16TH NEWCASTLE SYMPOSIUM

Excursion Synopsis, 30th April 1982

Compiled by C.F.K. Diessel

Purpose of the excursion is to provide a suitable background to a number of papers which will be read during the sumposium. These papers deal with a variety of geological aspects of the Greta Coal Measures in the vicinity of the Muswellbrook Anticline and it seems that some delegates to the Symposium would welcome the opportunity to familiarise themselves in the field with the sequence. The venue for the excursion includes visits to Bayswater Colliery and to the trial cut of Drayton Coal Pty. Ltd.. These visits have been arranged with the support of the companies concerned for which the organisers of the 16th Newcastle symposium wish to express their gratitude. Special thanks are due to Mr. Geoffrey Sharrock of The Caltex Group of Companies in Australia, Mr. Collin Randle, Manager of Bayswater Colliery and Mr. Stewart Butel of Drayton Coal Pty. Ltd..

GEOLOGICAL SETTING OF THE AREA

The excursion site is located within the axial zone of the Muswellbrook Anticline (see Fig.1) where it begins to plunge to the south. The Muswellbrook Anticline is one of several folds which occupy the northeastern (Hunter Valley) portion of the Sydney Basin close to the Hunter-Mooki Thrust System. During the Hunter Bowen Orogeny the latter formed as a series of border thrusts along which the New England Fold Belt was uplifted and partly pushed over its fore-deep remnants of which occur within the Sydney, Gunnedah and Bowen Basins.

The rocks studied during the excursion belong to the Greta Coal Measures which constitute a clastic wedge association emplaced during Mid-Permian time as part of the molasse fill of the Hunter Valley portion of the fore-deep. The Greta Coal Measures form the lowest stratigraphic unit exposed in the core of the Muswellbrook Anticline. Their outcrop area is surrounded by younger strata, in particular, the conspicuous marine tillites of the Branxton Formation. In the Upper Hunter Valley the Greta Coal Measures differ from their counterparts in the Lower Hunter Valley by the absence of thick interseam conglomerates and by the addition of a barren sequence below the coal bearing strata.

THE STRATIGRAPHY AND LITHOLOGY OF THE EXCURSION AREA (FIG.2)

In the Muswellbrook district the Greta Coal Measures are divided into two formations. The lower one, the Skeletar Formation is devoid of coal but consists of up to 150m of volcanic and volcaniclastic rocks which in the upper portion are extensively kaolinitised like the flint clays of LOUGHNAN (1973). Frequently they exhibit a pelletoidal texture with pellet sizes ranging from granule to fine arenaceous. Upward fining graded bedding is common and parallel alignment and imbrication fabric suggest that the volcaniclastic precursars of the clay pellets were not simply explosive ejecta but were subjected to some redistribution before burial.

At its base the Skeletar Formation grades into the Gyarran Volcanics whereas its upper boundary is given by the Balmoral Coal Member of the Rowan Formation although in the basal part of the latter pelletoidal clayrocks typical of the Skeletar Formation are still well developed (TOBIN, 1980).

The Rowan Formation is the coal bearing sequence of the Muswellbrook Coal Measures (Fig.2). In its type section in Balmoral DDH 7, stored at the Joint Coal Board Core Store in Cessnock, the formation is 111.6m thick but thicker sections have been encountered in areas where the sequence has been expanded by igneous intrusion (TOBIN, 1980). The Rowan Formation contains a number of coal seams of which the following (from bottom to top) have formal MEMBER status: Balmoral, Puxtrees, Grasstrees, Brougham and Hilltop. All seams are subjected to extensive splitting which presents difficulties in seam correlation and has caused the creation of additional informal names for both coal seams and interseam sediments. Examples are the Thiess seam which appears to be a split off the Puxtrees Coal Member, and a number of sandstones, such as the Brougham and Hilltop sandstones occurring between the Hilltop and Brougham and Brougham and Puxtrees Coal Members, respectively. The only formally named interseam sediment is the Ayrdale Sandstone which is situated above the Balmoral Coal Member and is between 5 and 25m thick over much of the coalfield. It exhibits a number of interesting sedimentary structures some of which are illustrated in Fig.3.

DESCRIPTION OF THE EXCURSION ROUTE

1. BAYSWATER NO.2 OPEN CUT MINE

From the assembly point at the car park of Bayswater Colliery the party will be taken into the open cut where a large section of the Rowan Formation is exposed. The following description of the mine has been prepared by Mr. Geoffrey Sharrock of Caltex Australia, supplemented by some extracts from the Company brochure:-

The Bayswater No.2 Open Cut Mine is based on a medium size deposit of steaming (60%) and low-volatile (40%) coal. Current production is around 750,000 TPA with expansion planned to raise output to 1.6 MTPA by the end of 1982. The mine is located 10 kilometres south of Muswellbrook with access being gained off the New England Highway via the Greta Road.

Bayswater Colliery Company, formed by Messrs Goodsir and Cooper formerly earth moving contractors and contract miners, commenced production at the present mine in 1968. Previous exploration consisted mostly of Joint Coal Board scout drilling (1952 - 1954) and Electricity Commission drilling in the mid 1960's where the commission was searching for coal to power the new Liddell power facility. Production in 1968 was 88,000 tonnes with 13 people employed at the mine.

Extensive drilling by the company in the period 1975 - 1978 was aimed at providing a basis for mine planning purposes. After the sale of Bayswater in 1981 to a consortium headed by Caltex Oil (Australia) Pty. Limited further drilling was undertaken with detailed analytical backup within the Colliery holding and surrounding Authorisation 171 area.

