

THE GEOLOGY OF COAL IN ZIMBABWE & TECHNOLOGIES FOR ITS COST EFFECTIVE MINING



**A PRESENTATION TO SAIMM
CONFERENCE 3-4 AUGUST 2017**

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PRESENTATION OUTLINE

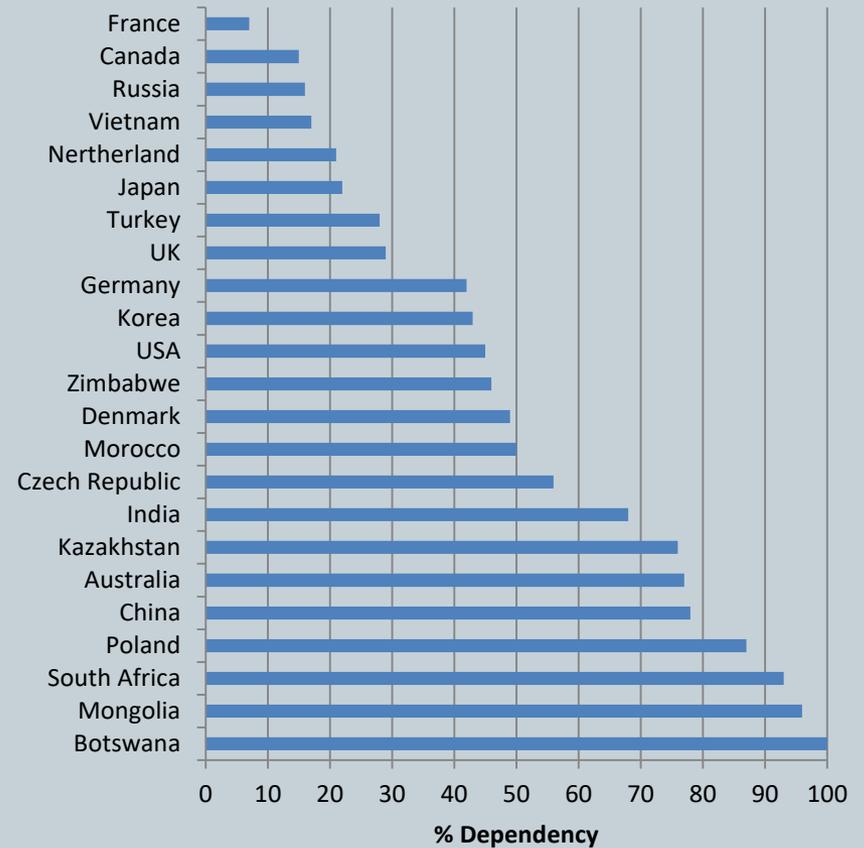


- INTRODUCTION
- COAL IN GENERAL
- ZIMBABWE COAL – LOCATION OF BASINS
- SEAM ATTRIBUTES
- GEOLOGY AND COAL QUALITY OF SELECTED COAL DEPOSITS
- COAL MINING TECHNIQUES – CURRENT AND TO CONSIDER FOR FUTURE
- CONCLUSION

INTRODUCTION



- The economic development of any country is directly proportional to the production and utilization of energy.
- Zimbabwe, a developing country is among the top 19 countries in the world with high dependence on coal as its energy source.



INTRODUCTION (CON'T)



- Coal mining in Zimbabwe commenced in 1902 at what was then Wankie Colliery and is now a mature industry.
- The technology used has evolved from a simple manual operation employing the hand-got system to a high level of mechanisation.
- This development has been a response to growing demand that called for use of use of more sophisticated and cost effective technologies.
- This paper looks both the geology of the coal and the technologies used to exploit this solid fossil fuel.

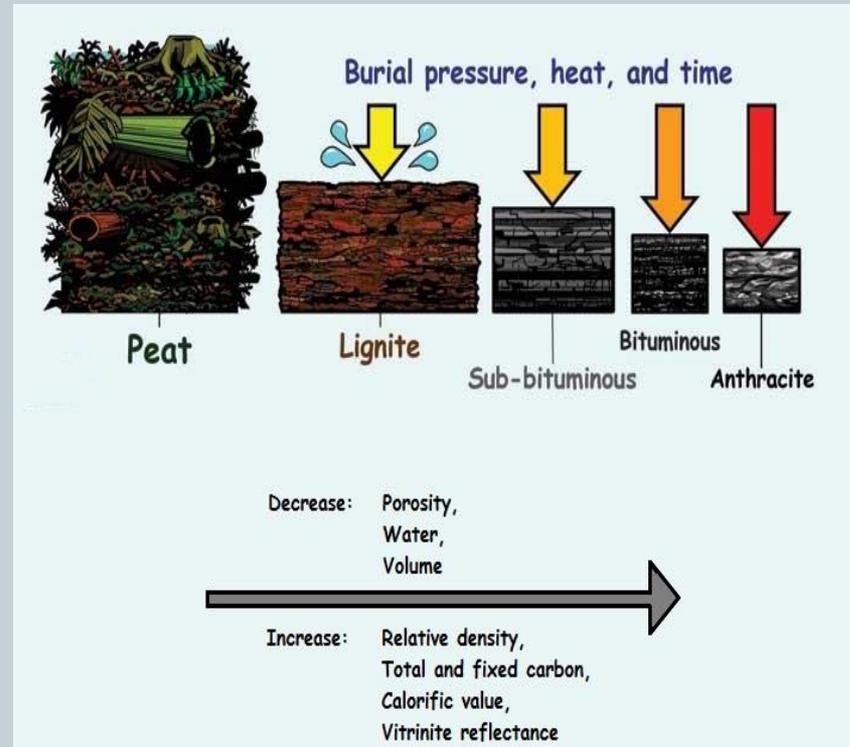
COAL IN GENERAL



- Coal is readily combustible sedimentary rock which was formed from **remains of vegetative** matter through the process known as **coalification**.
- The process was preceded by compaction of the plant remains within the swamp.
- With time the swamp floor subsided creating a high energy environment which led to ingress of sediments that buried the vegetative matter.
- In the process the plant material was subjected to elevated temperatures and pressure leading to physico-chemical changes to the vegetative matter – transforming it into the organic rock or coal seam.

THE COALIFICATION PROCESS

- Coal is classified according to the degree of increased exposure to elevated temperature and pressure into four broad sequential stages or ranks as shown in Figure 2.
- Each stage represents an increase in the carbon content (carbonisation).



