and the temperature distribution on the surface does not allow for conclusions about the amount of coal burning, thus giving an estimation of the size of the fire. However, it is not possible to pin-point the centre of the fire or to calculate exactly the amount of burning coal. In many countries of the world the infrared exploration is the only scientific technology to investigate the location and character of coal fires.
Why thermal surface anomalies occur?

There have been a lot of attempts in the past in different countries to use infrared mapping or remote sens-ing to locate the “Hot Spots” of coal fires. The main problem with this approach is that the surface temperature is often only marginally influenced directly by the coal fire. The most important control on surface temperature is the burning of combustion-derived gases like methane a. o. near the surface. The smouldering fire somewhere in the underground leads to a degasification of the coal. Due to losses of volume during the burning process in the underground (coal to ash), the overburden often fractures and vugs and fissures do form. Using these vugs and fissures the gases ascend to the surface. Near the surface the gases are compounded with oxygen. For example methane reacts to self-ignition reaching mixing ratios of 5-15% methane in 95%-85% oxygen. Reaching this mixture it explodes in mines and burns in open systems in the case of ignition. The vugs and fissures form natural “gas pipe-lines”. The burning gases lead to an enormous heating of the surface in areas far away from the actual

“Hot Spot” of the coal fire. In some fire areas it could be observed that the near surface burning combustion gases lead to higher temperatures as the coal fire below in the underground.

Conclusions

Remote Sensing and Infrared mapping document the surface situation. The location of the thermal anomaly at the surface and the “Hot Spots” in the underground are definitely different and any calculation based on measurements of the surface temperature must lead to impre-cise determinations of the amount of burning coal in the underground. Therefore the location of coal fires “Hot spots” using Infrared Mapping and Remote Sensing is impossible and has to be complemented by subsurface investigations.

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