GEOLOGY

6 main economic members are recognised in the Rowan Formation. Seam splitting is a notable characteristic with up to 21 individual coal horizons recognised.

Hilltop	Generally thin 0.5 - 1.0m net coal.
Brougham	20 - 25m below Hilltop, thickness is variable but generally 0.8 - 3.5 net coal with 2 well defined splits. Underlain by 5 - 10m of med-coarse sandstone.
Grasstrees	Net coal thickness 0.5 - 3.5m with 3 and sometimes 5 coal splits. Underlain by 2 - 10 metres of fine-coarse sandstone and minor shale.

Upper Puxtrees	Elsewhere referred to as Thiess but recognised locally as being a split off main Puxtrees member. Net coal thickness; 2.4 - 3.2m. Underlain by 3.5 - 10m of siltstone and sandstone.
Puxtrees	Thickness is highly variable as this seam is usually affected by igneous intrusions up to 6m thick plus 3m of coal or cinder. The seam generally consists of 2 splits separated by igneous material, usually dolerite. Underlain by 20 - 30m of massive fine - medium grained sandstone; the Ayrdale Sandstone.
Balmoral	Commonly split into 5 horizons with net coal thickness5 - 14 metres.

The Puxtrees and Balmoral Coal Members have been the only seams effectively mined in the past at Bayswater and it is the the thick Balmoral Coal Member which has made the mine economic. In the future mining to the north and west of the current open cut will include significant tonnages from the upper seams.

MINING

Mining of the Bayswater Colliery coal seams is by a conventional shovel and truck method with extensive use of front-end loaders. Bench height is determined by the type of loading machine in use and the bench width by the turning radius of the trucks and haul road layout. The position of the top of the dumping area is determined by the angle of repose of the loose overburden material and the swell factor of the overburden (this is the extra space occupied by the loose dumped material compared with its volume when it was in place in the ground prior to blasting and loading - at Bayswater this "swell" value is about 30%). From the above factors it can be concluded that as the mine gets deeper it also gets bigger.

The first stage in the mining operation is the removal of topsoil. Scraper type machines are used to transport the topsoil either to storage areas or to prepared overburden dumps. The scraper machine is very economic in removing overburden as it loads, transports and dumps the material in a single vehicle. Material too hard for scraping has to be drilled, blasted, loaded, transported and spread by specialised units which is much more costly. For this reason the scraper is aided by a pushing bulldozer which enable it to load much harder material than it could do on its own.

Once the softer materials have been removed, a large, electrically powered blasthole bores drills a series of 28cm diameter holes, approximately 8m apart. The holes are drilled through the overburden or waste rock to a suitable working level (often the top of a coal seam). The holes are filled with an explosive mixture (usually ammonium nitrate and fuel oil), and as much as 70 tonnes of such explosive can be detonated at one time to fragment up to 150,000 cubic meters of overburden weighing over 360,000 tonnes. All overburden is broken in this way to enable the loading machines to load the trucks.

Two different types of machine are used to load the waste rock. In places where the burden between seams is not too thick diesel powered, rubber tyred front-end loaders (F.E.L.) are used. These have a 12 cubic yard bucket and their rubber tyres enable them to move about quickly and "chase" the material to be loaded. The other machine used is the much bigger, electrically powered mining shovel. This machine costs six times as much as a front-end loader, but has a 22 or 33 cubic yard bucket which can be loaded, swung into position, discharged into a truck and returned to the dig position in about 30 seconds, giving it a loading rate of 60 to 90 tonnes per minute (the front-end loader rate is less than 25 tonnes per minute). It is a huge machine weighing up to 900 tonnes and moves on large crawler tracks. Because it is on tracks it only moves slowly and while it is moving it is not loading trucks. For this reason it is used to work overburden benches of 13 - 16m in height as this minimises the amount of time spent "chasing" the material. It is not practical to work benches above this height with a shovel because of the chance of large lumps falling onto the machine.

Once the overburden has been removed the coal drill can move in and drill the holes in the coal necessary to enable fragmentation of the coal prior to loading. Coal is loaded by front-end loader because the seams are relatively thin, 0.5 to 2m, say. The Balmoral Coal is much thicker, up to 13m, but this is also loaded by front-end loaders as it is normally worked as a series of smaller benches to enable quality control (quality of the coal varies in fairly distinct bands in the Balmoral Coal).

Coal is currently transported in small (35 tonne coal capacity) rear dump trucks to the processing area. The overburden is transported by 85 ton trucks (loaded by F.E.L.s) and 170 ton diesel electric trucks (loading by mining shovels). The 170 ton capacity overburden truck is equipped with a diesel-generator set of 1600 H.P. which powers a separate electric motor in each rear wheel.

The overburden is carried to the dumping grounds, normally in the mined out areas, where is it unloaded. Bulldozers shape the surface and eventually the scrapers cover the completed dump areas with clay and topsoil prior to revegetation.

A large range of ancillary equipment is needed to support the mining operations. Water carts minimise the dust pollution and consolidate road surfaces, graders maintain roads and do some landscaping, and bulldozers help build new haul roads, do landscaping and can be used to rip (break) materials too hard for digging but too thin for efficient drilling and blasting.

All this machinery and the people to operate it require a large support facility. Workshops and stores, service bays, cranes and mobile service vehicles help to keep the equipment running and minimise breakdown times.

Car parks and showering facilities must be provided for the operators, and office accommodation for the staff who manage the whole operation on a 24-hour, five day per week basis.