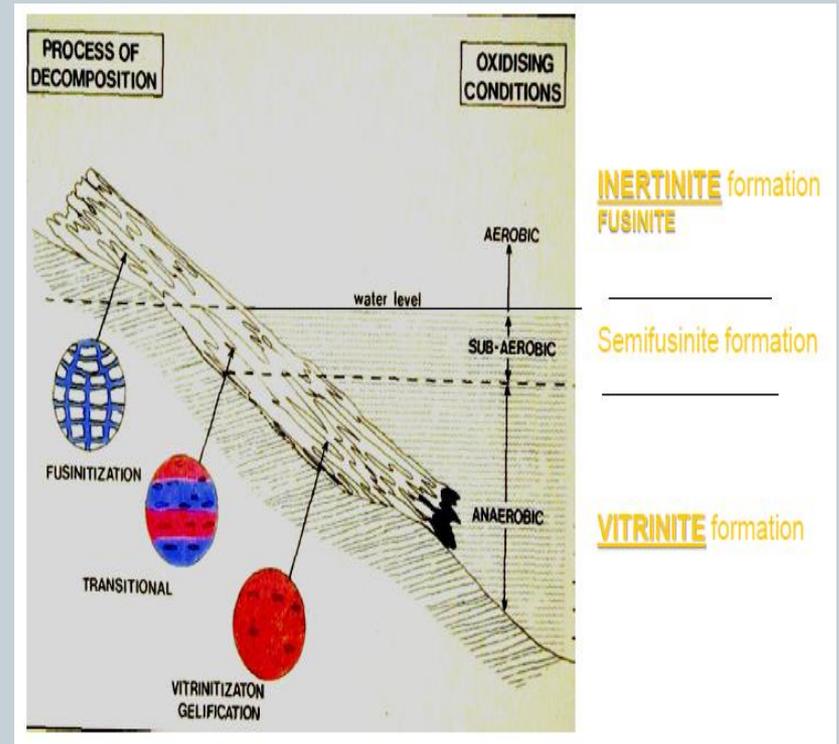
COAL COMPOSITION



- Coal is a complex commodity which is made up of:
 - Organic constituent – macerals analogous to minerals in inorganic rocks.
 - Inorganic component – mineral matter, e.g. quartz and feldspars.
- Macerals determine **coal type**; while inorganic components define **grade** of coal.

MACERALS AND ENVIRONMENT OF FORMATION

- Macerals fall into two groups:
 - Reactives, e.g. vitrinite formed under anaerobic conditions
 - Non-reactives/inert, e.g. Inertinite formed under aerobic environment (figure



GEOLOGY OF ZIMBABWE COAL

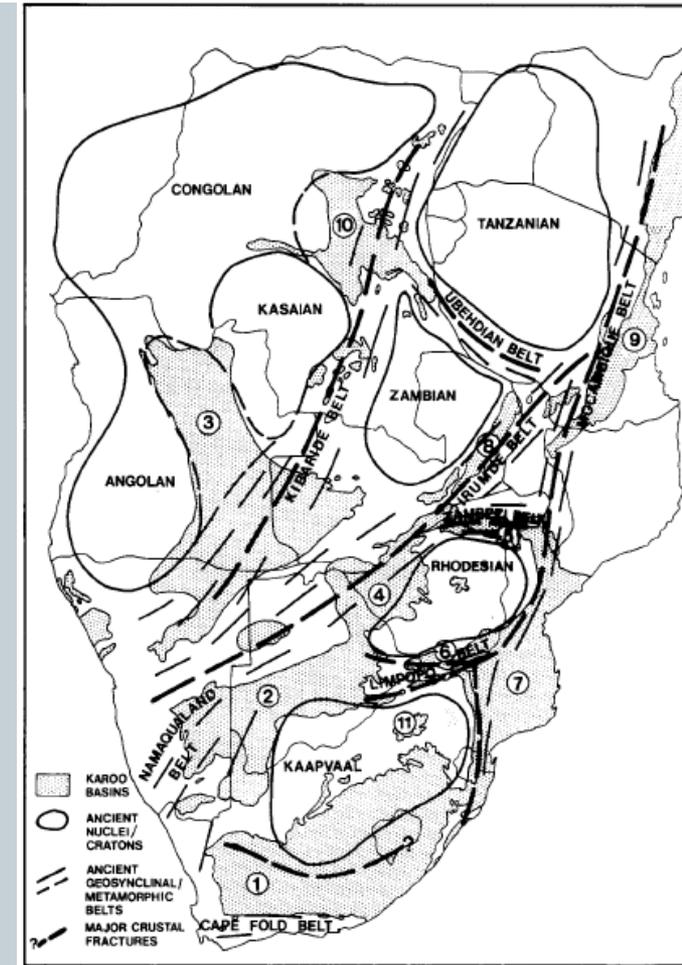


LOCATION OF KAROON BASINS

LOCATION OF ZIMBABWE'S KAROO BASINS IN RELATION TO KAROO BASINS OF THE SUB- REGION

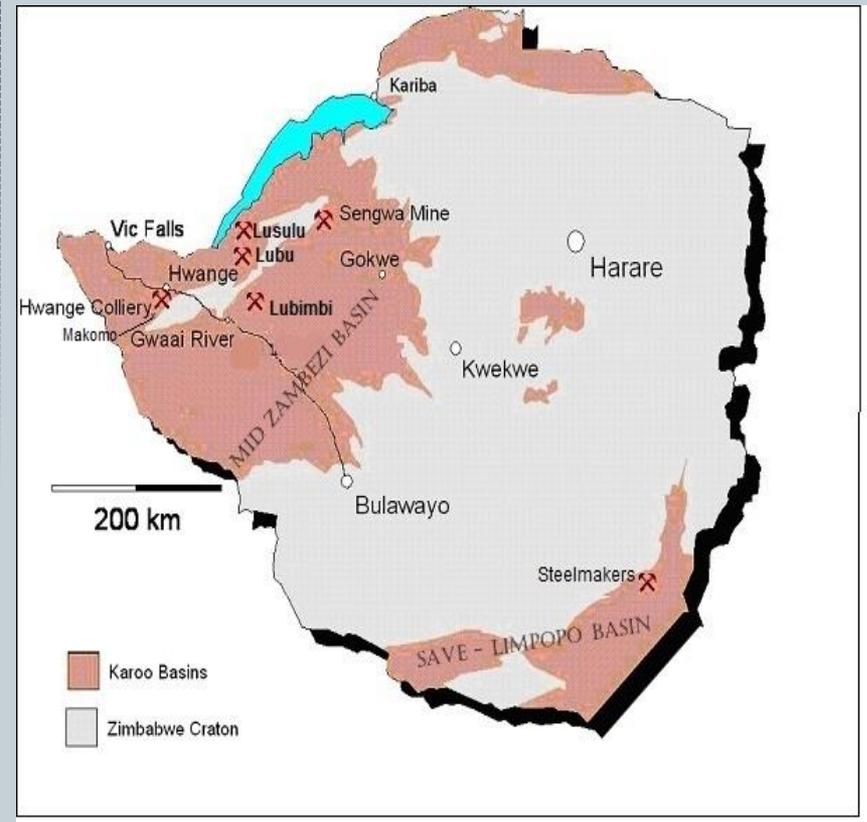


- Zimbabwe's coal measures, like those of the Sub-region, are an integral part of the Karoo Sequence deposited over a 100 year period.
- The period spans the Upper Carboniferous to the Jurassic.
- The sedimentation basin covered the whole of the southern end of the continent roughly south of Latitude 25°S. To the north of this are other, but smaller basins, including Mid-Zambezi and Save-Limpopo basins.



