

625-102 GEOLOGY



Lecture 29

Coal Resources

Melbourne Earth Sciences

What is Coal?

- Coal is a black, combustible sedimentary rock consisting chiefly of decomposed plant matter
- Most coals include easily visible plant material, such as wood and leaves
- The stored energy in coal was ultimately derived from the Sun through photosynthesis
- Coal occurs in strata, or seams, interbedded with other sediments, mostly sandstone and shale
- Coal is the most abundant of the fossil fuels

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Origin of Coal

- Coals accumulate in swamps mostly in low-lying coastal areas
- Plant material (wood, foliage, pollen, roots etc) partly decomposes and accumulates as peat
- Peat is a dark-coloured, unconsolidated mass of partly-decomposed plant remains
- Most coals form from plant material deposited in situ, ie where the plants grew (autochthonous)
- Some plant material, such as pollens etc, can be transported (allochthonous)

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Modern-day Coal Swamps

- Peat is forming in many localities today from the tropics to sub-arctic climates
- Examples of present-day coal swamps are:
 - The Everglades, Florida
 - Great Dismal Swamp, Virginia and Carolina
 - 2m thick layer of peat over 5,700 km²
 - Southern Kalimantan, Borneo



Resources

Conditions for coal accumulation

To accumulate a significant thickness of coal requires a combination of factors:

- Slowly subsiding basin: to allow thick accumulation under continuous shallow water
- Climate: need tropical to sub-tropical conditions to support luxuriant plant growth for major coals
- No clastic sediment: little or no influx of normal clastic sediment - normally true in swamps
- Reducing conditions: Stagnant or nearly stagnant water so that available oxygen is used up
 - > prevents oxidation of plant material

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Conversion of peat to coal

- Under stagnant conditions anaerobic bacteria partly decompose plant material
- Gradually increase carbon content by splitting off oxygen and hydrogen and releasing gases
- Bacteria themselves are eventually killed off by accumulating acid waste products
- Burial of coal by later sediments (sands and clays) increases pressure and temperature of the peat
- Burial drives off water, volatile gases (eg methane) and increase carbon content in residue

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Coal Rank

- With increasing pressure and temperature peat undergoes progressive changes:
 - to lignite (brown coal)
 - to sub-bituminous coal
 - to bituminous coal (black coal)
 - to anthracite

low rank
↓
high rank

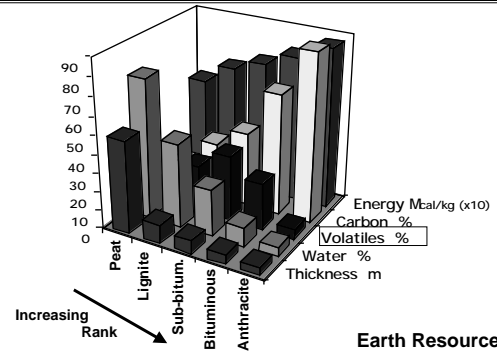
- These define the rank of a coal and are like low-grade metamorphic changes

- Increasing rank is accompanied by:
 - decreasing thickness
 - loss of water
 - reduction in volatiles
 - increasing carbon content

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Earth Resources

Coal Properties



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Constituents of Coal

- Coals of the same rank vary in appearance and properties
- Coals are made up of different proportions of microscopic organic components called Macerals
- Three Maceral groups are recognised:
 - Vitrinite: a shiny homogenous material derived from wood
 - Exinite: mostly hydrocarbons from waxes, resins, spores, pollens etc
 - Inertinite: dull black inert carbonaceous material from partly oxidized (burnt) wood

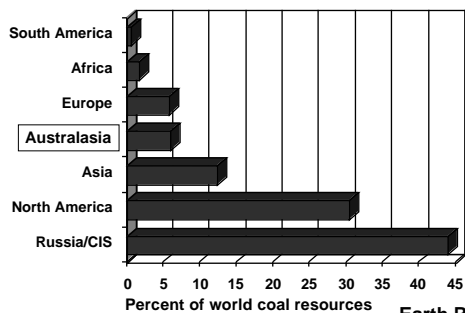
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Geographic distribution of coals

- Coals are abundant and widespread
- Found on all continents
- Largest deposits in Russia, USA, and China
- Other major deposits also found in Germany, Australia, UK and Canada
- Significant coal deposits even occur in Antarctica