An electrical distribution system must be maintained to power the shovels and blast hole drills as well as the workshops and coal washing plant. Coal from the washery mut be taken to stockpile areas (where it is sampled to ensure correct quality) and subsequently reloaded into highway vehicles for transport to Bayswater's rail siding. A water retriculation system must also be provided for filling water carts, supplying shower buildings and drinking fountains, and for fire fighting purposes as well as for the washery which uses large amounts of water to process the coal. Currently the water usage system is a closed circuit one.

COAL PREPARATION

The coal arrives from the open-cut in 35 tonne loads and is dumped into receival hoppers. Some of the coal at Bayswater is of such good quality that it is suitable for sale without the need for coal washing. Such coal is placed over a screen which allows coal of small enough size to proceed directly to a product bin, and oversize coal to be crushed before entering the bin. Another screen in the circuit prevents any oversize reaching the finished product bin if, for example, the crusher is incorrectly adjusted or a hole appears in the screen.

Unfortunately, some coal seams contain small dirt bands which cannot be economically removed, some have an "inherent" dirt content, and sometimes overburden contaminates the coal being mined. In all such cases the coal is delivered to the coal washing plant.

Each batch of washed coal is placed on the stockpile area separately and sampled. From the results of the analysis, the coal can be dispatched by road to the appropriate stockpile at Newdell siding. At Newdell the four qualities of coal produced are stockpiled separately for subsequent loading into rail wagons for transport to Newcastle port. The coal is also resampled at the port to check its quality against that specified in the selling contract.

Bayswater unwashed coal is transported direct to Newdell to avoid double handling but it is sampled at Newdell before being allocated to a customer stockpile.

RESERVES

Reserves have been calculated on the basis of a 10:1 overburden to coal ratio cut off and 0.3m minimum mineable coal thickness. The average mining ratio while operating to a 10:1 maximum is only 5.7:1. Measured Reserves for the Colliery Holding and A171 are 22.8 MT with indicated reserves of 35.5 MT, a total of 58.3 MT. An estimated 10 - 15 further drill holes are needed to raise all reserves to a measured status. No reserves in the potential underground area west of the 10:1 mining ratio line have been calculated.

COAL QUALITY AND CINDERED COAL AREAS

Approximately 40% of the Colliery Holdings and A171 resources is of a cindered nature. The coal quality parameters most affected are ash, 15-30%, volatile matter 3-10%, and Hardgrove Grindability Index, down to 25. Caltex is currently engaged in securing sales contracts for this coal and it is envisaged the product will be marked as an "anthracitic" briquetting product to Japan, Korea and elsewhere.

The majority of the coal resource at Bayswater is a low to medium ash, high specific energy, medium sulphur steaming coal.

ENVIRONMENT

In the past the rehabilitation of the mined out areas was carried out under advice from the Soil Conservation Service of the State Government, but with the advent of the latest Environment and Planning Act, stricter guidelines have to be followed. For this reason the E.I.S. will commit the company to the improved environment protection measures currently available.

Comments with regard to the likely effects on the environment of Bayswater's existing and future operations are as follows:-

Water:- Water usage should remain in a closed cycle, no water is imported to the site (except for drinking and showering), nor any water discharged from the site.

Noise:- No nuisance effect at present nor expected in the future. All new machinery is fitted with the latest sound suppression equipment. Initial

Noise (Contd.):-	investigations at the site indicate the mining, transport and blasting operations cause no problems of environmental noise or vibration levels, and the levels experienced are well within the local and state government criteria for such operations.
Dust:-	Dust pollution is not a problem at present, and all new equipment and systems will have improved dust control devices. The new stockpile system will have its own dust suppression equipment and all conveyors will be covered.
Landscaping:-	Detailed studies on the function of the existing landforms is in progress with a view to landscaping the rehabilitated areas to blend both visually and functionally with the existing landforms.
Visual Impact:-	The visual impact of the mining operations is expected to be decreased because of the improved screening of existing operations.
Social Impact:-	The expansion of Bayswater's operations to 1,600,000 tonnes of coal per annum is expected to have little social impact. The new employees will come from the well established local towns of Muswellbrook, Singleton and Cessnock, and the Hunter Valley area.

EXPANSION

At present the mine is undergoing a large expansion programme aimed at doubling coal production to 1,600,000 tonnes per year by mid-1982. In general, the plan involves the use of larger loading machines and larger trucks to perform the mining operations, replacement of the bulldozer fleet, introduction of large rubber tyred bulldozers, the enlargement and improvement of all the support facilities, and the introduction of more efficient mining practices and management control schemes. The expansion plan will involve the spending of more than A$25,000,000, $17,000,000 of which will be on new mining equipment. In addition to this, up to $14,000,000 may be spent on improved coal transport arrangements which will involve the building of new automatic stockpiling facilities, a rail balloon loop and a train loading facility adjacent to the existing colliery coal leases.

2. THE DRAYTON COAL PTY. LTD. MINE TRIAL EXCAVATION

After the inspection of Bayswater No.2 Open Cut the excursion will proceed to the trial excavation of Drayton Coal Pty. Ltd.. The following notes have been supplied by Mr. Stewart Butel:

GEOLOGY OF THE TRIAL EXCAVATION (FIG.4, 5 AND 6)

A trial pit involving the excavation of some 200,000m of overburdent was completed in late 1978. It is located on the eastern side of the Muswellbrook anticline in the middle of the East Pit Mine Area. Bulk samples for detailed analysis were taken of the Thiess Puxtrees and Balmoral Seams.