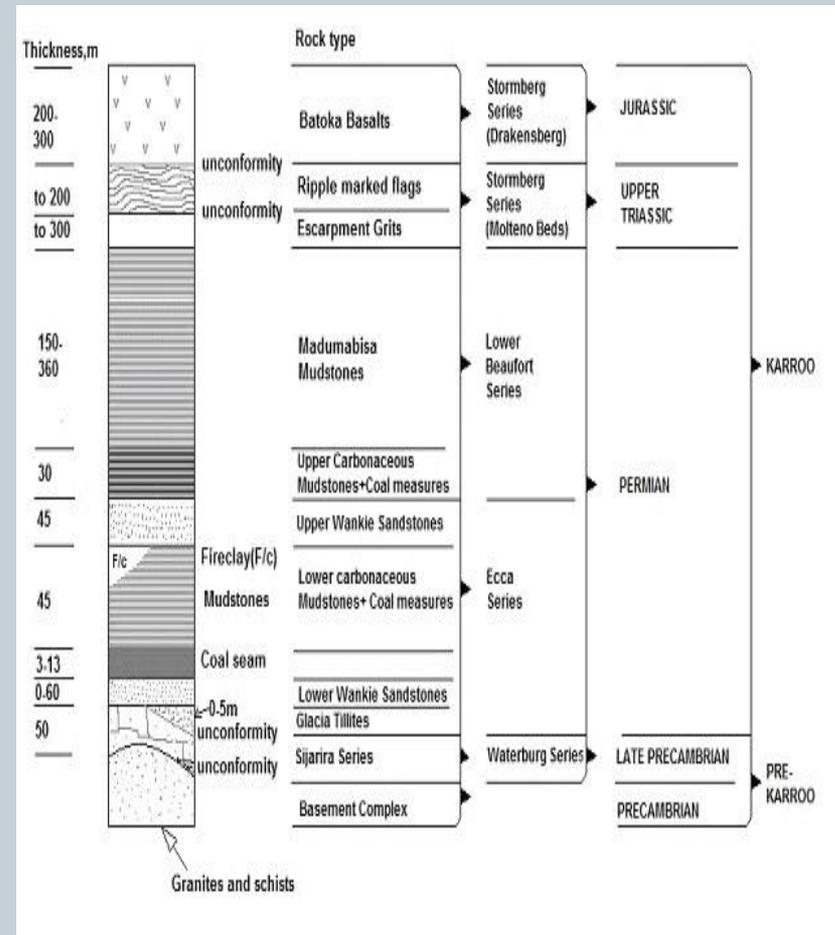
LOCATION OF THE ZIMBABWEAN KAROO BASINS AND SOME OF THE KNOWN COALFIELDS

- The coal deposits are part of the Karoo rocks which are preserved within the confines of the present day Mid-Zambezi and Save-Limpopo basins.
- Separating the two basins is the Zimbabwean craton.
- The Mid-Zambezi has been described as a half-graben (Orpen et al., 1989) and such structures host thick seams.
- The Save-Limpopo Basin on the other hand is a typical example of those basins that straddle intra-cratonic and metamorphic belts. Such basins are characterised by a multiplicity of thin seams which are laterally discontinuous and often intruded by dolerite bodies.



THE KAROO SEQUENCE IN ZIMBABWE

- Based on the Hwange area model Karoo sedimentation commenced with deposition rocks of glacial origin known as the Dwyka Formation and terminated with extrusion of basaltic lavas known as Batoka Basalts.
- The interval between the two is made up of true sediments which have varying grain sizes and composition, depending on the source of the sediments and the environment of deposition prevailing at that time.



