Detection of smouldering by electrical resistivity tomography

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Keywords: fire detection, resistivity tomography, waste fires, biofuel fires, smouldering fires

Spontaneous fires at waste and biofuel storage sites are a serious concern for waste management and biofuel companies and authorities. The toxic emissions from such fires pose a serious threat to the surrounding population and ecosystems. Smouldering fires are difficult to detect because hotspots are usually developed deep inside the stored material. Due oxygen deficient conditions, smouldering fires are non-flaming in nature and are often noticed some days or weeks after its initiation. The main goal of this study was to test electric resistivity tomography (ERT) as a technique to detect smouldering fires. A motivation to employ ERT for detecting the smouldering hotspot was its sensitivity to moisture content and density that varies at smouldering hotspots

A series of tests were performed in this study. To perform the experiments, a plastic bucket was used for holding the test material. The test bucket was equipped with 4 rings of electrodes (8 electrodes per ring). Electrodes were comprised of stainless steel screws that were inserted in the walls of the bucket to allow the flow of current through the test material. An externally controlled hot wire was placed within the test material to trigger smouldering fire within the test material. The full set of ERT measurements was repeated after every 20 min. The data was processed using the freeware pyGIMLi and 3D resistivity plots were created.

From the inversion results it was observed that the resistivity first decreased in the zone around the heat source (Figure B vs. Figure A), which probably can be related to the initial rise in temperature of the test material. At later time steps a zone of higher resistivity developed around the heat source (Figure C), potentially because of drying out of the material surrounding the hotspots. A physical examination of the test material after the trials reveals that the smouldering hotspot travelled in the upward direction. The results suggest that ERT has a potential for early detection of smouldering fires.

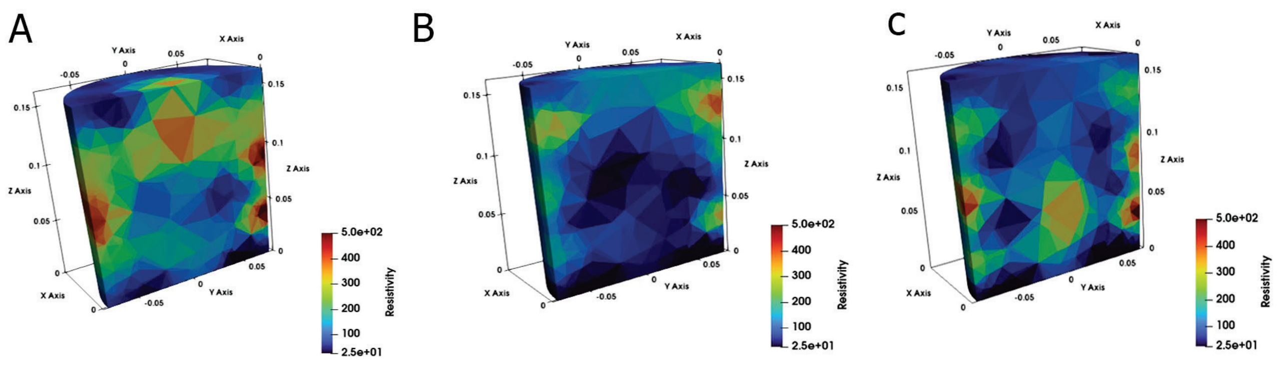

Figure: Vertical cut through view of the 3D resistivity model at three different timesteps; A) at time zero, B) after 100 minutes, C) after 380 minutes.

Acknowledgments: This work is sponsored by ÅForsk under grant number 21-106