The trial excavation runs approximately east-west deepening toward the western end and currently bottoms on the roof of the B3 Split of the Balmoral Coal Member. The average dip is 14^{o} to the east and flattens slightly where coal seams have weathered and compacted.

Jointing occurs in the Ayrdale Sandstone with frequencies of one to two per metre in minor sets, and one joint per five metres in major joint sets. These joints are fairly steeply dipping, ranging from 55^{o} to 84^{o} with a mean of approximately 75^{o}. The major set of joints is sub-parallel to the faulting while the minor set has a bearing of approximately north-west.

The axis of the eastern flexure of the Muswellbrook Anticline traverses the western end of the trial excavation, trending approximately north-north-east. In this region of the excavation the structure is complex. Two sub-parallel normal faults, each downthrown approximately 5 metres to the west and striking slightly east of the anticline axis, are the main structural features. Subsidiary small faults and breccia zones (with varying attitudes) are numerous between these two features. The overall effect of the faulting is a total downthrow to the west of approximately 10 metres.

On the eastern limb of the anticline, the upthrown side of the fault, the Puxtrees Seam (P2 Split), dips at approximately 14^{o} to the east from its outcrop. In the crest and on the western limb of the fold (the downthrown side of the faulting) the Puxtrees Seam (P2 Split) is sub-horizontal lying approximately two metres beneath the surface and dipping gently into the western end of the trial excavation. Igneous activity in the trial excavation is confined to the western end and occurs at the Puxtrees Seam horizon where the intruding igneous material has cindered the coal.

DRAYTON COAL MINE

Drayton Mine is based on a large deposit of steaming coal located in the Upper Hunter Valley of New South Wales. Markets have been secured and development is proceeding for the production of 3.2 million tonnes per annum in 1985.

LOCATION: The Drayton mine is to be located 12 kilometres south of the town of Muswellbrook in the Upper Hunter Valley of N.S.W. The land is mostly hilly infertile native pasture.

HISTORY AND OWNERSHIP: Thiess Bros Pty. Ltd. started investigation in the Drayton area in 1951 and gained knowledge of coal reserves and quality from a series of exploration programmes over later years.

In 1977 a co-venture between Thiess Bros Pty. Ltd. and Shell Company of Australia was formed to undertake further exploration and to develop the mine. Detailed feasibility studies were completed and a comprehensive environmental impact statement was submitted for public display in 1980. Agreements for admission of additional co-venturers are being finalised, following which ownership of Drayton will be:

C.S.R. Limited	44%
Shell Company of Australia Ltd.	39%
Australian Mutual Provident Society	7%
Mitsui Mining Australia Pty. Ltd.	3%
Mitsui Coal Development (Australia) Pty. Ltd.	2%
Hyundai Australia Pty. Ltd.	2.5%
Daesung Australia Pty. Ltd.	2.5%

Drayton Coal Pty. Ltd. (100% C.S.R.) is responsible for management of the project.

Approvals have been obtained from the Department of Environment and Planning and the State Pollution Control Commission to start construction. Development consent has been obtained from the Muswellbrook Shire Council and Drayton has purchased land within the lease area.

RESERVES: The present authorisation area of approximately 3200 ha, contains measured and indicated reserves totalling 438 million tonnes (167 measured, 271 indicated). Within the lease area (1652 ha included in the authorisation area) there are 114 million tonnes of steaming coal recoverable by open-cut methods.

MINING AND TRANSPORT: The coal measures contain five main seam horizons which will be worked using open-cut mining methods to depths of over 120 metres over a 20 year mine life. A proportion of the delineated reserves could be developed by underground methods at a later stage, subject to a separate set of lease conditions and the preparation of a further environmental impact statement.

In the open-cut mining program two adjacent pit areas will be developed using trucks, shovels and a large dragline to remove overburden material. The exposed coal will be mined by hydraulic excavators and loaders then trucked to the handling plant where it will be crushed, sized and stockpiled ready for blending. Due to the low ash content it is not planned to install a coal washery.

From the stockpile, a conveyor will feed the coal to the mine site rail loading station for transport to the port of Newcastle. A new rail spur, which will also serve other producers in the area, will link the Main Northern Railway at Antiene to the Drayton mine. The spur line will be built by the State Electricity Commission and the Drayton Co-venture.

Production is scheduled to commence at a rate of 1.8 million tonnes in 1983 rising to full capacity of 3.2 mtpa in 1985.

COAL QUALITY AND MARKETS: The coal at Drayton is high quality steaming coal, suitable for marketing internationally, in an unwashed state, as a low ash, high specific energy and medium sulphur product. Unwashed coal will be blended by the handling plant to produce two specifications.

Sales arrangements have been finalised with the Korean Electric Co. Other customers include Mitsui Mining, Shell Co. of Australia, Hokkaido Electric Power Co., Kyushu Electric Power Co., Toyo Soda and Shikoku Electric Power Co.

At Newcastle, the Port Waratah coal loading facilities are presently being expanded. Total port capacity will reach 25 mtpa in 1982. When harbour dredging is completed, PWCS will handle 110,000 DWT ships in a dual berth facility. A third coal loader, to be constructed on Kooragang Island, may also handle Drayton coal from about 1985.

EMPLOYMENT: The mine will employ about 250 people during construction and about 400 when operating at full capacity. Recruitment from the local area will be encouraged and employee training will form an integral part of mine operations.

Drayton proposes to build to an apprenticeship level of about one third the number of tradesmen employed. Women will be encouraged to take up trade apprenticeships and other employment at the mine.