GENERAL ATTRIBUTES OF ZIMBABWE'S COAL SEAMS

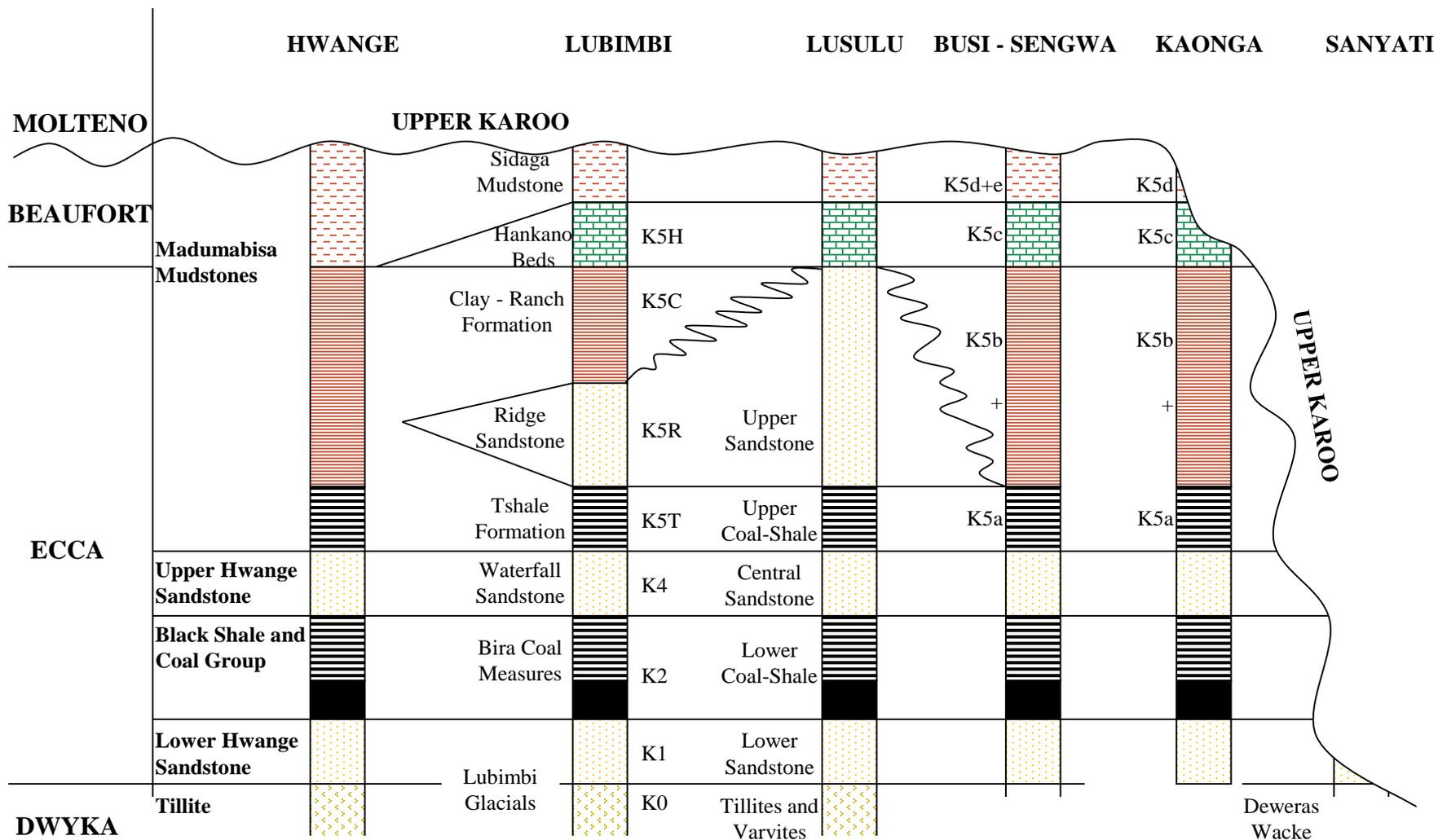


Information available reveals that though Zimbabwe coal deposits may differ from one another, there are similarities such as:

- The economic seams are of the Ecca Group;
- Their geology is relatively simple – flat, un-deformed to moderately deformed and therefore easy to work;
- In the majority of the deposits, only one seam is economically viable and that this is correlatable across the geography divide more so for the Mid-Zambezi Basin;
- The coals are in the main of the bituminous rank; and
- Some coal deposits are host to substantial amounts of coal-bed methane.

LOWER KAROO IN THE MID-ZAMBEZI BASIN (ZIMBABWE)

Schematic columnar sections of key areas and their lithostratigraphic correlation
(Adopted from J. Lepper)



not to scale

SEAM ATTRIBUTES (Con't)



The following differences have been noted between the coals in the Mid-Zambezi Basin and those in the Save-Limpopo Basin:

- While coals are bituminous, those in the Save-Limpopo Basin were thermally upgraded to anthracitic rank by dolerite dykes and sills, a phenomenon not found in the Mid-Zambezi coals.
- Coal seams hosted in the Mid-Zambezi Basin are generally thick with systematic vertical variations in quality parameters (e.g. Hwange Main Seam) Those in the Save-Limpopo are multi-seam deposits with individual seams ranging from a few centimeters to 4 m thick (e.g. Tuli Coal)

