Coal excavation design for environmentally perspective by using multi-configuration GPR antenna

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Coal Excavation Design for Environmentally Perspective by using Multi-Configuration GPR Antenna

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Abstract. Determining coal seam total moisture, thickness and fracture planes is of vital importance for coal exploitation. Determining the thickness of shallow coal outcrops is difficult and drill data is often needed to determine lateral coal seam thickness resulting in high exploration costs. Another difficulty is the lack of information about fracture plane orientations which increases the difficulty and cost of digging operations. Ground probing radar (GPR) measurements were carried out on the vertical wall of a coal outcrop to determine the applicability of GPR in mapping the distribution and continuity of lateral coal seam thickness, total moisture variation, and fracture planes. By using multi-configuration antennas, reflected waves were recorded giving information to a depth of about 3 m on coal seam thickness, interfaces with inter-burden layers, total moisture variations and fracture planes in coal seams. By comparing the GPR records with the conditions of the visible vertical coal outcrop it was also confirmed that the electromagnetic waves were most strongly reflected by coal seam interfaces with inter-burden layers in the form of compact-clays, by total moisture content variations in coal seams and fracture planes containing conductive minerals (i.e. hematite, magnetite, clays, and pyrite) and water.

INTRODUCTION

Accurate estimation of the thickness of coal seams is required for calculation of coal reserves. Coal in addition to being organic shows variations in total moisture and mineral content. Total moisture is one of the important physical parameters used to determine coal rank. Generally, fracture planes in coal seams will differ depending on their depositional process, and the fracturing dimension can be an expression of the coal rank. [5] Some references indicate that conductive minerals may infiltrate the fracture planes at the time of formation. Physically, such minerals may be conductive while coal is resistive creating a spatial contrast between the fractured and un-fractured coal. [4-5]. To improve understanding of fracture plane orientation, distribution, thickness and total moisture in coal seams a non-destructive high resolution measurement technique was needed which could be directly applied to in-situ coal seams.[2] Measurements were made using a reflection profiling mode where two way travel time (TWT) was observed. Variations in antenna configuration and orientation used in this research were perpendicular broadside (YY-mode), parallel end-fire (XX-mode) and cross-polarization (YX-mode). [2]

Analysis of the distribution and continuity of coal seam lateral thickness, total moisture variation, and fracture plane orientation was done using instantaneous attribute and interval attribute techniques.

METHOD

The investigation site is located in the north part of Air Laya mining field, Tanjung Enim town, South Sumatera, Indonesia. The section underlying the coal seam consists of silt stone and hard clay. The section adjacent to the coal seam fair to fine grained sandstone. The investigation site is a coal outcrop consisting of a vertical wall about 2.5 m thick.[3]

The measuring line was established horizontally along the vertical coal out crop at 6.05 m (Fig. 1. a).

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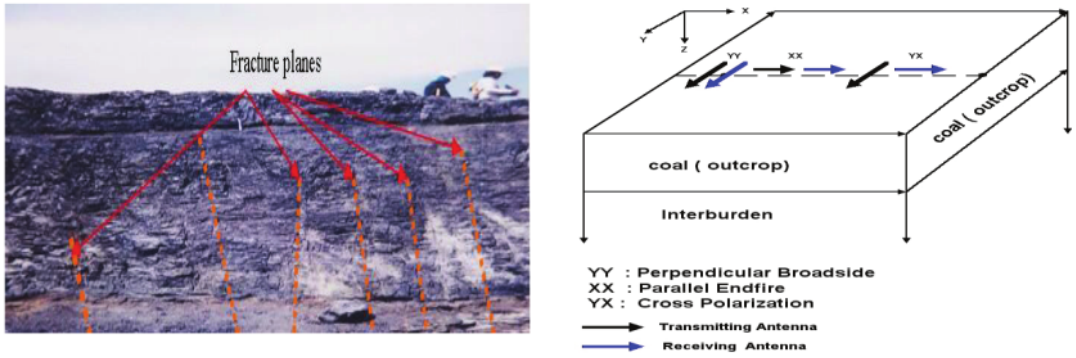
Geological Observation

The vertical coal outcrop was visually checked for lateral variation in luster, where part of the left side which is darker (dull) is compared to the right side which is bolder (bright). Fracture plane distribution and orientation were visually compared.

GPR Measurement

Measurement at the vertical coal outcrop used three different mode configurations and orientations of antennas (Fig. 2). The measurements were made using the reflection profiling mode in which the transmitting and receiving antenna array was moved along the coal outcrop. The antenna frequency used was 100 MHZ. The YY-mode used 121 traces, the XX-mode 115 traces and the YX-mode 177 traces.



(a) (b)

FIGURE 1. (a) Coal outcrop, and (b) Acquisition mode of reflection profiling for frequency of antenna 100 MHz direct above coal outcrop.

As YY-mode antenna configuration is where the position of both antenna arrays are parallel to the fracture planes and both of the antennas were perpendicular to the traverse line. The XX-mode is where both of the antennas are parallel to the traverse line direction The YX-mode is where the position of the receiver antenna is orthogonal to the transmitter antenna.

The instrument used in the GPR measurements was RAMAC/GPR, manufactured by MALA geosciences, Sweden.