The shortage of land and housing in the Muswellbrook region is well understood. As a first step, 36 blocks of land have been purchased, and a further 85 are being obtained with the intention of using these areas as a basis for the promotion of individual home ownership. Drayton is building a number of houses which will be available for rental while new members of the workforce establish their own homes. The construction workforce will be accommodated on the outskirts of Muswellbrook in a hostel, the first stage of which has been established.

The Drayton mine will indirectly create and sustain employment in other sectors of the economy such as service industries, manufacturing, transport and commerce. It is estimated that for every ten jobs at the mine, four other jobs will be created in the Muswellbrook region.

ENVIRONMENT: Drayton has several environmental factors in its favour and mine site environmental impact will be relatively small.

- The mine will be unobtrusive, and only distant glimpses will be seen from the New England Highway or other public areas.
- Coal transport outside the site will be by rail.
- Apart from a small amount of drinking water the mine will not draw on the Hunter River. Site water requirements are low as the coal does not require washing, and a local dam and bore water will satisfy these. Run-off water will be ponded and will not discharge off-site except in periods of heavy rain.
- Rehabilitation has been planned as an integral part of mining and its cost has been treated and budgeted for, as a production cost. The disturbed surface will be rehabilitated after mining for grazing purposes using native trees and shrubs in consultation with the Soil Conservation Service of N.S.W.
- Preventive measures will be followed to minimise dust and noise levels.

3. THE PIMPLE

Time permitting a brief stop will be made at The Pimple close to Bayswater No.2 Open Cut. A now abandoned quarry marks the site of a small halloysite deposit first described by LOUGHNAN and CRAIG (1960).

The halloysite which occurs near the top of the Skeletar Formation apparently originated from the rehydration of kaolinite which was subjected to heating by the underground combustion of coal.

REFERENCES:

LOUGHNAN, F.C., 1973: Kaolinite clayrocks of the Koogah Formation, N.S.W., Jour. Geol. Soc. Aust., 20, pp.329-341.

LOUGHNAN, F.C. and CRAIG, D.C., 1960: An occurence of fully hydrated halloysite at Muswellbrook, N.S.W., Am. Min., 45, pp.783-790.

TOBIN, C., 1980: The Geology of the Balmoral Area. Unpubl. Honours Thesis, The University of Newcastle.

Fig. 1.

Geological Map of the Excursion Area.
Modified from 1:500,000 Geological Sheet of the Sydney Basin.
For legend refer to that sheet.