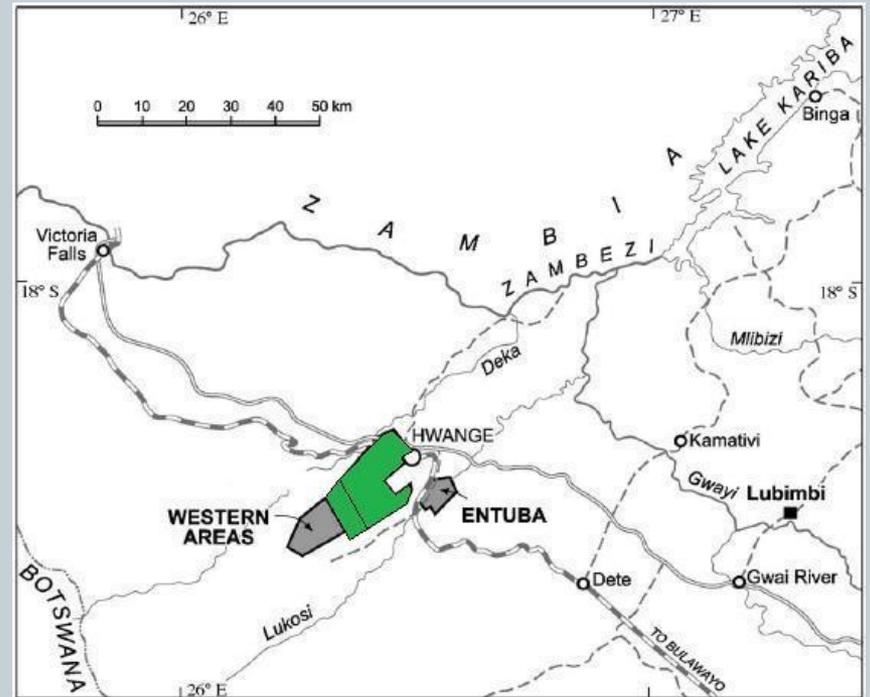
THE GEOLOGY AND COAL QUALITY OF SOME SELECTED COAL DEPOSITS IN ZIMBABWE



1.0 THE HWANGE COAL DEPOSIT

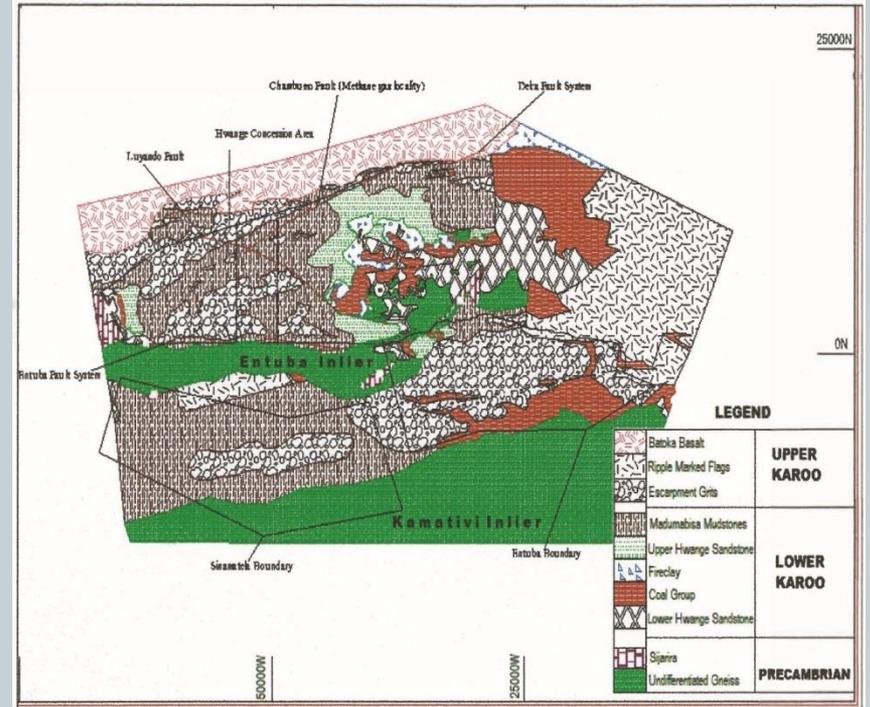
1.1 LOCATION AND ACCESSIBILITY

- Located in northwest Zimbabwe, 335 km from Bulawayo and 100km (by road) from the scenic Victoria Falls;
- Both the tarred Bulawayo-Victoria Falls Highway and Rail pass through Hwange;
- Scheduled local, regional and international flights land at Victoria Falls and Hwange town has its own airstrip for small aircrafts.



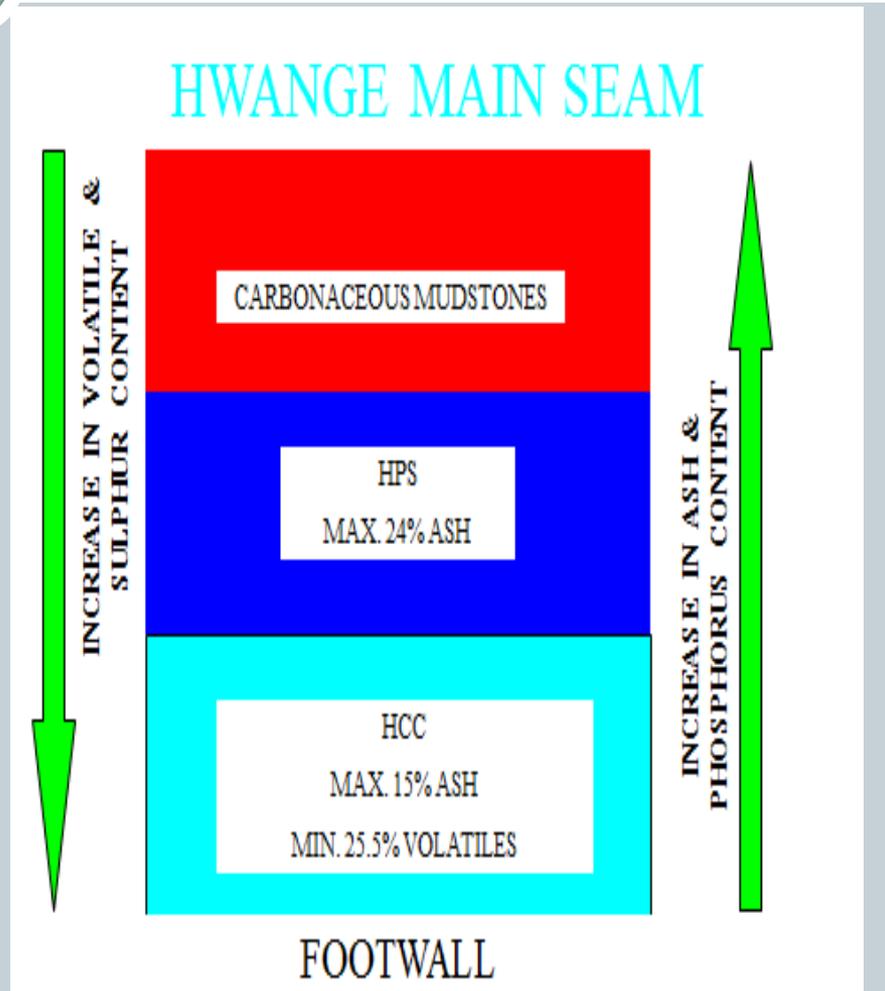
1.2 GEOLOGICAL SETTING OF HWANGE COALFIELD

- A western extension of the Mlibizi Intra-basin of the Mid Zambezi Basin;
- Dichotomous – Hwange Concession to the NW and Entuba-Lukosi to SE of the Entuba Inlier;
- Major faults – Deka and Entube – downthrown to the north; and
- Small to medium scale (mostly listric) faults in the intervals of these – consistent with the half-graben theory of Orpen et al (1989).



HWANGE MAIN SEAM ATTRIBUTES

- Depth of seam ranges from outcrop to 360m;
- A thick coal seam with minor intercalations of carbonaceous material;
- Thickness of geological seam averages some 30m;
- Systematical vertical variation in quality – good quality at base and progressively deteriorating towards hangingwall (top).



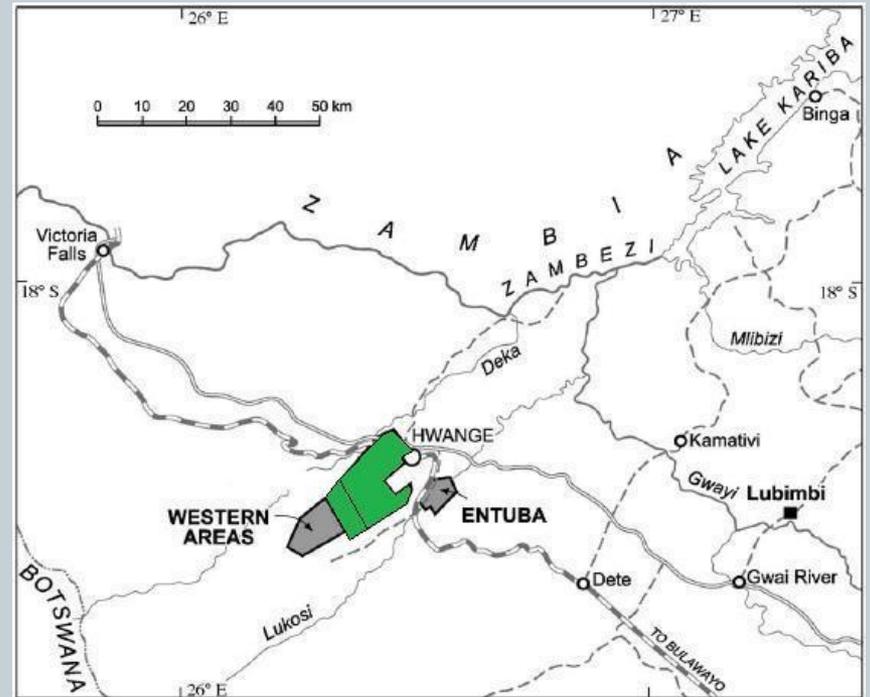
GEOLOGY & COAL QUALITY OF SOME SELECTED COL DEPOSIT(Con')