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World distribution of coal



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Coal distribution in time

- No coals older than Silurian, when land plants first evolved, found in all periods since
- Greatest period of coal formation was during the Carboniferous and Permian:
 - Carboniferous - North America & Europe
 - Permian - Gondwana continents and China
- Another major period lasted from Jurassic to mid-Tertiary, peaking in the Cretaceous
- Both were periods of warm global climates and very high atmospheric CO₂ and high sea-level
- Late Palaeozoic was also a time of maximum continental assembly in Pangaea

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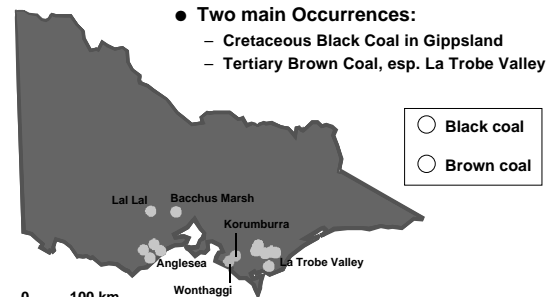
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Coal distribution in Australia

- Australia has large reserves of high quality coal
- Three groups:
 - Permian black coals (NSW, Qld, SA, WA)
 - Mesozoic black coals (Qld, SA, Vic, tas)
 - Tertiary brown coals (Vic)
- Coal is mined in Australia for export, power generation and steel making (coking coal)
- Most power generation in Australia is from coal-fired thermal power stations
- All mainland states generate electricity from coal fired power stations using local resources

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Coal in Victoria



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Victorian Black Coal

- Small deposits in Lower Cretaceous sediments of the Strzelecki Group
- Mainly in Wonthaggi - Korumburra area
- Mainly thin seams (<1m), formed in small discrete basins
- Heavily block faulted and discontinuous lenses in shale and sandstone sequence
- Coal has high moisture content but was worked for many years up until 1968 for steam railways
- Underground mining methods but no current mines operating

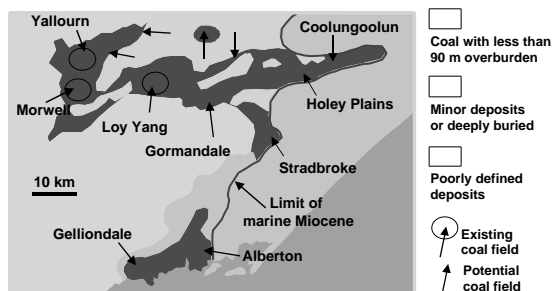
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Victorian Brown Coal

- Major Energy resource for Victoria
- Huge deposits of lignite with thin overburden
- Very low ash content (mainly clay) but high moisture
- Eocene to Miocene in age
- Largest deposits are in La Trobe Valley
- Other deposits at:
 - Bacchus Marsh, large but mainly under basalt
 - Lal Lal near Ballarat
 - Anglesea area
- Mines in La Trobe Valley, Bacchus Marsh, Anglesea
- All mined by surface open-cut methods

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La Trobe Valley coal deposits



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La Trobe Valley

- Geological conditions very favourable for exceptionally thick peat accumulation
- Slowly subsiding basin with high rainfall climate
- Luxuriant plant growth maintained for long time
- Very thin overburden in places due to later uplift
- Three main seams up to 160 m thick
- Merge in places, Loy Yang -> seam 230 m thick
- In places subsidence led to marine flooding in Miocene -> marine limestone intercalation
- Used for large scale power generation and briquetting (artificial rank upgrading)

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Permian Coals in Australia



- By far the largest coal resource in Australia and major export earner
- Mainly in the Permo-Triassic age Sydney and Bowen Basins
- Several thick seams in each case
- Largest up to 20 m thick and extensive
- High quality coals - excellent for steaming and coke making
- Much lower in sulphur (pyrite) than main Carboniferous coals of northern hemisph.
- Open cut and underground mining used

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References

- Skinner and Porter, Chapter 21, p 590 - 597
- Clark and Cook, Chapter 22a, p 545 - 548 & Chapter 22b, p 554 -557
- Hamblin Chapter 23, p 573 - 575

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