STRATIGRAPHY OF THE EXCURSION AREA

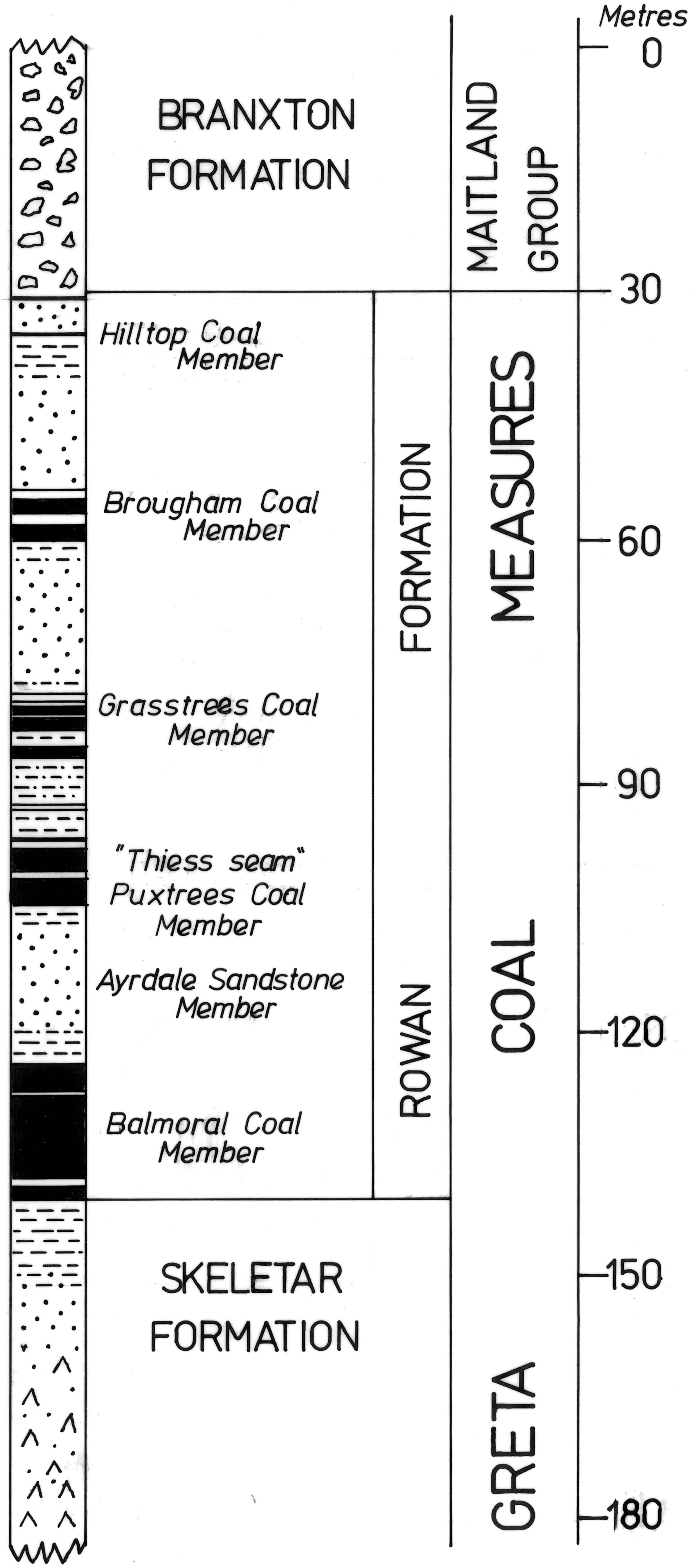
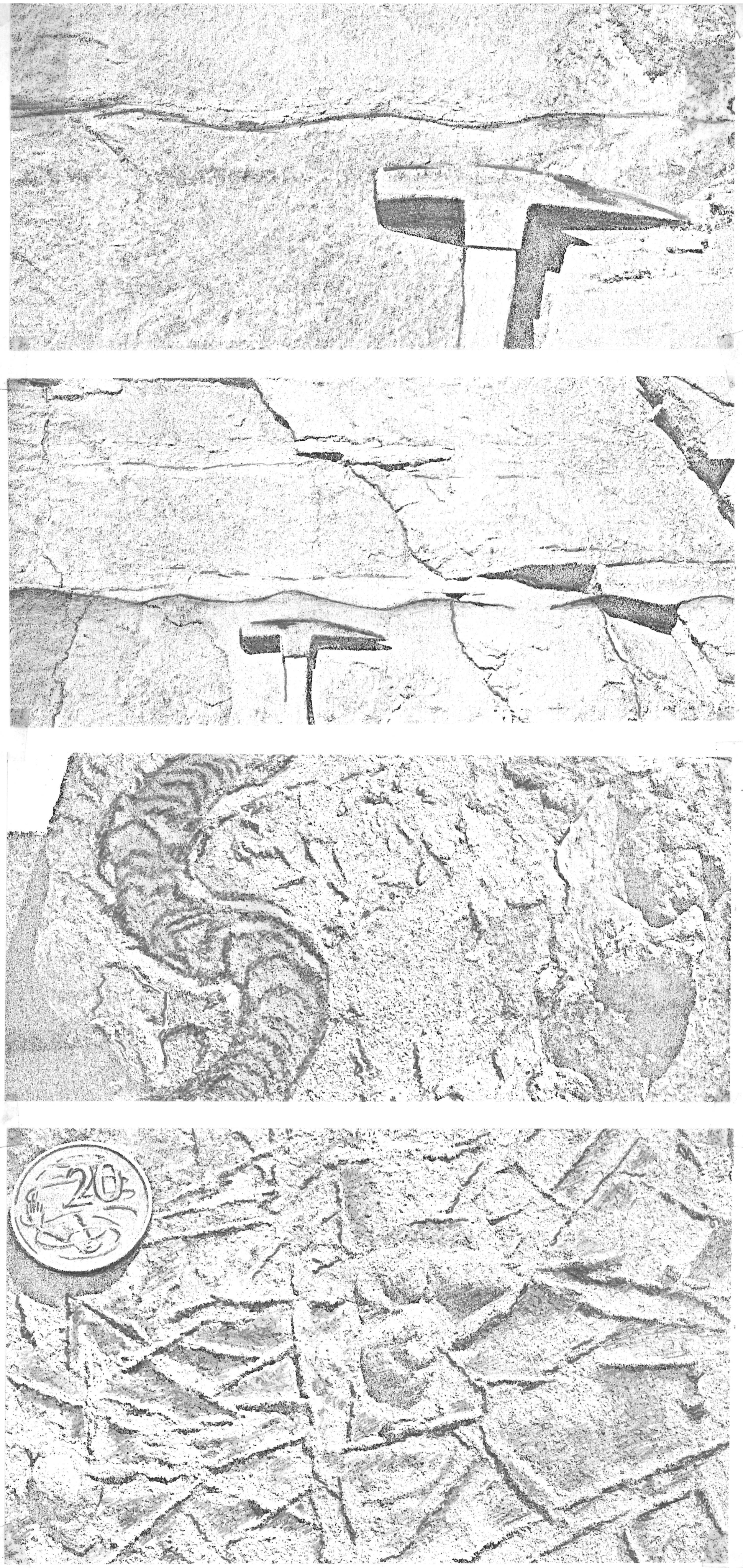


Fig. 2.



A

B

C

D

Fig.3. Examples of some sedimentary structures in Ayrdale Sandstone. A = Symmetrical ripple marks; B = Asymmetrical ripple marks; C = Horizontal feeding trace (12cm long); D = Casts of ice crystalls. Photographs by TOBIN (1980)