2.0 LUBIMBI COAL

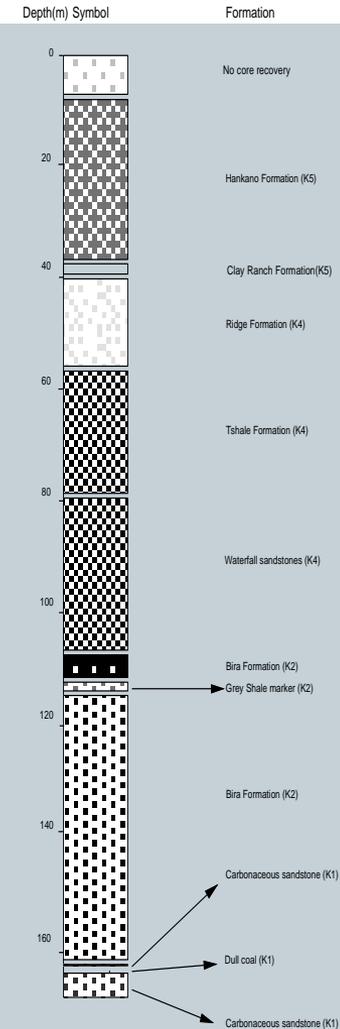
2.1 LOCATION AND ACCESSIBILITY

- Some 110km by road from Hwange town;
- Accessible by dirt road taking off, northwards, at a point 88km before Hwange along the Bulawayo-Victoria Falls Highway.
- Administratively falls under Binga District; and
- Adjoining Hankano and Dalia coal-bearing areas.



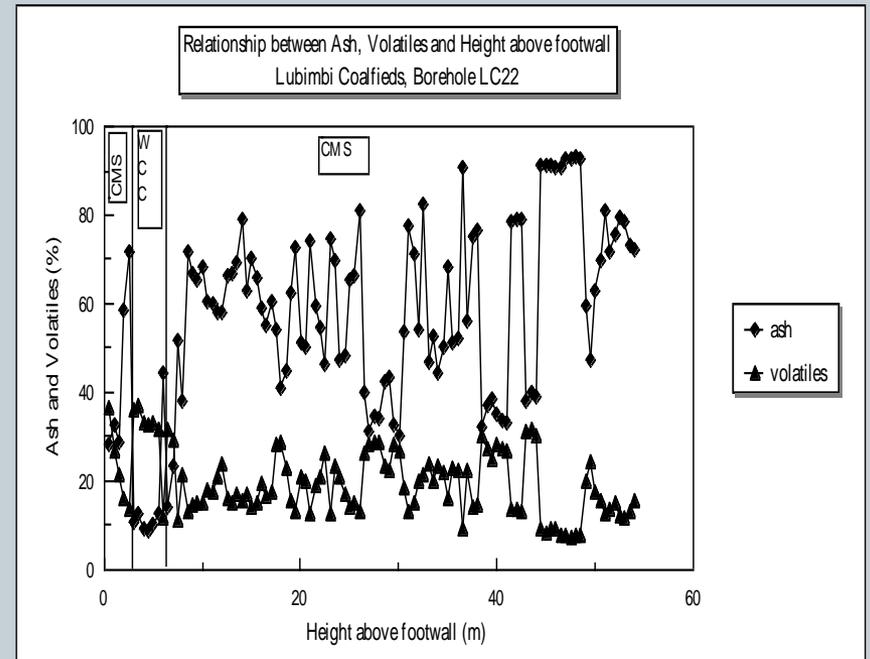
2.2 GEOLOGY OF LUBIMBI COALFIELD

- Structurally dissected by northeast southwest trending faults;
- Characterised by a northeast-southwest monoclinal features in the eastern part of the coalfield.
- Stratigraphic column on the right.
- Two seams- Tshale and Bira, with Bira being the Hwange Main Seam equivalent



2.3 LUBIMBI BIRA SEAM

- Depth from surface ranges from outcrop in the west to just over 500m in the east.
- Geological seam attains thickness of 50m;
- Basal high ash (carbonaceous) material followed by relatively good quality coal in the middle, followed by carbonaceous material towards the top; and
- Considered as a good candidate for the coal-to-liquid technology (C-T-L).



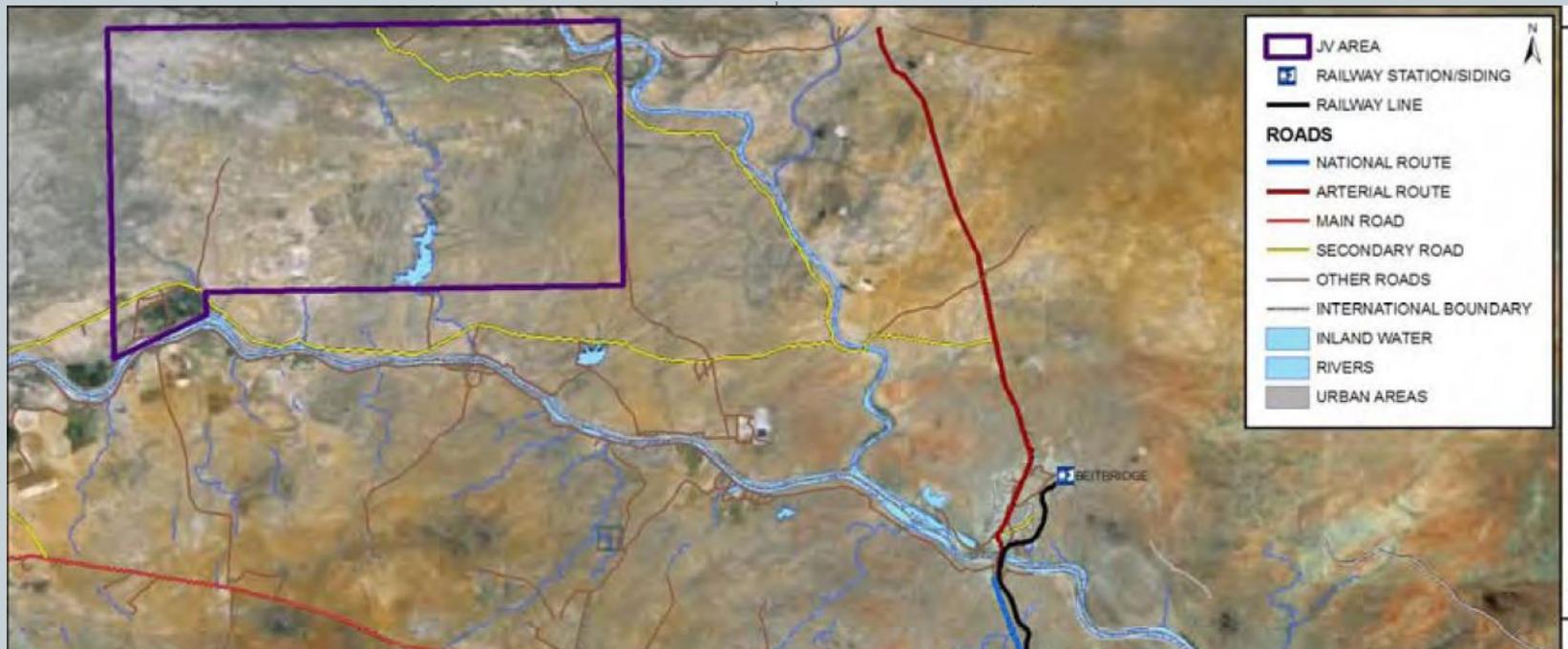
SELECTED COAL DEPOSITS (Con't)



