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Coal geology – a scientific building block for underground coal gasification

Van Dyk, J.C.^{1,3} and Brand J.F.²

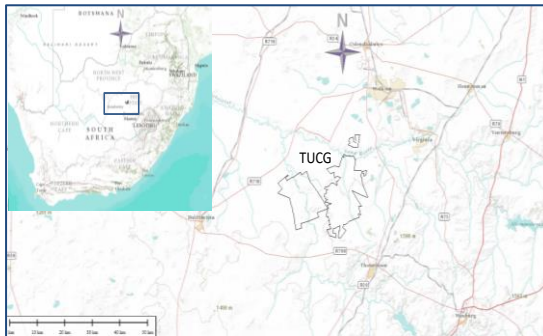
¹Technology Manager, African Carbon Energy, South-Africa, +27825500473, email: joan.vandyk@africary.com

²CEO and MD, African Carbon Energy, *Africary*, South-Africa

³Associate Professor, North-West University, South-Africa

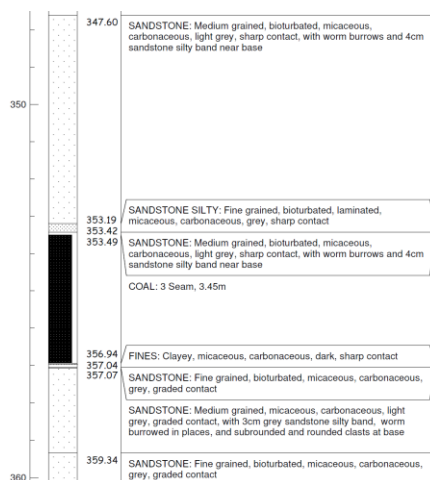
Coal characteristics and geology are the given inputs for an underground coal gasification (UCG) technical and economical evaluation, and thus the most important factors to consider when matching the gasification technology to the coal resource. More specifically, the coal geological conditions become the scientific building block for developing an UCG project.

UCG is a mining method that allows the in-situ exploitation of coal seams that are too deep (or uneconomical) to mine using conventional mechanical mining methods. The underground gasification process mines the coal chemically, by constructing at least two boreholes from the surface horizontally into the coal seam (where one borehole is used to inject air/oxygen to convert the coal into syngas and another to bring the syngas to surface). African Carbon Energy (Africary) is developing a one billion-tonne coal deposit in South Africa at Theunissen (Free State) to fill a vital gap in the country's electricity supply. The Theunissen resource comprises of typical low-grade coal, with a high ash content, as typically found in the Free State Coalfield of South Africa. The sedimentary rocks of the Karoo Supergroup containing the coal generally follow the course of the Vaal River in the north, but steeply increase to its maximum depth and thickness southwards. The Karoo rocks in the Theunissen Project area consist of the Dwyka Group (diamictites) at the base, followed by the coal bearing Vryheid Formation (Middle Ecca Group), which is overlain by shales of the Volksrust Formation.



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Figure 1: Location of the Theunissen coal reserve



Coal and geological properties can vary extensively from one coal formation to the next, and will have a major impact on the choice of a suitable gasification technology, but more importantly on the design of an efficient environmentally friendly UCG process². A total of four (4) coal seams have been identified in the Theunissen Project area, however not all seams meet the minimum requirements for potential UCG exploitation in terms of seam thickness, depth, qualities, etc. Seam 3 is the most widely distributed and economically significant developed, and also the most suitable for UCG, with average thicknesses of 3.2m (up to >5m) and a depth ranging from 345 to 385 metres below surface in the project area, where both the coal quality and geological conditions are excellent for UCG. The in-situ calorific value average is 20.3 MJ/kg, average volatile matter content is 19.2 %

and the average ash content is 30.8 % (on an air dried basis).

Figure 2: Seam 3 coal depth and rock formation

This paper will provide an overview of the geological conditions and coal properties of the Theunissen Project area and its suitability for efficient environmentally friendly exploitation by UCG.