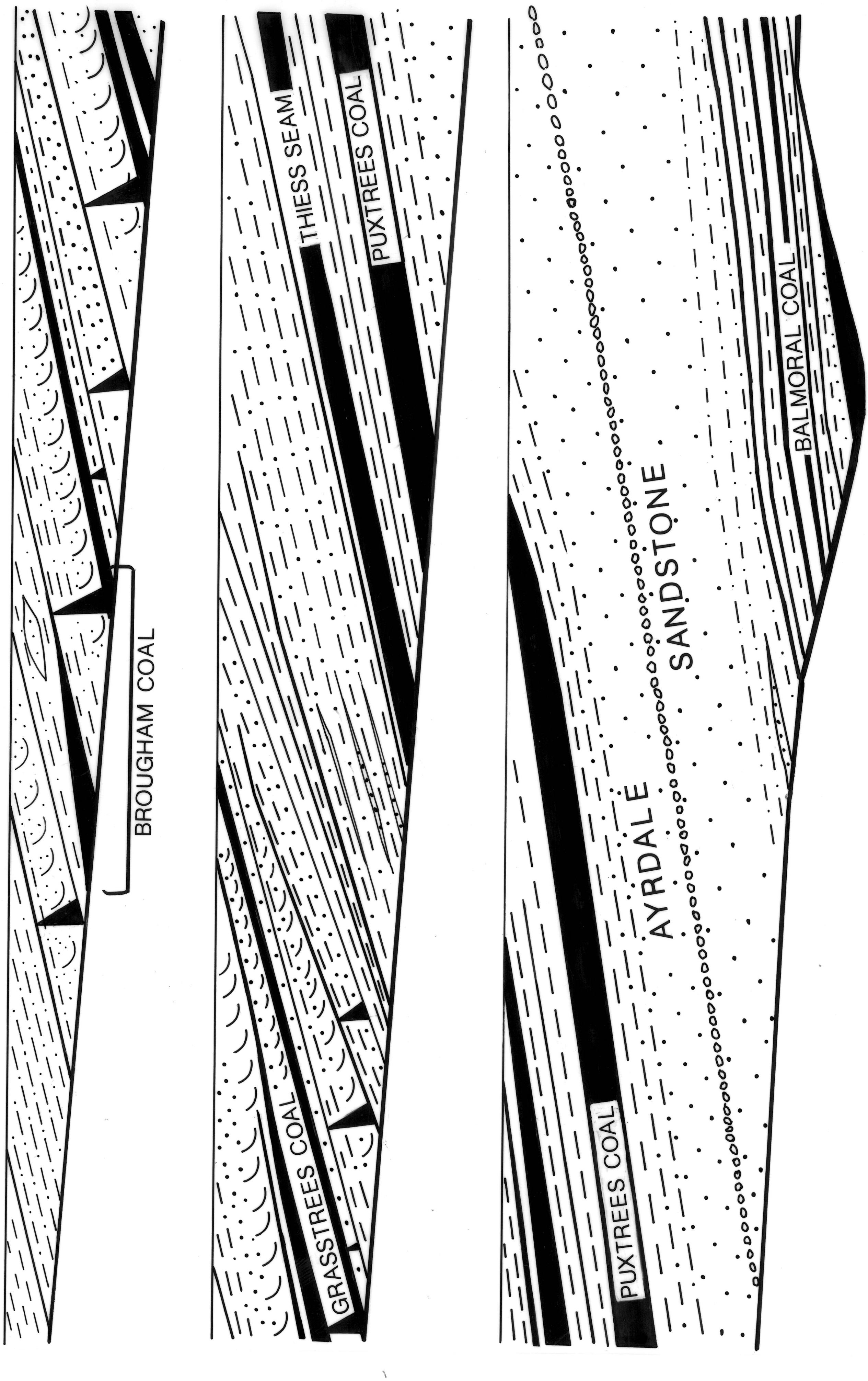


Fig.4 Section through the Thiess Trial Cut. Symbols conform to petrographic standards. Scale = 1:400.