3.0 TULI COAL

3.1 LOCATION AND ACCESSIBILITY

- Lies adjacent to and north of the Zimbabwe-South Africa border;
- Both the Bulawayo - Beitbridge Highway and Rail pass through the coal concession



3.2 GEOLOGY & COAL SEAM ATTRIBUTES



- Deposit consists of 6 coal seams numbered 1 to 6 from bottom to top;
- Depth to top of seam 6 ranges from outcrop to deep coal (m?).
- Washed product yields coking of 10.2 – 12.5Ash.

COAL MINING TECHNOLOGIES IN USE



1.0 INTRODUCTORY REMARK

REMARKS



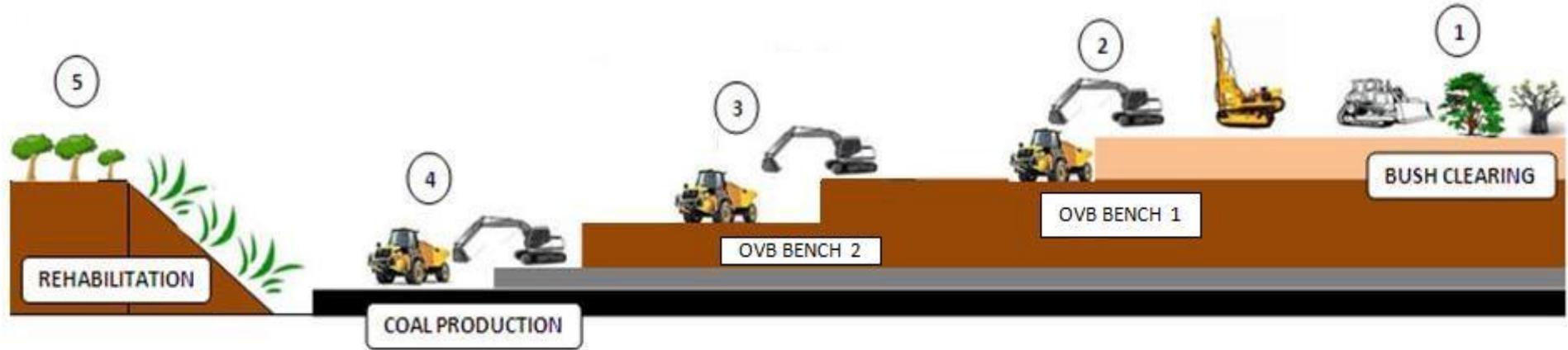
- Coal mining typically uses two methods – the surface and the underground techniques, and choice is primarily determined by geological factors.
- In Zimbabwe coal depth is the main determinant.
- Environmental and social factors confined to determining whether the deposit will be mined or not.
- First Zimbabwean coal left the mine at Hwange for the market in 1902 transported by ox-wagon.
- Zimbabwe's coal mining technology has evolved from the simple manual hand-got system to mature and highly mechanized technologies.

OPENCAST METHODS OF COAL MINING

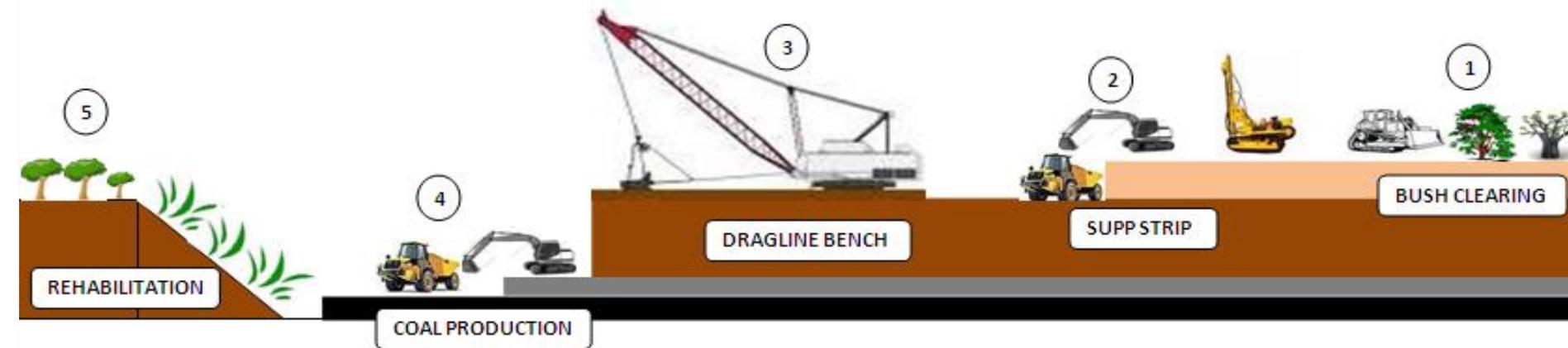


- Practised where the stripping ratio is economic.
- Two techniques;
 - Truck and Shovel
 - Dragline with Supplementary stripping

Truck and Excavator (Chaba)