RESULT

Differences of GPR Records According to Mode of Configuration and Orientation of Antenna

The results from the experiments showed that the lateral thickness and total moisture variations of the coal seams were better seen by using the YY-mode. Determination of fracture plane existence is best using the XX-mode and the YX-mode. Also it would be possible to detect the existence of nature of physical difference laterally in one coal seams laterally on positions of 3 m of measurement starting points by 3 m here in after to the last measurement traverse line that is 6.05 m by using GPR at coal seams use the YY mode (see Fig. 2) [2]

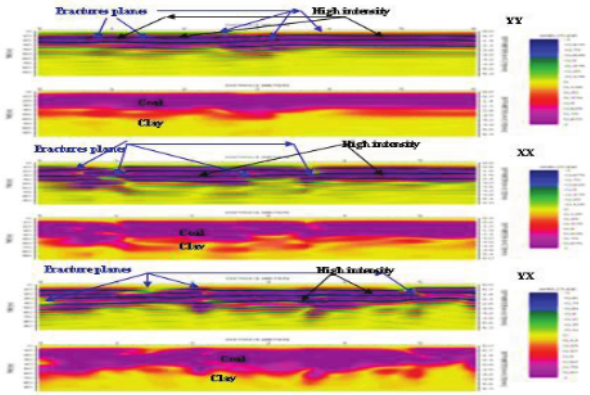


FIGURE 2. Profile GPR record, result of data acquisition (processed) at coal outcrop (fig. 1) with path length of traverse line that is 6.05 M to the mode of YY, mode of XX and mode of YX.[2]

Comparison between GPR Results and Direct Observation of Coal Outcrop

Fig. 3 shows the result of a radar record which has been processed to pass process step of fk-filter and frequency filter for the mode of YY, of above is proximate analysis results to eight positions by channel sampling which have been plotted laterally and most of top is coal outcrop measured. Fracture planes detected on the coal seams by visual observation are denoted by numbers (1) - (5) and the arrows indicate the fracture direction as estimated from direct observation. The thickness of the coal seam was clearly reflected at 2.5 m where the coal seam amplitude is very high while underlying sediment amplitudes are very low corresponding in position to the identified geometry. [3]. Total moisture variations in the coal outcrop are shown by letters (a) - (b) and the dashed circle. Strong reflections on the GPR records relate to the coal moisture. [4]

Comparison of the features of the fracture planes leads to the following interpretations:

- Reflected waves are generated from the fracture planes in coal seams containing conductive minerals (hematite, magnetite, pyrite, and clay), moisture seepages and inherent moisture content.
- Waves are not reflected from closed or dry fracture planes.

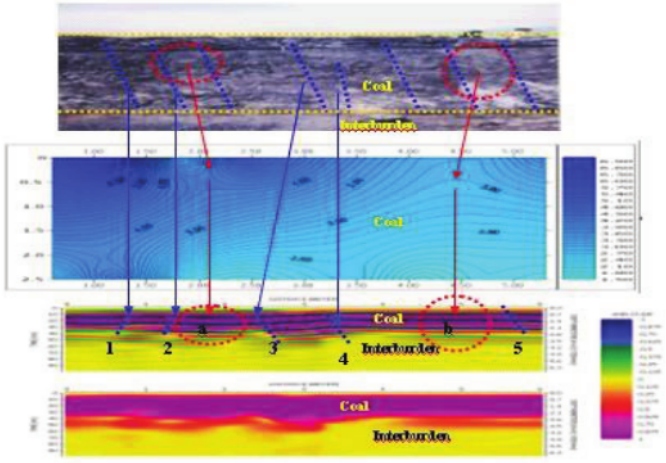


FIGURE 3. Comparison between the mode of YY GPR record and direct observations of coal outcrop [2]

CONCLUSIONS

With the objective of determining the applicability of GPR for mapping coal seam thickness, total moisture variation, and fracture plane distribution GPR measurements and geological observations were conducted at a coal outcrop and its surrounding layers. As a result, the following interpretations and conclusions were clearly obtained:

- Comparative measurements conducted using a single frequency with three different antenna configurations indicated that the YY-mode configuration was superior for detecting coal seam thickness and lateral variations in total moisture. While the XX-mode and YX-mode were superior for detecting fracture plane position in the coal seam.
- Comparison of the GPR results with direct observations of the coal outcrop revealed that fracture planes containing conductive minerals or moisture were identified in the GPR records as reflecting planes.

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REFERENCES

1. A.P. Annan, *Ground Penetrating Radar*, (workshop notes, sensors & software, Ontario, Canada 2001)
2. E. Ibrahim and A.A. Hadi, "Multi Configuration of GPR Antenna for Coal seams Characterization at Bukit Asam coal mining field", abstract accepted and Oral presented in PIT HAGI 41 (2016)
3. E. Ibrahim, L. Hendrajaya, G. Handayani, U. Fauziand S. Islam, The 32nd IAGI and the 28th HAGI annual convention and exhibition, Proceedings (2003).
4. E. Ibrahim, L.Hendrajaya, G. Handayani, U. Fauziand S. Islam, The 32nd IAGI and the 28th HAGI annual convention and exhibition, Proceedings. (2003)
5. D.W.V. Krevelen, *Coal, typology-chemistry-physics-constitution, Coal science and technology*, Elsevier chapter XVIII (3), (1993) pp. 373-399.

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