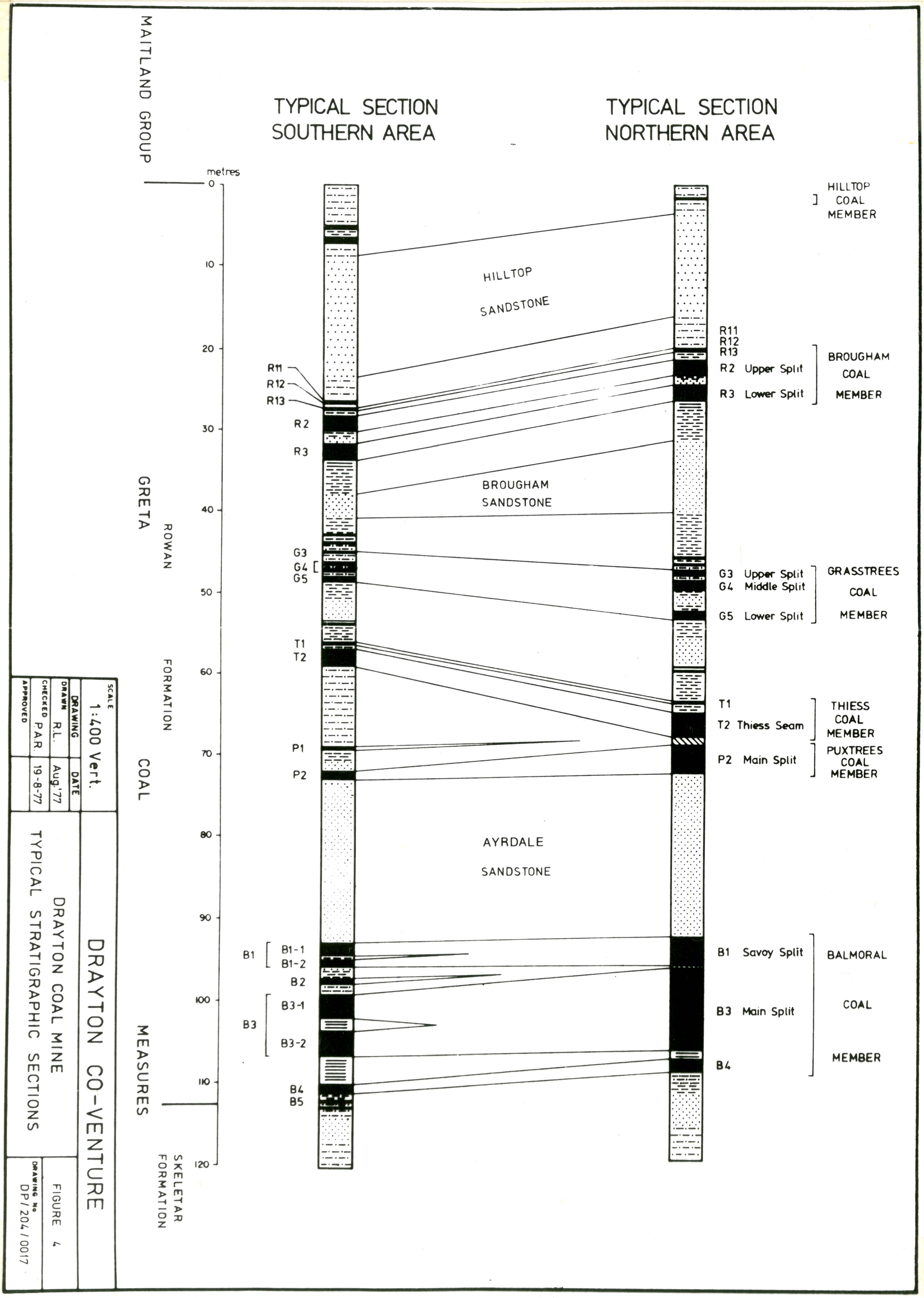


Fig.5 Stratigraphic section showing seam splitting in the Drayton area.

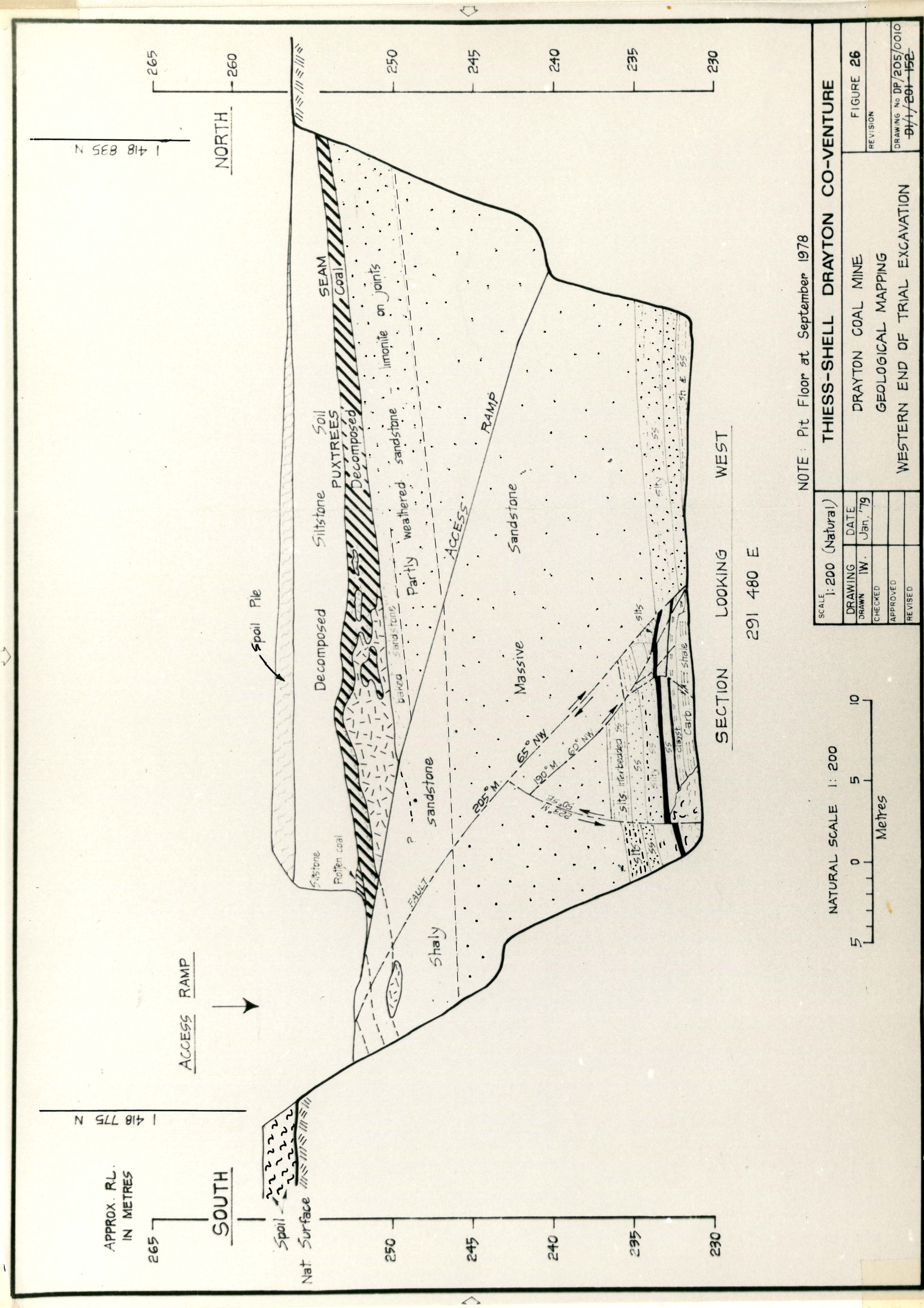


Fig.6 Geological profile of the western end of Drayton's trial cut.