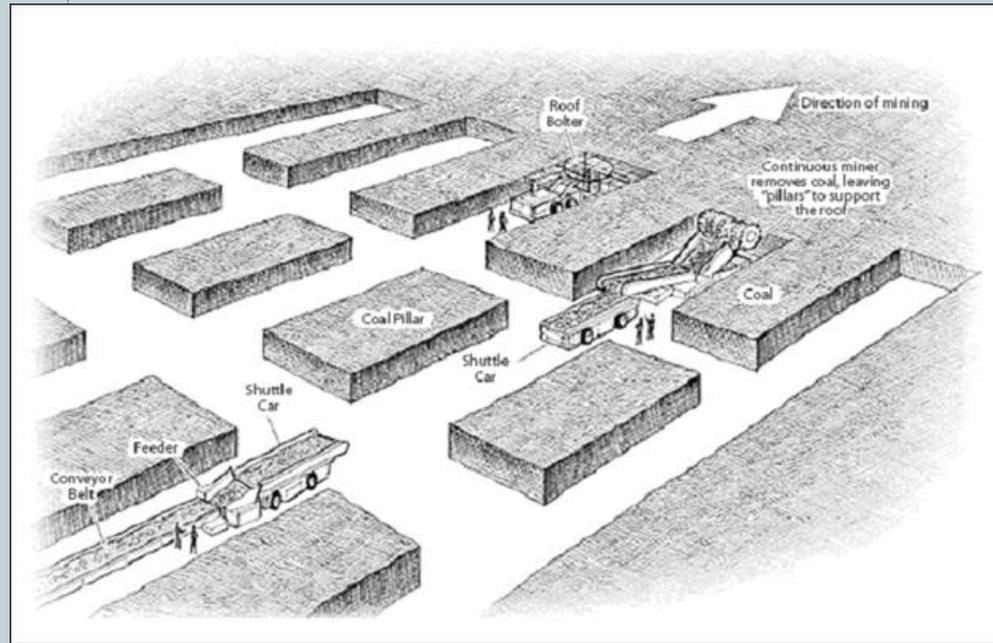
Dragline with Supplementary Stripping (JKL)



BORD AND PILLAR TECHNIQUE

OPERATION

- Continuous Miner (CM) used to cut coal (one per section);
- Shuttle Cars (ideally a fleet of 3 per Section); used to tram coal from face to dump coal onto face conveyor via a Feeder Breaker (the latter breaks coal to a nominal size);
- Mechanical Roof Bolter used for roof bolting;
- Load Haul and Dump (LHD) vehicle for stone dusting and bord floor cleaning.



COAL MINING METHODS TO CONSIDER

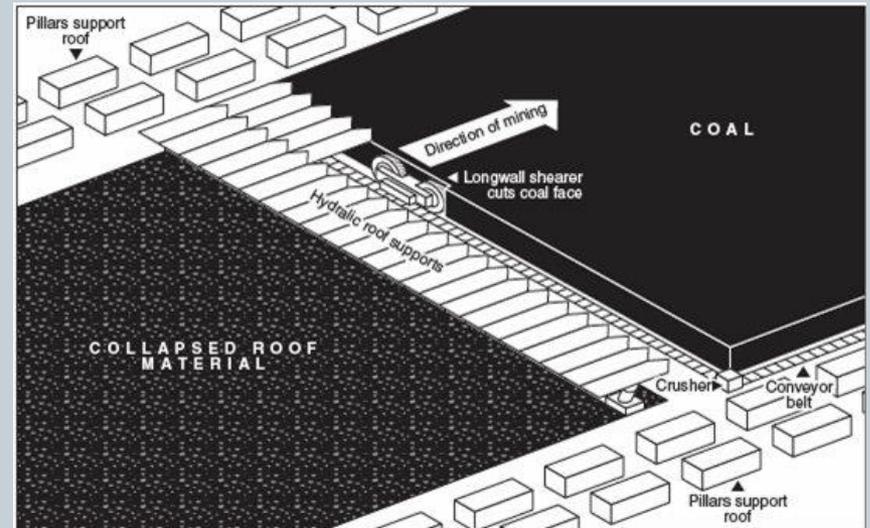


1.0 LONGWALL COAL MINING

LONGWALL MINING METHOD

LAYOUT

- Two roadways (i.e. **main gate** and **tail gate**) are developed which form the two sides of a longwall block.
- A third roadway also developed at right angle (100 to 300m long) with one rib forming the longwall face.



LONGWALL COAL MINING (con't)

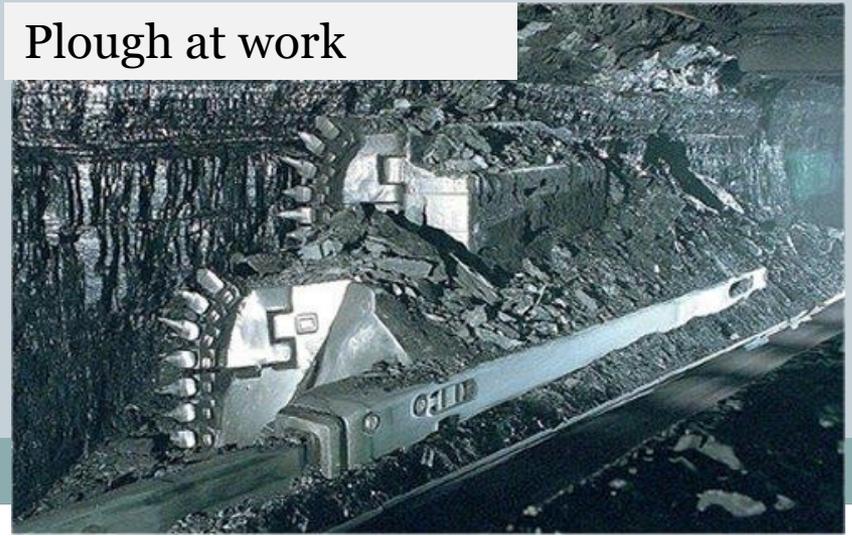
OPERATION

- Coal is mined in slices (web) of 0.6 -1.0m width using either a Shearer or Plough
- Coal loaded onto an armoured face conveyor (AFC).
- Hydraulic powered supports (jacks) moved across allowing roof of previously section to collapse – forming a goaf.
- Another web is mined and the process is repeated.

Shearer at work



Plough at work



ADVANTAGES OF LONG MINING



- The system can produce very significant outputs from a single longwall face – some 8 million tonnes per year;
- Higher extraction rates achieved (theoretically 100%)
- When operating safely the coal can be extracted in a systematic , continuous and repetitive fashion which is ideal for strata control as well as for associated mining operations;

COAL MINING TECHNOLOGIES TO CONSIDER



2.0 UNDERGROUND COAL GASIFICATION

CONCLUSION



- Zimbabwe has a huge coal resources base some of which are of good quality.
- Even those of mediocre quality could be upgraded by beneficiated (SA example), while some could be underground coal gasification technologies.
- The Supper PolLuter could remain a Super Fuel by use of CLEAN COAL TECHNOLOGIES; and
- ??????